A school-based behaviour change intervention to increase physical activity levels among Chinese children: intervention development and cluster non-randomised controlled feasibility trial

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Abstract

Children in China have low levels of physical activity. The aim of this thesis was to develop a school-based behaviour change intervention to increase physical activity levels among Chinese children and to determine the feasibility of undertaking the definitive cluster randomised controlled trial (RCT) in China. In order to achieve this aim, four inter-related studies were conducted:

First, a qualitative systematic review (study 1) synthesised barriers and facilitators to physical activity among ethnic Chinese children. These findings highlighted the challenges faced by Chinese children in their physical activity participation as well as the factors that could facilitate their participation in physical activities. From studies conducted in the Chinese territories, four synthesised findings (personal, socio-cultural, environmental, and policy- and programme-related barriers and facilitators) were aggregated from 37 extracted findings and 14 aggregated categories. From studies conducted in the non-Chinese territories, only two synthesised findings (personal and socio-cultural barriers and facilitators) were derived from 19 extracted findings and seven aggregated categories.

Second, the synthesised barriers and facilitators (from study 1) were used for behavioural analysis to systematically develop an intervention for improving Chinese children's physical activity participation, using the Behaviour Change Wheel (BCW) and Theoretical Domains Framework

(TDF) (study 2). This systematic process identified 10 relevant TDF domains to encourage engagement in physical activity among Chinese children: knowledge, memory, attention and decision processes, social influences, environmental context and resources, beliefs about capabilities, beliefs about consequences, social/professional role and identity, emotions, and physical skills. It resulted in the selection of seven intervention functions (education, persuasion, environmental restricting, modelling, enablement, training, and incentivisation) and 21 behaviour change techniques in the intervention, delivered over a period of 16 weeks.

Third, this thesis aimed to determine the feasibility of undertaking a cluster RCT in China (study 3). Specifically, a cluster non-RCT design was used, and the trial was conducted in two public schools (one intervention and one control) in Yangzhou, China. Participants in one school received the intervention i.e., a 16-week behaviour change intervention. Participants in the other school continued with usual physical activities. Eventually, sixty-four children and their parents participated in the study (32 per study group). The standard deviation of the primary outcome (i.e., seven-day steps) was 34519 steps. The intraclass correlation coefficient was 0.03. The recruitment and follow-up rates were 100%. The completion of data collection was 100% (except for the seven-day steps at baseline—one child lost the step log in the intervention group and two children lost their pedometer in the control group). The time needed to complete the self-

reported questionnaire by children was around 15 min per study group, and the measurement of their anthropometric parameters took around 40 min per study group. The intervention attendance was 100%.

Fourth, a qualitative process evaluation was conducted to 1) explore the experiences and perceptions of participants and providers in the intervention and trial, and 2) generate recommendations to inform a future intervention and full-scale cluster RCT (study 4). Findings believed to reflect experience and perceptions of participants in the intervention and the trial are presented as eight major themes: 1) perceived high efficacy of the intervention components to help children become more active, 2) appreciation of the intervention features, 3) factors that facilitated or impeded intervention attendance and delivery, 4) positive experiences and feelings gained through data collection process, 5) satisfaction regarding the organisation and implementation of the trial, 6) influences of personal beliefs and emotional responses to the trial, 7) social influences on participatory decision-making, and 8) key barriers to consider regarding the recruitment of participants. These findings indicated that the intervention and trial methods were acceptable to children, parents, and education providers. School-based behaviour change intervention was perceived to be a useful approach to increase physical activity in children aged 10-12 years in China. However, there were barriers to intervention delivery and

engagement that should be considered when designing a future cluster RCT to assess the intervention efficacy.

Researchers' contribution

The research work was designed by the researcher under the guidance and oversight of two supervisors: Dr. Kaushik Chattopadhyay and Dr. Holly Blake. The researcher was responsible for developing the protocols, acquiring the ethical approval, conducting the studies, data collection, analysis, interpretation and the write-up of the current thesis and all published papers. Help was received from Dr. Subhashisa Swain and Jihao Luo as second reviewers in conducting the systematic review (chapter two) for article screening, selection, quality appraisal, data extraction and data synthesis. A group of experts assisted with the behaviour change diagnosis, Theoretical Domains Framework mapping, selection of behaviour change techniques, and review on the intervention materials (chapter three). They are Dr. Anna Roberts, Dr. Helen Quirk, Dr. Benjamin Gardner, Dr. Kelly Bowden Davies, Dr. Mark Hammer, Jingsong Yang and Xiaoping Dai. Additionally, a total of 18 lay people were members of patient and public involvement and engagement, and piloting who contributed to the development of the intervention by providing feedback and comments on the intervention materials (chapter three). Bian, Zhou, Wei and Li from Yangzhou helped me recruit and contact the schools for the feasibility study. Dr. Andrea Venn from School of Medicine provided the statistical advice for doing quantitative analysis in chapter four. Yanxing Zhou from

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List of abbreviations

Abbreviation	Acronym
Auto M	Automatic motivation
APEASE	Affordable, practical, (cost-)effective, acceptable, safe, and equitable
B Cap	Beliefs about capabilities
B Con	Beliefs about consequences
BCT	Behaviour change technique
BCW	Behaviour Change Wheel
BMI	Body mass index
CLASS	Children's leisure activities study survey
CI	Confidence interval
CNKI	China National Knowledge Infrastructure
COM-B	Capability Opportunity Motivation Behaviour
CONSORT	Consolidated Standards of Reporting Trials
Ed	Education
Em	Emotions
Ena	Enablement
Env	Environmental context and resources
Env r	Environmental restricting
HPE	Health and physical education
ICC	Intraclass correlation coefficient
Id	Social/professional role and identity
Inc	Incentivisation
IQR	Interquartile range

JBI	Joanna Briggs Institute
Kn	Knowledge
MAD	Memory, attention and decision processes
MET	Metabolic equivalent of task
Mod	Modelling
MRC	Medical Research Council
MVPA	Moderate-to-vigorous physical activity
PA	Physical activity
PE	Physical education
Pers	Persuasion
Phys O	Physical opportunity
PPIE	Patient and public involvement and engagement
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International Prospective Register of Systematic Reviews
Psy C	Psychological capability
RCT	Randomised controlled trial
Ref M	Reflective motivation
SES	Socio-economic status
SD	Standard deviation
Sk	Physical skills
SI	Social influences
Soc O	Social opportunity

SUMARI	System for the Unified Management, Assessment and Review of Information
TDF	Theoretical Domains Framework
TIDieR	The Template for Intervention Description and Replication
Tra	Training
UK	United Kingdom
US	United States
WHO	World Health Organization

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Chapter one

Introduction

1.1 Physical activity and health

Physical activity is defined as the movement of the body produced by the skeletal muscles resulting in energy expenditure.[1] It could be broadly categorised into two: acute physical activity (i.e., a single bout of activity) and chronic physical activity (i.e., a repetition of bouts of activity over time).[2] In this thesis, chronic physical activity is the focus and the term "physical activity" encompasses a broad range of chronic physical activities with more specific terms such as “exercise”, “sport” and “physical education”. Physical inactivity increases the risk of many adverse health conditions including the world’s major diseases (e.g., type 2 diabetes, cancer, coronary heart diseases).[3] According to the World Health Organization (WHO), physical inactivity has been identified as the fourth leading risk factor for global mortality.[4] Moreover, physical inactivity is estimated to contribute to around 10% of breast cancer, 10% of colon cancer and approximately 9% of premature mortality.[3] Therefore, the promotion of physical activity among the public is a disease prevention strategy of a great increasing global importance.

1.2 The importance of physical activity in children

Health benefits of physical activity can be found in all age groups.[5,6] Childhood as the most physically active period across the lifespan, has

been recognised as the most crucial period in promoting the uptake of and adherence to physical activity.[7-9] Childhood is an important transition point where the physical activity level starts to decline as children grow into adolescence (at around 13 years of age), marking a new physical activity pattern in children.[10-12] For instance, children aged nine to 11 years spend more time participating in moderate-to-vigorous physical activity (MVPA) in schools than children aged six to eight years.[11] In other words, it can be beneficial to target health behaviours (including physical activity) at this transition period as children approach adolescence. Moreover, this transition period is critically important as health behaviours adopted at this stage could underscore both immediate and long-term health; for example, children who engage in physical activity are likely to have higher self-efficacy and less depression.[13] In general, physical activity promotes children's overall health and it can contribute to their sense of self, social well-being, and future health.[14] Moreover, it contributes to the quality of life in children with disabilities.[15,16] Physical activity in childhood may directly enhance body composition and skeletal health. It also helps prevent several chronic diseases such as obesity, type 2 diabetes, hypertension, and cardiovascular diseases across the lifespan.[3,17] In contrast, children who do not engage in physical activity at this stage are likely to have higher cardiovascular risks and increased incidences of being overweight or obese in adulthood.[10] In terms of psychological health, physical activity

improves self-esteem, and promotes the establishment of social contacts and friendship.[16] Regular physical activity among children may boost learning abilities, including improvement in concentration power, memory, intellectual development and academic performance.[14,16,17] In terms of economic benefits, it contributes to lower health care utilisation and healthcare costs associated with physical inactivity–related diseases.[3,18,19]

1.3 Physical inactivity among children in China and its potential impacts

Chinese and WHO physical activity guidelines recommend that children (aged five to 17 years old) should engage in at least 60 minutes of MVPA per day and reduce their sedentary time.[4,20] Sedentary behaviour refers to any waking activity characterised by an energy expenditure ≤ 1.5 metabolic equivalent of task (METs).[21] Physical activity and sedentary behaviour are distinct behaviours with independent risk factor for disease and this thesis focuses mainly on physical activity. In 2016, a study that pooled data from 146 countries and areas shows that globally, more than 80% of school-aged children and adolescents did not meet the WHO physical activity guidelines.[22] The WHO has set a global target of a 15% relative reduction in insufficient activity among school-aged children by 2030. However, the prevalence of insufficient physical activity has only decreased by 2.5% for

boys (from 80.1% to 77.6%) and 0.4% for girls (from 85.1% to 84.7%) between 2001 and 2016 globally. Moreover, this has further led to significant differences in insufficient activity between sexes. Yet in China, around 84% of children do not meet the recommended physical activity level, which is higher compared to many high-income countries in Asia(e.g., 76.3% in Singapore), Europe (e.g., 75.4% in Finland, 76.6% in Spain, 79.9% in UK) and America (e.g., 76.3% in Canada, 72% in US).[22] Moreover, evidence shows that 85.8% of school-aged children in China have engaged in sedentary behaviours longer than 2 hours per day,[23] which has led to significant declines in physical fitness.[24] For instance, it has reported that only 30% of school-aged children achieve an 'excellent' or 'good' rating in national fitness standards.[25] Although there is a slight decrease of the overall prevalence of insufficient physical activity among Chinese children and adolescents from 85.4% in 2001 to 84.3% in 2016, the prevalence of insufficient physical activity among girls in China has even increased over the period.[22] Specifically, it has increased from 88.6% in 2001 to 89.1% in 2016.[22] Poor physical activity engagement in national recommendations may affect Chinese children's mental health and well-being.[26] It is reported that 15.4% of children have mental disorders and over 25% of children have experienced some form of mental or psychological disorder (such as poor dependability, mentality, and confidence) as a result of low rates of physical activity.[26] In China, the total percentage of children who are

overweight and obese was 19.2% in 2010.[27,28] As a result, there is a need to investigate the issue of low physical activity among Chinese children and physical activity-related health problems. Furthermore, an urgent scaling up of implementation of effective programmes is needed to increase physical activity levels in children in China.

1.4 Reasons for insufficient physical activity among ethnic Chinese children

Children's academic achievements are heavily emphasised in China and schools are usually evaluated based on their academic performances. As a result, schools prefer to allocate their resources (including time) to academic curriculum rather than physical activity.[29] When comparing the Chinese national mass sports status investigation report (2014) with the 15 countries' (e.g., Australia, Canada, Finland, New Zealand, Ireland, UK, US) Active Healthy Kids Canada (AHKC, 2014) reports, it has found out that only 24.7% of Chinese children are reported to have participated in extracurricular physical activity throughout school compared to an average level of around 60% in high-income countries.[30] Ethnic Chinese children are less physically active compared to children of other ethnic origins in many high-income countries.[31,32] A study has reported that around 45% of Chinese American children are not actively playing outdoor games and

sports.[32] In these countries, ethnic Asian sub-groups are often aggregated as a homogenous group and the same generic physical activity promotion intervention is provided to all.[31,33] The intervention that works in children of other ethnicities may not have the same positive impact on ethnic Chinese children. This is also supported by previous studies conducted in non-Chinese territories demonstrating that the two main barriers to physical activity among ethnic Chinese children, irrespective of where they live, are the insufficient time for physical activity and a competing emphasis on educational attainment.[34,35] As such, a "shrinkage" of available physical activity time for children has been reported at the school level,[36] as well as a consistent decrease in the physical fitness of ethnic Chinese children.[37] Additionally, the stereotypical views of ethnic Chinese (such as not being good at ball games such as football or basketball) make ethnic Chinese children self-exclude from the physical activity cultures of their adopted countries.[38]

There are socio-cultural issues that hinder physical activity among ethnic Chinese children. Generally, parents of ethnic Chinese children are more concerned about their child's safety and academic achievements, which in turn promotes sedentary behaviour and impedes physical activity.[39] These children spend more time on academic studies after school hours and on weekends than on physical activity.[29] Ethnic Chinese girls are also less likely to engage in physical activity than boys.[40] In many conservative

Chinese societies, there is a huge socio-cultural pressure on girls to avoid physical activity. The image of Chinese women is incongruent with being physically active,[31] so there is a need for a socio-culturally appropriate intervention for ethnic Chinese children, addressing their specific barriers to physical activity. Interestingly, there are several barriers related to policy that were considered to be unique among ethnic Chinese children who reside in Chinese territories, including 1) state-run sports system, 2) "one-child" policy and 3) tight control at school level due to the fear of sports injuries and accidents.[41,42]

Unlike many low-and-middle-income countries, elite sports received more attention in China and the state-run sports system was implemented to elect, assemble and train talented athletes in order to win Olympics medals and other international sports competitions for the national glory.[43] In comparison, school sports was comparably less valued by the government, which in turn contributed to the poor physical activity resources for children in Chinese schools and delimited their participation in physical activity. Previous studies have suggested the imbalance of investment allocation within the Chinese national sports funding, specifically, there were significantly higher investments into elite sports (competitive sports) as opposed to that in public sports, including school sports.[44-46] In China, for instance, it was reported that the financial allocation to public sports only accounted for less than 10% of overall national sports grant from 2010 to

2013.[45] In contrast, the national investment into sports competition and training for elite athletes were made up approximately 20-26% of aggregated national sports budgets over the same period.[45] This unequal investment was also responsible for inadequate physical activity resources in Chinese schools. According to a survey on the sports facilities in Chinese schools, it was reported that only 5.9% of Chinese schools had sufficient facilities or space to implement physical education.[46] It was also reported that 56.4% of Chinese schools had only outdoor sports venues while schools with indoor sports venues accounted for only 30.4%.[46] In China, the previously implemented "one-child" policy shaped the unique Chinese "4·2·1" family structure, which represented the general household structure with four grandparents, two parents and one child.[47,48] In general, children received the best care in the household and were treated as the "emperor" in the family. As a result, they were suggested to be lack of intrinsic physical activity motivations.[47,48] In addition, this policy significantly influenced children's domestic physical activity due to there were no siblings to play with at home.[49] In previous systematic reviews, the physical education and after-class sports were reported to be purposively simplified or cancelled by schools due to the fear of sports injuries and accidents happening in school.[41,42] At school, the exercise-based injury surveillance and prevention schemes were suggested to be absent and children were not

taught about the safety implications of sports activities in physical education lessons.[42]

In terms of barriers and facilitators to physical activity among children from other ethnic groups or regions (i.e., outside China), research evidence has largely come from the studies conducted in Australasia, Europe and North America. For instance, several systematic reviews have synthesised similar broad themes with additional and unique barriers and facilitators. This highlights the complex interplay between barriers and facilitators of physical activity behaviours in children from different ethnic groups or regions. Specifically, these mutual themes spanned between one and all levels of the socio-ecological model (i.e., individual, interpersonal, organisational, community and public policy). Particularly, barriers and facilitators at the interpersonal (e.g. parents, peers, teachers), organisational (e.g., availability of equipment, time or staff) and community (e.g., support from communities) levels were most frequently cited, which reflected the consistent important role of adults/peers and physical environment in shaping children's physical activity behaviours.

1.5 School-based physical activity interventions for children

School settings offer a way of reaching large numbers of young people from a broad range of backgrounds, and it is regarded to be pragmatic and

attractive to utilise the school setting for recruitment and delivery of physical activity promotion targeting the young population.[50] Moreover, schools also provide opportunities throughout the school day (including before and after) to positively change behaviour,[51] while existing structures or systems within the school environment (e.g., social networks, educator-student relationships, school policies) can be integrated into the physical activity promotion efforts. Until now, the majority of previous systematic reviews on school-based physical activity interventions reported a positive effect on in-school, out-of-school or overall physical activity levels in young population.[52] However, these systematic reviews have commonly included studies that used self-report measures of physical activity,[53,54] rather than restricted to objective measures. This could potentially undermine the content and criterion validity for the measurement of physical activity levels.[55] Moreover, the included data was commonly combined and derived from a variety of tools (e.g., accelerometers and pedometers),[56] measurement periods (e.g., recess only and whole-day) and outcomes (e.g., MVPA, average activity intensity).[57,58] As such, a recent systematic review on this topic has restricted to inclusion of studies to cluster RCT design utilising accelerometer-measured physical activity across the whole day.[59] Surprisingly, it found that available school-based physical activity interventions have not been effective at increasing children's accelerometer-measured daily time spent in MVPA. Furthermore, it

suggests the null results should be either that the intervention components are not effective or that they are not reaching target populations, rather than they are effective in some groups but not others. Given this concern, it is required for future research to explore the implementation of these complex interventions, and there is a call for further school-based physical activity interventions to be conducted in a research context.[59]

1.6 The problems in Chinese physical activity policies and programmes

Over the last two decades, physical activity policies, guidelines and programmes have been implemented in China.[60] For instance, in 2007, the Chinese Centre for Disease Control and Prevention published physical activity guidelines for children, which recommends at least 60 minutes of MVPA daily.[61] In the same year, a national physical activity campaign ("one-hour physical activity") was implemented in collaboration with the General Administration of Sport and Ministry of Education, aiming to guarantee that 80% of school-aged students could achieve one-hour physical activity daily in three years.[62,63] In 2010, however, it was reported that only 22.7% of the students had been physically active doing physical activity for a total of at least 60 minutes per day.[64]

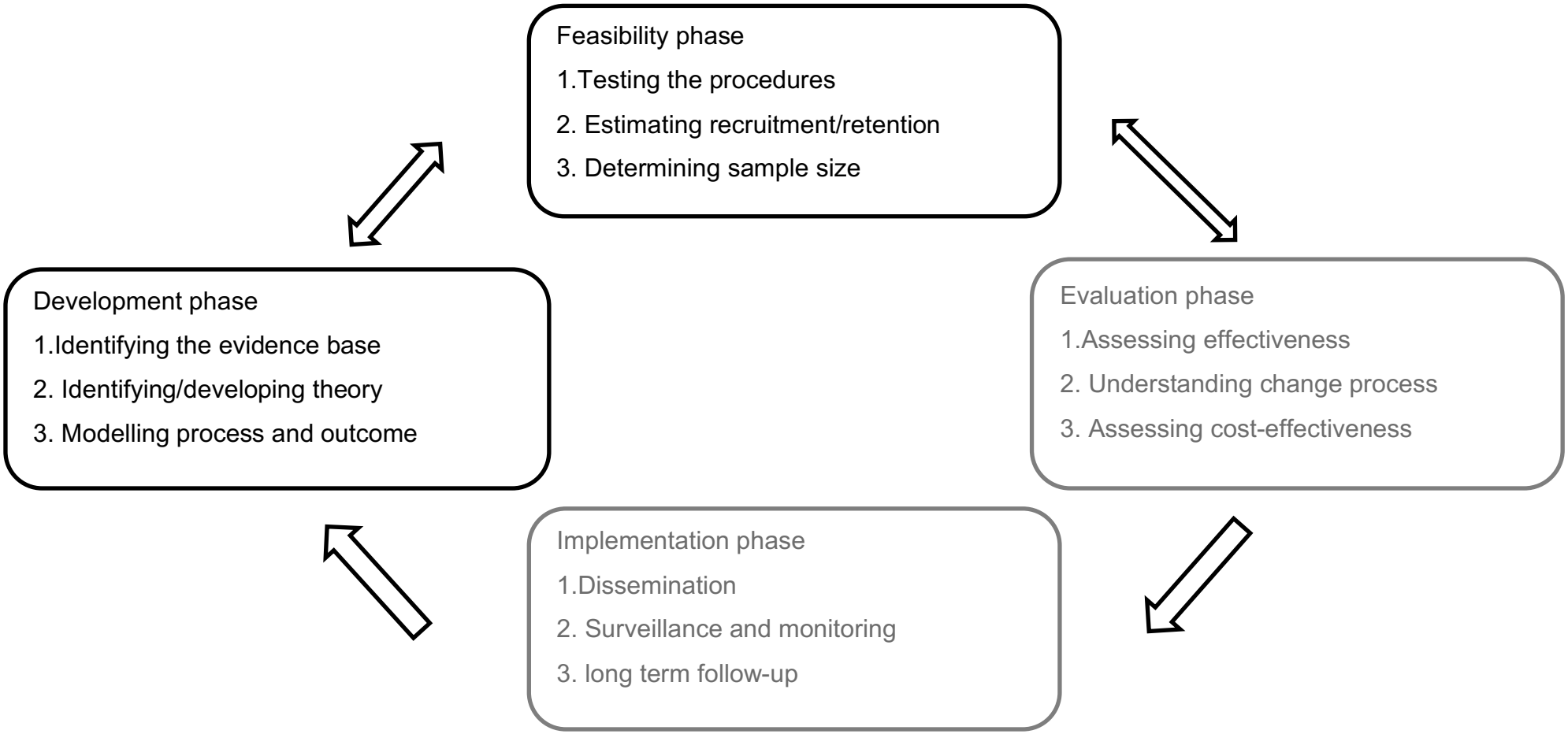
In schools, health (physical) education and structured exercise programmes are available and are delivered to children orally and/or in written format. Structured exercise sessions are run to achieve the recommended intensity and duration of physical activity. However, the development process of these programmes remains questionable (i.e., the intervention development processes are not adequately reported or these programmes are not developed and evaluated using systematic frameworks such as the United Kingdom (UK) Medical Research Council (MRC) framework for developing and evaluating complex interventions) and most of these programmes were not theoretically informed and developed.[65-67] Evidence suggests that available physical activity programmes in China limit the rigorous development and evaluation process.[68] A few physical activity programmes were developed based on the theoretical exploration regarding children's initiatives of physical activity.[39,69] Moreover, around 80.3% of physical activity programmes were rated as weak in quality overall according to a systematic review of the effectiveness of physical activity programmes in the past three decades.[67] Specifically, the systematic review synthesised 76 studies and reported that only 15 studies were rated as moderate quality and none included study was rated as strong quality. Of studies that were rated as moderate quality, 80% (n=12) of studies were appraised as weak in blinding or selection bias (n=3, 20%). Moreover, 32 studies were rated as weak (i.e.,

having three or more components rated in weak quality) out of all 76 studies.

1.7 Rationale for the development of a physical activity programme using the Medical Research Council's framework and Behaviour Change Wheel (BCW)

Given the limitation of existing physical activity programmes in China, there is a need to develop the intervention based on a theoretical rationale because the theory-based interventions are more likely to succeed and able to elucidate why and how the intervention components may contribute to the overall effectiveness.[70] Therefore, the thesis aims to use the United Kingdom (UK) Medical Research Council's (MRC) framework for complex intervention development and evaluation (see Figure 1) as guidance.[71] The MRC framework for complex interventions describes four phases involved in the process of complex intervention development, including development, feasibility/piloting, evaluation and implementation. The thesis focuses on the early stages which are intervention development and feasibility study of the MRC framework.

Figure 1: MRC framework for complex interventions



Although the MRC framework provides useful guidance to assist with the development and evaluation of complex interventions, it limits the detailed guidance regarding how to undertake the process within each phase. Until now, there is a wide range of theoretical models of behaviour to choose from (e.g., Theory of Planned Behaviour[72], the Health Belief Model[73]). However, evidence suggests that these models may not help to understand the behaviour change or develop interventions[74] but merely can be used to understand or predict behaviours.[75] In addition, it requires an in-depth understanding of the content of each theory and mastery of research techniques to collect and analyse data regarding the behavioural determinants to reach an informed design decision.[76] Moreover, Michie and colleagues questioned that the selection of theory in developing behaviour change intervention has been heavily reliant on the researcher's understanding of the behaviour and knowledge of the behaviour change theories, rather than following a systematic approach.[77] This could introduce a risk of excluding potential relevant and viable theories of behaviour change.[78] For instance, the approaches such as Transtheoretical Model and Health Belief Model have been criticised for incomplete mapping of automatic motivational factors (e.g. impulses, habits, and emotions) that can be powerful drives for some behaviours.[79] In order to address the gap, the Behaviour Change Wheel (BCW) has been developed that integrates behavioural change theory into the complex

intervention design.[77] Specifically, it is a synthesis of 19 frameworks of behaviour change in the literature.[77]

The BCW has brought all relevant components and provided a systematic way of characterising interventions that enable their outcomes to be linked to mechanisms of action.[70] Inside the framework, the Capability Opportunity Motivation Behaviour (COM-B) model is the central component of BCW; this is fundamental to the BCW and is used to identify the needed changes for the desired behaviour.[70] The COM-B model can also be used to guide the selection of the associated intervention functions and behaviour change techniques (BCTs). Theoretically, the COM-B model assumes that interactions between an individual's capability, opportunity and motivation can explain why a particular behaviour is or is not performed.[70] Each COM-B component can be further subdivided into two categories. For instance, capability can be physical (e.g., physical skills, strength) or psychological (e.g., knowledge, psychological skills) capability to engage in activity concerned. Opportunity can be physical (e.g., time, resource) or social (e.g., cultural norms, interpersonal influences) factors that lie outside the individual that prompt the behaviours. Motivation can be reflective (e.g., self-conscious intentions, plans) or automatic (e.g., emotional reactions, desires) brain processes that energise and direct behaviours. Altogether, the COM-B model provides a systematic and

comprehensive way to guide the behaviour change analysis to bring about the desired behavioural change

In addition, the COM-B model is further supported by the Theoretical Domains Framework (TDF), which is an elaboration of the COM-B and it comprises 14 theoretical domains drawn from a synthesis of 33 psychological theories and 128 key theoretical constructs relevant for behaviour change.[80] In total, a set of 14 domains covering the main factors influencing practitioner clinical behaviour and behavioural changes were identified, including 1) knowledge, 2) skills, 3) social/professional role and identity, 4) beliefs about capabilities, 5) optimism, 6) beliefs about consequences, 7) reinforcement, 8) intentions, 9) motivation and goals, 10) memory, attention and decision processes, 11) environmental context and resources, 12) social influences, 13) emotion and 14) behavioural regulation. Overall, these 14 domains provide an extensive framework to prompt the consideration of good coverage of influencers to behavioural change and therefore improves the intervention implementation.

The BCW has been successfully used to inform the design of many interventions that target at a variety of health-related issues, such as stroke rehabilitation, auditory rehabilitation and cancer symptom awareness.[81-83] There are also applications of BCW in the population of children.[84,85] Until now, there seems to have a dearth of published studies to develop an

intervention that aims at increasing Chinese children's physical activity levels, using the BCW and TDF.[68,86] As the application of the BCW varies in different contexts and behaviours, an example of the utilisation of the theoretical frameworks (the TDF and the BCW) is needed. Furthermore, it may help contribute to more of the theoretical-informed and effective physical activity interventions in China as well as refinement of this method.

1.8 Rationale for conducting a feasibility study

Feasibility is at the second stage of the MRC framework which is used before proceeding to a definitive trial to optimise the intervention and to test the research procedures for its acceptability, such as estimating recruitment and retention or determining the sample size.[87] In addition, feasibility study is useful in helping avoid the wastage of resources, especially in a middle-income country like China.[88] As suggested by methodological research; however, the feasibility study as the vital preparatory work is often skimped which undermines the later evaluation by problems such as acceptability of the developed intervention, compliance to the intervention components, and recruitment of participants. Given that the principal research question to be addressed by the proposed future main cluster randomised controlled trial (RCT) is whether the developed school-based behaviour change intervention is effective in

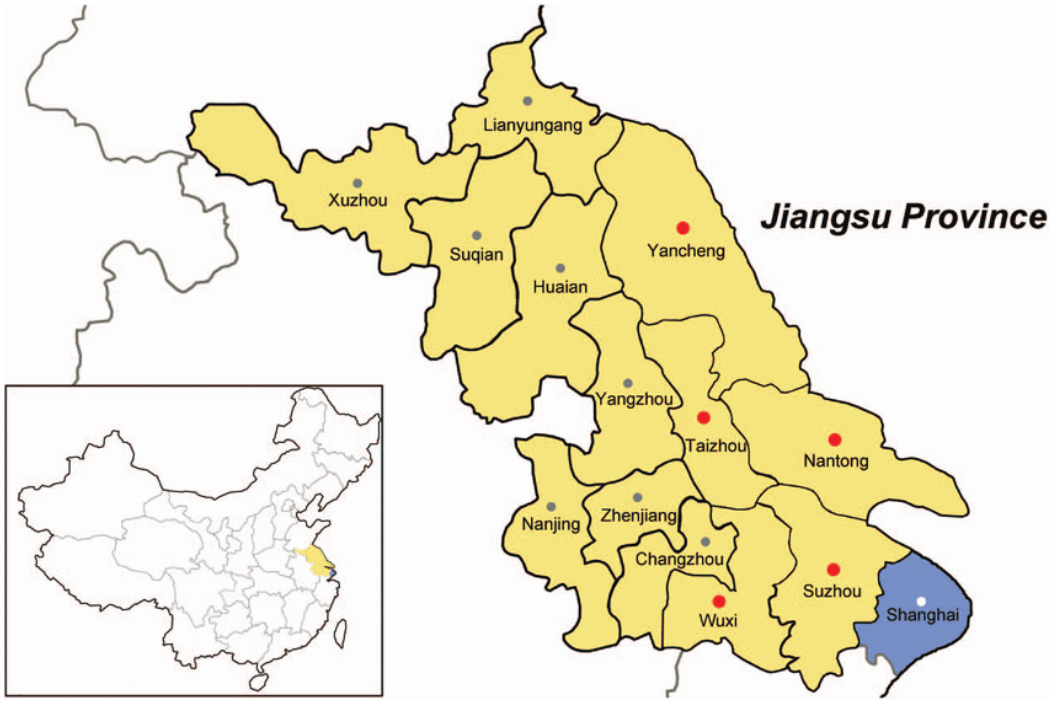
increasing physical activity levels among Chinese children, a preparatory feasibility is essential and indispensable for guiding the later full definitive trial.

1.9 Rationale for conducting the study in Yangzhou city of Jiangsu Province, China

Figure 2：Map of China[89]



Figure 3：Map of Jiangsu Province[90]



Yangzhou is an eastern city in China, located in the Jiangsu Province (see Figures 2 and 3).[89,90] There are in total three districts, two county-level cities and one country in Yangzhou. Altogether, it has a land size of 6634 square kilometres and about 4.51 million population in 2017.[91] In terms of economy, it has been reported that the gross domestic product has raised to approximately 506.5 billion Chinese Yuan and 113 thousand Chinese Yuan per capita in 2017.[91]

In Jiangsu Province, cities are divided into northern and southern cities[92,93] and Yangzhou is a northern city.[94] Generally, education system such as physical education structure and contents in southern cities is well-developed than that in the northern cities due to the disparities in economic

status between the two regions.[93,95] It has been reported that school-aged children in the southern region are more physically active than their counterparts from the northern area.[95] In 2017, 58% of children in southern areas have met the Chinese physical activity guidelines on weekdays as opposed to 50.7% of their counterparts in northern cities.[93] Additionally, there is a statistical difference that was reported in weekday's total MVPA time between children from those two regions, specifically, children spend more time on MVPA in southern cities compared to those from northern regions.[93]

According to the 2006 census of physical activity and health status in Jiangsu Province, the vast majority of children are physically inactive, and their health and fitness are below the national average.[96] There is a statistically significant difference in children's physical activity levels at different grades, specifically, around 66% of primary school children participated in over 30 minutes of physical activity while that of elementary and high school children were only 51% and 46% in 2016.[95] Similarly, there are approximately 25% of primary school children who participate in afterschool activity compared to their counterparts in elementary (15%) and high schools (10%).[95] Moreover, evidence shows that longitudinally 41 minutes of weekly physical activity decline happened among children aged 9 to 17 years old in Jiangsu Province annually.[93]

Conversely, the Chinese national survey on student's fitness and health (2010) has found that the highest overweight and obesity rate (17.1%) of children in primary school.[97] Altogether, it is an important health priority to reduce this physical activity decline of children at this period (7-12 years) as evidence shows that the health behaviours such as physical activity tends to track into adulthood from young age.[98]

Yangzhou as a northern city in Jiangsu Province has also faced the physical inactivity problem among children. According to the fitness survey in Jiangsu Province, it has reported that the physical fitness of children in Yangzhou is below the provincial average in 2009.[99] Although the "one-hour physical activity campaign" has been implemented in Yangzhou, an evaluation study shows that only 47.8% of students have spent one hour doing physical activity daily in 2011.[99] This situation is even worse on weekends, on which only 13.6% of children did physical activity.[99]

1.10 PhD aims

The aim of this thesis was to develop a school-based behaviour change intervention to increase physical activity levels among Chinese children and to determine the feasibility of undertaking the definitive cluster RCT in China. The specific aims of this thesis were:

- To synthesise the challenges faced by Chinese children in their physical activity participation as well as the factors that could facilitate their participation in physical activities (chapter 2).
- To systematically develop an intervention for improving Chinese children's physical activity participation (chapter 3).
- To determine the feasibility of undertaking a definitive cluster RCT in China (chapter 4).
- To explore the experiences and perceptions of participants and providers in the intervention and trial, and generate recommendations to inform a future intervention and full-scale cluster RCT (chapter 5).

Chapter two

Barriers and facilitators to physical activity among ethnic Chinese children: a qualitative systematic review

2.1 Introduction

Several studies have been conducted to explore the barriers and facilitators to physical activity among ethnic Chinese children.[31,32,39,69,92,95,100-103] Although a few systematic reviews written in Chinese are available on this topic, they are extremely brief and limited in searching scope (i.e., only include Chinese databases) and their quality can be inconsistent. In these reviews, there are no details regarding the development of the search strategy or the procedures of screening, data extraction, synthesis and quality appraisal.[41,42,104,105] Evidence shows that parents, guardians and teachers play an important role in shaping children's health behaviours concerning areas such as physical activity.[104,106] Extensive research has been conducted to explore which factors those with responsibility for children (e.g., parents, guardians and teachers), and the children themselves, perceive to be important for physical activity behaviour, but no qualitative systematic synthesis of this growing body of evidence has been conducted until now. Exploring and integrating previous qualitative evidence will enhance understanding of the barriers and facilitators to physical activity among ethnic Chinese children. Moreover, it may also lead to the identification of potential avenues for intervention that those who are instrumental to children's physical activity behaviours believe to be important but that has yet to be explored by researchers and policymakers as important components of interventions.

Ethnicity, cultural norms and residence can have an impact on children's views, experiences, attitudes, understandings, perceptions and perspectives regarding barriers and facilitators to physical activity.[107] In addition, the physical activity programme- and policy-related differences between Chinese territories and non-Chinese territories can have influences on a child's physical activity behaviour. In Chinese territories there are some unique influential factors including the 1) state-run sports system, 2) "one-child" policy and 3) tight control at the school level due to the fear of sports injuries and accidents.[41,42] In non-Chinese territories, ethnic Chinese children's physical activity behaviours may be influenced by the sports trend in the local community.[31,32] To uncover the particular views, experiences, attitudes, understandings, perceptions and perspectives of ethnic Chinese children, this systematic review only included data that could be analysed separately for ethnic Chinese children. In this systematic review, the repetition of bouts of physical activity over time is the focus, which includes exercise, sport, and physical education.[108]

2.2 Review objective

The aim of this systematic review was to synthesise the barriers and facilitators from the available studies that focused on physical activity among ethnic Chinese children and uncover any differences or similarities in these barriers and facilitators.

2.2.1 Inclusion criteria

Participants

This review included studies that were conducted among ethnic Chinese children (between six and 17 years of age) residing in either Chinese or non-Chinese territories or among people who have responsibility for them (such as their ethnic Chinese/non-Chinese parents, guardians, teachers). Studies were excluded if the ethnic Chinese children were not within the range of six to 17 years, or if children of other ethnicities were included. Studies conducted among the people responsible for the children were excluded if their children were not within the range of six to 17 years. If a study included both ethnic Chinese children and children of other ethnicities, only the barriers and facilitators to physical activity among ethnic Chinese children were extracted. Studies were excluded if it was not possible to extract these findings (i.e., not possible to distinguish between ethnic Chinese children and children of other ethnicities).

Phenomena of interest

This review included studies that focused on the views, experiences, attitudes, understandings, perceptions and perspectives regarding the barriers and facilitators to physical activity.

Context

All study settings were included, such as home, community and school, either in Chinese or non-Chinese territories.

Types of studies

The review included studies that focused on qualitative data, including, but not limited to, designs such as phenomenology, ethnography, grounded theory and action research. The authors also included cross-sectional surveys where free-texts relating to the review question were collected using open-ended questions, as free-text data are suggested to be of intrinsic value and analysis enables the researcher to explore the important contextual value of participants' responses.[109,110] The free-text data could provide additional information that is examined beyond the surface-level analysis.[109,110] The importance of free-text data in experience surveys has been acknowledged for its qualitative utility and for improving the health services.[111,112]

2.3 Methods

The systematic review followed the JBI methodology for systematic reviews of qualitative evidence.[113] It was conducted in accordance with a JBI protocol.[114] This systematic review was registered with International Prospective Register of Systematic Reviews (PROSPERO) (CRD42018097124). The process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[115]

2.3.1 Search strategy

An initial limited search was carried out on MEDLINE and China National Knowledge Infrastructure (CNKI) databases using the initial keywords "physical activity," "barriers," "facilitators," "Chinese" and "children." The titles and abstracts of the studies were screened for keywords and the index terms used to describe the article were also identified. As some databases have specific hierarchical categorisations, the initial search terms were indexed differently (e.g., physical fitness, child) or not indexed (e.g., barriers and facilitators) in the databases. As such, the final search strategy used both initial search terms and specific index terms (e.g., MeSH terms in MEDLINE) where appropriate. The search results were inspected to ensure that the relevant articles were identified.

Phenomenology, grounded theory, ethnography or qualitative descriptive studies were explored using "qualitative research" in the search strategy (the full search strategies are detailed in Appendix 1, which were developed for MEDLINE and then adapted for other databases in consultation with an information specialist/librarian).

The search spanned a range of sources to find both published and unpublished studies. The following databases were searched until 10 December 2018: MEDLINE (from 1946, Ovid), Embase (from 1947, Ovid), CINAHL (from 1937, EBSCO), PsycINFO (from 1806, Ovid), BNI (from 1993, EBSCO), AMED (from 1985, Ovid), Web of Science (from 1900, Clarivate Analytics), Scopus (from 1788, ELSEVIER), CNKI (from 1979, CNKI), Wanfang (from 1995, Wangfang Data), VIP (from 1989, VIP), EthOS (from 1925, British Library), OpenGrey (from 1997, GreyNet International), and ProQuest Dissertations and Theses (from 1980, ProQuest). The reference list of all the identified reviews and studies selected for inclusion in the review were screened for additional studies. No language restrictions were applied and translations from Chinese into English were sought where necessary. Whenever a translation was needed, two reviewers were independently involved in the translation and supplied comments. Consensus was reached through discussion between reviewers.

2.3.2 Study selection

Following the search, all identified citations were collated and uploaded into EndNote X8.2 (Clarivate Analytics, PA, USA) and duplicate citations removed. Titles and abstracts were screened for eligibility by two independent reviewers using the inclusion criteria. Studies identified as potentially eligible, or those without an abstract, had their full texts retrieved and their details were imported into the JBI System for the Unified Management, Assessment and Review of Information (JBI SUMARI; JBI, Adelaide, Australia). The full texts of the studies were assessed against the inclusion criteria by two independent reviewers. Full-text studies that did not meet the inclusion criteria were excluded and the reasons for exclusion reported. Any disagreements that arose between the reviewers were resolved through discussion or with a third reviewer.

2.3.3 Assessment of methodological quality

All studies selected for inclusion were critically assessed by two independent reviewers using the standardised critical appraisal tool for qualitative research incorporated within JBI SUMARI.[113] This tool uses a series of criteria that can be scored as being met, not met, or unclear or not applicable to that particular study. Prior to the critical appraisal, the use

of the appraisal tool was piloted among two independent reviewers for two papers. The reviewers discussed the acceptable criteria for each appraisal question and keep detailed notes/comments for each answer. In the appraisal, two independent reviewers independently went through each criterion and commented on it. Any disagreements that arose between the reviewers were resolved through discussion or with a third reviewer. The critical appraisal results are presented in tabular form (Table 1). All studies, regardless of the results of their methodological quality, underwent data extraction and synthesis. A cut-off score was not used to include or exclude studies in this systematic review, as many studies are likely to be of poor quality.[113] Poor-quality studies can generate potentially valuable insights[116] and can lead to a richer understanding of the research phenomenon.

2.3.4 Data extraction

Data were extracted from papers included in the review by two independent reviewers using the standardised data extraction tool incorporated within JBI SUMARI (JBI SUMARI; JBI, Adelaide, Australia). Any disagreements that arose between the reviewers were resolved through discussion or by involving a third reviewer. In the first phase of data extraction, study characteristics were extracted: study period, design, location (territory [Chinese/non-Chinese] and country), phenomena of interest, context (such

as home, community and school), participant characteristics (such as age and gender), inclusion and exclusion criteria, sample size, recruitment method, data collection procedure and tool, data analysis technique and authors' conclusion. In the second phase of data extraction, specific study findings were extracted: barriers and facilitators to physical activity among ethnic Chinese children. As suggested by previous qualitative studies and cross-sectional surveys, a structure was agreed on by the reviewers to extract findings.[41,69,92,95,100-103] This consisted of four aspects: i) personal (relating to physical, emotional or mood-associated factors of children), ii) socio-cultural (relating to people with whom the child would come in contact with, such as parents/guardians and teachers), iii) environmental (relating to structural elements such as facilities and transport) and iv) policy- and programme-related (relating to programmes, organisations and staff). This review categorised the extracted findings using a similar structure to previous systematic reviews conducted among other ethnic groups in non-Chinese territories,[117-119] which could help uncover the similarities and differences of perceived barriers and facilitators to physical activity when compared with other systematic reviews on this topic conducted among participants of different age and ethnic groups, settings or countries. In addition, illustrations from the text that support these findings were extracted (one illustration per finding). The findings and illustrations were the actual verbatim words of the study participants and the authors. The

credibility of each finding was assessed unequivocal (the finding is accompanied by an illustration that is beyond a reasonable doubt and is not open to challenge), credible (the finding is accompanied by an illustration that is lacking a clear association with it and is open to challenge) or not supported (when neither unequivocal nor credible can be applied and when the most notable findings are not supported by the data).[113]

2.3.5 Data synthesis

Study findings from all qualitative studies were pooled using JBI SUMARI with the meta-aggregation approach.[120] This involved the aggregation or synthesis of findings to generate a set of statements that represent that aggregation, through assembling the findings and categorising these findings on the basis of similarity in meaning.[113] These categories were then subjected to a synthesis in order to produce a single comprehensive set of synthesised findings.[113] Any free-text from cross-sectional surveys was intended to be pooled together with qualitative data from qualitative studies; however, this process was not required due to the nature of the data extracted.

In order to uncover any associated differences or similarities in the views, experiences, attitudes, understandings, perceptions and perspectives regarding barriers and facilitators to physical activity, the data from the

Chinese and non-Chinese territories were synthesised separately. In addition, the data from the children and parents/guardians/teachers were synthesised separately based on the pre-defined structure (i.e., personal and socio-cultural). Specifically, the findings relating to children and parents/guardians and teachers were assembled and synthesised under personal and socio-cultural aspects, respectively. In addition, specific themes relating to children, parents/guardians and teachers were separated on the basis of similarity in meaning of included findings and the interpretation illustrated in the included studies. The identification of themes relating to barriers or facilitators was based on the similarity in meaning of the included findings. The identification of barriers or facilitators was cross-checked by the two independent reviewers and consensus was reached in case of differences.

2.3.6 Assessing confidence in the findings

The final synthesised findings were graded according to the ConQual approach for establishing confidence in the output of research synthesis and presented in a Summary of Findings (Table 2).[121] The Summary of Findings included the major elements of the review and details of how the ConQual score was developed. The table included the title, population, phenomena of interest and context for the specific review. Each

synthesised finding from the review was then presented along with the type of research informing it, a score for dependability, credibility and the overall ConQual score.

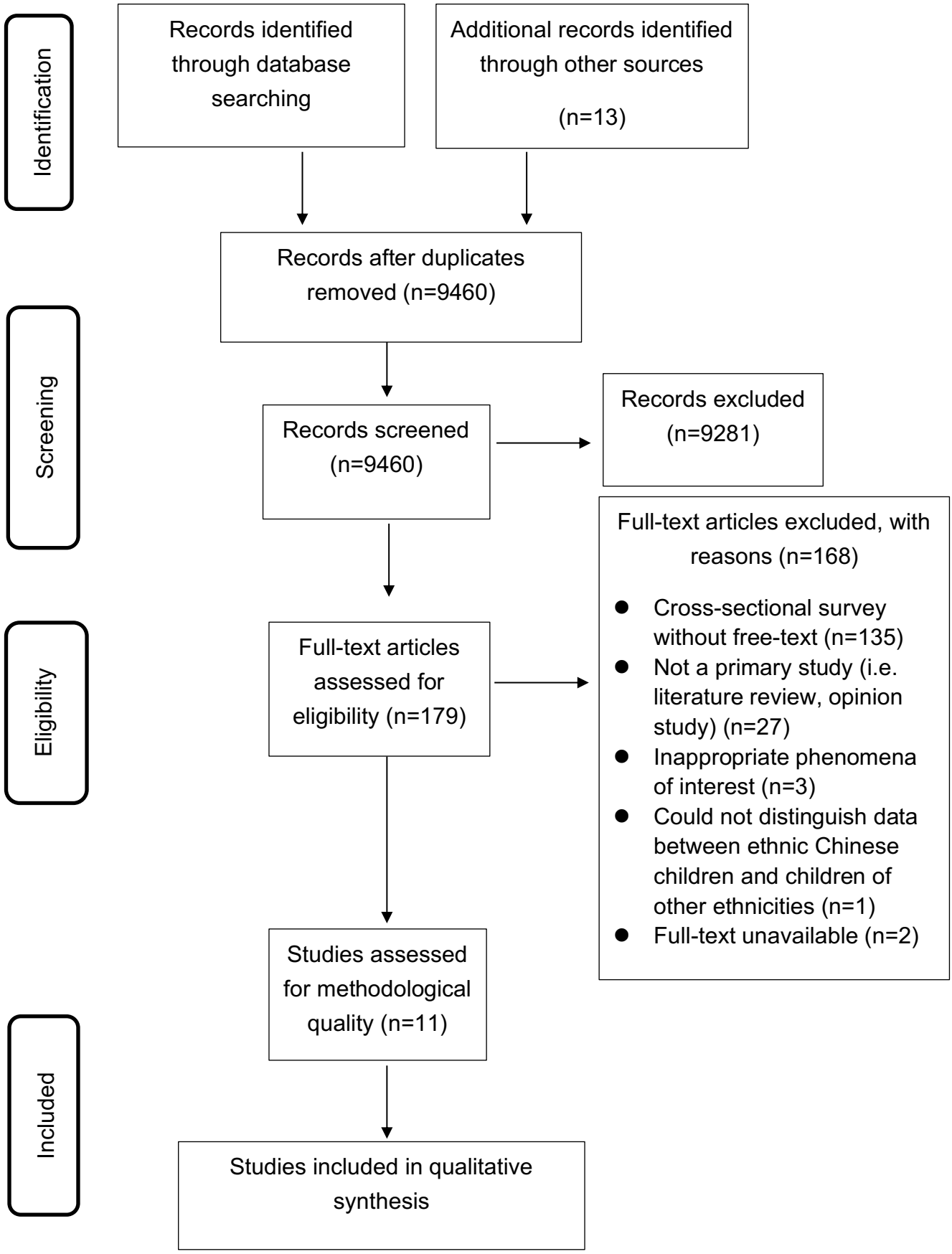
2.4 Results

2.4.1 Study inclusion

The comprehensive literature search returned 12,533 records through database searching and 13 through additional resources (i.e., hand-searching of PubMed), resulting in 12,546 potentially relevant records.

Following the removal of duplicates (n=3086), the titles and abstracts of the remaining records were assessed (n=9460). A further 9281 of these records were excluded with reasons (see Figure 1), leaving 179 records in the full-text screening. All 179 papers were retrieved for a full review, following which, 168 were excluded (Appendix 2). No disagreements arose during the screening. The remaining 11 papers were critically appraised and included in the review.[31,34,38,69,122-128] See Figure 4 for the full study selection process.

Figure 4: PRISMA flowchart of the search and study selection process


Identification
Records identified through database searching
Additional records identified through other sources (n=13)
Records after duplicates removed (n=9460)
Screening
Records screened (n=9460)
Records excluded (n=9281)
Eligibility
Full-text articles assessed for eligibility (n=179)
Full-text articles excluded, with reasons (n=168)
Cross-sectional survey without free-text (n=135)
Not a primary study (i.e. literature review, opinion study) (n=27)
Inappropriate phenomena of interest (n=3)
Could not distinguish data between ethnic Chinese children and children of other ethnicities (n=1)
Full-text unavailable (n=2)
Included
Studies assessed for methodological quality (n=11)
Studies included in qualitative synthesis

2.4.2 Methodological quality

The critical appraisal results of 11 included studies are presented in Table 1.[31,34,38,69,122-128] The results for most studies were six and above out of 10. Only one study had a score of four out of 10.[125] Nine of the 10 quality appraisal questions achieved a high proportion of "yes" ratings; however, question 7 (Is the influence of the researcher on the research, and vice versa, addressed?) had a significantly lower proportion of "yes" ratings. The issue of reporting of methodologies was identified in the majority of the included studies (except two studies conducted in Australia). It also highlighted a lack of reporting on the impact the researchers had on the studies.

Table 1: Methodological quality of included studies (n=11)

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Diep et al (2017)	Y	Y	Y	Y	Y	Y	U	Y	Y	Y
He et al (2014)	Y	Y	Y	Y	U	N	N	Y	Y	Y
Amy et al (2010)	Y	Y	Y	Y	Y	Y	N	Y	U	Y
Wang et al (2017)	Y	Y	Y	Y	Y	Y	U	Y	Y	Y
Zhang J et al (2007)	N	N	N	Y	Y	Y	N	Y	Y	Y
Zhang M et al (2015)	N	N	N	N	Y	Y	N	Y	N	Y
Pang (2014)	Y	Y	Y	Y	Y	Y	N	Y	U	Y
Pang et al (2008)	Y	Y	Y	Y	Y	Y	N	Y	N	Y
Pang et al (2016)	Y	Y	Y	Y	Y	Y	U	Y	Y	Y
Pang et al (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Trigwell et al (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
% "yes" responses	81.81	81.81	81.81	90.9	90.9	90.9	18.18	100.0	63.63	100.0

N, No; U, Unclear; Y, Yes.

Criteria for the critical appraisal of qualitative evidence:
Q1=Is there congruity between the stated philosophical perspective and the research methodology?
Q2=Is there congruity between the research methodology and the research question or objectives?
Q3=Is there congruity between the research methodology and the methods used to collect data?
Q4=Is there congruity between the research methodology and the representation and analysis of data?
Q5=Is there congruity between the research methodology and the interpretation of results?
Q6=Is there a statement locating the researcher culturally or theoretically?
Q7=Is the influence of the researcher on the research, and vice-versa, addressed?
Q8=Are participants, and their voices, adequately represented?
Q9=Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?
Q10=Do the conclusions drawn in the research report flow from the analysis, or interpretation of the data?

2.4.3 Characteristics of included studies

The characteristics of the included studies are presented in Appendix 3. All included studies used qualitative methods to investigate the perspectives of the participants. Of all 11 studies, seven were from China,[69,122-127] two from Australia,[38,128] one from the UK[34] and one from the US.[31] Only one study was written in Chinese and a translation of the findings was conducted.[125] Among the seven studies from China, four were from Hong Kong[69,122,126,127] and three were from mainland China.[123-125] Out of 11 studies, seven were conducted in schools,[38,69,122-126] two in communities[31,127] and two in both schools and communities.[34,128] Only one study was an unpublished thesis.[125] All studies were published between 2007 and 2017, with most (eight of 11) being conducted since 2014.[31,34,38,69,123,125,126,128] There were more studies exploring the experience of barriers and facilitators to physical activity from the perspective of children than that of parents and teachers. Two studies were conducted with both children and parents,[122,123] one with both children and teachers,[125] two with parents only[34,127] and six included children only.[31,38,69,124,126,128] Two papers originated from the same study.[38,128]

The number of study participants ranged from 12 to 115 and one study (conducted among teachers) did not mention the number of participants.[125] In exploring the methodological aspects of the 11 studies, two made specific commitments to a critical and interpretive ethnographic methodology,[38,128] while methodology was unspecified in the other nine.[31,34,69,122-127] The data collection

methods used were primarily semi-structured interviews, carried out in person[31,122,125,126] or by telephone.[31,122,127] Focus group discussion was used in two studies[34,123] and two studies only mentioned using interviews,[38,128] of which one also used field observation.[38] Specifically in two studies, alternative qualitative methods were used including self-completion elicitation[124] and nominal group technique.[69] Regarding the trustworthiness of these qualitative approaches, it is considered that interviews are better for investigating experience compared to quantitative methods.[129] Interviews are extremely helpful for in-depth exploration instead of broad surveys of surface patterns. A previous study reported that interviews could produce sufficient and trustworthy contributions when exploring children's perceptions compared to focus group discussion.[130] In terms of field observation, it is an effective qualitative approach to study the meaning of behaviour, language and the interactions of the group. However, this approach may not be appropriate to identify the barriers and facilitators to physical activity, as observation mainly entails looking at the individuals' behaviour rather than their attitudes and opinions.[131] In addition, observation is less appropriate to identify infrequent events, which might be of significance for their physical activity.

The data analysis techniques were thematic analysis,[31,38] inductive analysis,[34] framework analysis[123] and content analysis.[124,126,128] Two studies did not state the specific analysis but only stated using coding analysis,[122,127] whilst no data analysis methods were specified in one study.[125] All of these analytical

approaches were considered to be suitable for answering the question. However, thematic analysis and inductive analysis were seen to be better for comprehensively capturing all the themes of findings. This was because that these approaches did not cautiously measure the frequency of different themes as a proxy for significance (i.e., content analysis) or identify categories using the pre-existing concepts/frameworks (i.e., framework analysis).[132,133] As such, thematic and inductive analysis may be more appropriate to comprehensively evaluate each finding and avoid missing the potential barriers and facilitators that may have been neglected previously.

2.4.4 Review findings

As mentioned in the protocol, a standard structure with four themes was used to categorise all the extracted findings using the meta-aggregative approach.[114] Findings related to the participants of interest (i.e., children, parents/guardians and teachers) were aggregated under personal (relating to physical, emotional or mood-associated factors of children) and socio-cultural themes (relating to people with whom the child would come in contact with, such as parents/guardians and teachers). The findings from these two themes were aggregated into two specific synthesised findings looking at the barriers and facilitators to ethnic Chinese children's physical activity. In addition, findings related to structural elements (such as facilities and transport) and policies and

programmes (such as organisations and staff) were aggregated into environmental and policy- and programme-related themes.

All 11 studies included in this review explored the barriers and facilitators to physical activity among ethnic Chinese children. A total of 56 findings were extracted, of which 41 were assessed as unequivocal and 15 as credible (Appendix 4).

Among all the extracted findings, a total of 37 findings were extracted from the studies conducted in the Chinese territories, of which 24 were graded as unequivocal and 13 as credible. Specifically, the 37 findings were grouped into 14 categories and further aggregated into four synthesised findings. The first synthesised findings had 15 findings and six categories, of which 12 findings were unequivocal and three were credible. The second synthesised findings had 10 findings and three categories, of which eight findings were unequivocal and two were credible. The third synthesised findings had eight findings and three categories, of which one was unequivocal and seven were credible. The fourth synthesised findings had four findings and two categories, of which three findings were unequivocal and one was credible.

Among studies conducted in the non-Chinese territories, 19 extracted findings (17 unequivocal and two credible) were grouped into seven categories that were aggregated into two synthesised findings. The first synthesised findings had seven findings and three categories. Of these, six findings were assessed

as unequivocal and one as credible. The second synthesised findings had 12 findings and four categories, of which 11 findings were unequivocal and one was credible.

2.4.5 Confidence of the synthesised findings

The confidence of all synthesised findings was graded based on ConQual approach (see Table 2). This ranking system allowed the findings of individual studies to be downgraded based on their dependability and credibility. Downgrading for dependability occurred when the five criteria for dependability were not met across the included studies.[121] Where four to five of the responses to these questions were “yes” for an individual finding, then the finding remained at its current level. If two to three of these responses were “yes”, it moved down one level (i.e. from high to moderate). If zero to one of these responses were “yes”, it moved down two levels (from high to low, or moderate to very low). The synthesised finding then would be downgraded based on the aggregate level of dependability from across the included findings. In terms of credibility, it would be downgraded if the synthesised findings were not all unequivocal findings. Specifically, the synthesised finding would be downgraded one, two, three, and four levels if it contained a mix of unequivocal/equivocal findings, only equivocal findings, a mix of plausible/unsupported findings or no supported findings, respectively.[121]

For all synthesised findings, the majority of studies received four “yes” responses on the ConQual identified criteria for dependability; therefore, the level of confidence remained unchanged. The findings included a mix of unequivocal and credible ratings, necessitating downgrading one level, resulting in a credibility score of moderate. This represented a ConQual rating of moderate confidence in these qualitative synthesised findings and was supported by the evidence of sufficient quality.

Table 2: Summary of findings

Systematic review title: Barriers and facilitators to physical activity among ethnic Chinese children: a qualitative systematic review Population: Ethnic Chinese children aged 6-17 years or people who have responsibility for them Phenomena of interest: Views, experiences, attitudes, understandings, perceptions and perspectives regarding the barriers and facilitators to physical activity Context: Any study setting, such as home, community and school, either in the Chinese or non-Chinese territories					
Synthesised findings	**Type of research**	**Dependability**	**Credibility**	**ConQual score**	**Comments**
Personal barriers and facilitators (Chinese territories): The personal barriers and facilitators include both physical and psychological factors of children that may determine their physical activity choices and participation. A child's perceived interests, enjoyment of doing physical activity and their physically active pursuit may increase their physical activity level. In contrast, individual perceived lower value/utility of physical activity and time constraint may negatively influence children's participation in physical activity.	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings
Socio-cultural barriers and facilitators (Chinese territories): The socio-cultural barriers and facilitators include interactions brought by people who have a connection with children (e.g., parents, peers). A child's physical activity participation may be facilitated when there is a dynamic involvement of parents and teachers. Children may be	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings

more likely to take part in physical activity when there are available opportunities/conducts provided by supportive teachers and parents. In contrast, parental perceived lower value/utility of physical activity and time constraint may negatively influence their children's participation in physical activity.					
Environmental barriers and facilitators (Chinese territories): A child's activity may be hindered by the outer unfriendly physical activity-related environmental characteristics including environment structural elements (e.g., heavy transport), demographic characteristics (e.g., high population density) and physical activity resources (e.g., insufficient facilities). At the same time, having sufficient/physical activity-friendly resources within the community, including parks and playgrounds, may present opportunities for children's activity.	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings
Policy-and-programme related barriers (Chinese territories): The national policies and related programmes are the outer structure influencing a child's physical activity environment. A lack of appropriate physical activity programmes/structures and attractive programme contents may inhibit children's participation in physical activity	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings

Personal barriers and facilitators (non-Chinese territories): The personal barriers and facilitators include both physical and psychological factors of children that may determine their physical activity choices and participation. A child perceived physical activity interests and positive attitude may facilitate their participation while the negative interpersonal influences may hider their participation.	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings
Socio-cultural barriers and facilitators (non-Chinese territories): The socio-cultural barriers and facilitators include interactions brought by people who have a connection with children (e.g., parents, peers). A child's physical activity participation may be facilitated when there is dynamic involvement of parents and peers as well as their support. In contrast, unsupportive parenting and cultural belief may hinder children's activity participation.	Qualitative	Remains unchanged	Downgrade one level	Moderate	Downgraded one level as there was a mix of unequivocal and credible findings

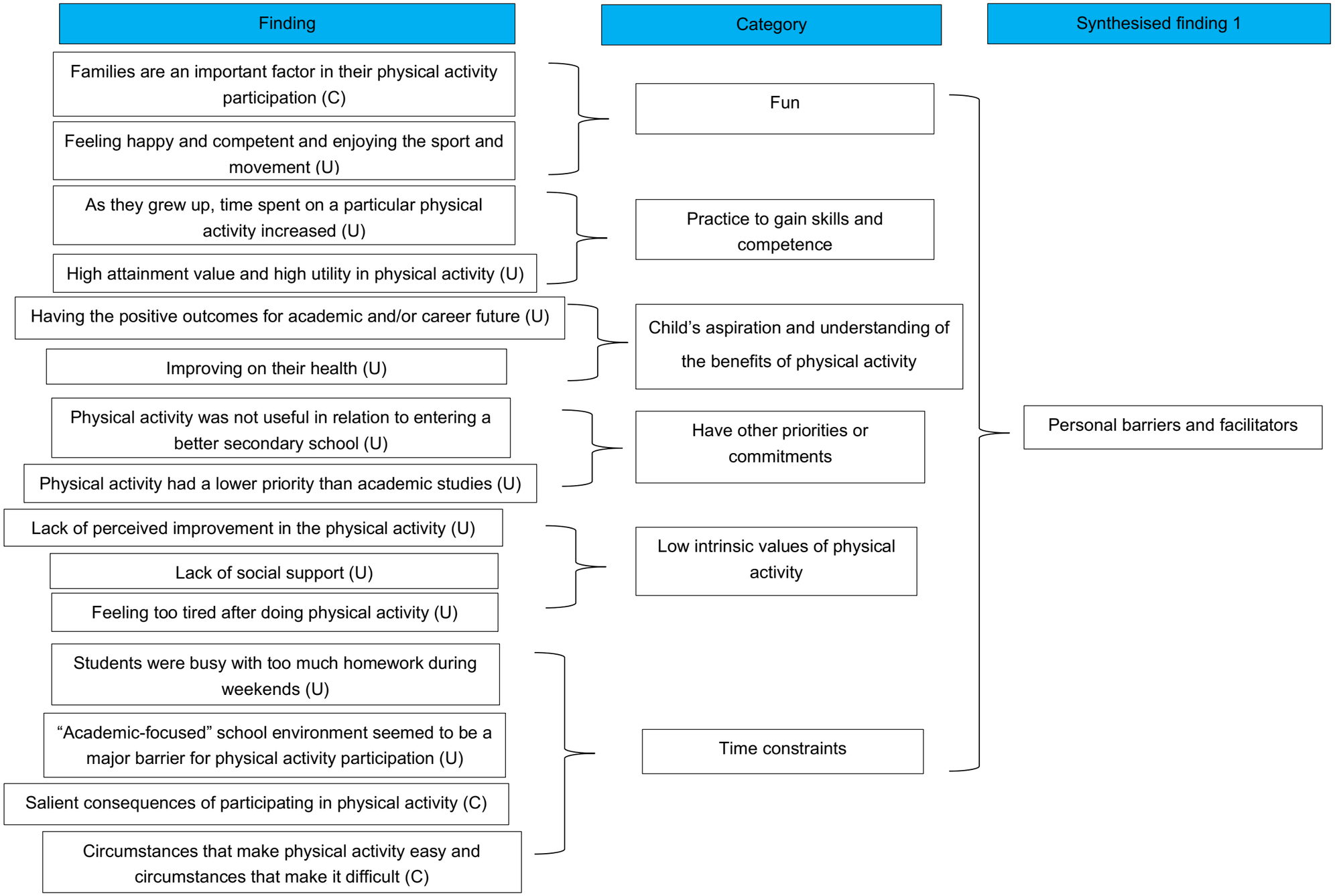
2.4.6 Results from Chinese territories

Of the studies conducted in the Chinese territories, the barriers and facilitators to a child's physical activity were identified and synthesised into four broad findings, including personal, socio-cultural, environmental and policy- and programme-related aspects. Both barriers and facilitators were identified in personal, socio-cultural and environmental factors, while only barriers were identified in the policy- and programme-related factors.

2.4.6.1 Synthesised finding 1: Personal barriers and facilitators

Personal barriers and facilitators include both physical, emotional and motivational factors that may determine children's choices and participation in physical activity. A child's perceived interest in, enjoyment in, and active pursuit of physical activity may increase their physical activity level. In contrast, factors such as individuals who place a lower value or perceived utility on physical activity and time constraints may negatively influence a child's participation in physical activity. This synthesised finding was derived out of 15 findings, which merged into six categories (see Figure 5)

Figure 5: Synthesised finding 1 (Chinese territories) - Personal barriers and facilitators



Personal facilitators

Category 1.1: Fun

Children generally had experience in physical activity and their positive feelings (e.g., fun, enjoyment and happiness) from those experiences were cited as important in facilitating physical activity participation.[122,126]

"Doing physical activity is fun and when I see other people playing, I want to be one of them . . . My parents also encouraged me. They would spend time jogging with me and I still remember we had so much fun."[122(p.390)]

"I feel satisfied when I can shoot a basketball into the ring . . . and usually I am able to hit the shuttlecock with a swift sound and therefore I feel really happy and have fun playing with it . . . When I play badminton, I think the sound of hitting a badminton cock is really interesting, I feel very happy when I could hit the cock with that kind of special sound."[126(p.390)]

Category 1.2: Practice to gain skills and competence

Children stated that they were more likely to do physical activity when they had a strong interest in practising a specific physical skill or to become more competitive or skilled in a particular activity.[122,126]

"I play table tennis more now and therefore have less time for other activities. I'd rather focus my time on improving in it than spending time doing various sports which seem to be wasting my time."[122(p.339)]

"I can boast in front of my teammates in basketball, which I think is important for me to do better in it."[126(p.390)]

Category 1.3: Child's aspiration and understanding of the benefits of physical activity

Physical activity participation among children who reside in China was also noted to be associated with their aspiration to physical activity. Moreover, the participation was dependent on whether an individual was aware of the benefits of physical activity to their physical health, clinical benefits (i.e., lower the risk of suffering chronic conditions like chronic pain) and career.[126]

"Physical activity is important because it is good for my health, I get less pain and disease after doing physical activities."[126(p.390)]

"Sport may be useful for my future job because I will find sport-related careers, like being an athlete. I want to be as good as those Olympic athletes, I think they are gorgeous"[126(p.391)]

Personal barriers

Category 1.4: Have other priorities or commitments

A particular barrier to physical activity mentioned by children was that physical activity was regarded as less important than other priorities or commitments.[126]

"Sometimes I think it [physical activity] is not really that useful at all as most schools do not think it is relevant to study."[126(p.392)]

"I would like to excel in my academic studies. I think studies may affect my future but not sport. I always place academic studies first."[126(p.391)]

Category 1.5: Low intrinsic values of physical activity

Low intrinsic values of physical activity among children were cited as a barrier inhibiting physical activity participation. Children stated that the negative feelings or experiences around physical activity delimited their motivation to be active; this included the perceived feeling of frustration, loneliness and tiredness while doing or after physical activity.[126]

"I do not feel any differences or improvements and I think it is boring. I am always like that, not a bit better."[126(p.392)]

"I always do sport alone by myself and this is why sport is not interesting to me. I do not like it because there is no one to compete or compare with me. There is no one to encourage me and I do not feel happy when doing sport."[126(p.392)]

"I need to put in too much effort in sport. I do not like the feeling of tiredness after doing sport."[126(p.391)]

Category 1.6: Time constraints

Lack of time was one of the most cited and particular barriers to a child's physical activity, and it was identified mainly because of the long school day and heavy study burden (e.g., assignments) for ethnic Chinese children who reside in China.[123,124]

"I do not have time for leisure time exercise at all from Monday to Friday. I came home late from school in the evening, and when I finish my homework, it's time to sleep. I just don't have time to exercise at all."[123(p.894)]

"The most frequently mentioned disadvantage, 'will take too much time,' was mentioned by 40.6% of the students."[124(p.43)]

"The most frequently mentioned barrier, 'having too many assignments,' was mentioned by about half (48.4%) of the students. Additionally, 'time' was the second most frequently mentioned circumstance; 14.2% of the students mentioned having more time as a facilitator and 18.8% mentioned not having enough time as a barrier."[124(p.43)]

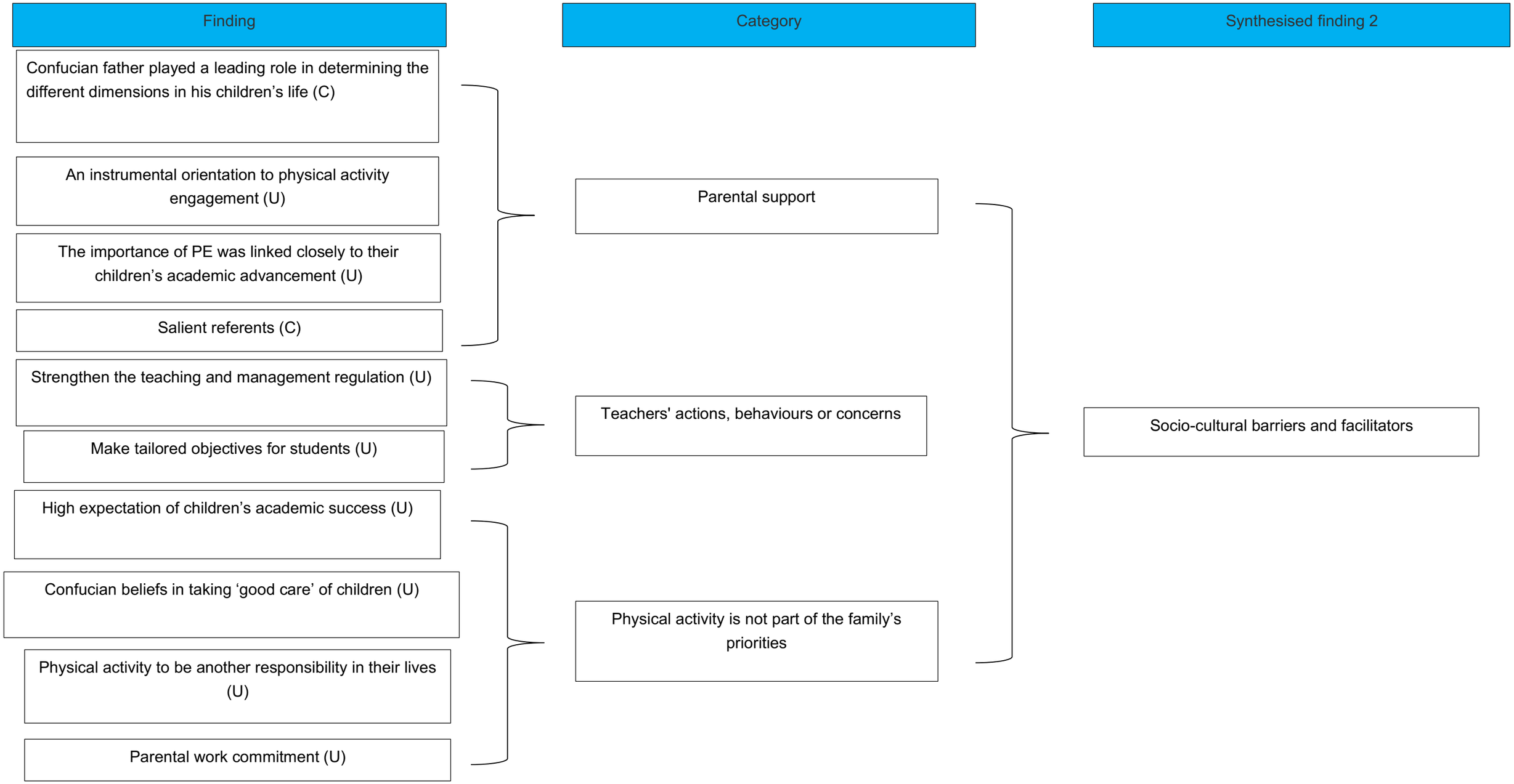
Similarly, parents also cited that their child's low participation in physical activity was a result of insufficient time being provided to them, which may indicate the "academic-focused" school environment.[123]

"The environment now is so different from the environment of my childhood. My kid is sitting there all day studying and no time for exercise. It seems that he does not like exercise at all, and when he has spare time, he watches TV."[123(p.894)]

2.4.6.2 Synthesised finding 2: Socio-cultural barriers and facilitators

The socio-cultural barriers and facilitators include interactions between children and people who have a connection with them (e.g., parents, peers). A child's participation in physical activity may be facilitated when there is dynamic involvement by parents and teachers. Children may be more likely to take part in physical activity when there are available opportunities or examples provided by supportive teachers and parents. In contrast, perceived lower value or utility of physical activity by parents and time constraints may negatively influence their children's participation in physical activity. This synthesised finding was derived from 10 findings, which merged into three categories (see Figure 6).

Figure 6: Synthesised finding 2 (Chinese territories) - Socio-cultural barriers and facilitators



Socio-cultural facilitators

Category 2.1: Parental support

Parents were commonly identified as important people with regards to the approval and disapproval of children's engagement in physical activity.[124] Particularly, fathers were cited as responsible for creating physical activity opportunities for their children.[122]

"Clearly, most of the salient referents for this behaviour were family members, including parents, others, fathers, and grandparents."[124(p.43)]

"Interestingly, within the group we interviewed, only fathers provided actual facilitation of their children's physical activity. One of them acted as an assistant coach regularly in his boy's rugby team, while a few attended their children's sports competitions, such as badminton and swimming during their leisure time, and two parents assisted with transporting children to playgrounds."[122(p.338)]

In addition, parental knowledge, as well as their understanding of the importance of physical activity in the betterment of physical health and academic performance, were cited as facilitators to children's participation in physical activity.[122]

"Students in Hong Kong, as far as I know, are not doing much sports and exercise. I'm sure exercise can help my son to be fit and maintain a good shape and weight."[122(p.341)]

"PE [physical education] is important because it makes my son healthier . . . good health may help him study better."[122(p.342)]

Category 2.2: Teachers' actions, behaviours, or concerns

While at school, a child's physical activity mostly took place at physical education class and therefore physical education teachers were able to facilitate and encourage children to be active. Physical education teachers believed that the establishment of proper teaching goals and a harmonious teacher-student relationship positively influenced children's physical activity.[125]

"We should combine the collective goal with an individual goal. Each student's physical quality and individual ability are different. We should fully consider the individual difference of each student when setting the teaching goal. When setting the collective teaching goal, we should make the goal has a certain range of fluctuation, because the requirement is universal for each student. We should ensure that for students whose sports learning ability are not strong enough can improve their sports achievements through hard work and their interest in sports learning can be increased due to the establishment

of motivation in sports learning. In the other way, this goal should also apply to those who have higher sports learning abilities."[125(p.24)]

"The PE [physical education] teachers should respect and care about students rather than criticise students at will. Teachers should equip a positive attitude and be the role model so that the students will feel the equality between themselves and teachers. In addition, they may be attracted to the class. With the establishment of a harmonious relationship between students and teachers, students will thus take the teachers as examples and change their behaviour."[125(p.25)]

Socio-cultural barriers

Category 2.3: Physical activity is not part of the family's priorities

Although parents did acknowledge the beneficial effects of physical activity, a child's educational attainment and academic development were considered to be the universal priorities among Chinese parents.[122,127]

"I know doing more physical activity is good for my child, but I'd rather have her study first and only allow her to play for a while if she could finish her school work. You know, too much play will negatively affect her academic performance."[122(p.338)]

"My son is now in the soccer team and he practices for many days a week …he comes back home at 7 pm and I think soccer is distracting him from studying well… I'm so afraid that he'll get hurt and I'm thinking not let him play anymore. I usually let him do whatever he wants in sports but if the exam is near, I'd advise him to play less basketball, I think it's better for him to spend more time studying than on playing."[127(p.42)]

"There was a time a basketball club invited me to join them, and I know this was a chance for me to play in a professional level. However, my mother opposed my decision, and I did not dare to argue with her."[122(p.340)]

It was also reported that the work commitment may be a barrier that restricted parents of ethnic Chinese children who reside in Chinese territories to accompany children to physical activities.[127]

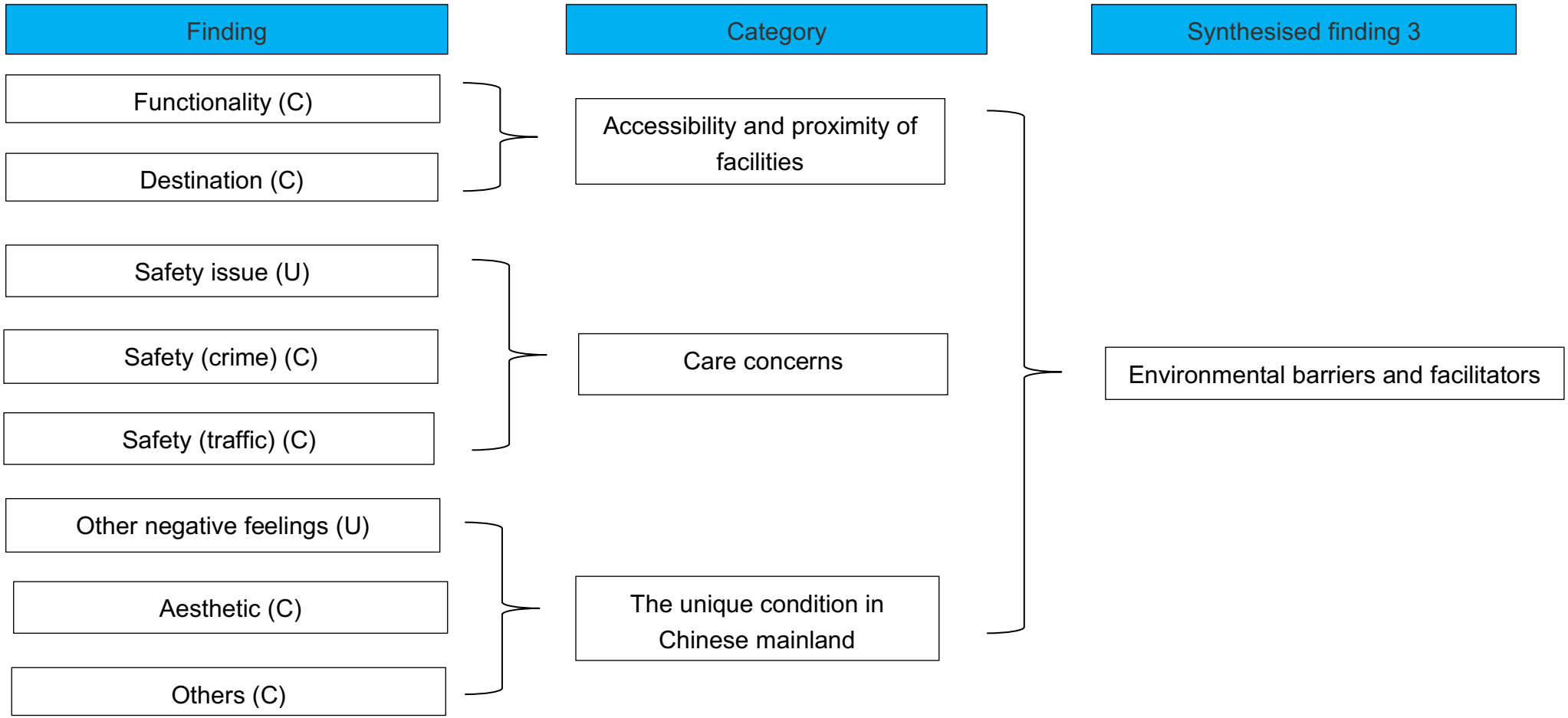
"Both of us need to work six days a week, well… we're not rich and we must work for the money for the family. Sometimes we would go out with the kids on Sundays and we usually go shopping or dining out."[127(p.41)]

2.4.6.3 Synthesised finding 3: Environmental barriers and facilitators

A child's physical activity may be hindered by environmental characteristics, including environmental structural characteristics (e.g., heavy transport),

demographic characteristics (e.g., high population density) and physical activity resources (e.g., insufficient facilities). This synthesised finding was derived from eight findings, which merged into three categories (see Figure 7).

Figure 7: Synthesised finding 3 (Chinese territories) - Environmental barriers and facilitators



Environmental facilitator

Category 3.1: Accessibility and proximity of facilities

The perceived physical activity–friendly environment was identified as a facilitator of physical activity. Specifically, it was identified that a child's engagement in physical activity was positively associated with the accessible facilities ("recreation grounds, parks") and the proximity of facilities ("convenient transportation, subway station").[69(p.50)]

Environmental barriers

Category 3.2: Care concerns

A common consideration mentioned by both parents and children was safety.[69,127] Parents stated that they worried that a child could get hurt doing certain types of activities while children identified their consciousness of neighbourhood safety.

"Some dangerous activities, like skating, it's not too safe for my girl to play. Children usually can't decide what is dangerous for them. They just play for fun but neglect the importance of safety. For example, I won't let him go climbing hills or rock…it's too dangerous. I've seen quite a lot of accidents happened in people climbing, it's definitely not suitable for children, especially girls), it's just not right for her to play such rough sport and Hong Kong don't have much safe

climbing places for younger ones and there is a lack of qualified teachers."[127(p.42)]

A child's physical activity was also related to an individual's perception of safety in the local environment, specifically through expressions of fear of surrounding safety ("afraid of being taken or hurt at night [crime]"[69(p.4)] *and the awareness of danger ("few cars on roads [traffic]")*[69(p.5)] *were cited by the children as barriers that delimited their activity.*

Category 3.3: The unique condition in the Chinese mainland

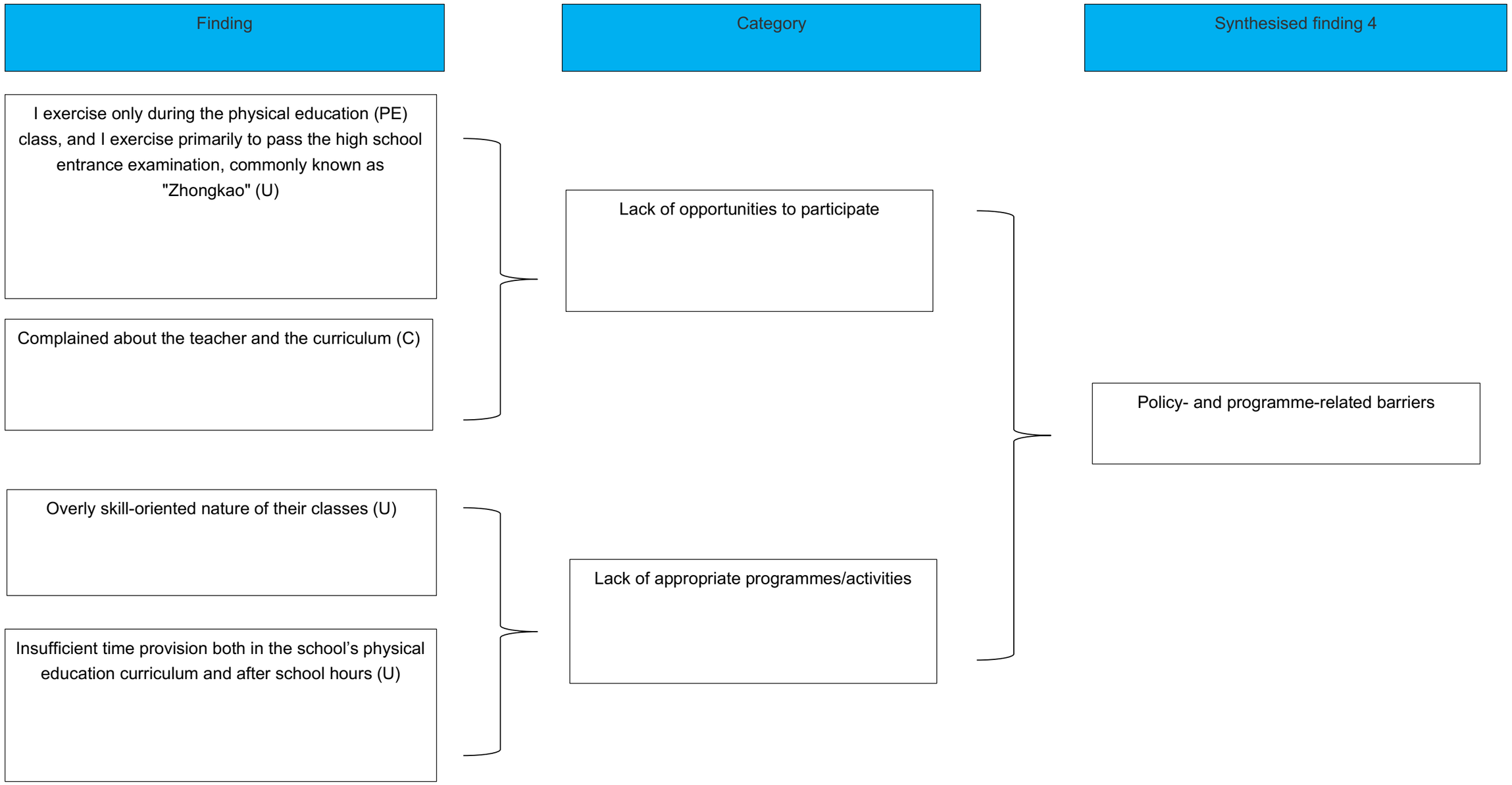
Three unique environmental barriers were mentioned by children who reside in China, which were pollution-related barriers, population density, and insufficient facilities. The air quality ("fresh air") and extent of noise ("too much noise") acted as barriers to children's engagement in activity.[69(p.5)] In addition, the large population density ("too many people in recreation grounds") was also cited as responsible for hindering a child's engagement in activity.[69(p.5)] The insufficient facilities were cited as a complaint by children for restricting their physical activity.[122]

"Other negative feelings, expressed by both boys and girls, included too many students in a class (40-45 students sharing one basketball court)."[122(p.343)]

2.4.6.4 Synthesised finding 4: Policy- and programme-related barriers

The national policies and related programmes are the outer structure influencing a child's physical activity opportunities. A lack of appropriate physical activity programmes or attractive programme contents may inhibit children's participation in physical activity. This synthesised finding was derived from four findings, which merged into two categories (see Figure 8).

Figure 8: Synthesised finding 4 (Chinese territories) - Policy-and-programme related barriers



Category 4.1: Lack of opportunities to participate

Physical education class was mentioned as the main physical activity opportunity provided to Chinese children. However, children cited that they had limited opportunity to participate in their activity of interest in the class. One possible reason was that physical education was only set up to help children pass the mandatory physical education component of the high school entrance examination (i.e., commonly known as "Zhongkao" in Chinese).[123] Instances of other academic curriculum displacing physical activity was also a barrier limiting physical activity opportunities for children at school.[122]

"We have a morning recess. Usually we start with group rhythmic gymnastics and then jump roping. We have PE [physical education] class, and each class content is arranged by teachers for us to run or do items for Zhongkao. We are not given free play time during PE class. I like playing badminton, but my PE teacher said I can only play badminton after I am capable of receiving full credits for all Zhongkao-tested items."[123(p.894)]

"… having academic subject lessons at the expense of PE (physical education) lessons, especially when it comes to the senior secondary level."[122(p.343)]

Category 4.2: Lack of appropriate programmes/activities

Children identified a lack of appropriate programmes or a deficiency within the available programmes as a barrier. At school, children were identified as having a limited interest in physical education lessons due to the overly skill-oriented nature of the classes and the inappropriate provision of time for physical education lessons.[34,126]

"It's not very nice because we always learn traditional sports, such as track and field, soccer, basketball, volleyball, and gymnastics. It is no fun at all. Teachers are actually repeating the same content we have already learnt in senior primary schools. I dislike running long distances; it is so boring."[122(p.343)]

"Well, it seems that during PE [physical education] lessons, most of the time, about 15 to 20 minutes was allocated to doing stretching and warm up, and the time for us to really learn a sport is not enough."[126(p.392)]

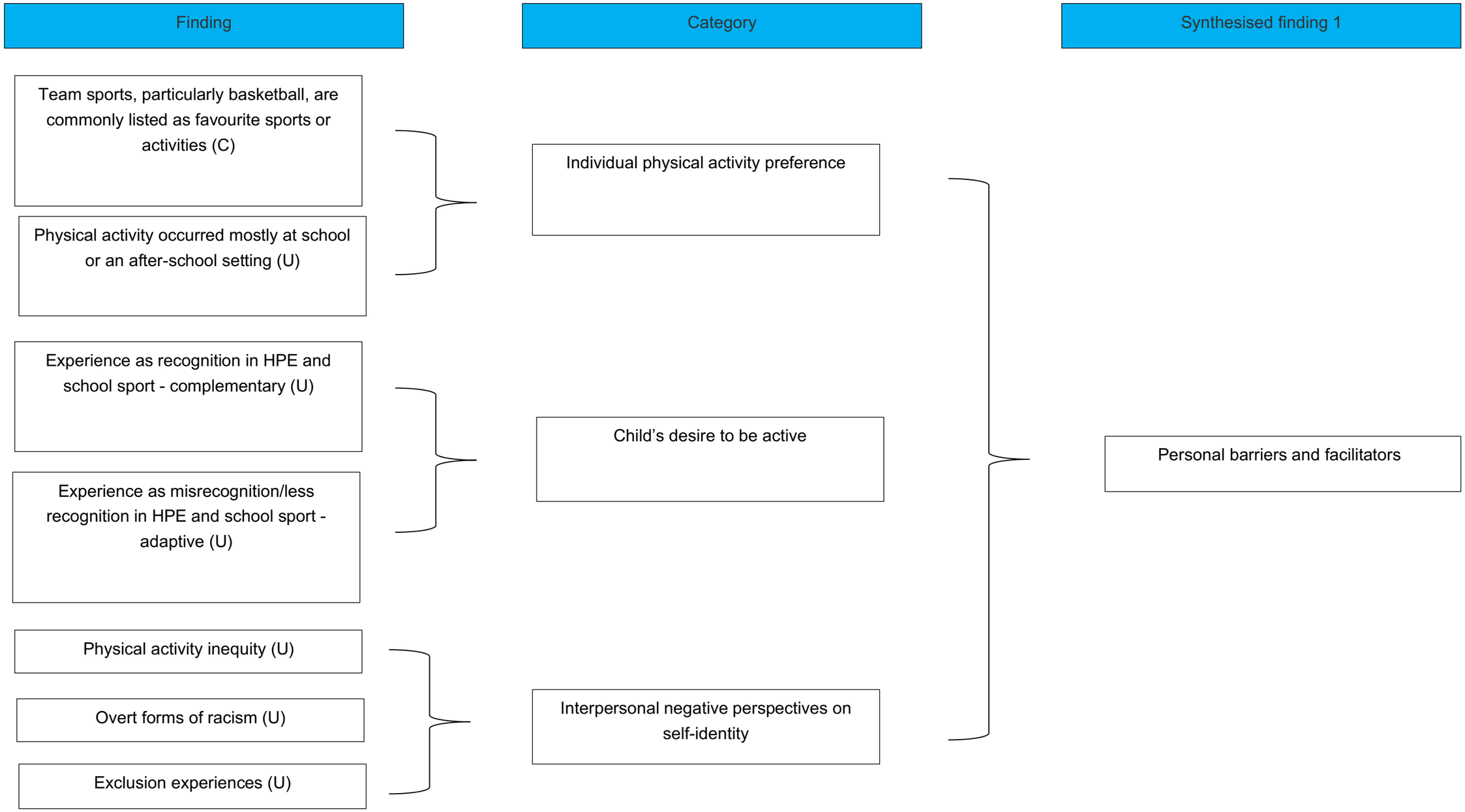
2.4.7 Results from non-Chinese territories

Unlike the synthesised findings from studies conducted in the Chinese territories, only personal and socio-cultural barriers and facilitators to physical activity were extracted and synthesised from the studies conducted in non-Chinese territories.

2.4.7.1 Synthesised finding 1: Personal barriers and facilitators

The personal barriers and facilitators include both physical and psychological factors that may determine children's choices and participation in physical activity. A child's physical activity interests and positive attitude may facilitate their participation, while negative interpersonal influences may hinder their participation. This synthesised finding was derived out of seven findings, which merged into three categories (see Figure 9).

Figure 9: Synthesised finding 1 (non-Chinese territories) - Personal barriers and facilitators



Facilitators to physical activity

Category 1.1: Individual physical activity preference

At an individual level, a child's own physical activity preferences were perceived to be influential on their physical activity participation.[31] Team sports were reported to be most popular among ethnic Chinese children and they stated that physical activity mostly took place at school and in after-school settings (e.g., home, neighbourhood).[31]

"Of the team sports, the most commonly mentioned were basketball and soccer. Other examples were baseball, dodgeball, football, volleyball, badminton, kickball, tennis, hockey, ping pong, and ga-ga (a variation of dodgeball), which were mostly played during physical education [PE], at summer camp, or on an extracurricular team."[31(p.361)]

"I sometimes play chase with my brother around the house, practising hockey in the yard, or we do work outside in the garden."[31(p.362)]

Category 1.2: Child's desire to be active

A child's own need and willingness to participate in physical activity were also noted as important. [60] The participation in physical activity was dependent on whether the individual had the desire to do so.

"I like being a prefect but I wouldn't want to be house captain, because if you want to be a house captain, you have to be really active, you always have to cheer up and do this and do that, and I'm not that kind of sporty person, so I signed up for the prefect (role) instead."[38(p.448)]

"I don't really study, because I hate studying, it's boring, I like to have fun . . . I'm having fun and feeling good. I like sports but I'm not good at it because I'm not as fast as everyone else, and I can't swim that well either. I'd like to join an AFL club but I haven't found a club yet that I like. Australian Football League [AFL] is fun."[38(p.451)]

Personal barriers

Category 1.3: Interpersonal negative perspectives on self-identity

A particular barrier mentioned by the ethnic Chinese children who reside in non-Chinese territories was their experiences of inequality, exclusion, and racism at school.[38] Girls in general excluded themselves from physical activity, and captains in physical education sessions picked teammates from the boys over girls first. Additionally, ethnic Chinese children who reside in the non-Chinese territories were "oppressively silenced" because of their ethnicity or race.

"Yeah, well I guess in PE [physical education], the captain chooses the boys first, like you know, they are the stronger players, and he kind of chooses

the girls last . . . Some of the girls are strong as well, but coz the boys always want those who's able to kick and able to goal. Well, in HPE [health and physical education] class, not many girls participate in it, coz like we're girls, we don't want to do it, and the teachers is like, you can walk around the field and do nothing."[38(p.449)]

"I just think they [Europeans] think they are better, my other friends, they used to be in the A team, but then they are too inside, they don't express much things in schools, they don't talk to other people, they're just not used to it, that's why they don't pass the ball to them."[38(p.450)]

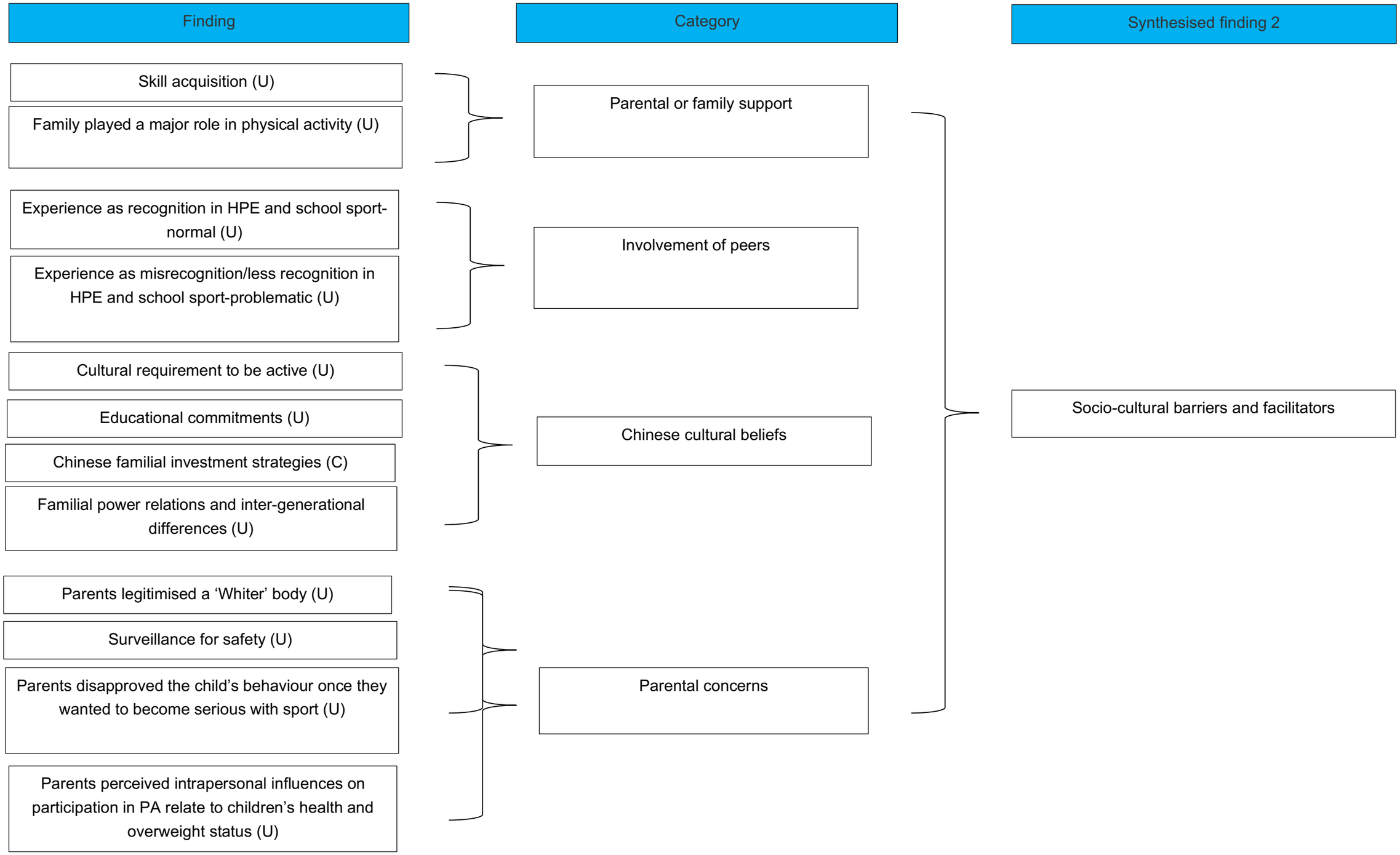
"Like back in primary school, you don't notice that much, since your English is not good enough, you won't know what they're saying, but when your English gets better, sometimes, you hear stuff, sometimes in playing sport, they'll say you're Asian and you can't play sport, they like to start things like that."[38(p.450)]

2.4.7.2 Synthesised finding 2: Socio-cultural barriers and facilitators

The socio-cultural barriers and facilitators include interactions with people who have a connection with children (e.g., parents, peers). A child's participation in physical activity may be facilitated when there is dynamic involvement by parents and peers as well as their support. Unsupportive parenting and cultural

beliefs may hinder children's participation in activity. This synthesised finding was derived from 12 findings, which merged into four categories (see Figure 10).

Figure 10: Synthesised finding 2 (non-Chinese territories) - Socio-cultural barriers and facilitators



Socio-cultural facilitators

Category 2.1: Parental or family support

Parental and familial support were identified as facilitating children's participation in physical activity.[31] The availability of opportunities for physical activity for children was also associated with parental understanding and knowledge of the physical activity.[34]

"My mom and dad... because they're the ones that tell me: okay, you can go to the park or you can go outside and play, so they'd be the ones that control what I do after school."[31(p.362)]

"We just hope our children can fully develop their skills, I will let him try everything."[34(p.1009)]

Category 2.2: Involvement of peers

The wider social networks of a child presented both positive and negative impacts on their participation in physical activity. Specifically, the conduct of peers was important in determining an individual's motivation for physical activity.[38]

"I have been known in my class to be one of the best long-jumpers . . . I'm really proud of my quick thinking, coz of debating, you do a lot of debating on the spot . . . people say I'm a good public speaker in debating and

sometimes in HPE [health and physical education], so I'm really proud of that one."[38(p.447)]

"Well, when I was skinny, I just look(ed) so fragile that I'll be pushed over by wind, and now when I'm not that skinny, people just assume that I don't do much exercise anyways . . . they just don't pick me first."[38(p.449)]

Socio-cultural barriers

Category 2.3: Chinese cultural beliefs

The Chinese ethnic ethos promotes the comprehensive development of an individual.[34] Children were encouraged to lead a physically active lifestyle and become positive active role models within the family.

"Because our nation requires us to pursue all kinds of development including moral, intellectual and physical aspects."[34(p.1010)]

However, this cultural ethos was also identified as the cultural barrier to physical activity participation for children. In general, a child's educational attainment or academic success was given more emphasis by parents and children.[34,128] This belief, in turn, delimited participation in physical activity for ethnic Chinese children.

"You will understand how to balance and you will make your children have sport, for activities, and have time for study too."[34(p.1010)]

"Academics is important because if I don't do well at school, I would let down my Mum and Dad, coz I mean what would it feel like if you were the parent of your child, others will say, oh my god, that person is so dumb, that child is so stupid, you know what I mean? I don't wanna feel that way or have my parents looked down upon by others like that."[128(p.1053)]

These attitudes also highlighted the traditional familiar power relationship in the Chinese family. A child was culturally legitimised to value filial piety, including adopting parental discourse without questioning, which makes ethnic Chinese children feel obligated to excel in academic performance as expected by their parents.[128]

"Pretty stilted, I mean they don't know what to do with me, my problems, like the Asian thing. Basically, to be Asian daughter, it's like I need to get A+ and everything, though they say they don't mind me getting a B in English…Chinese kids wouldn't ask to go out, they'd be too busy studying. I'm meant to like learning, I'm supposed to take what they say without questions, you know, and to look after my sister, just basically be a model daughter…I'm different from this model, I think I'm reasonably ok, because I don't go out and party and drink and stuff like that, a lot of other people do. I'm ok. I mean I'm not ashamed of myself."[128(p.1059)]

Category 2.4: Parental concerns

The perceived negative impacts of physical activity by parents were commonly cited as barriers to a child's participation in physical activity. Four parental concerns were identified: including academic concerns, aesthetic concerns, safety concerns and weight concerns.[34,128]

"My parents don't really like me doing fencing…My parents are like whenever I ask to join a new sport, they're like What's the point of that? Are you going to get world champion? Are you going to get number one like gold medal in sailing? If not, I don't think you should do it, coz it's not going to get you any money and it's not going to get you an OP1."[128(p.1056)]

"…all I got was getting tanner and tanner and tanner in my sport and my Dad starts complaining, like oh my gosh, you look like you're getting darker, no no no! They prefer me to be Whiter… they don't really want me to get tanner coz they think it's like the marine people. They just don't want me to be dark, not like a chocolate."[128(p.1055)]

"Sometimes when I go outside, I ride my bike but my parents don't want me to ride outside, coz there's more cars in the place where I lived before, the place I lived before was like a circuit."[128(p.1056)]

"For example if a child is already fat, that means he will have less interest in sport."[34(p.1009)]

2.5 Discussion

This systematic review explored qualitative evidence relating to barriers and facilitators to ethnic Chinese children participating in physical activity, and uncovered the similarities and differences in these barriers and facilitators. This is beneficial to researchers working in the fields of physical activity as it could provide novel information about the barriers and facilitators to ethnic Chinese children's physical activity behaviours. The included 11 studies resulted in 41 unequivocal and 15 credible findings that were grouped into 21 categories. Finally, four synthesised findings emerged from the data: 1) personal, 2) socio-cultural, 3) environmental (only in the Chinese territories) and 4) policy- and programme-related barriers and facilitators (only in the Chinese territories).

The synthesised findings described barriers and facilitators to ethnic Chinese children's physical activity in school, home and community settings. For many identified barriers and facilitators, the constructs were similar and were particularly dependent on the presence or absence of that factor. Overall, the identified personal and socio-cultural facilitators were consistent in both Chinese and non-Chinese settings; however, there were some differences regarding the barriers in the four synthesised findings. It is important to critically assess the barriers distinctive to ethnic Chinese children in the Chinese and non-Chinese territories. This systematic review identified personal barriers and facilitators similar to those identified by previous Chinese quantitative systematic reviews on this topic.[42,104,134] Specifically, children's participation in

physical activity was associated with a child's physical activity preferences, motivation, self-perceived physical activity value, and experience of participating previously, regardless of residence (in the Chinese or non-Chinese territories).[31,38,122,126] It was highlighted that children who experienced enjoyment and happiness while doing physical activity were more likely to participate in physical activity.[38,122,126] In contrast, negative feelings (e.g., tiredness) about physical activity would inhibit their future participation in physical activity.[126] Children's motivations for physical activity increased when they perceived that benefits could be gained by engaging in physical activity.[126]

In this systematic review, parents were consistently identified as integral "gatekeepers" in providing ethnic Chinese children with physical activity opportunities, in line with previous Chinese quantitative systematic reviews on this topic.[31,34,41,128,134] Regardless of whether children resided in the Chinese or non-Chinese territories, their parents were aware of the responsibility to provide opportunities for their child to be active, such as going out at weekends.[31,34,122,124] However, parents were generally seen to be over-emphasising children's educational attainment.[122,127,128] Their perception that physical activity was a factor negatively influencing their child's academic performance was presented as a barrier inhibiting children from participating in physical activity.[122,127,128] On the other hand, parental support and willingness to provide greater opportunities for children to participate in physical activity, resulted in higher physical activity levels in their children.[31,34,122]

Beyond parental influences, the role of peers and teachers in shaping a child's physical activity behaviour was reported to be an important facilitator. In Chinese and non-Chinese territories, children were likely to participate in physical activity if they had peers to play with. Additionally, their interest in physical activity increased when they had experiences of better performance than their peers in certain physical activities.[122] As only one Chinese study involving teachers was included, it was not possible to distinguish the similarities or differences relating to teachers between the two settings. In Chinese territories, it was identified that physical education lessons that demonstrated a good approach to teaching (e.g., "set appropriate goals," "establish an equal and harmonious relationship between teachers and children") led to an increase in children's physical activity levels.[125] This may be potentially related to the social support from engaging in physical activity that is perceived by children.[135] Children spent the majority of their time at school and social interaction was a considerable factor in their decision to participate in sports. Children were more likely to engage in physical activity when teachers and peers were encouraging and supportive.

Specific to children in Chinese territories, a lack of time was identified as a personal barrier to being active.[123,124] Children commonly expressed interest in engaging in physical activity, yet they had very little leisure time as they spent the majority of time at school or working on assignments.[123,124] This was also consistent with other Chinese quantitative systematic reviews, suggesting that

children who reside in China commonly experience a great burden of academic study that limits the amount of time they have available for physical activity.[126,134] A previous study shows that the school hours for primary school children in China are nine hours on average.[136] Children normally arrive at school around 7.30 am to 7.55 am and leave school around 4.30 pm to 5.30 pm, which is significantly intensive when compared with the school periods in the US and the UK (e.g., approximately 8.30 am to 3.30 pm).[136-140]

Experiences of exclusion, overt racism, and/or gender inequality were specific socio-cultural barriers that emerged among children in non-Chinese territories.[38] In general, ethnic Chinese children had the feeling of being purposely excluded and discriminated against by peers while doing certain types of sports (e.g., touch football) due to their ethnicity. The stereotypical perceptions of Chinese (Asians) as being quiet and not good at sports negatively influenced ethnic Chinese children's participation in physical activities. The general idea that girls are less competitive and strong compared with boys was identified as a barrier to girls being physically active and led to them self-excluding from participation in physical activity.[38] Gender inequality was also reflected in the scenario where captains always picked teammates from the boys over girls first at physical education. Given the difficult experience of being a migrant, it is important for ethnic Chinese children who reside in non-Chinese territories to be aware of the impact of these stereotypes on individuals and not to perpetuate them through their own internalised physical activity

behaviours.

An interesting socio-cultural barrier was identified among Chinese female children who reside in non-Chinese territories who claim that their physical activity is hindered by pressure from their parents to maintain "white" skin, as traditional Chinese culture considers "whiter" skin to be associated with higher social classes, while darker-skinned people (or those who are tanned) indirectly represent a low socio-economic status, as it implies working outside under the scorching sun.[70,141] Although the preference for fair skin remains in Chinese culture, it was only identified as a barrier to physical activity in ethnic Chinese children who reside in non-Chinese territories, which may suggest conflicts in values between the first migrant generation and their descendants. It is important for parents of ethnic Chinese children who reside in non-Chinese territories to be aware of the cultural differences relating to preferences for skin colour and not restrict children's participation in physical activity as a result of this belief.

In addition to personal and socio-cultural barriers and facilitators, the synthesised findings of environmental and policy- and programme-related barriers and facilitators were only identified in children who reside in Chinese territories. This may suggest that children's physical activity levels may have more complex and multifaceted barriers and facilitators in Chinese settings compared to non-Chinese settings. Environmental barriers and facilitators in

relation to safety and convenience of physical activity environments were identified in this review, and were consistent with previous Chinese quantitative systematic reviews on this topic.[42,104,134] Children's participation in physical activity may be hindered by poor neighbourhood safety (e.g., crime) and traffic, but can be facilitated by an exercise-friendly environment (e.g., available equipment and resources for physical activity).[69,122,127]

Air quality and population density were additionally identified as barriers relating to environmental sanitation among ethnic Chinese children who reside in China,[31] and poor air quality and high population density negatively impacted children's motivation to be physically active. Evidence suggests that children have different physical activity patterns compared with adults, such as playing outdoors, playing close to the ground, and engaging in more contact activities. These two sanitary barriers in China may inhibit children's participation in physical activity, particularly for ethnic Chinese children who reside in the Chinese territories.[142] Being aware of the unique Chinese environmental barriers to children's physical activity and involving public health policymakers in promoting physical activity may help to increase the physical activity levels in ethnic Chinese children who reside in Chinese territories.[143]

In terms of policy- and programme-related barriers, ethnic Chinese children who reside in China were repeatedly prevented from doing physical activity as a result of insufficient opportunities for participation in their preferred physical

activity in physical education lessons.[31,122,123,126] In China, children are required to take a sports test before entering high school, which means physical education lessons are generally used as (exam-oriented) training by schools and, therefore, children lack opportunities to do their preferred physical activity at school.[123] In addition, the overly skill-oriented nature (e.g., ball games, track and field) and time provision (e.g., most of the class time allocated to do warm-up or stretching) of physical education lessons negatively influenced a child's motivation to engage in physical activity.[122,126] Several previous Chinese quantitative systematic reviews reported that physical education lessons in China were not attractive to children (i.e., a lack of intriguing curriculum content/structure), and they are simply delivered by organising children to do free self-practice.[42,134] A child's physical activity may be determined by their preferences and they will allocate more time to specific activities as they grow up, so age-specific physical activity guidance could assist in engaging children more broadly. It may be more appropriate to offer young children general and interesting physical activities while providing more skill-oriented sports for older children. Strategies to improve the content and structure of physical education lessons, as well as a focus on physical activity policy adherence in schools, are warranted. The use of surveillance systems to monitor the implementation performance of physical education in schools could be considered in order to support school policy adoption.[117]

Strengths and limitations

To the best of the researcher's knowledge, this is the first qualitative systematic review to synthesise the barriers and facilitators to physical activity in ethnic Chinese children aged between six and 17 years of age. This review applies rigorous JBI review methods, an extensive search strategy, and included all papers regardless of language or type of publication (i.e., published or unpublished). It is acknowledged that the synthesised findings cannot be generalised as this is a qualitative systematic review; however, the included studies were carried out across four countries (China, Australia, US and UK) and included children from different age groups, ranging from nine to 16 years, and various participant groups including children, teachers and parents. These qualitative studies provided useful insights in the contexts of home, school and community in which barriers and facilitators are experienced by children and perceived by parents and teachers. The studies also provided narrative illustrations from all the participants, which give a better understanding of the specific needs from the perspective of children, parents and teachers. In addition, this review categorised the extracted findings using a similar structure to that of previous reviews, which could help uncover the similarities and differences of perceived barriers and facilitators to physical activity when compared with other systematic reviews on this topic conducted among participants of different age groups, settings or countries.

A limitation is that publication bias cannot be ruled out, as a non-peer reviewed thesis was included in this review, possibly lowering the methodological quality and the credibility of synthesised findings. The confidence of the recommendations may be compromised due to the poor quality of the included thesis based on the JBI critical appraisal tool; however, none of the identified theses or dissertations were left out in the process of screening. The majority of studies were not written in Chinese, which may lead to the conclusions being biased by a general view on China held by Western society. One study was in Chinese and a translation of extracted findings was conducted by reviewers; however, the credibility of synthesised findings may be reduced due to language bias and the accuracy of the translation.

This review did not stratify the barriers and facilitators specific to children of different ages and genders because the participants included children, teachers and parents, and the majority of included studies did not report the barriers and facilitators according to children's gender. The perceived barriers and facilitators to physical activity may differ between younger and older children as well as between boys and girls, so future research may benefit from reporting the barriers and facilitators to children of different ages and genders independently.

The review data offered limited insights into barriers and facilitators to physical activity specifically for ethnic Chinese children who reside in the non-Chinese

territories, since the synthesised findings were drawn from just four research studies that met the inclusion criteria. Of the seven studies conducted among children who reside in Chinese territories, only six were published peer-reviewed studies and these studies were generally conducted in large Chinese cities, such as Beijing and Hong Kong. Considering the limited number of included studies and the social differences between different jurisdictions, it is not possible to claim a universal understanding of barriers and facilitators for children residing in Chinese territories

2.6 Conclusions

The reasons ethnic Chinese children engage in physical inactivity are complex and multi-factorial. A range of personal, social, environmental, and policy- and programme-related barriers and facilitators have been identified that influence their participation in physical activity. Particularly, barriers and facilitators at the personal and socio-cultural level (e.g., parents and teachers) were most frequently cited, reflecting the importance of children's self-influence and the key role adults play in shaping children's physical activity behaviours. There are fewer qualitative studies on this topic conducted with Chinese children who reside in non-Chinese territories than in the Chinese territories. It is important that future research examines this topic given there is a large population of ethnic Chinese children living outside Chinese territories and the differences

noted regarding the barriers to physical activity among ethnic Chinese children in different countries. The focus on identified barriers and facilitators to physical activity in ethnic Chinese children will assist parents, health professionals, teachers and policymakers in developing successful programmes to encourage and increase participation in physical activity within this population.

2.7 Recommendations for practice

Using the JBI guidance for recommendation, development implications for practice have been identified and recommendations made.[144] Grade A recommendations are strong and Grade B recommendations are weaker. On the strength of the ConQual Summary of Findings, it is recommended that future physical activity promotion practice needs to consider the children's, parents', and teachers' concerns as well as the unique Chinese social, cultural, environmental and policy- and programme-related influences. Specific recommendations are listed in Table 3.

Table 3: Recommendations for practice

Recommendation	Grade
1. Appropriate physical activity programmes (such as street basketball, street dance) should include elements that could increase children's intrinsic value, enjoyment, interests and knowledge of physical activity.	A
2. Parents need to encourage their children to participate in physical activity and create a more supportive environment/opportunities for them.	A
3. Schools/parents should review the appropriate time and workload for children and alleviate the academic burden on children.	A
4. Schools should give education to help change the traditional academic-focused beliefs among parents.	A
5. Governments/schools should persuade children and parents regarding the benefits of physical activity to physical health and its clinical benefits such as help increase motivation to do physical activity.	A
6. Schools in non-Chinese territories need to have a greater awareness of children's experiences of suffering stigma on ethnicities while doing physical activity.	A
7. The government should consider the unique national demographic and environmental barriers to children's participation in physical activity and take actions to address air quality and limited physical activity spaces.	A
8. Policymakers should review the implementation of available physical activity programmes/physical education lessons at school and take necessary actions to ensure children are provided sufficient opportunities to take part in them.	A

2.8 Recommendations for research

This review identifies the issue of poor reporting of methodologies in the majority of the included studies (except two studies conducted in Australia). It also highlights the overall poor reporting of the potential impact of the researcher on the study findings. In addition, the systematic review calls for

more high-quality qualitative research into understanding the perceived barriers and facilitators to physical activity in ethnic Chinese children who reside in either Chinese or non-Chinese territories, particularly from the perspectives of teachers, parents and policymakers. To better increase physical activity levels in ethnic Chinese children and help them establish healthy physical activity behaviours, future physical activity interventions might address these identified barriers and enhance the facilitators when developing interventions.

Chapter three

Development of a school-based intervention to increase physical activity levels among Chinese children: a systematic iterative process based on Behaviour Change Wheel and Theoretical Domains Framework

3.1 Introduction

Health benefits of physical activity among children are vast.[3,4] Regular participation in physical activity can improve children's overall health (e.g., cardiovascular health, mental health, musculoskeletal health) and can contribute to their social well-being.[14] Evidence shows low physical activity levels among children and physical inactivity continues to be a major public health problem globally.[22] The World Health Organization's (WHO) physical activity guideline recommends a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day among children aged 5-17 years, including vigorous activities and activities that strengthen muscles and bones at least three days per week.[4] WHO also recommends that these children should limit the amount of time spent on being sedentary and recreational screen time in particular.[4] In China, however, only 34% of school-aged children have met the recommended 60 minutes of MVPA per day, and only 9% of children have spent at least three days on vigorous activities per week.[30,145] Around 35% of children have failed to adhere to the recommendations on sedentary and recreational screen time.[30,145] Boys are more likely to meet the MVPA recommendations compared to girls. However, boys are less likely to meet the sedentary and recreational screen recommendations compared to girls.[146] A range of factors may influence a child's physical activity, including (i) personal (relating to physical, emotional, or mood-associated factors among children), (ii) socio-cultural (relating to people with whom the child would come

in contact with, such as parents/guardians and teachers), (iii) environmental (relating to structural elements such as facilities and transport) and (iv) policy- and programme-related (relating to programmes, organisations and staff) factors.[41,69,92,95,100,102,103] MVPA starts to decline among children at around 13 years of age irrespective of their residence (i.e., urban or rural).[11,12,145] These factors are interconnected and important at different stages across the lifespan, with certain aspects being more influential at different points across the life course. Approximately 25% of Chinese children have spent over 30 minutes on MVPA in primary school (aged 7-12 years) whilst only 15% and 10% of junior middle children (aged 13-15 years) and junior high children (aged 16-18 years), respectively.[95] This is consistent with several national and international surveys that have reported children's physical activity starts to decline at 10-12 years of age.[147,148] In other words, it can be beneficial to target health behaviours (including physical activity) at this transition period as children approach adolescence.

In China, children are under huge academic pressure as a result of the national exam-oriented education system. Over one-third of these children report psychosomatic symptoms at least once a week, and around 76% of them report being in a bad mood because of academic pressure and high parental expectation.[149] This pressure increases from junior middle school to junior high school in Chinese territories.[150] On weekdays, the school hours last for approximately nine hours for Chinese children in primary school in Chinese

territories, which is more intensive than in the United States (US) and United Kingdom (UK).[136-138] In schools, health (physical) education and structured exercise programmes are available and delivered to the children orally and/or in written format. Structured exercise sessions are run to achieve the recommended intensity and duration of physical activity. However, evidence suggests that these programmes either do not intervene on the children's intrinsic determinations to physical activity or physical activity that occurs after school (e.g., weekends and holidays).[36] At the administrative level, a "shrinkage" of physical activity time for children has been identified due to the low enforcement of physical activity policy and unorganised school support.[36,151] Moreover, there has been a consistent decline in physical activity time among Chinese children over the past two decades in China.[152] Health education sessions are often replaced by other elements of the academic curriculum due to bad weather or during periods when children are due to undergo academic assessments.[36] Health education has not historically been valued within the curriculum because it is not a mandatory module listed on the national university entrance exam.[36,153] In addition, the number of health education sessions set up for children reduces as they move into higher classes.[153] In turn, the organisation of health education becomes relatively insignificant in Chinese territories' schools, which fails to provide a supportive physical activity environment and appropriate physical activity education or values for the children, parents and teachers. Moreover, the development process of these

programmes remains questionable (i.e., the intervention development processes are not adequately reported or these programmes are not developed and evaluated using systematic frameworks such as the United Kingdom (UK) Medical Research Council (MRC) framework for developing and evaluating complex interventions), and most of these programmes are not based on behaviour change theories.[65-67] For instance, evidence suggests that available physical activity programmes (or intervention that included physical activity as a component) in China has suggested that the programmes delimit the rigorous process of development and evaluation.[67,154,155] Around 80% of these physical activity programmes are found to be of poor quality. Furthermore, the programme designs lack a theoretical basis for the analysis regarding potential drivers of target behaviours.[67,154,155] The quality of interventions could be improved through consulting experts and by having patient and public involvement and engagement (PPIE) during intervention development, dissemination and implementation;[156-158] however, previous studies have often neglected or not reported these steps in the intervention development.[159] This could be due to the associated costs of PPIE, short timescales for delivery of interventions, not understanding the importance of PPIE steps or having a tight word limit in peer-reviewed publications.

Theory-based interventions are more likely to succeed and could help to elucidate why and how the intervention components may contribute to the overall effectiveness.[70] In contrast, non-theory based interventions are less

likely to be successful as they may fail to translate the existing scientific evidence into knowledge and practice and neglect the potential explanatory underpinnings of the target behaviours or problems.[160,161] As such, there is a need to develop theory-based interventions. The Behaviour Change Wheel (BCW) and Theoretical Domains Framework (TDF) are models that could provide a systematic and comprehensive assessment of the factors that are likely to influence behaviours.[77,80] The descriptions of BCW and TDF are mentioned in chapter 1. Physical activity interventions are likely to be complex interventions as several components interact with those who deliver and those who receive the intervention. It is also needed to take account of the role of parents and the environment for physical activity. Developing an intervention that is aimed at increasing children's physical activity level has much to do with behavioural change.[71] This is because intervening through the promotion of physical activity is a long-term behaviour change process that should include both behaviour initiation and maintenance. However, previous studies have paid little attention to behavioural changes of children and people who have responsibility for them (i.e., parents, guardians, or teachers) in the development and implementation of complex interventions.[67,154,155] Similarly, previous studies have understated the role of policy- and programme-related factors (i.e., sports programmes, organisations and government departments) in the development process. Interventions aimed at changing Chinese children's behaviour have generally proven problematic in demonstrating efficacy,

possibly because of a lack of or inadequate theoretical foundation in the development phase.[67] The research focused on physical activity promotion in children has been growing in the past two decades in China, and multiple studies have reported the positive outcomes associated with physical activity behaviours and weight management.[86,162-164] However, a consistent decline in physical activity time for children in China has been reported.[145] Several studies have revealed a decline in children's physical fitness and health (e.g., strength, endurance) and an increase in the prevalence of overweight and obesity among children in China.[165,166] Furthermore, interventions have been criticised for lacking a theoretical rationale and detailed reporting, thus complicating both the development and the possibility of replicating or improving interventions.[70]

The application of the BCW varies from one context or behaviour to another. For instance, the barriers and facilitators to children's physical activity differ in different cultural contexts. As such, a theory-based physical activity intervention is needed in China. Thus, the aim of the study was to use BCW and TDF for designing the components of an intervention to improve Chinese children's (aged 10-12 years) physical activity. Specifically, this is the first stage of the UK Medical Research Council's (MRC) widely used framework for developing and evaluating complex interventions, which describes four phases: intervention development, feasibility/piloting, evaluation, and implementation.[71] The specific objectives were to (i) map the relevant TDF domains based on the identified barriers and facilitators (reported in chapter 2), (ii) identify the type of

intervention functions required to bring about the change, (iii) identify specific BCTs aligned to the purpose of physical activity promotion and (iv) develop the intervention content and structure for the physical activity programme.

3.2 Methods

BCW and TDF intervention development steps were followed, and this was an iterative process (e.g., going back to the previous step and making changes based on the feedback).[77] In the BCW, the intervention design has eight steps: (i) defining the problem in behavioural terms, (ii) selecting the target behaviour, (iii) specifying the target behaviour, (iv) identifying what needs to change, (v) identifying intervention functions, (vi) identifying policy categories, (vii) identifying BCTs and (viii) identifying the mode of delivery (see Figure 11).[77] Moreover, an additional three steps were followed to develop the intervention content (i.e., the process of expert consultation, PPIE, and piloting in developing the physical activity intervention). Reporting of the developed intervention is in accordance with The Template for Intervention Description and Replication (TIDieR) (see Table 4).[167]

Figure 11: The eight steps of the BCW intervention development process

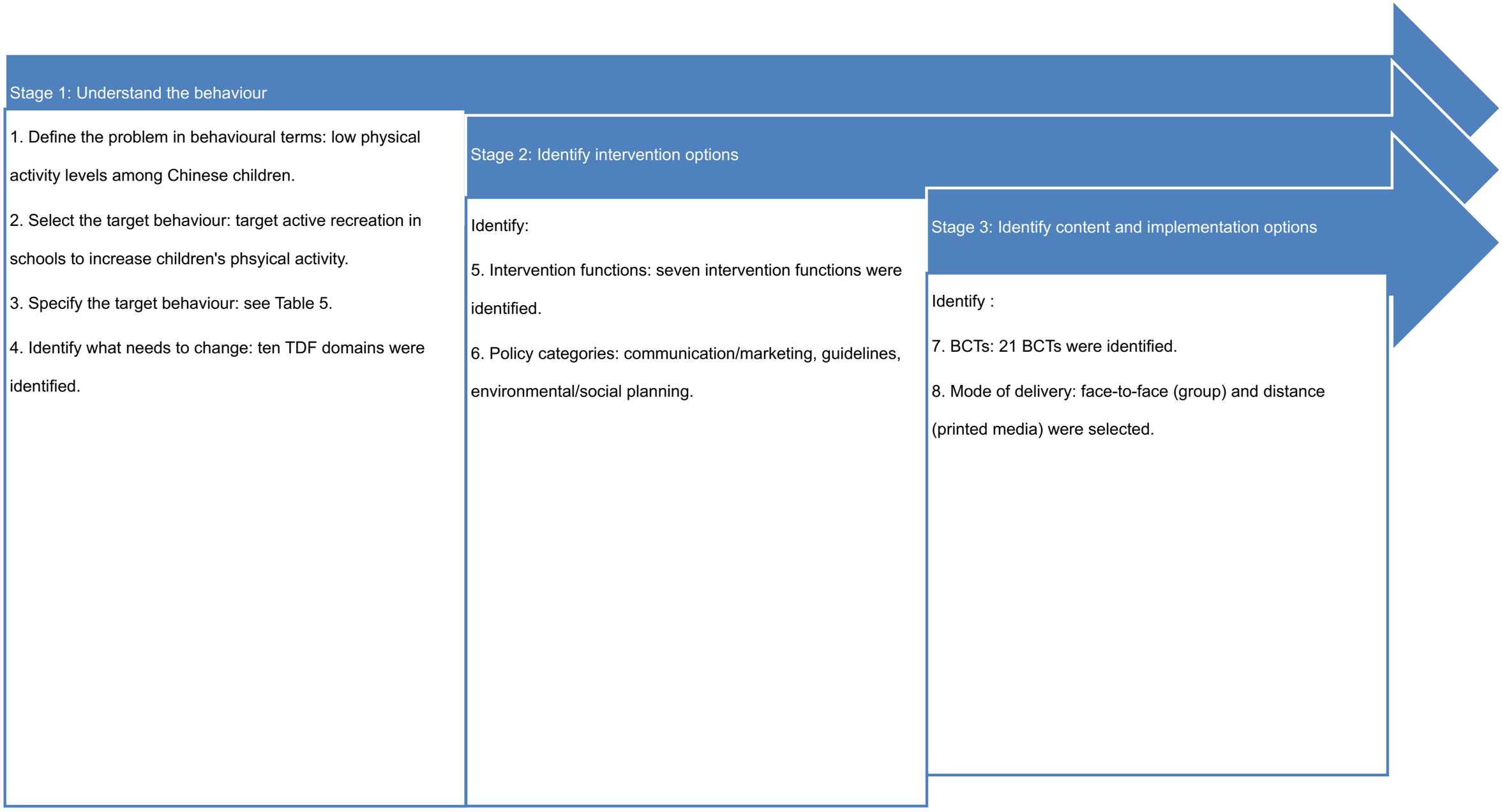


Table 4: Description of the finalised intervention and implementation strategy using the TIDieR checklist

Item number	Item	
	BRIEF NAME	
1.	Provide the name or a phrase that describes the intervention.	Development of a behaviour change intervention to increase physical activity among children aged 10-12 years in China.
	WHY	
2.	Describe any rationale, theory, or goal of the elements essential to the intervention.	This study is aimed to develop a school-based behaviour change intervention to increase physical activity among children aged 10-12 years in China. The intervention was systematically developed based on the Behaviour Change Wheel and Theoretical Domains Framework.
	What	
3.	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or training of intervention providers. Provide information on where the materials can be accessed	This intervention involves three levels, including i) environmental support in school, ii) health education for children and iii) family involvement. Materials used for each level are: i) School environmental support: i. Physical activity poster ii. Sports equipment for children ii) Health education for children: i. Slides ii. An activity diary iii) Family involvement: i. Slides ii. A physical activity booklet iii. Physical activity expert clips

	(e.g. online appendix, URL).	Training of intervention providers includes training in measurement of body weight, height and waist circumference. Information on the development of intervention materials and the source of materials are mentioned in the 'Result section' (step 8,9,10).
4.	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.	This intervention involved three levels, including i) environmental support in school, ii) health education for children and iii) family involvement. i) School environmental support The environmental support in school is provided to children by the physical education teachers and the researcher (HW) from the beginning of the intervention until the end. The support consists of (i) verbal encouragement for doing physical activity at the class break, (ii) provision of physical activity posters in the classroom and (iii) provision of sports equipment for children to use during the class break. ii) Health education for children Health education for children is a multi-faceted intervention and aims to increase children's knowledge, motivations for physical activity and help them make their own physical activity plans. The multi-faceted strategy consists of (i) a general introduction to physical activity (definition, positives, negatives of physical inactivity) using slides, (ii) discussion about what sort of things motivate them to do physical activity / what stops them doing it and the previous successful physical activity experience, (iii) tips for doing physical activity (intense, duration, safety) and motivation, (iv) encouragement for children to make physical activity plans to be active at school and home gradually (whenever the goal or plan is achieved, verbal congratulations or non-verbal rewards will be offered to them), (v) encouragement for children to make physical activity poster and organisation of presentation, (vi) provision of follow-up educational material (e.g., activity diary) for each child and (vii) encouragement for children to set up activity goals and record their daily physical activity (steps) using the activity diary.

		iii) Family involvement Family involvement is provided to parents and it aims at encouraging parents to support their children in doing physical activity. The strategy consists of (i) a session of health education for parents in terms of physical activity knowledge and ways to promote physical activity among children (using slides), (ii) utilisation of video clips as the demonstrations (from experts), (iii) encouragement for parents to discuss the barriers that hinder children's physical activity as well as the facilitators that can enable physical activity among children, (iv) encouragement for parents to support children in doing physical activity (e.g., making action plans) and (v) provision of follow-up educational material (e.g., a booklet) for each parent to reflect on the knowledge of physical activity.
	WHO PROVIDED	
5.	For each category of intervention provider (e.g. psychologist, nursing assistant), describe their expertise, background, and any specific training given.	i) School environmental support The school environmental support is provided by physical education teachers and HW. The physical education teachers are eligible if he/she is the teacher of the children in our intervention. Sports equipment is purchased and provided by HW. ii) Health education for children Health education for children is delivered by HW with expertise in health behaviour change, physical activity in conjunction with the physical education teacher with expertise in education and safeguarding. iii) Family involvement Health education for parents is delivered by HW with expertise in health behaviour change, physical activity in conjunction with the physical education teacher with expertise in education and safeguarding.
	HOW	
6.	Describe the modes of delivery (e.g. face-to-face	i) School environmental support

	or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group.	The school environmental support (i.e. a poster and sports equipment) is delivered to the children's class at the start of the intervention by HW. ii) Health education for children Health education for children (including discussion, plan-making, poster-making and presentation) is delivered to children in four face to face group sessions by HW (with the presence of the physical education teacher) using Powerpoint slides. The activity diary is used as an educational material delivered to children individually in hardcopy format at the start of this intervention. iii) Family involvement Health education for parents (including discussion) is delivered to parents in an online session by HW (with the presence of the physical education teacher) using the slides. The physical activity booklet is used as an educational material delivered to parents individually in hardcopy format at the start of this intervention.
	WHERE	
7.	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.	i) School environmental support The School environmental support (i.e. a poster and sports equipment) is delivered at the school (intervention group). ii) Health education for children Health education for children (including discussion, plan-making, poster-making and presentation)) is delivered at the school (intervention group). iii) Family involvement Health education session for parents (including discussion) is delivered remotely through an online platform (intervention group).
	WHEN and HOW MUCH	
8.	Describe the number of times the intervention was	i) School environmental support

	delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity, or dose.	The School environmental support is delivered at the beginning of the intervention and it lasts for 16 weeks. ii) Health education for children Health education for children is delivered four times over 45-minute sessions at week 1, 5, 9, and 12. Ongoing supports are available for children from the team subsequently. iii) Family involvement Health education session for parents is delivered once over a 45-minute session, at week 1. Ongoing supports are available for parents from the team subsequently.
	TAILORING	
9.	If the intervention was planned to be personalised, titrated, or adapted, then describe what, why, when, and how.	i) School environmental support The School environmental support is standardised through the use of a printed poster and purchased sports equipment. It is also acknowledged that additional unforeseen questions from children may arise which HW may have to deal with on a case-to-case basis. ii) Health education for children Health education for children is standardised using slides and printed activity diary. These materials are developed by the study team with input from the six physical activity and behaviour change experts. iii) Family involvement Health education for parents is standardised using slides and printed physical activity booklet. These materials are developed by the study team with input from the six physical activity and behaviour change experts.
	MODIFICATIONS	
10.	If the intervention was modified during the course of the study, describe the	N/A

	changes (what, why, when, and how).	
	HOW WELL	
11.	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.	A feasibility study is registered with the Chinese Clinical Trial Registry (ChiCTR1900026865) and is being conducted to test the intervention procedures for its acceptability, such as estimating recruitment and retention, determining the sample size, and optimising the intervention. Specifically, a detailed protocol is developed which included the selection of appropriate data collection tools to measure the change in children's physical activity. Adherence and fidelity are measured by the registry record and the practitioner questionnaire.
12.	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.	Attendance of children and parents for health education sessions are assessed by the registry record on the respective session. Fidelity is assessed among the physical education teacher by a questionnaire.

3.2.1 Behaviour change wheel Intervention development process

3.2.1.1 Step 1: Define the problem in behavioural terms

In this step, researchers are to define the problem in behavioural terms, and there are two components: (i) who would perform the behaviour and (ii) what the behaviour would be.[77] We took into account the specific behavioural context of the problem (i.e., low physical activity levels among Chinese children), and conducted an exploratory literature review to identify the national statistics on physical inactivity and its negative health consequences among Chinese children, and major barriers and facilitators to improving their physical activity.[20,22,26,30,145,146] Specifically, to support our study rationale, an initial search was carried out on MEDLINE and China National Knowledge Infrastructure (CNKI) databases using the keywords: ‘‘physical activity’’, ‘‘physical education’’, ‘‘Chinese’’, ‘‘children’’, ‘‘barriers’’, and ‘‘facilitators’’.

3.2.1.2 Step 2: Select the target behaviour

Having defined the problem of the low level of physical activity in step one, the next step was to decide which behaviour to target through the research literature. In this step, a literature search on the trends of physical activity among Chinese children in different physical activity domains (i.e., everyday activity, active recreation, and sport) was undertaken to identify the target behaviour that could address the defined problem (as identified in step

one).[29,126,134,168-174] Four criteria from the BCW model were used to inform the selection of the final target behaviour: (i) how much of an impact changing the behaviour would have on the desired outcome, (ii) how likely it is that the behaviour can be changed, (iii) how likely it is that the behaviour would have a positive or negative impact on other related behaviours and (iv) how easy it would be to measure the behaviour.[77]

3.2.1.3 Step 3: Specify the target behaviour

Behaviour specification is the step following the selection of the target behaviour where the researchers need to specify the behaviour in precise and appropriate detail and in its context. As guided by the BCW, six questions were raised in this step to help us specify the target behaviour.[77] These questions include i) who would perform the target behaviour, ii) what they would need to do differently to achieve change, iii) where and iv) when they needed to do it, v) how often, and vi) with whom would they do it. Similar to step one and two, a literature search along with researchers' knowledge of children's physical activity helped us to develop the behaviour specification.[41,134,175-177]

3.2.1.4 Step 4: Identify what needs to change

The researcher previously conducted a Joanna Briggs Institute (JBI) qualitative systematic review to synthesise the barriers and facilitators to physical activity (as understood, perceived, or experienced) among ethnic Chinese children who reside in the Chinese and non-Chinese territory or among people who had responsibility for them (e.g., ethnic Chinese/ non-Chinese parents, teachers).[114,178] As this intervention is aimed at Chinese children who are residing in China, only barriers and facilitators to physical activity among Chinese children who reside in the Chinese territories were included. Using the TDF domains and definitions as a guide, the identified barriers and facilitators were coded into 14 TDF domains based on similarity in statements and were illustrated with the quotations. The statements and quotations identified from the systematic review were examined to determine (i) any conflicting beliefs within the domain and (ii) the frequency of specific beliefs across the data (i.e., the percent (count) of statements coded for each specific TDF domain out of the total identified statements).

3.2.1.5 Step 5: Identify intervention functions

Using the mapping table (TDF-intervention function) in the BCW, the intervention functions that most likely affect the behavioural change were selected based on the TDF diagnosis.[77] All the intervention functions were then

assessed according to their affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, and equity (APEASE).[77]

3.2.1.6 Step 6: Identify policy categories

This step aimed to identify policy categories to be used following the TDF analysis and how each of the intervention functions could be supported by the authorities.[77] However, as this screening process largely relied on resource availability (i.e., as the study was not primarily concerned with changing policy at the national agency level). In this study, the identification of policy categories mainly focused on categories that could be supported at the school level. Specifically, the policy categories were identified through the BCW intervention function-policy categories matrix which signposts the seven broad policy-level interventions for achieving behavioural change. The matrix suggests which policy categories are likely to be appropriate and effective in supporting each intervention function. Thus, the researcher mapped the policy categories that might support the delivery of the intervention functions (that were identified in step 5: identify intervention functions). The APEASE criteria were again used to narrow down the most appropriate policy categories at school-level.

3.2.1.7 Step 7: Identify behaviour change techniques and intervention contents

BCTs are considered as the “active ingredients” of an intervention to change behaviours.[77] Specifically, BCTs are observable, replicable, and an irreducible component of the behavioural change intervention and a postulated active ingredient within the intervention (i.e., the proposed mechanisms of change). Previously, BCTs have been identified in relation to particular types of behaviours (e.g., physical activity), and these behaviour-specific ‘taxonomies’ of BCTs have been synthesised. The BCW is linked with a taxonomy of BCTs that allows systematic and transparent selection of the specific BCTs that would best serve the intervention functions.[77,179] As such, this step used BCT taxonomy (BCTTv1) to identify and map the most frequently used BCTs for each intervention function.[179] To identify any additional BCTs, a comprehensive matrix developed by Michie and colleagues to map the relevant 59 BCTs from the BCTTv1 to the TDF domains was utilised.[77] The intervention content was then identified in the form of BCTs that would help bring about the target behaviour. The APEASE criteria were again used to narrow down the most frequently used BCTs for each intervention function.[77]

3.2.1.8 Step 8: Identify the mode of delivery

In the final step of the BCW, it prompts researchers to consider the full range of possible modes of delivering the interventions before deciding the most appropriate one for the particular target behaviour and population and setting.[77] We identified the modes of delivery for BCTs after taking into consideration the context in which the intervention would be implemented. Specifically, the selection was based on the previous experience of physical activity intervention development in the research team and supplemented by the findings obtained from similar research of physical activity intervention among children.[52,54,86,98,176,180-182] Once again, the APEASE criteria were used to assess the selection of the modes of delivery.[77]

3.2.2 Intervention content development

3.2.2.1 Step 1: Expert consultation

A consultation on the intervention was conducted with six academic researchers from the UK (n=4) and China (n=2). Specifically, they have specialised knowledge and professional experience in developing physical activity interventions and/or behavioural change interventions. They were purposively selected to ensure representation of diversity by expertise. Two of the study researchers (HB/KC) have expertise in the field of physical activity

and behaviour change, and so access to these physical activity and behaviour change experts was gained through professional networks within the study team. The intervention materials were shared with them through email, and they reviewed the selection of intervention functions, BCTs, and content as well as the readability, flow of information, and consistency of expressions in the developed intervention. All experts reviewed the intervention materials independently, and their feedback (received via email) was used to improve the intervention structure and materials. Specifically, we thoroughly reviewed and discussed each comment given by the experts and then revised the intervention materials accordingly.

3.2.2.2 Step 2: Patient and public involvement and engagement (PPIE) in research

PPIE in research means doing research 'with' the patients and public in research.[156] In other words, they should be actively involved in research activities as partners and decision-making. In turn, it could make the methods and outcomes more appropriate to research participants.[157] In this case, PPIE involvement provided their perspectives, and the aim was not to ensure their "representativeness".[158] We aimed for a variety of perspectives and different viewpoints. Six lay people in China were part of this PPIE. They were the intended user community and purposively selected. Like step eight, we used

our lay members' contact to approach these lay people. Specifically, PPIE group included one boy and a girl aged 10-12 years, parents of each child (one father and one mother who had university education and were employed), and two physical education teachers (one male, one female) who had more than 20 years of teaching experience in a local public primary school in China. The intervention materials were shared with them (i.e., children viewed materials for children, parents viewed materials for children and parents, teachers reviewed all materials), and their preferences were identified (i.e., decision was made by considering whom the material was targeting at) and used to finalise the intervention materials (e.g., whether they preferred cartoon or photo for illustrations in the intervention materials and whether they were comfortable with the length of the text in the intervention materials).

3.2.2.3 Step 3: Piloting

Piloting is a preparatory investigation that provides specific information needed for planning subsequent studies.[183] It can assist the researchers to identify potential problems as well as possible solutions.[183] In this step, participants' understanding of the intervention materials was tested and then finalised. Specifically, comments raised about unintelligible, unacceptable or offensive words within the intervention materials were reviewed and revisions were made after considering the alternative words or expressions that best represent the

acceptable and common language in Chinese culture. The intervention materials were piloted among four children (aged 10-12 years), four parents (whose child was aged 10-12 years), and four physical education teachers. They were purposively selected from a local primary school. Like step nine, the researcher aimed for a variety of perspectives and different viewpoints. The intervention materials were shared with them to read and understand in their free time (i.e., children viewed materials for children, parents viewed materials for children and parents, teachers reviewed all materials). The shared intervention materials were reported in the result section (i.e., step eight, nine and ten). The objectives were to identify any difficulties they had in reading and understanding the intervention materials (i.e., comprehension of content/instructions). Parents and teachers were requested to make suggestions for change or discuss any queries directly with the researchers. Teachers were requested to collect and record any queries that children had and report these to the researchers. Their feedback was used to finalise the intervention.

3.3 Results

3.3.1 Behaviour change wheel Intervention development process

3.3.1.1 Step 1: Define the problem in behavioural terms

Physical inactivity among children is a serious public health problem. Evidence suggests that physical inactivity is significantly associated with many negative health (physical and mental) consequences, including increased risk of cardiovascular diseases, cancers, type 2 diabetes, musculoskeletal disorders, anxiety and depression.[20,26] The researcher identified four systematic reviews that synthesised the reasons for low engagement in physical activity among Chinese children.[41,42,104,105] In summary, the researcher synthesised that physical inactivity among children was a result of a combination of personal, social-cultural, environmental and policy- and programme-related factors.[114,178] All these factors should be taken into consideration when developing a behaviour change intervention to increase physical activity among Chinese children.

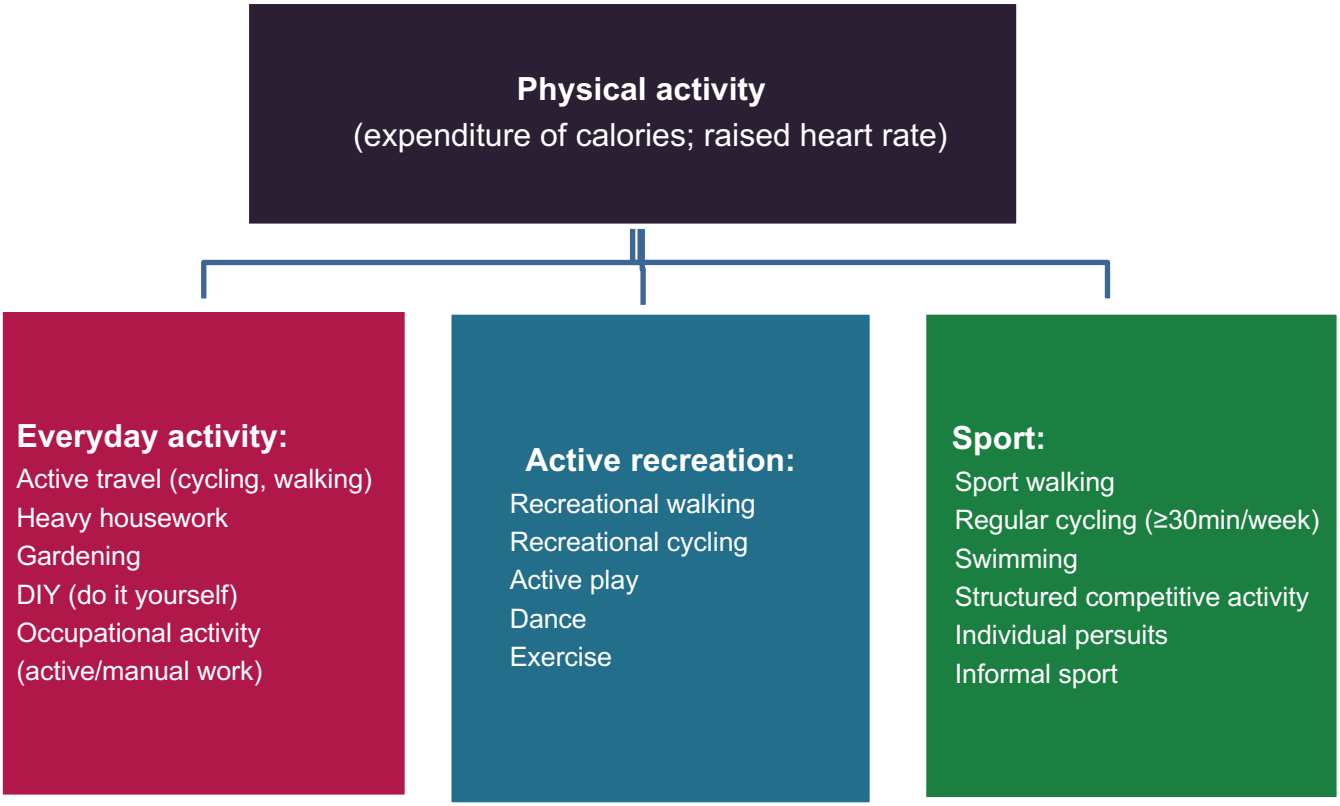
3.3.1.2 Step 2: Select the target behaviour

Physical activity is a complex behaviour and can be divided into three domains: everyday activity (e.g., active travel, occupational activity), active recreation (e.g., active play, recreational walking, exercise) and sport (e.g., sport walking, structured competitive activity) (see Figure 12).[184] In China, the decline in children's physical activity can be found in all of these three domains, and this decline continues from childhood into adolescence. Regarding everyday

activity, for instance, a great decline was reported in children's active travel.[168] Specifically, there were only approximately 41% of Chinese children who travelled to school on foot or by bike in 2016.[169] In terms of active recreation, it has been significantly influenced by the increasing utilisation of computer, television (TV), and video games.[170] Children should not have more than 120 minutes of sedentary behaviour per day (e.g., watching TV, using computers, playing video games).[171] However, over a third of Chinese children did not achieve this recommendation in 2016.[174] Chinese children are reported to have insufficient physical activity (sport) opportunities, and they spend the majority of their time on academic attainment.[126,134,172,173] Previous research has reported an average of nine hours in school's weekday (ranges from 6.5 to 11.65 hours) in Chinese schools.[40] The majority of Chinese children are suggested to spend around 30 to 90 minutes per day on homework, and there are 30% of children who spend over 90 minutes on homework.[40,137] Chinese children have a higher study load than children from other areas of the world (around 14 hours per week on homework compared to around six hours in the US and three hours in Finland).[40] In addition, more than 66% of Chinese children are having extracurricular tutoring classes each week. In contrast, only 24.7% of Chinese children participated in organised exercise sessions afterschool.[30] In China, academic achievements are heavily emphasised and schools are evaluated based on their academic performances. As a result, schools prefer to allocate greater resources (including time) more to academic

curriculum compared to physical activity.[29,136,137] Overall, all these three domains were identified to be the pivotal domains. As suggested by the BCW, it is more effective to intervene intensively on one or two target behaviours than to intervene less intensively on multiple behaviours.[77] Children's physical activity through active recreation at school appeared to be promising and could have a positive impact on children and their peers and parents. These criteria addressed that (i) how much of an impact changing the behaviour would have on the desired outcome, (ii) how likely it is that the behaviour could be changed, (iii) how likely it is that the behaviour would have a positive or negative impact on other related behaviours, and (iv) how easy it would be to measure the behaviour.[77] Children spend the majority time of their waking hours in school, and therefore schools represent an ideal environment to reach the majority of school-aged children.[185] Schools can provide access to children from different socioeconomic backgrounds and help institutionalise the physical activity programmes into other settings, such as communities.[185] Five to 45 minutes per day of improvement in MVPA can be achieved through school-based physical activity interventions.[54] Based on existing literature, targeting schools to increase children's physical activity appears to be promising and is relatively easy to implement and reasonably easy to measure.[175-177]

Figure 12: Physical activity domains



3.3.1.3 Step 3: Specify the target behaviour

The behaviour specification is detailed in Table 5. Previous systematic reviews on school-based physical activity interventions have identified that the increase in children's physical activity level can be potentially achieved through (i) active lunch breaks (i.e., providing opportunities for children to be physically active during the lunch break), (ii) classroom physical activity breaks (i.e., short breaks for doing physical activities) and (iii) education on being physically active.[175,176] The classroom physical activity breaks are highly effective in presenting opportunities for children to participate in a range of organised or unorganised physical activities.[176,177] Classroom physical activity breaks were therefore

considered as an important intervention target time in our study. In terms of the people who could influence children's physical activity engagement, parents and teachers were identified as the integral "gatekeepers" because they play an important role in establishing children's health behaviours.[41,134] Parents and grandparents are likely to be over-attentive due to the "one-child policy" in China, and this may result in children having less intrinsic physical activity motivations.[186] Beyond the parental influences, the role of teachers and peers is influential in shaping a child's physical activity behaviour and has been identified as another important facilitator in the literature.[41,42,104,134] Altogether, children were identified as the intervention target, and their peers, teachers, and parents were identified as important people who may influence children's physical activities.

Table 5: Behaviour specification

i) Who needs to perform the behaviour?	Children[22,145]
ii) What do they need to do differently to achieve the desired change?	Participate in more physical activity at school[93,95]
iii) When do they need to do it?	Physical education class, break time and after school time[175-177]
iv) Where do they need to do it?	At school and after school[54,185]
v) How often do they need to do it?	At least 60 minutes' MVPA per day[4]
vi) With whom do they need to do it?	Peers, teachers, parents[41,42,104,134]

3.3.1.4 Step 4: Identify what needs to change

The findings of the systematic review are reported in detail in chapter 2.[178] Briefly, 11 studies were included in the systematic review explored the barriers and facilitators to physical activity among ethnic Chinese children and extracted 56 findings. Of which 37 findings were extracted from the studies conducted in the Chinese territories and 19 findings were from the studies in non-Chinese territories. Overall, ten TDF domains were coded based on the findings of systematic review in this step (see Table 6). Of 37 extracted findings, the most commonly coded TDF domains accounting for 89.1% of the total findings were environmental context and resources (n=12; 32.4%), social influences (n=8; 21.6%), beliefs about consequences (n=6; 16.2%), memory, attention, and decision process (n=3; 8.1%), emotion (n=2; 5.4%), and belief about capabilities (n=2; 5.4%). The remaining findings were coded into other four TDF domains, which accounted for 2.7% (n=1) respectively (e.g., belief about capabilities, skills, knowledge, social/professional role, and identity). Four domains (optimism, reinforcement, intentions, and behavioural regulation) were not identified from the 37 findings and thus were not coded. The table of TDF domains, findings, and quotations was made and organised hierarchically by percent frequency (see Table 6). Of 37 findings, 16 were facilitators and 22 were barriers. Only one finding (circumstances that make physical activity easy and circumstances that make it difficult) was discussed as both barrier and facilitator. In terms of the TDF domains, more barriers than facilitators were

discussed relating to environmental context and resources (three facilitators, eight barriers, and one both) while only the social influences had more facilitators than barriers discussed in the domain (five facilitators, two barriers). As for the memory, attention and decision process, emotion, skills, and social/professional role and identity, only the barriers were discussed within these domains. In comparison, only facilitators were discussed in the domains of belief about capabilities, knowledge, and goals. Barriers and facilitators were equally discussed in beliefs about consequences.

Table 6: Summary of behavioural diagnosis using the TDF (quotes are taken verbatim from the systematic review)

TDF	Frequency* (% total)	Findings (barriers and facilitators)/ why are children doing or not doing physical activity	Quotes
Environmental context and resources	32.4%	I have no time or peers to play with me for leisure-time exercise (B)	"I do not have time for leisure time exercise at all from Monday to Friday. I came home late from school in the evening, and when I finish my homework, it's time to sleep. I just don't have time to exercise at all"
		Salient consequences of participating in physical activity (B)	"The most frequently mentioned disadvantage, "will take too much time," was mentioned by 40.6% of the students"
		Circumstances that make physical activity easy and circumstances that make it difficult (B, F)	"Many of the circumstances (e.g., assignments, time, and weather) were mentioned both as circumstances that make physical activity easy and as circumstances that make it difficult. The most frequently reported facilitator of physical activity, "having fewer assignments", was mentioned by 27.7% of the students. The most frequently mentioned barrier, "having too many assignments", was mentioned by about half (48.4%) of the students. Additionally, "time" was the second most frequently mentioned circumstance; 14.2% of the students mentioned having more time as a facilitator, and 18.8% mentioned not having enough time as a barrier. These data also suggest that "having fun activities," "having others to participate with," "approval from others" and "making facilities more available" operate as facilitating and hindering circumstances"
		"Academic-focused" school environment seemed to be a major barrier for PA participation (B)	"I personally think childhood obesity nowadays is due to the fact that kids eat too much and move too little. The environment now is so different from the environment of my childhood. My kid is sitting there all day studying and no time for exercise. It seems that he does not like exercise at all, and when he has spare time, he watches TV"
		Safety (crime) (B)	"Afraid of being taken or hurt at night"
		Safety (traffic) (B)	"Few cars on roads"
		Safety issue (B)	"Some dangerous activities, like skating, it's not too safe for my girl to play. Children usually can't decide what is dangerous for them. They just play for fun but neglect the importance of safety. For example, I won't let him go climbing hills or rock…it's too dangerous. I've seen quite a lot of accidents happened in people climbing, it's definitely not suitable for children, especially girls, it's just not right for her to play such rough sport and Hong Kong don't have much safe climbing places for younger ones and there is a lack of qualified teachers"
		Functionality (F)	"Convenient transportation"
		Other negative feelings (B)	"Too many students in a class (40-45 students sharing one basketball court)"
		Destination (F)	"Recreation grounds"
		Aesthetic (F)	"Fresh air"
		Others (B)	"Too many people in recreation grounds"
Social influences	21.6%	Families are an important factor in their physical activity participation (F)	"Doing physical activity is fun and when I see other people playing, I want to be one of them . . . My parents also encouraged me. They would spend time jogging with me and I still remember we had so much fun"
		Confucian father played a leading role in determining the different dimensions in his children's life (F)	"Interestingly, within the group we interviewed, only fathers provided actual facilitation of their children's physical activity. One of them acted as an assistant coach regularly in his boy's rugby team, while a few attended their children's sports competitions such as badminton and swimming during their leisure time, and two parents assisted with transporting children to playgrounds"
		Salient who approve referents (F)	"Clearly, most of the salient referents for this behaviour were family members, including parents, others, fathers, and grandparents. Teachers and classmates were also mentioned by these middle school students. Doctors and other health professionals were not very frequently mentioned. Parents were the most frequently mentioned approving group and disapproving group and were mentioned more frequently as approving (42.6%) than as disapproving (27.7%)"

		High expectation of children's academic success (B)	"My son is now in the soccer team and he practices for many days a week …he comes back home at 7 pm and I think soccer is distracting him from studying well… I'm so afraid that he'll get hurt and I'm thinking not let him play anymore. I usually let him do whatever he wants in sports but if the exam is near, I'd advise him to play less basketball, I think it's better for him to spend more time studying than on playing"
		Physical activity to be another responsibility in their lives (B)	"There was a time a basketball club invited me to join them, and I know this was a chance for me to play at a professional level. However, my mother opposed my decision, and I did not dare to argue with her. Well, actually I don't really feel too regretful as I treated it as an interest. It only matters if I could play basketball happily or not. After practising for a long time, I saw there was not much improvement, and I felt that I had reached the top already. Therefore, I gave up the interest in swimming"
		Make tailored objectives for students (F)	"We should combine the collective goal with the individual goal. Each student's physical quality and individual ability are different. We should fully consider the individual difference of each student when setting the teaching goal. When setting the collective teaching goal, we should make the goal has a certain range of fluctuation, because the requirement is universal for each student. We should ensure that students whose sports learning ability are not strong enough can improve their sports achievements through hard work and their interest in sports learning can be increased due to the establishment of motivation in sports learning. In the other way, this goal should also apply to those who have higher sports learning abilities"
		Strength the teaching and management regulation (F)	"The PE teachers should respect and care about students rather than criticise students at will. Teachers should equip a positive attitude and be the role model so that the students will feel the equality between themselves and teachers. In addition, they may be attracted to the class. With the establishment of a harmonious relationship between students and teachers, students will thus take the teachers as examples and change their behaviour"
		Lack of social support (B)	"I always do sport alone by myself and this is why sport is not interesting to me. I do not like it because there is no one to compete with or compare with me. There is no one to encourage me and I do not feel happy when doing sport"
Beliefs about consequences	16.2%	Improving on their health (F)	"Physical activity is important because it is good for my health, I get less pain and disease after doing physical activities"
		Having positive outcomes for academic and/or career future (F)	"Sport may be useful for my future job because I will find sport-related careers, like being an athlete. I want to be as good as those Olympic athletes, I think they are gorgeous"
		Physical activity was not useful in relation to entering a better secondary school (B)	"Sometimes I think it [physical activity] is not really that useful at all as most schools do not think it is relevant to study"
		Physical activity had a lower priority than academic studies (B)	"I would like to excel in my academic studies. I think studies may affect my future but not the sport. I always place academic studies first"
		The importance of PE was linked closely to their children's academic advancement (F)	"PE is important because it makes my son healthier . . . good health may help him study better"
		Confucian beliefs in taking 'good care' of children (B)	"I used to do some sports and stretching exercises at home. I don't participate in too many activities now after I've had my child. I need to take care of her academic matters and other aspects of life such as driving her to a private tutoring centre to learn English and taking a computer course after school. Therefore, I don't have much time to do exercise myself. I know doing more physical activity is good for my child, but I'd rather have her study first and only allow her to play for a while if she could finish her school work. You know, too much play will negatively affect her academic performance"
	8.1%	Feeling too tired after doing physical activity (B)	"I need to put in too much effort in sport. I do not like the feeling of tiredness after doing sport"

Memory, attention and decision process		I exercise only during the physical education (PE) class, and I exercise primarily to pass the high school entrance examination, commonly known as “Zhongkao.” (B) Complained about the teacher and the curriculum (B)	“We have a morning recess. Usually, we start with group rhythmic gymnastics and then jump roping. We have PE class, and each class content is arranged by teachers for us to run or do items for Zhongkao. We are not given free play time during PE class. I like playing badminton, but my PE teacher said I can only play badminton after I am capable of receiving full credits for all Zhongkao-tested items" "Having academic subject lessons at the expense of PE lessons, especially when it comes to the senior secondary level"
Emotion	5.4%	Overly skill-oriented nature of their classes (B) Insufficient time provision both in the school’s physical education curriculum and after school hours (B)	“It’s not very nice because we always learn traditional sports, such as track and field, soccer, basketball, volleyball, and gymnastics. It is no fun at all. Teachers are actually repeating the same content we have already learned in senior primary schools. I dislike running long distances; it is so boring” "Well, it seems that during PE lessons, most of the time, about 15 to 20 minutes was allocated to doing stretching and warm-up, and the time for us to really learn a sport is not enough"
Belief about capabilities	5.4%	Feeling happy and competent and enjoying the sport and movement (F) High attainment value and high utility in physical activity (F)	"I feel satisfied when I can shoot a basketball into the ring . . . and usually, I am able to hit the shuttlecock with a swift sound and therefore I feel really happy and have fun playing with it . . . When I play badminton, I think the sound of hitting a badminton cock is really interesting, I feel very happy when I could hit the cock with that kind of special sound" "I can boast in front of my teammates in basketball, which I think is important for me to do better in it"
Goals	2.7%	As they grew up, time spent on a particular physical activity increased (F)	"I play table tennis more now and therefore have less time for other activities. I’d rather focus my time on improving in it than spending time doing various sports which seem to be wasting my time"
Skills	2.7%	Lack of perceived improvement in physical activity (B)	"I do not feel any differences or improvements and I think it is boring. I am always like that, not a bit better"
Knowledge	2.7%	An instrumental orientation to physical activity engagement (F)	"Students in Hong Kong, as far as I know, are not doing much sports and exercise. I’m sure exercise can help my son to be fit and maintain a good shape and weight"
Social/professional role and identity	2.7%	Parental work commitment (B)	“Both of us need to work six days a week, well… we’re not rich and we must work for the money for the family. Sometimes we would go out with the kids on Sundays and we usually go shopping or dining out"

B, barrier; F, facilitator

*%, the percent (count) of statements coded to each specific TDF domain, out of the total identified statements.

3.3.1.5 Step 5: Identify intervention functions

All nine intervention functions were available for selection. Two intervention functions (i.e., coercion and restriction) were excluded as they did not meet the APEASE criteria.[77] Coercion was not considered as practicable, acceptable or equitable in the school context. The restriction was deemed not to be acceptable to children, parents and teachers. Eventually, seven intervention functions were selected for this study design including education, persuasion, incentivisation, training, environmental restructuring, modelling and enablement.

Table 7: Selected BCTs for this intervention

TDF	Intervention function	BCT	Does the BCT meet the APEASE criteria?
Skills	Training	Demonstration of the behaviour	No: not acceptable
		Instruction on how to perform a behaviour	No: not acceptable
		Feedback on the behaviour	Yes: provide feedback on the behavioural performance
		Feedback on outcome(s) of behaviour	No: not practicable or acceptable
		Self-monitoring of the behaviour	Yes: incorporate a measuring method for own physical activity level
		Behavioural rehearsal/practice	No: not practicable, effective, or acceptable
		Graded tasks	Yes: include easy-to-perform tasks
Knowledge	Education	Information about social and environmental consequences	No: not effective or acceptable
		Information about health consequences	Yes: educate on the health outcomes of physical activity
		Information on emotional benefits	Yes: educate on the emotional outcomes of physical activity
		Feedback on the behaviour	No: not effective or acceptable
		Feedback on outcome(s) of the behaviour	No: not effective or acceptable
		Prompts/cues	No: not practicable or acceptable
		Self-monitoring of the behaviour	No: not effective or acceptable
Memory, attention and decision processes	Training	Demonstration of the behaviour	Yes: provide observable examples of children who are enjoying the physical activity
		Instruction on how to perform a behaviour	Yes: give advice about how to perform the behaviour
		Feedback on the behaviour	No: not practicable, effective, or acceptable
		Feedback on outcome(s) of behaviour	No: not practicable, effective, or acceptable
		Self-monitoring of the behaviour	No: not practicable, effective, or acceptable
		Behavioural rehearsal/practice	No: not practicable, effective, or acceptable
	Enablement	Social support (practical)	Yes: advise, arrange or provide practical help to do physical activity
		Goal setting (behaviour)	No: not practicable, effective, or acceptable
		Goal setting (outcome)	No: not practicable, effective, or acceptable
		Adding objects to the environment	No: not practicable, effective, or acceptable
		Problem-solving	No: not practicable, effective, or acceptable
		Action planning	No: not practicable, effective, or acceptable
		Self-monitoring of the behaviour	No: not practicable, effective, or acceptable
		Restructuring the physical environment	Yes: advice changing the "exam-oriented" physical education environment
		Review behaviour goal(s)	No: not practicable, effective, or acceptable
		Review outcome goal(s)	No: not practicable, effective, or acceptable
Social/professional role and identity	Education	Information about social and environmental consequences	No: not practicable or acceptable
		Information about health consequences	Yes: educate on the outcomes of physical inactivity
		Information on emotional benefits	Yes: educate on the emotional outcomes of physical activity
		Feedback on the behaviour	No: not practicable or acceptable
		Feedback on outcome(s) of the behaviour	No: not practicable or acceptable
		Prompts/cues	No: not practicable or acceptable
		Self-monitoring of the behaviour	No: not practicable or acceptable
	Persuasion	Credible source	Yes: present verbal or visual communication from a credible source against the physical inactivity
		Information about social and environmental consequences	No: not practicable or acceptable
		Information about health consequences	Yes: persuasive communication on the benefits of exercises for children
		Feedback on behaviour	No: not practicable or acceptable
		Feedback on outcome(s) of the behaviour	No: not practicable or acceptable
	Modelling	Demonstration of the behaviour	Yes: provide observable examples where parents play with their child

Belief about capabilities	Education	Information about social and environmental consequences	No: not practicable or acceptable
		Information about health consequences	Yes: educate on the outcomes of physical inactivity
		Feedback on the behaviour	Yes: provide informative on the behavioural performance
		Feedback on outcome(s) of the behaviour	No: not practicable or acceptable
		Prompts/cues	No: not practicable or acceptable
		Self-monitoring of the behaviour	Yes: incorporate a measuring method for own physical activity level
		Focus on past Success	Yes: advice to think about or list previous successes in doing physical activity
		Verbal persuasion about capability (to boost self-efficacy)	Yes: tell the children that they can successfully do any (paly) physical activity even they may not good at it now
	Persuasion	Credible source	No: not effective or acceptable
		Information about social and environmental consequences	No: not effective or acceptable
		Information about health consequences	No: not effective or acceptable
		Feedback on behaviour	Yes: provide feedback on the behavioural performance
		Feedback on outcome(s) of the behaviour	No: not practicable or acceptable
	Modelling	Demonstration of the behaviour	Yes: provide observable examples of children/sportsman who have successfully participated in sports/exercises
Belief about consequences	Education	Information about social and environmental consequences	No: not effective or acceptable
		Information about health consequences	Yes: educate on the outcomes of physical inactivity and benefits of physical activity
		Information on emotional benefits	Yes: educate on the emotional outcomes of physical activity
		Feedback on the behaviour	No: not practicable, effective, or acceptable
		Feedback on outcome(s) of the behaviour	No: not practicable, effective, or acceptable
		Prompts/cues	No: not practicable, effective, or acceptable
		Self-monitoring of the behaviour	No: not effective or acceptable
		Pros and cons	Yes: educate on the outcomes of physical inactivity and benefits of physical activity
	Persuasion	Credible source	No: not practicable or acceptable
		Information about social and environmental consequences	No: not effective or acceptable
		Information about health consequences	Yes: educate on the outcomes of physical inactivity and benefits of physical activity
		Feedback on behaviour	No: not practicable, effective, or acceptable
		Feedback on outcome(s) of the behaviour	No: not practicable, effective, or acceptable
	Modelling	Demonstration of the behaviour	Yes: provide observable examples of benefits obtained by the children from doing sports/exercises
Goals	Education	Information about social and environmental consequences	No: not practicable, effective, or acceptable
		Information about health consequences	No: not practicable, effective, or acceptable
		Feedback on the behaviour	Yes: provide feedback on the physical activity
		Feedback on outcome(s) of the behaviour	No: not practicable, effective, or acceptable
		Prompts/cues	Yes: have physical activity poster posted in the classroom
		Self-monitoring of the behaviour	Yes: incorporate a measuring method for own physical activity level (e.g., pedometer diary)
	Persuasion	Credible source	No: not practicable, effective, or acceptable
		Information about social and environmental consequences	No: not practicable, effective, or acceptable
		Information about health consequences	No: not practicable, effective, or acceptable
		Feedback on behaviour	Yes: provide feedback on the physical activity
		Feedback on outcome(s) of the behaviour	No: not practicable, effective, or acceptable
	Incentivisation	Feedback on behaviour	Yes: provide feedback on the physical activity
		Feedback on outcome(s) of behaviour	No: not practicable, effective, or acceptable
		Monitoring of behaviour by others without evidence of feedback	No: not practicable, or acceptable
		Monitoring outcome of behaviour by others without evidence of feedback	No: not practicable, acceptable, or effective

		Self-monitoring of the behaviour	Yes: incorporate a measuring method for own physical activity level (e.g., pedometer diary)
		Material reward	Yes: provide stickers for children who have achieved physical activity goals
	Modelling	Demonstration of the behaviour	No: not practicable, effective, or acceptable
	Enablement	Social support (practical)	Yes: advise parents to do physical activity with children
		Goal setting (behaviour)	No: not practicable, effective, or acceptable
		Goal setting (outcome)	No: not practicable, effective, or acceptable
		Adding objects to the environment	No: not practicable, effective, or acceptable
		Problem-solving	No: not practicable, effective, or acceptable
		Action planning	No: not practicable, effective, or acceptable
		Self-monitoring of the behaviour	No: not practicable, effective, or acceptable
		Restructuring the physical environment	Yes: advise changing the structure of physical education
		Review behaviour goal(s)	No: not practicable, effective, or acceptable
		Review outcome goal(s)	No: not practicable, effective, or acceptable
		Social support (emotional)	Yes: advise parents and teachers to provide positive feedback/encouragement
Emotions	Enablement	Social support (practical)	Yes: advise, arrange or offer practical help to do physical activity
		Goal setting (behaviour)	Yes: advise children to make physical activity plans
		Goal setting (outcome)	No: not practicable or acceptable
		Adding objects to the environment	No: not practicable, effective or acceptable
		Problem-solving	Yes: discussion on barriers and provision of feedback
		Action planning	No: not practicable, effective, or acceptable
		Self-monitoring of the behaviour	No: not practicable, effective or acceptable
		Restructuring the physical environment	Yes: advise changing the "exam-oriented" physical education's environment
		Review behaviour goal(s)	No: not practicable, effective, or acceptable
		Review outcome goal(s)	No: not practicable, effective, or acceptable
		Social support (emotional)	Yes: provide emotional encouragement and positive feedback
Environment context and resources	Environmental restructuring	Adding objects to the environment	Yes: provide sports equipment for children
		Prompts/cues	Yes: have physical activity poster posted in the classroom
		Restructuring the physical environment	No: not affordable, practicable, or acceptable
	Enablement	Social support (practical)	Yes: advise parents/teachers to encourage or do physical activity with children
		Goal setting (behaviour)	Yes: agree on a daily walking goal with children
		Goal setting (outcome)	No: not practicable or acceptable
		Adding objects to the environment	Yes: provide sports equipment for children
		Problem-solving	Yes: prompt the children to identify barriers that prevent them from doing physical activity and discuss ways in which they could overcome the barriers
		Action planning	Yes: encourage to make a plan to do physical activity on weekends
		Self-monitoring of the behaviour	Yes: give the child a pedometer and a diary for recording the daily total number of steps
		Restructuring the physical environment	Yes: provide sports equipment for children
		Review behaviour goal(s)	Yes: examine how well a person's performance corresponds to agreed goals
		Review outcome goal(s)	No: not practicable or acceptable
Social influences	Modelling	Demonstration of the behaviour	Yes: provide observable examples of parents who encourage children to do physical activity or play with their child
	Enablement	Social support (practical)	Yes: advise parents/teachers to encourage or do physical activity with children
		Goal setting (behaviour)	Yes: agree on a daily walking goal with children
		Goal setting (outcome)	No: not practicable or acceptable
		Adding objects to the environment	Yes: provide sports equipment for children

	Problem-solving	Yes: prompt the children to identify barriers that prevent them from doing physical activity and discuss ways in which they could overcome the barriers
	Action planning	Yes: encourage to make a plan to do physical activity on weekends
	Self-monitoring of the behaviour	Yes: give the child a pedometer and a diary for recording the daily total number of steps
	Restructuring the physical environment	Yes: provide sports equipment for children
	Review behaviour goal(s)	Yes: examine how well a person's performance corresponds to agreed goals
	Review outcome goal(s)	No: not practicable or acceptable
	Social support (emotional)	Yes: advise parents and teachers to give positive feedback/encouragement
	Identification of self as role model	No: not practicable or acceptable
	Social reward	Yes: verbally praise the children who have achieved the goal

Embolden BCTs were identified through the TDF-BCT matrix

3.3.1.6 Step 6: Identify policy categories

The broad policy options, signposted by the BCW intervention function-policy categories matrix as being potentially useful for achieving behavioural change at school level, were a) communication/marketing (e.g., using verbal communication, written materials and physical activity posters to increase awareness of benefits of physical activity), b) guidelines (e.g., informing children of relevant physical activity guidelines), and c) environmental/social planning (e.g., proving sport equipment in the school context).

3.3.1.7 Step 7: Identify behaviour change techniques and intervention contents

In terms of the BCTs, fifteen BCTs that best serve the seven intervention functions were first identified using the BCTTv1 taxonomy and then selected based on evaluation against the APEASE criteria.[77,179] Specifically, the acceptability was assessed by taking consideration of the appropriateness of a BCT from the perspectives of the teachers in the intervention school and the researcher. In the domain of skills, for instance, the BCTs of demonstration of the behaviour, instruction on how to perform a behaviour and behavioural rehearsal/practice were assessed as ineligible as the incorporation of a training module (e.g., structure exercises) into the school would be considered as not acceptable from the school and time-consuming from the researcher.

Practicability was assessed by taking consideration of the viability of the BCTs. For instance, in the domain of social influences, the BCT of identification of self as role model was assessed as not practicable as there were not enough opportunities to apply this BCT in this behaviour change intervention. Effectiveness was assessed by considering the potential intervention effects of the BCTs in relation to the desired objectives in the school context. For instance, in the domain of education, the BCT of information about social and environmental consequences was considered with possibly low effectiveness in physical activity promotion in the school context. Subsequently, a review of the matrix of TDF and BCTs identified six additional BCTs to include in this intervention (see Table 7).[187] As a result, there were 21 BCTs in total selected for the intervention.

A summary of intervention functions, BCTs as well as examples of intervention contents that describe how the BCTs are delivered in the intervention is presented in Table 8. This table represents a summary of all the steps in the BCW and is the culmination of all the steps of the work in the current study. As suggested in step four, the barriers and facilitators were, by and large, related to the TDF domains of environmental context and resources; social influences; the belief about the consequences; memory, attention and decision process; and emotion. In other words, environmental, socio-cultural, and personal factors would be the priorities of our intervention, and the selected BCTs would help bring about the target behaviour. Restructuring the physical environment

is to make a change in the physical environment to help facilitate the performance of the target behaviour.[77] By adding objects to the environment (providing sports equipment) and using prompts/cues (e.g., poster), children's initiatives for doing physical activity may increase (see Table 8). The teachers will persuade the role of physical activity and encourage children to use the provided sports equipment.

Provision of information about health consequences/emotional benefits in the intervention could educate both children and parents. Additionally, the demonstration of the behaviour could act as persuasion whenever there exists an opportunity for doing physical activity (see Table 8). Emphasising the pros and cons, previous successful experience, and personal capacities in physical activity may encourage children to perform the activity voluntarily. Information that indicates when and how to perform physical activity is crucial content for the individuals and could act as a prompt or cue to action (see Table 8). Goal setting, graded tasks, and action planning were also identified as valuable BCTs and emphasised the importance of acting in the present but also planning for the future. Engaging children to self-monitor the behaviour may facilitate the completion of individual actions and act as a springboard from which children can improve with feedback (on their behaviour) from a health practitioner. Moreover, teachers and health practitioners will review the behavioural goals of children through the intervention to encourage them to act on their own self-set personalised goals (see Table 8). Other social support strategies will involve

asking children to buddy up with friends (i.e., social support (emotional)) or parents to prepare sports gear for their children (i.e., social support (practical)). Whenever a child achieves the physical activity goal, giving a social reward or material reward may help incentivise their motivation in keeping the desired behaviour.

Table 8: Examples of the intervention content and mechanism of action using the BCW and TDF

Intervention contents (examples of application within the intervention)	BCTs selected	Intervention functions	TDF	COM-B
School environmental support				
Verbal encouragement for doing physical activity during the class break.	15.1 Verbal persuasion about capability	Pers	B cap	Ref M
Put physical activity posters in the classroom.	7.1 Prompt/cues 12.5 Adding objects to the environment	Ed, Env	Env, Goals	Ref M, Phy O
The intervention will provide sports equipment for children to use during the class break.	3.2 Social support (practical) 12.1 Restructuring the physical environment 12.5 Adding objects to the environment	Ena, Env	Env, MAD	Phy O, Psy C
Health education for children				
General introduction to physical activity via slides (definition, positives, negatives of physical inactivity).	5.1 Information about health consequences 5.6 Information on emotional benefits	Ed	B con, Kn	Ref M, Psy C
Discussion about what sort of things make them want to do physical activity, what stops them from doing it, and the previous successful physical activity experience.	1.2 Problem-solving 9.2 Pros and cons 15.3 Focus on past success	Ed	B cap, Kn	Ref M, Psy C
Tips for doing physical activity (intense, duration, safety) and motivation.	4.1 Instruction on how to perform the behaviour 6.1 Demonstration of the behaviour	Pers	B cap	Ref M
Encourage children to make physical activity plans to be active at school and home gradually. Whenever the goal or plan is achieved, verbal congratulations or non-verbal rewards will be offered to them.	1.1 Goal setting (behaviour) 1.4 Action planning 10.2 Material reward (behaviour) 10.4 Social reward 15.1 Verbal persuasion about capability	Pers, Inc	B cap	Ref M
Encourage children to make physical activity poster and give the presentation.	1.1 Goal setting (behaviour) 1.4 Action planning	Pers, Ena	B cap, B con	Ref M
Provide follow-up educational material (e.g., activity diary) for each child.	5.1 Information about health consequences 5.6 Information on emotional benefits 7.1 Prompts/cues 12.1 Restructuring the physical environment 12.5 Adding objects to the environment	Ed, Env	B con, Kn, B cap, SI	Soc O, Ref M, Psy C
Children will be asked to set up activity goals and record their daily physical activity.	1.1 Goal setting (behaviour) 1.4 Action planning 1.5 Review behaviour (goals) 2.3 Self-monitoring of the behaviour 8.7 Graded tasks	Ena, Tra	Sk, Goals	Phy C, Ref M
Provide feedback with children about the activity plans.	2.2 Feedback on behaviour	Pers	B cap	Ref M
Family involvement				
Educate parents about the physical activity knowledge and ways to promote physical activity among children.	5.1 Information about health consequences 5.6 Information on emotional benefits	Ed, Pers	Kn, Id	Psy C, Ref M
Use the video clips as the demonstrations (from experts).	6.1 Demonstration of the behaviour	Ed, Mod	B con, Kn	Ref M, Psy C

Encourage parents to discuss the barriers that hinder children's physical activity as well as the facilitators that can enable physical activity among children.	1.2 Problem-solving 9.2 Pros and cons	Ed	B cap, Kn	Ref M, Psy C
Encourage parents to support children in doing physical activity (e.g., making action plans).	1.1 Goal setting (behaviour) 3.2 Social support (practical) 3.3 Social support (emotional)	Ena	SI, Em	Soc O, Auto M
Provide follow-up educational material (e.g., physical activity booklet) for each parent to reflect on the knowledge of physical activity.	4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.6 Information on emotional benefits 7.1 Prompts/cues 12.1 Restructuring the physical environment 12.5 Adding objects to the environment	Ed, Env	SI, Kn, Id, B con, B cap	Soc O, Psy C, Ref M

TDF domain abbreviations: Kn knowledge; MAD memory, attention and decision processes; SI social influences; Env environmental context and resources; B Cap beliefs about capabilities; B Con beliefs about consequences; Id social/professional role and identity; Em emotions; Sk physical skills. COM-B abbreviations: Psy C psychological capability; Soc O social opportunity; Phys O physical opportunity; Ref M reflective motivation; Auto M automatic motivation. Intervention function abbreviations: Ed education; Pers persuasion; Env r environmental restricting; Mod modelling; Ena enablement; Tra training; Inc incentivisation.

3.3.1.8 Step 8: Identify the mode of delivery

Several systematic reviews suggest that school-based interventions are the most effective way to counteract low physical activity in children aged 5-18 years, and it is typically made up of a combination of school curricula, printed educational materials, educational sessions and physical activity-specific sessions.[52,54] In addition, previous studies have demonstrated the effectiveness of group-based sessions and printed media (e.g., poster, written materials) in helping increase children's physical activity level.[86,98,176,180-182] As a result, the face-to-face (group) and distance (printed media) were selected as the modes of delivery.

3.3.2 Intervention content development

3.3.2.1 Step 1, 2, 3: Expert consultation, PPIE, and piloting

As part of the intervention, we adapted a physical activity booklet, poster, slides and two physical activity diaries (see Table 8). With permission, the information on children's physical activity, reasons behind the physical inactivity among children, and recommendations for helping increase children's physical activity were extracted from two existing booklets of the British Heart Foundation (UK), the websites of Better Health Channel (Australia), Caring for Kids (Canada), and two WHO reports.[4,188-192] These were adapted to the Chinese context and used in the physical activity booklet and slides for parents. The physical activity

booklet was distributed among teachers to use as guidance for health education practices. In addition, the intervention includes video clips (i.e., physical activity expert's speech) to provide an introduction about children's physical activity among parents. The content of the slides for children was based on existing slides of the Zhejiang Centre of Disease Control (China), and the poster was adapted from a poster produced by the US Centre for Disease Control and Prevention.[193,194]

Rather than developing a completely new diary, we adapted two existing theory- and evidence-based physical activity diaries (Steps for Active Kids (STAK) and STAK-Diabetes, UK). Both diaries were found to be effective in engaging children in physical activities.[181,182] With permission, the information on physical activity knowledge, recommendations to become physically activity and activity log to record daily physical activity, was extracted from both diaries as well as the Better Health Channel's website[181,182,190] and the materials were then adapted to the Chinese context. Two BCTs (information on emotional benefits and material rewards) were added to the intervention based on expert consultation. In addition, the disagreements that arose regarding the selection of certain intervention functions and BCTs (i.e., not appropriate or wrong coding) were addressed through iterative revisions until the consensus was reached. The intervention content, complex language, lengthy wording, inconsistent use of phrases and colour scheme, and typos were addressed based on the expert

consultation. For instance, experts' comments regarding the intervention content and complex language included:

- "*Promoting a health behaviour like physical activity does not mean that you must promote the health benefits of that behaviour. Instead, you should focus on encouraging people to pursue activity for some intrinsically valued motive.*"
- "*Have you considered the whole issue of financial constraints and how to deal with it. For example, parents might say the only thing their daughter really wants to do is horse riding but they cannot afford it.*"
- "*The language used throughout the resources is quite technical/advanced.*"
- *"…particularly the slides both for parents/children and the booklet are that they are far too complex (especially for young children) and there is a lot of scientific language that is not appropriate for members of the public/children.*"
- "*The participant-facing wording is technical and not lay-friendly.*"
- "*Consider using 'mental health' instead of 'psychological'*."

Experts' comments regarding the length of wording included:

- "*I have included suggestions of ways you could think about simplifying some of the language, particularly in the slides for the children in the*

comments function on PowerPoint, … see where you can simplify the language and cut down on as much text as possible where you can."

- "*You should simplify your wording throughout, so that it speaks to participants in their own language; not necessarily informal language, but a more simple and direct form of wording that resonates with them.*"

Experts' comments regarding the inconsistent use of phrases, colour scheme and typos included:

- "*I think you should use the language from the activity diary in your slides/booklet and use that consistently across all the intervention materials.*"
- "*The colour scheme throughout these resources could be more consistent.*"
- "*Keep font size consistent throughout. Including size of titles.*"

The cartoons (for physical activity illustration) used in the activity diary and slides for children were chosen based on the feedback received from children. The photo (for physical activity illustration) used in the physical activity booklet and slides for parents were chosen based on the feedback received from parents and teachers. For instance, PPIE comments regarding the preference of the photograph and length of wording included:

- *"I would prefer the cartoons because these are more appealing."*

- *"I think cartoons are interesting and our teachers make slides in this way [use cartoons as illustrations] as well."*
- *"I think cartoons are too childish for us [parents] and I would like the photo instead."*
- *"I would suggest you use photos as illustrations in the materials for parents."*
- *"I think the length is fine."*
- *"I am fine with the length."*

All these intervention materials are available in English and Mandarin. The translation work was completed after PPIE. Translational and literal mistakes in the Mandarin version were corrected after the piloting work. For instance, comments from piloting regarding the translational (including unintelligible expressions), literal mistakes and recommendations included:

- *"The translation of title 'Welcome to physical activity promotion programme' (not clear)."*
- *"Translation of 'Tips for safely doing physical activity' (not clear)."*
- *"Suggest to re-translate the phrase 'become more active."*
- *"Translation - Be creative and vary your child's activities (unclear)."*
- *"Please give the definition and benefits of physical activity in the end of presentation rather than give a brief summary. This could make children have a direct understanding and it may be easier for them to memorise."*

3.4 Discussion

This chapter reports the systematic development of a physical activity programme for Chinese children aged 10-12 years. Physical activity interventions for Chinese children have previously been criticised for being underdeveloped or underreported.[65-67,154,155] Among health practitioners and researchers, it is argued that a systematic and transparent theory-and-evidence-based approach can prevent research waste that is led by poor-quality research methods or researchers' biased manner. In this study, the researcher supplemented this process with findings from a JBI qualitative systematic review.[114,178] This strengthens the likelihood of generalisation as the intervention is based on a broader perspective that includes different contexts (e.g., school, home, community) and participants (children, parents, teachers). To the researcher's knowledge, the current study is the first to apply the BCW and TDF in this population and context. This systematic process identified ten relevant TDF domains and selected seven interventions and 21 BCTs in the programme. Three main components constitute the intervention, namely: (i) school environmental support, (ii) health education for children and (iii) family involvement. The school environmental support is based on the provision of sports equipment, pedometers and a physical activity poster. Health education for children is delivered via face-to-face mode using presentation slides and print materials including a physical activity diary. Family involvement is promoted via a face-to-face workshop and a physical activity booklet. Moving

forward, a feasibility pre- and post-intervention study has been conducted to determine the feasibility of undertaking a cluster randomised controlled trial (RCT) among Chinese children (see chapter 4). The feasibility study has been registered with the Chinese Clinical Trial Registry (ChiCTR1900026865). If the intervention is found to be feasible and acceptable, the researcher will design and conduct the cluster RCT.

In the cluster RCT, if the intervention is found to be effective, it could be a low-cost, acceptable and local solution for increasing the physical activity level among Chinese children. It may also alleviate the future personal and economic burden of physical inactivity on individuals, the health system and the economy. The advantages of increasing physical activity in this population may extend to the prevention of physical inactivity related complications. This programme of work means that evidence-based practices could be available to health professionals to promote physical activity among children. The intervention may simultaneously empower children or their parents to actively engage in physical activity. Given that physical inactivity and its related costs are global concerns, there could be worldwide interest in this low-cost behaviour change theory-based physical activity programme.

Strengths and limitations

This systematic approach provided insights to inform the development of a school-based physical activity programme for Chinese children. The MRC framework was used along with existing evidence, which led to a logical, practical, and theory-based intervention. The use of the BCW and TDF helped categorise and comprehend potential barriers and facilitators to Chinese children's physical activity. Although several subjective and pragmatic decisions were made throughout the development process, detailed and transparent processes are presented in this paper to clarify why options were or were not taken. The expert consultation on the intervention design was conducted, and this minimised risk of bias in the identification of domains, intervention functions, BCTs, and increased trustworthiness. In addition, the PPIE ensured the intervention would be appropriate in the Chinese context. Altogether, the developed intervention will be followed by a thorough evaluation (feasibility pre- and post-intervention study).

This work has several limitations. The study identified the target behaviour problem (in step 1) through an exploratory literature review and not a systematic review as there are existing systematic reviews and other primary studies to support this. The total count (frequency) of barriers or facilitators coded to each TDF domain was used as a proxy for importance. However, domains that coded infrequently might be highly important to determine the physical activity level among children. Therefore, the design and selection bias may delimit the effectiveness of the intervention. However, it should be noted that using the

integrative theoretical framework (i.e., TDF) could enable all the necessary elements for our intervention programme are in place to maximise potential benefits. Although expert consultation, PPIE and piloting were part of the intervention development process, there could be selection bias as convenience sampling was used throughout, and recruitment for this input was undertaken through the researchers' professional and social networks. BCW provides a systematic, theory-driven and evidence-based approach to develop an intervention that meets the unique needs of the target group. However, the process was time-consuming from problem identification to intervention design.

3.5 Conclusion

This chapter describes how an intervention to increase physical activity in Chinese children was developed. The researcher followed a systematic and transparent process using the BCW and TDF to exemplify the first phase (i.e., intervention development) when developing and evaluating a complex intervention. A school-based intervention facilitated by environmental support, health education and family involvement may help to engage children in physical activity. A feasibility study was undertaken (described in the next chapter) to determine the utility (initial estimates) of the programme and the feasibility of undertaking a definitive cluster RCT in China.

Chapter four

A school-based behaviour change intervention to increase physical activity levels among children: a feasibility cluster non-randomised controlled trial in Yangzhou, China

4.1 Introduction

The Chinese physical activity guideline recommends that children aged five to 17 years should engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day and reduce their sedentary time.[20] Physical activity improves children's overall health and can contribute to their social well-being.[14] It can boost their learning abilities, including improvement in concentration power, memory, intellectual development and academic performance.[14,16,17] However, around 84% of children in China do not meet the recommended physical activity levels, and this proportion is higher compared to that in many high-income Asian, European and American countries.[22] The problem is more common among girls as there is a huge socio-cultural pressure in the conservative Chinese society, and they are not allowed to do physical activities.[22] MVPA starts to decline at around 10-12 years of age.[95,145,147,148] For example, approximately 25% of children spend over 30 minutes on MVPA per day in primary school (for children aged 7-12 years) whereas it is only 15% and 10% in junior middle schools (for children aged 13-15 years) and junior high schools (for children aged 16-18 years), respectively.[95] In other words, it can be beneficial to target health behaviours (including physical activity) at this transition period as children approach adolescence.[152]

Yangzhou is an eastern city in China, located in the Jiangsu Province. Over half of the school-aged children are physically inactive in the Jiangsu Province, and their health and fitness are below the national average.[96] In this province, physical activity, health, and fitness levels are worst in Yangzhou city.[12] In Yangzhou, less than 50% of children do physical activities for an hour per day,

and the situation is even worse during the weekends when it comes down to only 14%.[99]

Targeting schools to promote children's physical activity appears to be promising. Children spend the majority of their waking hours in school, and therefore, schools represent an ideal environment to reach them.[185] Schools can provide access to children from different socioeconomic backgrounds and help institutionalise the physical activity interventions into other settings, such as communities.[185] For instance, five to 45 minutes of MVPA per day can be achieved through school-based physical activity interventions.[54] School-based physical activity interventions are relatively easy to implement and reasonably easy to evaluate.[175-177]

The promotion of physical activity requires an understanding of the underlying influences on this behaviour.[71] However, in China, previous physical activity interventions for children lacked a theoretical basis for targeting the potential drivers of this behaviour.[67,154,155] The researcher has addressed this issue, and the JBI qualitative systematic review on barriers and facilitators to physical activity among ethnic Chinese children has synthesised four broad themes, namely, personal, socio-cultural, environmental, and policy- and programme-related factors.[114,178] Based on these findings, the researcher has developed a school-based behaviour change intervention to increase physical activity levels among children (aged 10-12 years) in China.[195]

From the evaluation point of view, the principal research question to be addressed by the cluster randomised controlled trial (RCT) in the future is whether the intervention is effective in increasing physical activity levels among

children in China. The primary outcome of the definitive cluster RCT will be the difference in mean seven-day steps between the two study groups (i.e., intervention and control). The chances of successful completion of a costly cluster RCT will improve if the feasibility of its key elements is checked before it starts. Thus, the aim of this study was to determine the feasibility of undertaking the definitive cluster RCT in China and estimate important parameters (e.g. recruitment rate, follow-up rate, intervention adherence) that are needed to design this cluster RCT.

4.2 Methods

4.2.1 Study design

This feasibility study was a cluster non-RCT. Cluster design (rather than individual allocation) was required to minimise contamination between intervention and control group participants due to the nature of the intervention.

4.2.2 Study setting, participants, and duration

In China, the majority of children attend public schools.[196] This study was conducted in two public schools in Yangzhou. The intervention was provided in one public school. Another public school in the city, matched on the basis of similar socio-economic background of attending students, class size, and curriculum structure, acted as the control. The distance between the two schools is around 15 kilometres, which minimised contamination. In these two

schools, children aged 10 to 12 years (i.e., from one class) with verbal assent and their parents with verbal consent were eligible i.e., child-parent dyads. The study information sheet, opt-out consent and pedometer guide form (Appendix 5 and 6) were provided to parents through their children. Those who did not return the opt-out consent form signed by their parents were included in the study. Those with medical conditions or physical injuries that prevented them from engaging in outdoor physical activities were excluded (as reported by their parents or teachers). The study duration was from May 2020 to October 2020 i.e., the autumn semester in China.

4.2.2.1 Sample size

A formal sample size calculation is not usually required for a feasibility study.[197] Sim and Lewis have recommended recruiting at least 50 participants.[198] Thus, a total of 64 children and their parents (32 per study group) was set based on i) the number of schools approachable to the researcher, ii) the number of children felt to be manageable by the researcher, and iii) the time and budgetary restrictions in this PhD project.

4.2.2.2 Intervention

A structured school-based behaviour change intervention was provided over 16 weeks to increase physical activity levels among children (aged 10-12 years). The intervention development paper was published elsewhere.[195] Briefly, this

behaviour change intervention is based on the Behaviour Change Wheel (BCW) and Theoretical Domains Framework (TDF).[77,80] It has three components: a) health education (physical education), b) family involvement, and c) school environment support. Health education for children was delivered face-to-face, using presentation slides and printed materials including a physical activity diary. Family involvement was promoted through an online session and a physical activity booklet. Under school environmental support, sports equipment (e.g., jumping rope, shuttlecock), a pedometer, and a physical activity poster were provided to children. The content, structure, and theoretical basis of each intervention component are detailed in Table 9.

4.2.2.3 Control

No intervention was delivered in the control group, and children were requested to continue their usual physical activities.

Table 9: The intervention content, structure, and theoretical basis

Intervention structure	When	Intervention contents	Resource	Adaptation (where possible)	Intervention material	Mode of delivery	Delivered to	TDF	Intervention functions	BCTs (as numbering in BCT taxonomy)
Health education	Session 1 (Week 1)	a. General introduction to physical activity (definition, positives, negatives of physical inactivity). b. Discussion about what sort of things made children want to do exercise and what stopped them from doing it. c. Making their own weekly physical activity plan to be active at school and home for the next four weeks, including (a) what type of physical activity would you do? (b) how long? (c) how many times a week? and (d) when would you start?	Adapted based on the Zhejiang Centre of Disease Control's (CDC, China) physical activity slide for children. Permission was received from Zhejiang CDC (China).	1. The majority of contents of this slide are taken directly from the CDC's slide (China). 2. Some of the other contents of this slide (interactive discussions) are developed by the researcher.	a. Slide (activity plans were included in it). b. Pedometer and activity diary were delivered in the session.	Face-to-face group session	Children	B con, Kn	Education, Persuasion	1.1 Goal setting (behaviour) 1.4 Action planning 2.3 Self-monitoring of behaviour 5.1 Information about health consequences 5.6 Information on emotional benefits 9.2 Pros and cons 12.5 Adding objects to the environment 15.1 Verbal persuasion about capability
	Session 2 (Week 5)	a. Reviewing children's physical activity plan that made in week one and gave feedback. b. Providing tips for physical activity (intense, duration, safety) and motivation. c. Making their own weekly physical activity plan to be active at school and home for the next four weeks, including (a) what type of physical activity would you do? (b) how long? (c) how many times a week? and (d) when would you start?	1. Adapted based on the Zhejiang CDC's (China) physical activity slide for children. 2. Developed based on the information from the Better Health Channel (AUS), NHS (UK) physical activity guideline for children. Permissions were received from all organisations.	1. The majority contents of this slide are taken directly from the CDC's slide (China). 2. Some of the other contents of this slide are taken from the National Health Service (NHS, UK), Better Health Channel websites (AUS).	a. Slide (activity plans were included in it). b. Activity diary	Face-to-face group session	Children	B con, Kn, B cap	Persuasion, Modelling	1.1 Goal setting (behaviour) 1.4 Action planning 1.5 Review behavioural goals 2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform behaviour 15.1 Verbal persuasion about capability 15.3 Focus on past success

	Session 3 (Week 9)	a. Reviewing children's physical activity plan that made in week one and gave feedback. b. Poster making session. c. Making their own weekly physical activity plan to be active at school and home for the next four weeks, including (a) what type of physical activity would you do? (b) how long? (c) how many times a week? and (d) when would you start?	Adapted from a previous intervention (CLICK-Obesity study, China, 2012).	The contents of this session are taken directly from the Click-Obesity study.	Slide (activity plans were included in it).	Face-to-face group session	Children	B cap, B con	Persuasion	1.1 Goal setting (behaviour) 1.4 Action planning 1.5 Review behavioural goals 2.3 Self-monitoring of behaviour
	Session 4 (Week 13)	a. Reviewing children's physical activity plan that made in week 9 (session 3) and gave feedback. b. Discussion about the poster making and ideas and then gave feedback. c. Poster presentation.	Adapted based on a previous intervention (CLICK-Obesity study, China, 2012).	One component (stage drama) of the original presentation is removed in this session.	Slide	Face-to-face group session	Children	B con, B cap	Enablement	1.4 Action planning 1.5 Review behavioural goals 2.3 Self-monitoring of behaviour
Family involvement	Week 1	A physical activity session was to (a) deliver knowledge of the physical activity and tips for encouraging children to be active (including video clip demonstrations (from physical activity experts and active kids)), (b) discuss the barriers to children's physical activity and how can they help their child to be active (discussion among parents), (c) encourage parents to buddy up with the child to make activity plans (e.g. walk) and encourage/congratulate to the child if the goal has achieved.	Developed based on the British Heart Foundation booklets (2014 & 2018); information from the Better Health channel (AUS), Caring for Kids (CAN) and WHO reports (2009 & 2010). Permissions were received from all organisations.	1. The majority contents of this booklet are taken directly from the British Heart Foundation booklets (Get Active Stay Active & Physical Activity for children and Young People). 2. Some of the other contents of this booklet are taken from the Caring for Kids and WHO websites.	Slide (including video clips)	Online session	Parents	SI, Kn, Id, Em	Education, Enablement, Persuasion, Modelling	1.2 Problem solving 1.4 Action planning 3.2 Social support (practical) 3.3 Social support (emotional) 4.1 Instruction on how to perform behaviour 5.1 Information about health consequences 5.6 Information on emotional benefits 6.1 Demonstration of the behaviour

				3. The tables/data are developed based on the published studies (Li (2017) & Song (2012)) and a WHO report (2009).						
	Week 1-16	Providing physical activity booklets with parents to consolidate the content of the health education.	Developed based on the British Heart Foundation booklets (2014 & 2018); information from the Better Health channel (AUS), Caring for Kids (CAN) and WHO reports (2009 & 2010). Permissions were received from all organisations.	1. The majority contents of this booklet are taken directly from the British Heart Foundation booklets (Get Active Stay Active & Physical Activity for children and Young People) and Physical Activity guidelines for children and young people (5-18 years) factsheet (UK). 2. Some of the other contents of this booklet are taken from the Caring for Kids (CAN), WHO website and our systematic review (barriers and facilitators to physical activity among	Booklet	Physical activity booklet	Parents (distributed to parents at week one and asked them to use throughout the intervention)	SI, Kn, Id	Education	4.1 Instruction on how to perform behaviour 5.1 Information about health consequences 5.6 Information on emotional benefits

				ethnic Chinese children). 3. The tables/data are developed based on the published studies (Li (2017) & Song (2012)).						
School environmental support	Week 1-16	Providing children with sports equipment to use during class break and after school.	Adapted from a previous study (Physical Activity 4 Everyone, UK).	Provide more culturally appropriate sports equipment (e.g., shuttlecock, jumping rope).	Sports equipment	Equipment provision	Children (distributed to children at week one and asked them to use throughout the intervention)	Env, MAD	Enablement, Environmental restructuring	3.2 Social support (practical) 12.1 Restructuring the physical environment 12.5 Adding objects to the environment
	Week 1-16	Physical activity poster put in the classroom.	The content is developed based on a previous intervention (CLICK-Obesity study, China, 2012). The poster is developed based on the US CDC poster. Permissions were received from all organisations.	The developed poster utilised the striking "slogan" with the phase "Be Active and Play 60 minutes every day" on it. It was designed to encourage children to engage at least 60 minutes of moderate-to-vigorous physical activity every day.	Poster	Equipment provision	Children (put in the classroom from week one)	Env, Goals	Environmental restructuring, Enablement, Education	7.1 Prompts/cues 12.5 Adding objects to the environment
	Week 1-16	Providing children with pedometers to use daily.	Adapted from the Steps for Active Kids (STAK) study ((UK).		Pedometer	Equipment provision	Children (distributed to children at week 1 and asked them to use	Env, Goals	Enablement, Environmental restructuring	2.3 Self-monitoring of behaviour 12.5 Adding objects to the environment

							throughout the intervention)			
	Week 1-16	a. Providing an activity diary with each child to record their daily step count and learn activity knowledge and tips. b. The activity diary includes 5-a-day physical activity concepts, which helped motivate children to participate in more physical activity and continuously use the diary. Children were rewarded with stickers if the 5-a-day physical activity task was completed. c. Encouraging children to set a gradually increased goal of step counts. Children were given verbal feedback from the researcher and advice on how to achieve it.	Adapted from the STAK activity diary (UK) and Better Health Channel (AUS). Permissions were received from Professor Cris Glazebrook, Dr Helen Quirk and 'Better Health Channel'.	1. The majority contents of this diary are taken directly from the STAK activity diary (UK). 2. The contents that are inappropriate for the culture and target behaviour (e.g., Dance DVD, text about diabetes) of the original STAK activity diary are removed. 3. Some of the other contents of this diary are taken from the Better Health channel's website (AUS).	Activity diary	Equipment provision	Children (distributed to children at week 1 and asked them to use throughout the intervention)	Env, Goals, Sk	Enablement, Training, Environmental restructuring, Education, Incentisation	1.1 Goal setting (behaviour) 1.4 Action planning 1.5 Review behaviour (goals) 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 7.1 Prompts/cues 8.7 Graded tasks 10.4 Social reward 10.2 Material reward (behaviour)

TDF domain abbreviations: Kn knowledge; MAD memory, attention and decision processes; SI social influences; Env environmental context and resources; B Cap beliefs about capabilities; B Con beliefs about consequences; Id social/professional role and identity; Em emotions; SK skills.

4.2.3 The behaviour change intervention components and materials

4.2.3.1 Children's activity diary

The activity diary was adapted from the STAK activity diary, which aimed to inform children about physical activity, raise awareness about their physical activity level and provide a daily target for activity (5-a-day). The activity diary consists of educational and interactive inserts including a) 'What is being active?'; b) 'What does being active mean to me?'; c) 'How active should I be?'; d) 'The easy way to get 5-a-day'; e) 'What can I do to get this point?'; f) 'Why it is good to be active?'; g) 'Be flexible about your physical activity routine'; h) 'Overcoming disruptions to your physical activity routine' and i) 'Being active at home'. The educational information has been altered by the researcher for this study to be relevant to children in Chinese context.

4.2.3.2 Pedometer and step-count log

Additional activity diary inserts, produced by the researcher, provide examples of how to set step count based on the child's total step count from the previous day or week. With guidance from the researcher, the children were encouraged to set step count goals and record daily step count in the step-count log.

4.2.3.3 Group activity sessions for children

Four children's group activity sessions took place in the classroom where children were based. The physical education teacher was present to facilitate

the sessions. Children were encouraged to voice any questions, comments or concerns. The group activity sessions were designed to disseminate knowledge to promote individual physical activity behaviours and to increase inside/outside-school physical activity. Four 45-minute lessons were delivered by the researcher each month for one academic semester (i.e., autumn semester) in the intervention group. The curriculum consists of two broad education modules: one focused on physical activity knowledge (in sessions 1 and 2) and the other one on fun programmes i.e., poster-making and presentation competition (in sessions 3 and 4). Specifically, the physical activity knowledge module consisted of educational and interactive inserts including a) 'What is physical activity?'; b) 'Why is physical activity important to you?'; c) 'Why should you avoid sitting for a long time?'; d) 'How to participate in physical activity?'; e)' Tips for safely doing physical activity' and f) 'How to keep yourself motivated?'. The module of the fun programme encouraged children to reflect on the physical activity knowledge taught in the first two sessions and make their own physical activity posters (in the third session) to present their understanding or ideas about how to keep a physically active lifestyle. A poster presentation was required to be presented by a classmate team (i.e., at least five members) in the fourth group session.

4.2.3.4 Family involvement

Family involvement was developed to introduce families to the behaviour change intervention and to assist them to create a supportive environment for helping children change inactive physical activity behaviours and increase their

children's physical activity. Families were allowed to discuss practical aspects of the behaviour change programme and to extend their knowledge of physical activity. The curriculum designed for parents were organised by the class teacher but presented by the researcher. The curriculum was intended to be delivered through a face-to-face offline group activity session. However, the delivery was changed to an online session taking into consideration of the safety issue (i.e., social distancing for COVID-19).

a) Group activity session for parents

First, family involvement was achieved by a) an online education session delivered to parents (on week 1) that elicited their positive feelings and impulses relating to physical activity promotion among their children, physical activity benefits and direct parental influences on children's physical activity behaviour. It also offered parents ways to encourage children to be active, including a) the provision of emotional social support (e.g., buddy up with children for physical activity) and practical social support (e.g., parents to prepare sports gear for their children, and b) encouragement of giving a social reward or material reward to help incentivise children's motivation in keeping the desired behaviour whenever a child achieves the physical activity goal.

b) Physical activity booklet for parents

Second, a physical activity booklet for parents, developed by the researcher programme, was provided to each parent after the group activity session. It sought to encourage parents to think about providing a physical activity-friendly environment for their children. Specifically, the inserts include a) 'What is physical activity?'; b) 'Why should your child be active?'; c) 'Factors affecting physical activity'; d) 'How can I help my child to be active?'; e) 'How can families support healthy active living?', and ' Top tips to keep going'.

4.2.3.5 School environmental support

School environment can be critical to helping students make desirable health-related behavioural changes and maintain an active lifestyle. School environment support was achieved by organisational changes to a) restructure the physical environment via adding objects to the environment (providing sports equipment such as jumping rope, shuttlecock) and use prompts/cues (e.g., a physical activity poster) to increase children's initiatives for doing physical activity, b) provision of verbal encouragement to engage children in physical activity participation, c) provision of a pedometer with each child to self-monitor the daily steps, and d) provision of rewards (e.g., stickers) with children when their physical activity goal (e.g., step goal) was achieved.

4.2.4 Study parameters and data collection

4.2.4.1 Primary outcomes: feasibility measures

Primary measures addressed the feasibility of the delivery of the behaviour change intervention (see bullet points below). Data were collected on standard deviation (SD) and intracluster correlation coefficient (ICC) of primary physical activity outcome (i.e., seven-day steps), rates of recruitment and follow-up, data collection completion, time needed for data collection and intervention adherence.

► Standard deviation (SD) of the primary outcome (i.e., seven-day steps in children) and intracluster correlation coefficient (ICC) were estimated and used to calculate the sample size of the definitive cluster RCT.

► Recruitment of child-parent dyads—number of them approached to participate, gave assent (children) and consent (parents), screened for eligibility, and found eligible and recruited.

► Follow-up of children—number of them followed-up at 16 weeks (post-intervention).

► Data collection completion among children—number of them completed the self-reported questionnaire, on whom anthropometric parameters were measured, and provided the recording of seven-day steps at baseline and 16 weeks (post-intervention) (see Table 10).

► Time needed for data collection among children—time needed to complete the self-reported questionnaire by them and measure their anthropometric parameters at baseline and 16 weeks (post-intervention).

► Intervention attendance—number of children and parents attended their respective group sessions.

4.2.4.2 Secondary outcomes

Although the feasibility study was not adequately powered to detect a difference in outcomes between the two study groups. However, the collection of secondary outcomes in the feasibility study could be used for initial estimates of effects to guide the design of the definitive cluster RCT. Secondary outcome measures for assessing the potential efficacy of the intervention included a) anthropometric measurements of height, weight and waist circumference, b) self-reported physical activity, c) Self-efficacy of physical activity, d) perceived physical activity enjoyment, and e) perceived social support.

a. Anthropometric measurements

Body mass index (BMI)

Physical inactivity is positively associated with obesity and overweight whilst BMI has been widely used as a proxy measure of body fatness for Chinese children.[199] Although BMI has been argued to be limited in distinguishing between lean body mass from fat mass,[200] it is regarded as a simple and cost-effective measure of body fatness in childhood.[170] Moreover, it can be used to define obesity and detect the possibility of suffering associated health risks.[201,202] Weight was measured to the nearest 0.1 kg using a calibrated lever-type weight scale (RGT-140, China).[203] Height was measured to the nearest

0.1 cm using a calibrated stadiometer (TZG, China).[203] BMI was calculated as body weight (kg) divided by height (m) squared (kg/m^2).[204] Height and weight were measured twice and the mean of the two readings for each was used in the analysis.

Waist circumference

Evidence shows that waist circumference is an effective method to detect central adiposity[205,206] and it has been used as a useful parameter for predicting obesity-related diseases such as hypertension and hyperlipidaemia among Chinese children.[207,208] This is because Chinese people are suggested to be predisposed to central body obesity.[60] Moreover, waist circumference overcomes the limits that exist in using BMI, which is the poor discrimination between adiposity per se and body mass.[205] At both baseline and post-intervention, the measurement used a calibrated anthropometric tape (Lufkin W606PM, US) based on previously validated guidance at school.[209] The tape was placed horizontally at the level of 1 cm above the umbilicus.[207] It was measured twice and the mean of two readings was used in the analysis.

b. Questionnaires (see Appendix 7).

Socio-demographic characteristics

Specific questions were developed to collect participant characteristics at baseline and the questions assessed the information regarding children's age and gender as well as parental employment and education status.

Physical activity level

The change of physical activity level would be the primary outcome in the definitive cluster RCT. In the questionnaire pack, physical activity was measured using a valid (criterion validity; Spearman correlation ranged from 0.31 (on weekdays) to 0.48 (on weekends) for the comparison between CLASS and motion sensor) and reliable (test-retest reliability; ICC=0.84) questionnaire - children's leisure activities study survey-Chinese (CLASS-C) questionnaire.[210] The CLASS-C questionnaire has replaced the inapplicable activities (e.g. cricket, tennis) with more common-seen daily activities (e.g. table tennis, martial arts) among Chinese children. Specifically, it consists of 24 MVPAs, including 1) basketball, 2) volleyball, 3) soccer, 4) badminton, 5) table tennis, 6) handball, 7) radio callisthenics, 8) dance, 9) aerobics, 10) gymnastics (e.g. pull-up, sit-up, push-up), 11) martial arts (e.g. Taiji), 12) jogging or running, 13) high jump, 14) long jump, 15) distance casting, 16) skipping rope, 17) swimming, 18) roller blading, 19) kicking shuttlecock, 20) playing group games, 21) bicycling, 22) travel to school by walking, 23) household chores and 24) climbing stairs. The CLASS questionnaire data were converted to units of time (minutes per week) spent in combined moderate- and vigorous-intensity (total) physical activity.

In addition to self-report questionnaire, the physical activity level was also measured utilising an objective measurement in order to comprehensively capture the physical activity changes. Specifically, it used the Yamax SW-200 pedometer (Japan), which has been wildly used and examined with good

validity and reliability for measuring children's physical activity.[211] Children were given the pedometers with an explanation of how to wear the pedometers and how to operate the reset button and they were asked to wear it for a consecutive 7-day at both baseline and post-intervention. Children were asked to record their daily step count on a paper log and the records were collected by the researcher in a week. Of each participant, their daily step count would be accumulated as for the previous week. The standard deviation of the primary physical activity outcome measure (i.e., mean seven-day steps of children in both intervention and control groups) in physical activity level was used to calculate the sample size for the future RCT.[88]

Self-efficacy of physical activity

Individual self-efficacy of physical activity is a determinant to its initiation and maintenance.[212] Evidence shows that it is easier to sustain a physical activity behaviour if individuals are self-motivated.[181,213] Therefore, the change of individual self-efficacy to physical activity would help indicate the individuals' desirability to participate in physical activity. A valid and reliable 8-item self-efficacy scale for Chinese children was utilised in the questionnaire pack to assess the self-efficacy of children to physical activity.[214] Each item uses a Likert scale ranging from 1 ("Disagree a lot") to 5 ("Agree a lot") with higher scores indicative of greater self-efficacy. The items include a) I can be physically active on most days of the week, b) I can ask my parent or other adult to do physically active things with me, c) I can be physically active during my free time on most days even if I could watch TV or play (sedentary) video

games instead, d) I can be physically active on most days even if it is very hot or cold outside, e) I can ask my best friend to be physically active with me on most days, f) I can be physically active even at home, g) I can do active things because I know how to do them and h) I can be physically active during my free time on most days no matter how busy my day is.

Physical activity enjoyment

The feeling of enjoyment to physical activity is a facilitator to enhance individuals' physical activity participation.[214,215] Therefore, a validated and reliable physical activity enjoyment questionnaire[214] (a 7-item scale) for Chinese children was used in the booklets to measure the enjoyment of children doing physical activity. The questionnaire was measured using a 5-point Likert scale which ranges from 1 ("Disagree a lot") to 5 ("Agree a lot"). All 7 items ("When I am active, a) I feel bored, b) I dislike it, c) it's not fun at all, d) it makes me depressed, e) it frustrates me, f) it's not at all interesting and g) I feel as though I would rather be doing something else") are negatively worded; thus higher scores indicate lower physical activity enjoyment.

Social support

Parental involvement plays a vital role in increasing physical activity of children.[186,216] Therefore, change in children's perception of the social support (particularly parental support) was measured using a valid and reliable ten-item social support questionnaire[214] for Chinese children in the questionnaire pack.

Children rated how often they received physical activity-related social support ("During the past three months, my family or friends a) did physical activity with me, b) offered to do physical activity with me, c) gave me helpful reminders to engage in physical activity, d) gave me encouragement to stick with my physical activity programme, e) changed their schedule so we could do physical activity together, f) discussed PA with me, g) planned for exercise on recreational outings, h) helped plan physical activity, i) asked me for ideas on how they can engage in physical activity and j) talked about how much they like physical activity") on a 5-point Likert scale (1 = none to 5 = very often) with higher scores indicative of greater social support.

Table 10: Data collection

	Assessment details*	Baseline	At 16 weeks (post-intervention)
Socio-demographics		√	√
Measurement of anthropometric parameters in children			
Height	TZG (stadiometer)	√	√‡
Weight	RGT-140 (weighing scale)	√	√‡
Body mass index (BMI)	Weight divided by the square of height (unit)	√	√‡
Waist circumference	Lufkin W606PM (measuring tape)	√	√‡
Physical activity	a) Children's Leisure Activities Study Survey (CLASS)[210]; time recall: past 1 week, b) Yamax SW-200 pedometer: seven-day steps	√	√
Self-efficacy (to assess confidence in children's ability to do physical activities)	0–40 rating scale; time-recall: at the time of questionnaire completion[214]	√	√
Enjoyment (to assess children's perceived enjoyment when doing physical activities)†	0–35 rating scale; time-recall: at the time of questionnaire completion[214]	√	√
Social support (to assess children's perceived support from parents and friends when doing physical activities)	0–50 rating scale; time-recall: at the time of questionnaire completion[214]	√	√

*A standard operating procedure was developed for this purpose. †Enjoyment scales are negatively worded and thus, higher scores indicate lower physical activity enjoyment. ‡Anthropometric measurements (including height, weight, waist circumference) among children were altered to be conducted by parents with the guidance of the researcher at the post-intervention due to the self-distancing regulations of Covid-19.

4.2.5 Adverse events

Adverse events were defined as any unfavourable or unintended symptom or sign that were temporarily associated with an investigational intervention during the conduct of a clinical trial.[217] The plan was to collect information on any adverse event (including death) occurring in children as a result of participation in the study and to involve two physical activity experts to determine the relationship between the intervention and adverse event.

4.2.6 Withdrawal

Children and their parents were made aware (through the information sheet) that their participation was entirely voluntary, and they could withdraw from the study at any time. The study was planned to remove participants from the post-intervention analysis if they withdrew from the feasibility trial, but to retain for baseline assessment unless they had specifically requested that their data be withdrawn.

4.2.7 Data analysis

Data were summarised using summary measures of mean or median and spread (for continuous data) and numbers and percentages (for categorical data, recruitment rate, follow-up rate, data collection completion and intervention adherence). The feasibility measures (e.g., recruitment rate, follow-up rate) were evaluated by comparing the results with that of similar cluster RCTs conducted in Chinese or non-Chinese territories.[86,162,218,219] This was a feasibility study and so was not adequately powered to detect a difference in outcomes between the two study groups. However, the researcher calculated the initial estimates of effects to guide the design of the definitive cluster RCT. All primary analyses were based on the intention-to-treat principle and were unadjusted. Missing data were imputed using multiple imputations. Between the study groups, baseline and post-intervention continuous data were compared using an independent t-test (for normally distributed data) or Mann–

Whitney U-test (for skewed data). Categorical data were compared using the chi-squared test. Within a study group, the change in an outcome from baseline to post-intervention was compared using a paired t-test. As the study was not randomised, the adjustment was subsequently done for children's sex and the respective baseline value using multiple linear regression (in case of continuous data). The results were considered statistically significant when p values were less than or equal to 0.05. Statistical analysis was performed using Stata 15 (StataCorp LLC, TX, USA).

4.3 Results

The results are reported in accordance with the relevant extension of the Consolidated Standards of Reporting Trials (CONSORT) statement and checklist (for pilot and feasibility trials) and flow diagram (for cluster trials; adapted).[220-222] The study flow diagram and study design are shown in Figure 13 and 14. Sixty-four children and their parents participated in the study (32 per study group).

Figure 13: Flow diagram of study

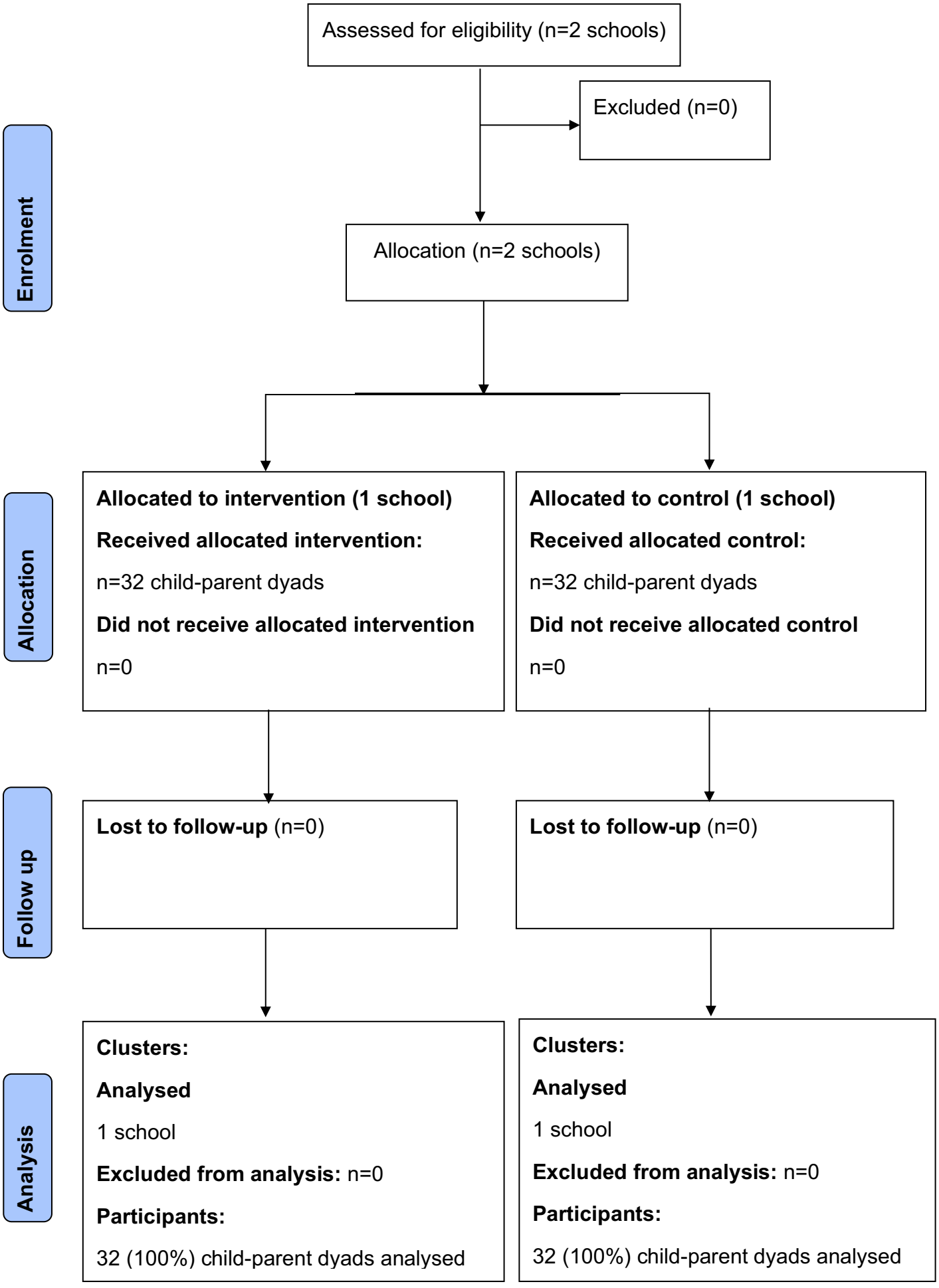
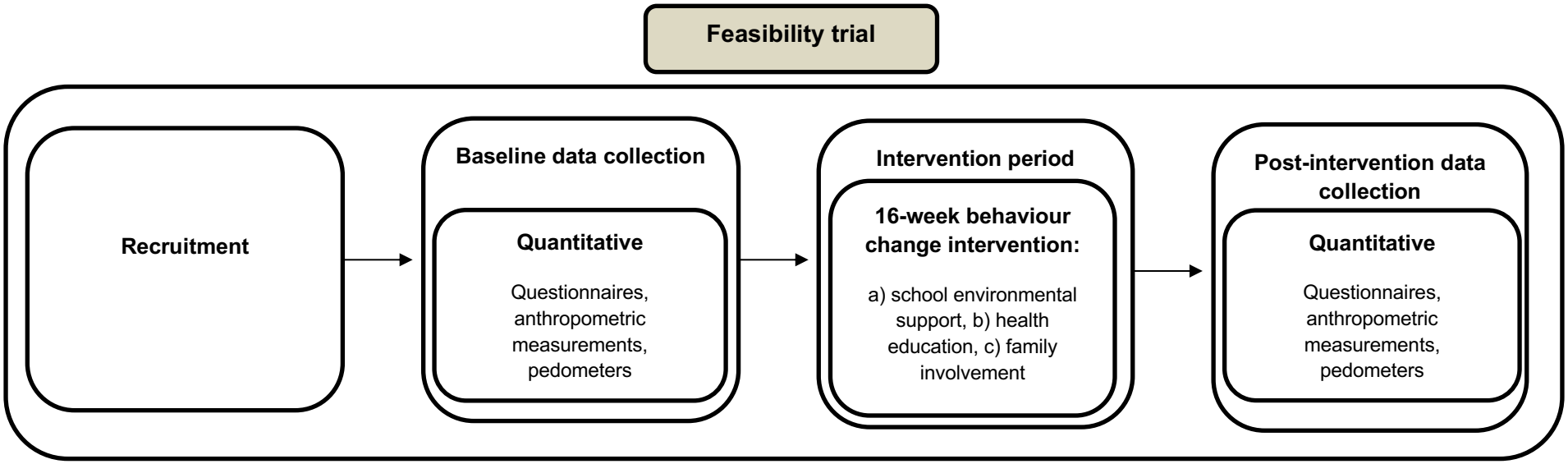


Figure 14: The feasibility study design



4.3.1 Estimation of parameters needed for designing the definitive cluster RCT

Table 11 reports the estimation of parameters needed for designing the definitive cluster RCT.

Sample size calculation for the definitive cluster RCT

The SD of the primary outcome (i.e., seven-day steps) was 34519 and ICC was 0.03 (previous Chinese studies have found similar smaller estimates).[162,223,224] Using these estimates, a power of 80%, a significance level of 5%, an average class size of 32 children, and assuming a 20% loss to follow-up at 16 weeks (post-intervention), a sample size of 2000 participants recruited from 50 schools (i.e., 1000 participants in 25 intervention schools and 1000 participants in 25 control schools) will be sufficient to determine a minimum clinically important difference of 7000 steps in the mean seven-day steps between the two study groups.[225,226]

Feasibility of undertaking the definitive cluster RCT

The recruitment and follow-up rates were 100%. The completion of data collection was 100% (except for the seven-day steps at baseline - one child lost the step log in the intervention group and two children lost their pedometer in the control group). The time needed to complete the self-reported questionnaire by children was around 15 minutes per study group, and the measurement of their anthropometric parameters took around 40 minutes per study group. The intervention attendance was 100%.

Table 11: Estimation of parameters needed for designing the definitive cluster RCT

	Total	Intervention	Control
Recruitment of child-parent dyads n (%)			
Child-parent dyads approached to participate	64 (100%)	32 (100%)	32 (100%)
Children gave assent	64 (100%)	32 (100%)	32 (100%)
Children's parents gave consent	64 (100%)	32 (100%)	32 (100%)
Child-parent dyads screened for eligibility	64 (100%)	32 (100%)	32 (100%)
Child-parent dyads found eligible and recruited	64 (100%)	32 (100%)	32 (100%)
Follow-up of children at 16 weeks (**post-intervention)** n (%)	64 (100%)	32 (100%)	32 (100%)
Data collection completion among children n (%)			
a) Children completed the self-reported questionnaire			
Baseline	64 (100%)	32 (100%)	32 (100%)
16 weeks (post-intervention)	64 (100%)	32 (100%)	32 (100%)
b) Anthropometric parameters were measured in children			
Baseline	64 (100%)	32 (100%)	32 (100%)
16 weeks (post-intervention)	64 (100%)	32 (100%)	32 (100%)
c) Children provided the recording of seven-day steps			
Baseline	61 (95.3%)	31 (96.9%)	30 (93.8%)
16 weeks (post-intervention)	64 (100%)	32 (100%)	32 (100%)
Time needed for data collection among children (mean minutes)			
a) Time needed to complete the self-reported questionnaire by children			
Baseline	30	15	15
16 weeks (post-intervention)	30	15	15
b) Time needed to measure anthropometric measurements in children			
Baseline	80	40	40
16 weeks (post-intervention)	80	40	40
Intervention attendance n (%)			
a) Group sessions for children			
Group session 1	n/a	32 (100%)	n/a
Group session 2	n/a	32 (100%)	n/a
Group session 3	n/a	32 (100%)	n/a
Group session 4	n/a	32 (100%)	n/a
b) Group session for parents	n/a	32 (100%)	n/a

4.3.2 Baseline characteristics of participants

The baseline characteristics of participants are presented in Table 12. Due to the non-randomised study design, there was an imbalance between the characteristics of parents' education, self-reported physical activity level, seven-day steps, self-efficacy, and perceived social support from parents (see Table 12). Compared to the control group, intervention group parents were more well educated (father who had university or equivalent education: 46.9% versus 6.3%; mother who had university or equivalent education: 31.4% versus 0%). At baseline, the intervention group reported a higher amount of total MVPA minutes per week (median 508.8, IQR 231.5 to 752.0 versus median 201.0, IQR 87.0 to 2930), self-efficacy (median 33.0, IQR 27.5 to 37.5 versus median 26.0, IQR 22.0 to 30.0), but a lower seven-day steps (median 4989.0, IQR 35430.0 to 64805.0 versus median 67447.0, IQR 43667.0 to 90950.0).

Table 12: Baseline characteristics of participants

	Intervention (n=32)	Control (n=32)	P value
Children's age (years)*	11.3±0.7	11.3±0.6	0.302
Children's sex n (%)			
Female	11 (34.4%)	17 (53.1%)	0.131
Male	21 (65.6%)	15 (46.9%)	
Parents' education n (%)			
Father			
None	0	1 (3.1%)	0.001
High school diploma or equivalent (0-12 years)	17 (53.1%)	29 (90.6%)	
University or equivalent (>12 years)	15 (46.9%)	2 (6.3%)	
Mother			
None	0	1 (3.1%)	0.002
High school diploma or equivalent (0-12 years)	22 (68.6%)	31 (96.9%)	
University or equivalent (>12 years)	10 (31.4%)	0	
Parents' employment n (%)			
Father			
Employed	31 (96.9%)	32 (100%)	0.313
Unemployed	1 (3.1%)	0	
Mother			
Employed	29 (90.6%)	32 (100%)	0.076
Unemployed	3 (9.4%)	0	
Physical activity			
MVPA (minutes/week)^	508.8 (231.5, 752.0)	201 (87.0, 293.0)	<0.001
Seven-day steps^	54989.0 (35430.0, 64805.0)	67447.0 (43667.0, 90950.0)	0.036
Height (cm)*	138.6±7.2	137.1±7.1	0.378
Weight (kg)*	38.0±8.8	36.2±6.2	0.360
BMI (kg/m^2)*	19.7±4.1	19.3±3.1	0.652
Waist circumference (cm)*	69.2±10.7	65.5±6.4	0.101
Self-efficacy^	33.0 (27.5, 37.5)	26.0 (22.0, 30.0)	0.001
Enjoyment^	8.0 (7.0, 10.5)	8.0(7.0, 16.5)	0.730
Social support^			
Parents	32.0 (26.5, 35)	25.5 (17.0, 29.5)	0.018
Friends	26.0 (14.0, 34.0)	22.5 (15.0, 31.0)	0.455

Values are n (%), *mean±SD or ^median (IQR). MVPA, moderate-to-vigorous physical activity.

4.3.3 Initial estimates of effects

Table 13 and Table 14 report the unadjusted and adjusted study outcomes, respectively. Compared to the control group, the seven-day steps were significantly lower in the intervention group (mean difference: -27742.3; 95% CI -49112.6 to -6372.0) but had a higher self-efficacy (mean difference: 6.3; 95% CI 3.1 to 9.5). In the intervention group, BMI significantly reduced from the baseline to 16 weeks (mean difference: -1.9; 95% CI -2.3 to -1.4) and self-efficacy significantly increased during this period (mean difference: 4.6; 95% CI 2.4 to 6.8). After adjustment, similar results were found except for the BMI.

Table 13: Unadjusted study outcomes

	Intervention				Control				At 16 weeks (post-intervention) comparison	
	Baseline	**At 16 weeks (post-intervention)**	**Mean difference** (95% CI)**	**Within-group P value**	**Baseline**	**At 16 weeks (post-intervention)**	**Mean difference* (95% CI)**	**Within-group P value**	**Mean difference^^ (95% CI)**	**Between-group P value**
Physical activity										
MVPA (mins/week)^	508.8 (231.5, 752.0)	348.0 (187.5, 519.0)	-188.3 (-378.9, 2.4)	0.053	201.0 (87.0, 293.0)	271.0 (159.0, 352.5)	99.9 (-62.4, 262.3)	0.219	80.1 (-106.9, 267.2)	0.171
Seven-day steps^	54989.0 (35430.0, 64805.0)	49096.0 (38084.0, 61005.5)	-3295.0 (-19757.6, 13167.7)	0.686	67447.0 (43667.0, 90950.0)	76923.0 (45487.0, 101723.5)	11739.8 (-5232.5, 28712.1)	0.168	-27742.3 (-49112.6, -6372.0)	0.006
Seven-day steps*	56966.5±36941.0	53671.5±32960.5			69674.0±31201.9	81413.8±50703.9				
Weight (kg)*	38.0±8.8	38.5±8.6	0.5 (-0.2, 1.3)	0.177	36.2±6.2	37.2±6.8	1.0 (0.1, 1.9)	0.041	1.3 (-2.6, 5.2)	0.504
BMI (kg/m^2)*	19.7±4.1	17.8±3.8	-1.9 (-2.3, -1.4)	<0.001	19.3±3.1	17.5±2.4	-1.8 (-2.5, -1.2)	<0.001	0.4 (-1.2, 2.0)	0.616
Waist circumference (cm)*	69.2±10.7	68.2±9.2	-1.0 (-3.1, 1.0)	0.315	65.5±6.4	65.9±8.5	0.3 (-1.2, 1.9)	0.645	2.3 (-2.1, 6.7)	0.304
Self-efficacy^	33.0 (27.5, 37.5)	37.0 (34.0, 40.0)	4.6 (2.4, 6.8)	<0.001	26.0 (22.0, 30.0)	29.0 (24.0, 36.0)	3.4 (1.1, 5.8)	0.006	6.3 (3.1, 9.5)	<0.001
Enjoyment ^	8.0 (7.0, 10.5)	7.0 (7.0, 8.5)	-1.0 (-2.9, 0.8)	0.261	8.0 (7.0, 16.5)	8.5 (7.0, 14.0)	-0.3 (-2.5, 2.0)	0.800	-1.8 (-4.4, 0.8)	0.090
Social support (from parents)^	32.0 (26.5, 35.0)	30.0 (20.0, 38.5)	0.4 (-4.2, 4.9)	0.868	25.5 (17.0, 29.5)	27.0 (17.0, 34.0)	1.4 (-1.6, 4.5)	0.355	3.6 (-1.5, 8.7)	0.195
Social support (from friends)^	26.0 (14.0, 34.0)	28.5 (17.0, 37.5)	2.8 (-1.2, 6.7)	0.161	22.5 (15.0, 31.0)	25.5 (17.0, 32.5)	1.7 (-2.3, 5.7)	0.385	2.7 (-2.7, 8.0)	0.310

Values are median (IQR)^ or mean±SD*.
MVPA, moderate-to-vigorous physical activity; CI, confidence interval.
**At 16 weeks (post-intervention)-baseline.
^^Intervention-control at 16 weeks (post-intervention).

Table 14: Adjusted study outcomes

	Intervention		Control		At 16 weeks (post-intervention) comparison	
	Regression coefficient (95% CI)†	**P value**	**Regression coefficient (95% CI)†**	**P value**	**Regression coefficient (95% CI)††**	**P value**
Physical activity						
MVPA (mins/week)^	-188.3 (-430.6, 54.1)	0.125	99.9 (-65.4, 265.3)	0.232	-33.9 (-229.6, 161.7)	0.730
Seven-day steps^	-3295.0 (-20908.1, 14318.1)	0.710	11739.8 (-9475.8, 32955.3)	0.273	-25216.8 (-46387.1, -4046.4)	0.02
Weight (kg)*	0.5 (-3.8, 4.9)	0.816	1.0 (-2.1, 4.0)	0.538	-0.6 (-1.8, 0.5)	0.276
BMI (kg/m^2)*	-1.9 (-3.8, 0.1)	0.065	-1.8 (-3.1, -0.5)	0.006	-0.1 (-0.7, 0.6)	0.839
Waist circumference (cm)*	-1.0 (-5.8, 3.7)	0.663	0.3 (-2.9, 3.6)	0.832	-1.1 (-3.5, 1.4)	0.383
Self-efficacy^	4.6 (1.4, 7.8)	0.006	3.4 (0.2, 6.7)	0.037	4.3 (1.3, 7.3)	0.005
Enjoyment^	-1.0 (-3.4, 1.4)	0.395	-0.3 (-3.0, 2.5)	0.839	-1.6 (-4.1, 0.8)	0.193
Social support (from parents)^	0.4 (-4.7, 5.5)	0.884	1.4 (-2.8, 5.6)	0.504	2.1 (-3.0, 7.2)	0.418
Social support (from friends)^	2.8 (-2.7, 8.3)	0.314	1.7 (-3.3, 6.8)	0.497	1.6 (-3.3, 6.5)	0.527

Values are median (IQR)^ or mean±SD*.

MVPA, moderate-to-vigorous physical activity; CI, confidence interval.

†Multiple linear regression adjusted for children's sex (16 weeks (post-intervention)-baseline).

††Multiple linear regression adjusted for children's sex and the respective baseline value (intervention-control at 16 weeks (post-intervention)).

4.3.4 Adverse events

No adverse event was reported during the study.

4.3.5 Withdrawal

No one withdrew from the study.

4.4 Discussion

In this study, the feasibility of undertaking the definitive cluster RCT was found to be promising even though the study was conducted during the COVID-19 pandemic (see chapter six, section 6.4 for more details on the impact of the COVID-19 pandemic on the study). The recruitment, follow-up, completion of and time needed for data collection, and intervention attendance were promising. In our study, the recruitment rate was high (100%), similar to cluster RCTs conducted in China where the intervention targeted the physical activity levels of children in school settings (91.2% and 96.5%).[86,162] This indicates that schools are an appropriate place to recruit child-parent dyads in China. Globally, similar school-based studies have reported lower recruitment rates. For example, the recruitment rates were 87.1% and 67.2% in studies conducted in the UK and Finland, respectively.[218,219] Similarly, the follow-up rate was high

(100%) in this study, similar to the studies conducted in China (96.4% and 93.7%), UK (97%), and Finland (86.5%).[86,162,218,219] The completion of data collection was 100% (except for the seven-day steps at baseline - one child lost the step log in the intervention group and two children lost their pedometer in the control group). In the definitive cluster RCT, different strategies will be used to minimise such losses, such as sending reminders and giving rewards.[218] The intervention attendance was high (100%) in this study, compared to children's attendance in studies conducted in the UK (53%) and Finland (70.4%).[218,219]

Although the seven-day steps did not increase in the intervention group compared to the control, the improvements were observed in children's BMI and self-efficacy, which could enhance children's motivation to take part in future physical activities.[215,227,228] This decrease in BMI among children may be partly due to puberty i.e., growth in terms of height.[229,230] It should be noted that this feasibility study was not adequately powered to detect a difference in outcomes between the two study groups, and the effectiveness of the intervention will be determined in the definitive cluster RCT. As the pedometer acted as both an intervention component and a data collection tool, the data of seven-day steps may be biased because the control group was exposed to the similar content. Moreover, the self-measurement of steps by children could potentially increase their incentives to walk, which could lead to the collection of biased data. Future research could improve the interaction between intervention component and measurement by using closed measurement (i.e.,

the records to be taken by the research team). In the future cluster RCT, a leaflet containing information on physical activity will be provided to the participants in the control group.

If the school-based behaviour change intervention is found to be effective in the definitive cluster RCT, it could be scaled up in China and integrated into the health education curriculum through the involvement and engagement of key stakeholders. The intervention could increase the physical activity levels among children and their self-efficacy for physical activity participation. The support needed from family and school to promote physical activity could be improved. The schools and teachers (responsible for promoting physical activity) will get an evidence-based intervention to increase children's physical activity levels.

To the best of researcher's knowledge, this was the first feasibility study of a physical activity intervention in Yangzhou. Although the baseline characteristics of the intervention and control group participants in this study were exceedingly different due to the non-randomised study design, the non-randomised study design has provided the estimates of many important parameters needed to design the definitive cluster RCT. A qualitative study (using semi-structured interviews) was also conducted with a sample of children and their parents and teachers to explore their experiences in taking part in this intervention and study, which was reported in the next chapter. Decisions over whether to modify the intervention and study will mainly be informed by the qualitative data. The

sample size was modest, although reasonable to address the aim of this feasibility study and was comparable with other feasibility studies of physical activity interventions targeting children.[182,218] This study was not blinded and was open, and this could have introduced information bias and performance bias. Although it was difficult to blind participants and those delivering the intervention in this case, the plan is to blind the outcome assessors and data analysts in the definitive cluster RCT. The follow-up was short in this study. The researcher intend to do long-term (≥1 year) follow-ups in the definitive cluster RCT. In the future cluster RCT, there will be 25 schools (clusters) per study arm, and the multilevel models should be used in the analysis that will address the clustered nature of the data.[231] Due to the COVID-19 pandemic and related social-distancing rules, the anthropometric parameters at post-intervention were not directly measured by the study team. Instructions were provided by the study team over a video call, and anthropometric parameters were measured synchronously by the parents.

4.5 Conclusions

Based on the promising recruitment, follow-up, completion of and time needed for data collection, and intervention attendance, it would be feasible to undertake the definitive cluster RCT in China.

4.6 Human participants approval statement

Ethical approval (Appendix 8) was obtained from the Faculty of Medicine and Health Sciences Research Ethics Committee, University of Nottingham, UK (255-1902). Local approvals were obtained from the two local schools in Yangzhou, China. The study was registered with the Chinese Clinical Trials Registry (ChiCTR1900026865).

Chapter five

School-based physical activity intervention: a qualitative process evaluation of a feasibility trial in Yangzhou, China

5.1 Introduction

Process evaluations are integral elements of complex behaviour change interventions,[71] which oversee the intervention delivery, the reach (number of people who receive the intervention), fidelity (the extent to which the intervention was delivered as planned), and implementation (how well the program was implemented).[232] However, process evaluation has often been neglected or not adequately reported in previous physical activity programmes for children in China.[65] This may undermine our understanding of participants' experiences and perceptions of intervention delivery and participation in trials. Exploring the experiences and perceptions of those involved is essential for successful recruitment and retention in intervention trials, and to better understand what makes acceptable and effective intervention. The UK MRC framework for developing and evaluating complex interventions recommends a feasibility and piloting phase after an intervention has been developed.[71] At this stage, process evaluation can have a vital role in understanding the feasibility of the intervention and optimising its design and evaluation. Moore and colleagues suggested that process evaluation can also be used for formative purposes to test the feasibility of intervention elements in a pilot prior to full implementation and to make implementation adjustments to ensure high dose, fidelity, and acceptance.[232] Depending on the stage of intervention development and implementation, researchers could use different components of process evaluation. Process evaluations are helpful during the feasibility

evaluation of behavioural interventions as they can capture information on how the intervention may work in a trial setting as well as gather feedback from participants, intervention deliverers, and key stakeholders on how the intervention content could be improved to maximize the potential for behaviour change.[233] Specifically, the information collected can be used to improve recruitment, increase follow-up, enhance attendance, and refine and improve the intervention design prior to conducting the full-powered definitive trial.[233,234]

Behaviour-change-theory-based interventions have shown positive effects on children's health behaviours, such as physical activity.[77] However, evidence is still lacking regarding the feasibility and efficacy of theory-based interventions targeting physical activity of children in China, or the research processes used to evaluate them. In chapter 4, a cluster feasibility non-randomised controlled trial (RCT) was conducted to examine the feasibility of delivering a 16-week behaviour change intervention for increasing physical activity levels among children in Yangzhou, China.[235] Specifically, the study provided estimates of many important quantitative parameters (e.g., recruitment, follow-up, initial estimates of effects) needed to design the future cluster RCT. These are reported in detail in chapter 4.[235] Briefly, the study indicated that the intervention may lead to improvement in children's self-efficacy, enjoyment, and social support for physical activity. Although the cluster feasibility non-RCT analysis showed promising recruitment (100%), follow-up (100%), completion of data collection (100%), and intervention attendance (100%), more work is needed

to explore intervention delivery and implementation, the influence of context, aspects of the intervention that were more or less successful, and how it could be improved to facilitate the desired behaviour change. The aim of the study was to conduct a qualitative process evaluation to: (1) explore the experiences and perceptions of participants and providers in the intervention (i.e., intervention-specific questions for participants and providers who were in the intervention group only) and trial (i.e., feasibility-trial-specific questions for participants and providers who were in both intervention and control groups); and (2) make recommendations to inform the design of a future intervention and full-scale cluster RCT. The study was conducted in the context of the cluster feasibility non-RCT which examined the feasibility and acceptability of undertaking main cluster RCT with participants and providers in China.[235]

5.2 Methods

5.2.1 Study Design, Location, Period, and Reporting

This qualitative study was conducted in two public schools in Yangzhou, China.[235] Participants in one school received the intervention in addition to their usual physical activities. Participants in the other school continued with their usual physical activities. In this qualitative study, semi-structured interviews were conducted with children, their parents, and health education teachers at

the end of the intervention (from September 2020 to October 2020, by prior appointment). Reporting of this study was guided by the Consolidated Criteria for Reporting Qualitative Research (COREQ-32) guidelines.[236]

5.2.2 The Behaviour Change Intervention

The researcher used the Behaviour Change Wheel (BCW), Theoretical Domains Framework (TDF), and information gathered through PPIE activities to systematically develop a school-based behaviour change intervention.[77] The intervention was developed with the aim of encouraging children to be more active during the school day and increasing their overall physical activity levels (including leisure-time physical activity after school and at weekends). Children's physical activity is recognized as being unstructured and intermittent, which may not be encompassed by traditional approaches (e.g., structured exercise programmes). Instead, redesign of the physical activity environment may help to provide children with more opportunities for being active, in addition to the provision of quality and mandated physical education. In the intervention development phase, the behavioural diagnosis revealed that physical activity engagement among children in China was largely determined by TDF domains of environmental context and resources, social influences, beliefs about consequences, memory, attention, and decision process, emotion, and belief about capabilities.[195] Therefore, in the development of the intervention, the

researcher chose to focus on active behavioural change (i.e., promoting at least 60 min of MVPA per day) in children, rather than focusing on specific types of physical activity. The intervention development is reported in detail in chapter 3.[195] Briefly, the intervention consisted of three components: (a) health education (physical education), (b) family involvement, and (c) school environment support (see Table 9). Health education was achieved by imparting knowledge to children via four group activity sessions and the provision of printed materials (e.g., activity diary). Examples of key features include: (a) provision of information about health consequences/emotional benefits to increase understanding, (b) demonstration of the physical activity domains to act as persuasion, (c) emphasis on previous successful experience and personal capacities to encourage children to perform the activity voluntarily, and (d) encouragement of goal setting and action planning for physical activity participation. Family involvement was achieved by: (a) an online education session and a physical activity booklet delivered to parents that elicited their positive feelings and impulses relating to physical activity promotion among their children; and (b) provision of emotional social support (e.g., buddying up with children for physical activity) and practical social support (e.g., encouraging parents to prepare sports gear for their children). School environment support was achieved by organisational changes, including: (a) restructuring aspects of the physical environment (e.g., provision of physical activity poster, sports equipment, and pedometer) to increase children's initiatives for performing

physical activity; and (b) provision of verbal encouragement or material reward (e.g., stickers).

5.2.3 Study Participants and Recruitment

All children, parents, and teachers who participated in the cluster feasibility non-RCT were eligible to take part in a semi-structured interview. Particularly, the interviews for children and their parents were conducted in dyads (pairs). Child-parent dyads were purposively selected and contacted by an independent teacher. Two health education teachers from the intervention (n = 1) and control school (n = 1) were contacted directly by the study team for independent interviews. Children aged 10 to 12 years with verbal assent and parents' consent were interviewed. Parents and health education teachers with verbal assent and informed consent were interviewed.

5.2.4 Sample size

In the cluster feasibility non-RCT, a total of 64 child-parent dyads (32 per study group) were recruited. Interviews aimed to achieve data saturation to the point where no new or relevant data were discovered in the analysis.[237] Evidence suggests that the majority of themes in a homogenous sample tend to be captured in around six to seven interviews (i.e., six interviews to reach 80%

saturation).[238] The researcher believed that data saturation was reached after the 10th interview among child-parent dyads in both intervention and control groups, when no new information was arising from the discussions. However, in the case of providers, only two health education teachers were part of the trial, i.e., one in the intervention group and one in the control group. The characteristics of the interviewees are summarised in Table 15.

Table 15: Participant characteristics by group

	Intervention	Control
Children, n	10	10
Age in years, (range, mean)	10-12, 11.2	10-12, 11.2
Gender		
Female, n (%)	5 (50%)	4 (40%)
Male, n (%)	5 (50%)	6 (60%)
Parents, n	10	10
Mother, n (%)	6 (60%)	8 (80%)
Father, n (%)	4 (40%)	2 (20%)
Education		
High school diploma or equivalent (0-12 years), n (%)	5 (50%)	8 (80%)
University or equivalent (>12 years), n (%)	5 (50%)	2 (20%)
Employment		
Employed, n (%)	10 (100%)	10 (100%)
Unemployed, n (%)	0	0
Health education teachers, n	1	1
Gender		
Female, n (%)	1 (100%)	1 (100%)
Male, n (%)	0	0
Education		
High school diploma or equivalent (0-12 years), n (%)	0	0
University or equivalent (>12 years), n (%)	1 (100%)	1 (100%)

5.2.5 Interview guides

This study followed the structured process evaluation framework proposed by Reelick and colleagues.[234] The framework was chosen for the current study for its systematic and comprehensive guidance for process evaluations at the feasibility stage of development. The framework evaluates three main components of intervention and research processes: (a) the success rate of recruitment and quality of the study population; (b) the process of data collection; and (c) the quality of implementation of the intervention. Each process component can be assessed by several measures and multiple variables (Table 16). As such, three semi-structured interview guides (see Appendix 9) were adapted, one each for children, their parents, and health education teachers from similar feasibility studies.[182,239] These were then translated from English into Mandarin, and the translation was checked for accuracy by a bilingual researcher (HW). The three interview guides are largely the same for general questions that explored participants' and providers' experiences and perceptions in the intervention (e.g., experiences and perceptions of participating in the education sessions, perceptions of intervention frequency and timing, and attitudes toward the intervention providers; intervention-specific questions were asked in the intervention group only) and feasibility trial (e.g., recruitment, understanding of the information sheet, and data collection; feasibility-trial-specific questions were asked in both intervention and control groups). Meanwhile, the interviews included specific

questions for different categories of participants (e.g., questions relating to the use of the activity diary and physical activity booklet for children and parents, respectively).

Table 16. Process-evaluation components and related process measures of a complex intervention

Process Components	Process Measures
Study population	1. Recruitment and selection rate
	2. Barriers and facilitators in recruitment and selection process
	3. Follow-up: attrition rate
	4. Barriers and facilitators for follow-up
Multiple components	1. Quality of delivery of the interventional components
	2. Barriers and facilitators for delivery of interventional components
	3. Adherence to interventional components
	4. Barriers and facilitators for adherence to interventional components
	5. Experience of participants and instructors with interventional components
Evaluation data	1. Outcome measures: coverage of interventional components
	2. Completeness of data collection
	3. Barriers and facilitators for data collection

5.2.6 Interview procedures, transcription, and translation

Prior to commencing the interviews, the purpose and procedures of the interview were explained. Participants (i.e., children, parents) and providers

(i.e., health education teachers) were assured that their participation in the interviews was entirely voluntary, and they could stop the interview at any time during the process of interviews. As the researcher brings own beliefs and experiences into qualitative research and data interpretation, the researcher's background is briefly described to enhance reflexivity as follows: the researcher (HW) is doing PhD (male) and have a Master of Science qualification (MSc physical activity for health). At the time of the feasibility cluster non-RCT, the researcher was the intervention provider and was trained in qualitative research. Interviewees had no prior relationship with the researcher. All interviews were conducted in Mandarin using the telephone; interviews lasted 20 min on average (i.e., from 15–25 min). Face-to-face interviews were originally planned but were rescheduled to take place by telephone due to the social-distancing regulations of schools, put in place due to the COVID-19 pandemic at the time of the study. During the interviews, the interviewer used open-ended questions and constantly reminded interviewees that there were no right or wrong answers to help prompt free speech. The researcher made notes about the interview (e.g., insights about the interview, emerging points of interest), which helped in coding and generation of themes. With consent, interviews were audio-recorded. Transcripts were imported into QSR International's NVivo version 12 software to enable data storage and organisation for analysis.[240] Transcripts were not returned to the participants and health education providers, but efforts were made to minimise transcription errors and omissions.

Specifically, encrypted files were then transferred to an external professional company for transcription (verbatim) and translation (from Mandarin into English) after signing the nondisclosure agreement. Moreover, two researchers (HW/YZ) constantly checked the transcripts provided by the transcriptionist against the audio recording to further rule out the possibility of errors and missing data.

5.2.7 Ethics

Ethical approval was obtained from the Faculty of Medicine and Health Sciences Research Ethics Committee, University of Nottingham, UK (255-1902).

5.2.8 Data Analysis

Transcripts were analysed using thematic analysis,[241,242] using both inductive and deductive approaches. Data analysis began with an inductive approach (i.e., codes arose purely from the data) to ensure important aspects of the data were not missed. In addition, codes could also be theory-derived (i.e., codes arose through a deductive approach), which allowed the researcher to be sensitive to existing knowledge that may arise in the data. For example, initial codes of “fun”, “personal interests in physical activity”, and “curiosity about

physical activity knowledge" were deductive, as evidence has suggested that internal motivation could be a facilitator to children's physical activity participation. The analysis was iterative rather than a rigid linear process, and all these codes were refined during analysis as the data emerged (inductive). All transcripts were rechecked, read, and reread by the two researchers (HW/YZ) independently to ensure credibility. The initial codes were developed through discussion between the two researchers, and applied initially to a small number of transcripts, enabling further discussion and iteration of the coding. Transcripts were independently coded by the two researchers, and the codes were discussed between them if any discrepancies were found in order to reach a consensus. The researchers analysed and coded the children's transcript first, followed by that of parents and teachers. Similar codes from children, parents, and teachers were then collated together, which led to the emergence of themes and subthemes within each overarching category. In addition, specific codes relating to children, parents, or teachers were collated and grouped on the basis of similarity in meaning of quotations (e.g., codes related to the activity diary for children or physical activity booklet for parents). The identification of specific themes and subthemes relating to children, parents, or teachers was based on the similarity in meaning of the specific codes. Efforts were made to minimise bias by (a) involving researchers (HB, KC) who had not conducted interviews in analytic decisions relating to data interpretation, (b) applying reflexivity (HW) and examining reflective accounts (HW, YZ) during analysis

processes, and (c) involving a researcher (YZ) in the analysis of data who was not involved in intervention delivery or cluster feasibility non-RCT design. Participants and providers did not provide feedback on the findings.

5.3 Results

Findings believed to reflect participants' and providers' experiences and perceptions in the intervention and trial are presented as eight themes. Within these eight themes, there were 32 subthemes. Themes, subthemes, and verbatim quotes are presented in Tables 17 and 18.

Table 17: Experiences and perceptions of participating in the intervention

Themes	Subthemes	Verbatim quotes
Theme 1: Perceived high efficacy of the intervention components to help children become more active	1.1) Activity diary plays an active role in helping children review behaviour goals	1.1.1) “I do try to spare some time each day reading them, and then if I find anything beneficial for me, I will just do it and if not, I will make slight adjustments.” (Child 3, Male, Intervention group).
		1.1.2) “My favourite is the exercise diary because I can record my daily steps, so I can adjust my exercise amount according to my situation.” (Child 4, Female, Intervention group).
		1.1.3) “The forms [daily physical activity plan and steps log] are able to motivate me to do exercise.” (Child 5, Male, Intervention group).
	1.2) Positive impact of the group activity sessions on physical activity beliefs	1.2.1) “The course is quite helpful. As what has mentioned in the course, physical activity is quite beneficial to our body. If you do something quite opposite to the content without even knowing it yourself, it will do harm to your body, and then it will remind yourself of how harmful it is.” (Child 1, Female, Intervention group).
		1.2.2) “They are helpful to some extent. I know its importance. Sometimes, when I am guiding my child, parents including me will know about the importance through attending the group session.” (Parent 7, Father, Intervention group).
		1.2.3) “Generally speaking, his participation has a positive influence on him and he is very motivated. This course is helpful for motivating his enthusiasm for exercise. He would be reluctant to record his steps if he were told to do so by the parents. However, if he were told by the teacher in the school, the result would be different.” (Parent 2, Father, Intervention group).
		1.2.4) “It’s quite interesting. Writing the knowledge of physical activity on the handwritten poster helps one better understand such knowledge, and it is actually the self-reflection process of the knowledge.” (Child 1, Female, Intervention group).
		1.2.5) “I am quite impressed by the last class on handwritten newspaper making…Because I think it is easier to arouse students’ interest in exercise.” (Child 9, Female, Intervention group).
	1.3) Increased awareness of ways for doing physical activity	1.3.1) “As long as there are suggestions for children's guidance, we will coordinate with the arrangement of the time in and out of class. For example, we will refer to them in the spare time, and use the time after work, either at home or outside, and borrow some instructive suggestions from the materials. They are quite instructive for both us and our child.” (Parent 4, Father, Intervention group).
		1.3.2) “Parents had no idea of them before, but they will know after reading the materials. Then parents will guide their child to do some physical activities. It is quite a good method.” (Parent 6, Father, Intervention group).
		1.4.1) “I believe that each time I had them with me, they served as a reminder of more exercise.” (Child 4, Female, Intervention group).

	1.4) Increased actions of self-monitoring through the provision of pedometers	1.4.2) “The child was very happy about the pedometer given to him and liked going outside every day. In days when he was reluctant to go outside, he’d like to get some fresh air and exercise a little whenever he saw his pedometer.” (Parent 3, Mother, Intervention group).
		1.4.3) “Sometimes, he tells me that his steps are not enough and he needs to go out for a walk. This is such a great help and also the invisible supervision.” (Parent 10, Mother, Intervention group).
		1.4.4) “In fact, the children are quite willing to participate in this study, including the later period when they pay attention to how many steps they take every day, and even the students compete with each other, that is to say, how many steps you take every day and how many steps I take every day, and there is this kind of competition between them”. (Teacher, Female, Intervention group).
	1.5) Positive influences of sports equipment on children’s unstructured and intermitted physical activity pattern	1.5.1) “You gave us a pedometer further promoted our exercise in daily walking, and you gave us a skipping rope which made us actively participate in exercise such as rope skipping… The equipment provided arouses our interest in exercise and motivates us to complete the exercise.” (Child 3, Male, Intervention group).
		1.5.2) “Sometimes they are quite convenient in use. Actually, we also have similar stuff at home and if time permits, we would love to use them.” (Parent 8, Mother, Intervention group).
Theme 2: Appreciation of the intervention features	2.1) Understanding of intervention materials (e.g., activity diary, physical activity booklet)	2.1.1) “I think it’s fine. Some information related to our body activity that was unknown to me has been explained.” (Child 1, Female, Intervention group).
		2.1.2) “Everything is fine, or at least it is quite good from my non-professional point of view. All including the examples are good.” (Child 7, Father, Intervention group).
	2.2) Satisfaction with venues	2.2.1) “In my opinion, it will be easier to understand if the lecture is face-to-face because I can just ask you whenever it is hard to understand.” (Child 1, Female, Intervention group).
		2.2.2) “I think it’d better not use the PE [physical education] class time…You can use the time for class meetings and reading class.” (Child 4, Female, Intervention group).
		2.2.3) “The online form is quite convenient because you can reach out to us at any time. If you choose the offline parents’ meeting, first, the time might be intense, and second, parents’ meeting is only held once in school in one semester. Therefore, the online form makes us communicate with each other at any time and it is great.” (Parent 6, father, Intervention group).
	2.3) Researcher’s characteristics in delivering the intervention	2.3.1) “It is quite friendly. The vivid language you use in class makes the course very interesting.” (Child 10, Female, Intervention group).
		2.3.2) “I believe that the communication is quite tacit.” (Parent 2, father, Intervention group).

	2.4) Acceptability of the group activity sessions' duration, frequency, and timings	2.4.1) "There is no need for any increase or decrease and such arrangement is quite appropriate for me." (Child 3, Male, Intervention group).
		2.4.2) "In my opinion, four classes are too much to accept and two or three classes are OK with me." (Child 1, Female, Intervention group).
		2.4.3) "We can increase it a little. However, we should neither increase it too much nor decrease it too much." (Child 4, Female, Intervention group).
		2.4.4) "I think the arrangement is quite reasonable. To my understanding, many parents have no idea of their children's hardship. If children can attend their class for such a long time, parents can also seriously take a class that long, and I think it is OK." (Parent 10, Mother, Intervention group).
		2.4.5) "OK, no problem. So I need to take the class each semester. I think it will be better if it is held twice each semester." (Parent 5, Mother, Intervention group).
		2.4.6) "In my opinion, the time length of one class is a bit long and it can be divided into two. So it will slightly shorten the time length, am I right? It is my opinion. To be honest, it is not realistic for us to calm down and read the materials. It especially fits my situation because I have two children and am very busy. The time interval can be made shorter, that is, you can have two classes in one semester. It is my opinion because 45 minutes is too long for us." (Parent 2, Father, Intervention group).
	2.5) Social interaction and engagement	2.5.1) "Because I want all of us to experience the feeling of exercise, enjoy the healthy and happy growth and do exercise together." (Child 5, Male, Intervention group).
		2.5.2) "If possible, I will recommend it…In my opinion, a lot of people have no idea what exactly physical activity is. Generally speaking, to most parents, physical activity is equal to running and walking. So we need to expand their recognition of physical activity. As a matter of fact, it is understandable that most people have such a definition of physical activity, which might be partially or incompletely correct. So everyone needs such propaganda for knowledge popularization or understanding." (Parent 7, Father, Intervention group).
Theme 3: Factors that facilitated or impeded intervention attendance, and delivery	3.1) Gaining support from schools and education departments	3.1.1) "In my point of view, the solution to this problem mainly depends on the school and it will be solved only if the school and the education department attach great importance to it. That's to say, your pure dependence on parents is useless. When parents are forced to choose between study and exercise, most parents will put study ahead of exercise. As for the knowledge lectures, you need to ask the help from the education department and then require the school to reasonably allocate children's time for study and exercise." (Parent 8, Mother, Intervention group).
	3.2) Provision of electronic materials	3.2.1) "It would be better to have the electronic version of these materials. As what I said before, paper is not easy to find after a long time… There should be an official account regularly pushing information about the content or arrangement of the activity, and I think it will be great." (Parent 6, Father, Intervention group).

		3.2.2) “To my understanding, exercise refers to movement related to physical quality. So you may hand out some audio and video materials for the children to watch and understand what exercise is.” (Parent 9, Mother, Intervention group).
		3.2.3) “I think it's OK, because today's children have a strong ability to accept, and there are many modern means of science and technology. In fact, can they provide some more such as the Internet, some examples, some good documentaries on sports and health, or some good ones? Some promotional videos and videos of knowledge can be recommended to him or the website so that children can make more use of this modern means and media means to learn more about such information at home and abroad, including paying more attention to their own health in all aspects, and even recommending some good sports methods, including what aerobics they can lead the children to do together, or I think examples can be diversified and multi-angled, so that children can actively participate in it, don't know if it is right?” (Teacher, Female, Intervention group).
	3.3) More physical activity options	3.3.1) “In my opinion, exercise should not be limited to simple movements such as skipping ropes. Instead, exercise with larger intensity should be added to the programme. It is OK for students to do exercise of larger intensity.” (Parent 6, Father, Intervention group).
	3.4) More instruments for self-monitoring	3.4.1) “I am not quite clear about it and I think it is good that each child in school is given a pedometer and it can serve as the bottom line of testing students’ possible exercise data. However, if there is such a device that can serve as functionally as the pedometer, it will be better.” (Parent 5, Mother, Intervention group).
		3.4.2) “We may give them children some metrics or data that they can actually touch, enabling them to observe a change on a daily basis…. You may provide the children with something more interesting, such as pulse measurement device, and you can have the children test other kinds of data” (Parent 7, Father, Intervention group).

5.3.1 Topic 1: Participants' and providers' experiences and perceptions of participating in the intervention

5.3.1.1 Theme 1: Perceived high efficacy of the intervention components to help children become more active

This theme explored whether the intervention components were perceived by participants and providers to be suitable and beneficial to help children become physically active in their daily routine. Five subthemes were identified in regard to which components of the intervention helped children to keep active.

1.1) Activity diary plays an active role in helping children review behaviour goals

The activity diary received positive evaluations from children. All children could appreciate the information about physical activity and its benefits. Some felt that the physical activity plans and step logs in the activity diary reinforced their motivation for performing physical activity, and this encouraged them to continue being active (see Table 17, quote 1.1.1 to 1.1.3).

1.2) Positive impact of the group activity sessions on physical activity beliefs

Both children and parents deemed that the attendance of group activity sessions helped them in better understanding physical activity and spending more time actively engaging in physical activity. Moreover, a number of parents explicitly reported having observed their children becoming more physically active after attendance in the group activity sessions (see Table 17, quote 1.2.1 to 1.2.3). In the third group activity session, the researcher facilitated a poster-making session to provide the children with opportunities to reflect on the knowledge they learned, and use the production of physical activity posters as a way of demonstrating and reinforcing their understanding of physical activity. Overall, children acknowledged the session was interesting and appreciated it as a "burden-free" way to promote self-motivation in physical activity (see Table 17, quote 1.2.4 to 1.2.5).

1.3) Increased awareness of ways of doing physical activity

Parents frequently discussed the usefulness of the examples and illustrations given in the physical activity booklet. They also highlighted the benefits of using the physical activity booklet to help actively support physical activity participation in their children (see Table 17, quote 1.3.1 to 1.3.2).

1.4) Increased actions of self-monitoring through the provision of pedometers

The pedometer was a popular component of the behaviour change intervention for children. Children expressed that they actively used the pedometers to monitor and reflect back on their daily and weekly step count, which in turn further motivated them to increase their amount of walking (see Table 17, quote 1.4.1). Parents and teachers referred to the pedometers as providing "invisible" supervision that helped children to self-monitor their physical activity levels and establish a motivating element of "competition" between children for comparing their daily step counts (see Table 17, quote 1.4.2 to 1.4.4).

1.5) Positive influences of sports equipment on children's unstructured and intermittent physical activity pattern

It appears that both children and parents found the provision of sports equipment to facilitate children in actively performing physical activity at any time. They valued the convenience of having the sports equipment available, which could be accessed by children whenever they chose (see Table 17, quote 1.5.1 to 1.5.2).

5.3.1.2 Theme 2: Appreciation of the intervention features

In general, children and their parents found the intervention to be acceptable and they were particularly content with the organisation and delivery of the intervention (e.g., in terms of materials provided and the venues) and the opportunity to be involved. Five subthemes emerged in regard to the feelings around acceptability of the intervention features.

2.1) Understanding of intervention materials (i.e., activity diary, physical activity booklet)

Children and their parents perceived that the information and expressions in the written intervention materials (i.e., booklets, activity diary) were well-prepared, informative, and understandable to them (see Table 17, quote 2.1.1 to 2.1.2).

2.2) Satisfaction with venues

Most children expressed high levels of satisfaction with the venue (e.g., using health education to deliver the session in the school setting). Children stated that the venue was convenient and easily accessible. However, one child expressed a preference for the session to be scheduled at other timeslots instead of taking up the health education session time. In addition, being able

to interact with the study team face-to-face was also often reported to be an advantageous feature in the intervention delivery (see Table 17, quote 2.2.1 to 2.2.2). Parents discussed that having the parental session conducted remotely was perfect as they could arrange their time appropriately (see Table 17, quote 2.2.3).

2.3) Researcher's characteristics in delivering the intervention

Children and their parents spoke positively about the personality traits and professional characteristics of the researcher delivering the intervention. They described the researcher as motivating, encouraging, helpful, and the communication with the researcher went well during the delivery of group activity sessions (see Table 17, quote 2.3.1 to 2.3.2).

2.4) Acceptability of the group activity sessions' duration, frequency, and timings

All children felt that the duration of group activity sessions was appropriate. However, there were mixed feelings among children about the frequency of group activity sessions. For example, one child expressed an expectation for more sessions whereas another child reported a preference for fewer sessions to be held in one semester (see Table 17, quote 2.4.1 to 2.4.3). Similarly,

parents reported different perceptions towards the duration and frequency of the group activity session for parents. The majority of parents found the duration and frequency to be appropriate and acceptable while some parents advised to reduce the duration of the session or introduce more sessions in a semester (see Table 17, quote 2.4.4 to 2.4.6).

2.5) Social interaction and engagement

At the end of the intervention, a number of children and parents expressed their desire to be future ambassadors for the intervention and help to disseminate it to more peers and friends. Children and their parents also expressed their desire to share the experience and knowledge they had learned from the group activity sessions with others (see Table 17, quote 2.5.1 to 2.5.2).

5.3.1.3 Theme 3: Factors that facilitated or impeded intervention attendance, and delivery

This theme draws on participants' experiences and perceptions of taking part in the intervention to derive potential facilitators and barriers to intervention attendance and delivery. Specifically, there were four subthemes raised by participants and providers regarding the factors that facilitated or impeded intervention attendance and delivery.

3.1) Gaining support from schools and education departments

All participants gave a positive evaluation of the organisation of the intervention. The variety of intervention components was considered to be appealing. However, parents suggested that implementing the intervention at a wider level would require understanding and cooperation from schools and education departments (see Table 17, quote 3.1.1).

3.2) Provision of electronic materials

One parent suggested that an electronic version of intervention materials may be easier to keep and more accessible than a hard copy (paper version). In addition, both parents and teachers discussed ways of providing the information related to physical activity in an electronic format (e.g., audio or video clips as a resource) or on social media platforms (e.g., promotion via Twitter) (see Table 17, quote 3.2.1 to 3.2.3).

3.3) More physical activity options

Although parents believed that the provision of sports equipment facilitated an increase in children's physical activity levels, one parent suggested including

further activity options to cover a wider range of physical activity categories (see Table 17, quote 3.3.1).

3.4) More instruments for self-monitoring

The parents thought the pedometers provided to children were helpful for children's self-monitoring of their daily physical activity levels. They expressed an expectation for user-friendly devices for their children to use to monitor their physical activity levels (see Table 17, quote 3.4.1 to 3.4.2).

Table 18: Experiences and perceptions of participating in the trial

Themes	Subthemes	Verbatim quotes
Theme 4: Positive experiences and feelings gained through data collection process	4.1) Understanding of the translated Mandarin version of information sheets	4.1.1) “It is quite easy to understand.” (Child 10, Female, Intervention group).
		4.1.2) “Well, there is no need to make any improvement and nothing is hard to understand. Everything is fine.” (Child 2, Female, Control group).
		4.1.3) “Everything is OK and the content in it is easy to understand.” (Parent 2, Father, Intervention group).
		4.1.4) “In fact, we are a little under-educated. So some information is hard for us to understand and some are beyond our knowledge. We can neither tell you the details nor explain ourselves well”. (Parent 9, Mother, Control group).
		4.1.5) “No, I think it's very good. Moreover, his informed consent form, including explanations, is particularly clear, and your affiliations are very clear at a glance, which makes it easy for everyone to have a kind of trust and be willing to cooperate. I think it's very good.” (Teacher, Female, Intervention group).
		4.1.6) “No. It is quite easy to understand and even the children can understand it.” (Teacher, Female, Control group).
	4.2) Perceived “burden-free” completion of self-reported questionnaire	4.2.1) “I felt no burden, and everything is acceptable.” (Child 3, Male, Intervention group).
		4.2.2) “It’s quite easy to understand and there is nothing hard to understand.” (Child 6, Male, Control group).
	4.3) Positive reflection and self-feedback gained from completing seven-day steps’ measurement	4.3.1) “It’s quite great. I can feel my progress and my PE [physical education] score is also getting better and better.” (Child 5, Male, Intervention group).
		4.3.2) “They were quite well organised. It’s fun to check my steps with a pedometer on me while I am walking!” (Child 2, Female, Control group).
	4.4) Anthropometric measurement promotes self-monitoring behaviour and active emotional response	4.4.1) “In my opinion, the measurement provides me an official opportunity to understand my own weight and height. This is helpful for me to have a better understanding of myself.” (Child 1, Female, Intervention group).
		4.4.2) “Quite comfortable.” (Child 1, Male, Control group).
	4.5) Satisfaction regarding the organisation of data collection	4.5.1) “I am quite satisfied. It took me only a while to get measured in school before I could go back to continue my class.” (Child 1, Female, Intervention group).
		4.5.2) “The measurement was well organised.” (Child 3, Female, Control group).
		5.1.1) “I am satisfied with most of the content and there is nothing dissatisfying about it.” (Child 2, Male, Intervention group).

Theme 5: Satisfaction regarding the organisation and implementation of the trial	5.1) Satisfaction with the trial content, organisation, and engagement	5.1.2) “I am satisfied. The event was organised by our school and any school event does no harm but good to its students.” (Child 1, Male, control group).
		5.1.3) “The child was very excited about it and was also willing to participate in it. He also told us about the small presents he brought back. He’d like to share everything with us. It is a good thing, I think.” (Parent 7, Mother, Intervention group).
		5.1.4) “It’s fine. Nothing needs to be improved and everything is fine.” (Parent 7, Mother, Control group).
	5.2) Meaningful and unprecedented experience	5.2.1) “In my opinion, it is a new type of teaching mode, which is needed by the children. For parents, it’s something new.” (Parent 1, Mother, Intervention group).
		5.2.2) “I hoped that it would be helpful for the child’s education.” (Parent 9, Mother, Control group).
		5.2.3) “In fact, I think participating in this research is a very good experience for the whole students, including teachers and parents, including a very good education for us. Whether it is knowledge education or manual distribution, children are quite fresh, curious, and fresh, and I think it is a good study at the same time. This kind of knowledge education is very good for us, especially for paying attention to sports health. There are other practical components, and there are materials to distribute and then exercise. You also include the parents, I think you have considered it very carefully. I think each piece is very important and good.” (Teacher, Female, Intervention group).
		5.2.4) “Well, first I think it is quite a meaningful activity. Under the current education circumstance, children have a limited amount of time each day for activities. Second, children may not have an adequate understanding of their own physical health. Third, I think this activity can help children develop their interest in sports in a better way. At last, this activity does good to their physical fitness and enables them to have a better understanding in all aspects.” (Teacher, Female, Control group).
Theme 6: Influences of personal beliefs and emotional responses to the trial	6.1) Personal motivation for doing physical activity	6.1.1) “I am a fan of sports and like running and playing football. I am also a runner and the pedometer is very useful. I’d like to know my steps.” (Child 5, Male, Control group).
		6.1.2) “It’s great and it would be an opportunity for me to do some exercise.” (Child 1, Female, Intervention group).
		6.1.3) “I am a teacher too, so I like participating in various activities held for children, either activities that I can understand now, or those that I cannot understand now, and we will still participate in them. Participation in various activities might have become a hobby.” (Parent 7, Father, Intervention group).
		6.1.4) “I was quite happy when I first heard of it because it is a good thing for children to participate in physical activity. Children barely have such an opportunity to participate in such a practical study, and I think it is a rare opportunity.” (Teacher, Female, Control group).
	6.2) Curiosity about the trial content	6.2.1) “I participated in it out of curiosity and enthusiasm, and I did it to become healthier because physical activity makes people healthy.” (Child 5, Male, Intervention group).
		6.2.2) “Just because I could participate in it and I never participated in such kind of activities.” (Child 10, Male, Control group).

		6.2.3) “It was fine. As a matter of fact, I wanted to know about the specific content of this study.” (Parent 9, Mother, Intervention group).
		6.2.4) “We wanted to know a little about our child [via participation in the trial].” (Parent 3, Mother, Control group).
	6.3) Desirability to advance physical activity knowledge	6.3.1) “Actually, it’s because of the child. Children nowadays are lack of exercise and they like staying at home all day. I just wanted to know the child’s physical fitness and I found that his exercise amount was far less than ours when we were kids. I just wanted to participate in this activity, making us get to know what exactly physical activity is. Our previous activities are too simple.” (Parent 1, Mother, Intervention group).
		6.3.2) “We parents want our children to be as healthy as possible and want to understand how to make the children’s body better from all aspects such as nutrition.” (Parent 6, Father, Intervention group).
		6.3.3) “For the sake of the child’s education and for the sake of the child’s growth.” (Parent 10, Father, Control group).
		6.3.4) “Children today have no awareness of active exercise. This activity can improve the children's physical activity and make them less resistant to exercise.“ (Parent 2, Mother, Control group).
	6.4) Perceived physical activity-related benefits	6.4.1) “I was lazy and have been stayed at home. I believe that this physical activity would make me healthier, so I wanted to know more about it.” (Child 1, Female, Intervention group).
		6.4.2) “Well, because exercise can do some good to our body, and I’d like to give it a try.” (Child 1, Male, Control group).
		6.4.3) “…we care more about his physical health. The learning environment nowadays has a big influence on children, resulting in less time for extracurricular activities. Therefore, I quite agree with the opportunity for exercise.” (Parent 4, Father, Intervention group).
		6.4.4) “I am overweight but I don't want my child to be overweight like me. He needs to start doing exercise at an early age.” (Parent 8, Father, Control group).
		6.4.5) “…When I reported to our principal, the principal was especially willing and hoped to participate in such a study, which is also a very meaningful thing to promote the health of the whole student, so he was especially willing to participate.” (Teacher, Female, Intervention group).
		6.4.6) “em.. in my opinion, as a teacher, the object of our education is to cultivate children as a ‘full’ person. So I think that our obligation should not just be limited to cultivating students' academic and intellectual development, and more attention should be paid to the physical development of children, and those are the reasons.” (Teacher, Female, Control group).
	6.5) Using vivid expressions and appealing advertising materials	6.5.1) “If you want to arouse their interest, first, you need to use the vivid and slightly humorous language, which will make them slightly interested in it. Second, you can make some posters with interesting pictures because all my classmates like pictures and similar stuff. Posters with pictures will make them feel how great this course will be. If you want to deprive them of their interest, you just need to provide stuff in text only without any illustration, and students will soon lose patience in reading them.” (Child 10, Female, Intervention group).

Theme 7: Social influences on participatory decision-making	7.1) Interpersonal influences by children and teachers	7.1.1) “First, it was introduced by the headteacher. Later, I got the news. Finally, the child told us the news after school. I thought we were very lucky. We have been attaching great importance to the child. So after we received the invitation from the teacher and you, both my child and I were quite excited.” (Parent 5, Mother, Intervention group).
		7.1.2) “I was contacted and introduced by the teacher.” (Parent 4, Mother, Control group).
	7.2) Preferred recruitment in the school context	7.2.1) “My personal information is safe in school and I think it’s fine.” (Child 1, Female, Intervention group).
		7.2.2) “I am satisfied.” (Child 6, Male, Control group).
		7.2.3) “…the only approach is through the school and teacher. You may be able to contact us personally and the school, but it seems more convenient while doing it through the school as a media, which might be easier for us to accept. In my opinion, contacting parents through the school is the most appropriate approach.” (Parent 4, Father, Intervention group).
		7.2.4) “I’d rather not take such a risk [not having recruitment via school].” (Parent 1, Mother, Control group).
		7.2.5) “Well, it is quite a good approach. First, I will say something about the invitation through the school. The study using such an approach is able to provide children with a guarantee in all aspects and is a relatively formal method.” (Teacher, Female, Control group).
	7.3) Highly influenced by the curriculum that had been set up in schools	7.3.1) “You have to make the school attach great importance to it. As long as the school pays attention to this activity, your promotion will be acceptable to students and be no problem for parents. As parents, we all wish our children have a certain amount of activities and exercise, right? Exercise is very helpful for children’s physical health. Not all energy shall be invested in the study in the classroom. As for outdoor activities, if the school can truly pay attention to them, parents will definitely cooperate with the school. As long as you can coordinate well with the school, your promotion will be quite smooth, I believe.” (Parent 4, Father, Intervention group).
Theme 8: Key barriers to consider regarding the recruitment of participants	8.1) Academic pressure faced by children	8.1.1) “It is possibly because my classmates have no sufficient time for participation due to study.” (Child 9, Female, Intervention group).
		8.1.2) “A lot of people find it useless, and not mention that we have the heavy homework.” (Parent 7, Father, Intervention group).
		8.1.3) “Some students do their homework slowly and if they are still doing the homework, they will miss this interview.” (Child 5, Male, Control group).
		8.1.4) “Children today are lack of exercise but in the face of a lot of homework and great pressure.” (Parent 6, Mother, Control group).
	8.2) Time constraints on parents	8.2.1) “…First, parents do not have much time to understand your activity and they can only know it through their children in school. Parents are helpful in guidance and supervision. However, we do not have time to take the initiative to do anything.” (Parent 9, Mother, Intervention group).
		8.2.2) “You’d better call me in the evening because I am working in the day.” (Parent 2, Mother, Control group).
		8.3.1) “In my opinion, some parents will be the obstacle. Some parents put study ahead of exercise.” (Child 5, Male, Intervention group).

	8.3) Lack of emphasis on the physical activity at parental, school, and education department levels	8.3.2) “Just like what I mentioned before, you need to focus on the role of the education department, that is, if the school pays attention to it, the parents will also pay attention to it. If the school ignores it, the parents will not pay much attention to it either. A lot of parents including us are following the steps of the school, that’s to say, when the school pays attention to one thing, we will also put our emphasis on it. If the school does not pay attention to it, parents will not either. It is actually a good thing. … However, pure dependence on parents is useless and you have to rely on the mutual efforts of us and the education department, as well as the participation of all parties. We have to work together and strive for the same goal. Most importantly, you have to get the attention of the education department. As long as the education department pays attention to something, parents will definitely pay attention to it.” (Parent 8, Mother, Intervention group).

5.3.2 Topic2: Participants' and providers' experiences and perceptions of participating in the trial

5.3.2.1 Theme 4: Positive experiences and feelings gained through data collection process

Participants and providers seemed to have a clear understanding of the aims of the research trial. They appreciated the information about physical activity for children and felt it was appropriate and beneficial for children to measure their own physical activity levels. Five subthemes emerged from the interviews which were grouped under the broader category of experiences and feelings gained through the data collection process.

4.1) Understanding of the translated Mandarin version of information sheets

Participants and providers expressed a common view on the acceptability of the information sheets. Most participants found the information sheets and explanations to be informative and straightforward. Yet, one parent found the materials to be over-complicated and suggested the materials would be improved if "simplified". All teachers believed the explanations in the information

sheets were clear and provided sufficient study details to the participants (see Table 18, quote 4.1.1 to 4.1.6).

4.2) Perceived "burden-free" completion of self-reported questionnaire

All children felt the questions listed in the questionnaires were very comprehensible to them, and this was seen to expand their knowledge about physical activity (e.g., types of activities and examples of how to do it). The children felt that they had no problems in completing the self-report questionnaire and as such, it was seen to impart a low level of burden (see Table 18, quote 4.2.1 to 4.2.2).

4.3) Positive reflection and self-feedback gained from completing seven-day steps' measurement

All children positively discussed the measurement of seven-day steps that they received on their pedometer. Children found the measurement interesting, and they felt motivated and satisfied by the visibility of their achievements on the device (i.e., steps they walked). Children also liked that the pedometer was portable (see Table 18, quote 4.3.1 to 4.3.2).

4.4) Anthropometric measurement promotes self-monitoring behaviour and active emotional response

Children considered the anthropometric measurement to be an acceptable component in the trial, which could help them to better understand their own body (see Table 18, quote 4.4.1 to 4.4.2). Moreover, children did not report any negative feelings or experiences during the delivery of the measurement.

4.5) Satisfaction regarding the organisation of data collection

Children reported that they enjoyed participating in the data collection in the trial. They appreciated the process of the data collection which was seen to be well organised and delivered. Some children talked about the implementation of data collection as convenient and not time-consuming, which led them to suggest that the data collection had no negative influence on their schedule at school (see Table 18, quote 4.5.1 to 4.5.2).

5.3.2.2 Theme 5: Satisfaction regarding the organisation and implementation of the trial

There were two broad subthemes that emerged from the interviews related to participants' and providers' perceptions of participation in this trial. In general, these demonstrated that the main benefits of the involvement in the trial were

the experience and feelings of enjoyment, and satisfaction gained from interacting with others.

5.1) Satisfaction with the trial content, organisation, and engagement

All children and parents perceived participation in the trial positively, and they reported that taking part was satisfactory and enjoyable. Specifically, the main emotional feeling of children was the enjoyment gained from engaging in the trial. Parents discussed feelings of encouragement and motivation from observing their children and how children enjoyed communicating and sharing the trial information with them (see Table 18, quote 5.1.1 to 5.1.4).

5.2) Meaningful and unprecedented experience

All parents and teachers felt that participation in the trial was a beneficial and meaningful experience in children's development. They felt that an important feature of the trial was the provision of a new approach for physical activity education for children, parents, and teachers. Teachers also found that participation in the trial could help cultivate children's interest in physical activity and generate an in-depth understanding of physical activity (see Table 18, quote 5.2.1 to 5.2.4).

5.3.2.3 Theme 6: Influences of personal beliefs and emotional responses to the trial

Understanding what motivated people to participate in this trial may help with future engagement of those who may be less likely to take part in an intervention trial. In general, all participants and providers expressed high enthusiasm to participate in this trial. The facilitators for participation in the trial could be grouped into five subthemes.

6.1) Personal motivation for doing physical activity

Children were happy to be approached by the study team and they believed that participation in the trial would provide a great opportunity for them to perform more physical activities and understand their physical activity level (see Table 18, quote 6.1.1 to 6.1.2). Parents and teachers stated that their desire to encourage children to engage in such a trial is primarily due to the dearth of physical activity programmes available for children in China (see Table 18, quote 6.1.3 to 6.1.4).

6.2) Curiosity about the trial content

Some children and parents were curious about the content after the enrolment in the trial and were extremely enthusiastic about doing physical activity (see Table 18, quote 6.2.1 to 6.2.4).

6.3) Desire to advance physical activity knowledge

Some parents described being motivated by the opportunity to help towards advancing scientific knowledge about physical activity, and receiving information about ways to help children keep fit (see Table 18, quote 6.3.1 to 6.3.2).

6.4) Perceived physical-activity-related benefits

Children valued the health benefits that could be gained from participating in physical activity and discussed being motivated to participate in the trial as this would help improve an individual's well-being. Parents stated that participation in physical activity could act as a way to help relieve the academic pressure on their children and ultimately improve their health. Teachers stated that participation was beneficial to children's personal development (see Table 18, quote 6.4.1 to 6.4.6).

6.5) Using vivid expressions and appealing advertising materials

Some children suggested that the trial could trigger children's interest in participation even more by using vivid language and cartoons. They believed that the combination of text and cartoon pictures would be beneficial for future recruitment of children into this sort of trial (see Table 18, quote 6.5.1).

5.3.2.4 Theme 7: Social influences on participatory decision-making

Participants' and providers' decision-making to participate in the trial was not determined by personal beliefs and emotional responses independently. However, the social influences derived from the interpersonal and school levels appeared to play a significant role in their decisions to take part. Three subthemes emerged in regard to the social influences on participation in the trial.

7.1) Interpersonal influences by children and teachers

After initial contact and recruitment under the help of head teachers in two schools, children went on to spread the information to their parents, and parents were also informed by the teachers about the trial information. Parents stated that their participation in the trial was influenced by the teachers as they valued teachers' suggestions and recommendations (see Table 18, quote 7.1.1 to 7.1.2).

7.2) Preferred recruitment in the school context

Schools emerged as a preferable context for reaching children and their parents. It was also identified as a safe and formal approach to have parents' consent for their child to take part in the trial—this appeared to be an important reason that children and parents expressed interest in participation (see Table 18, quote 7.2.1 to 7.2.5).

7.3) Highly influenced by the curriculum that had been set up in schools

Parents valued the role of physical activity for children and believed that their participation would be facilitated if the schools gave more attention and importance to delivering physical activity in the school environment (see Table 18, quote 7.3.1).

5.3.2.5 Theme 8: Key barriers to consider regarding the recruitment of participants

Children and parents expressed interest in participating in the trial, but some of them discussed potential barriers that might impede their participation in a future trial. These barriers to recruitment in the trial could be grouped into three subthemes.

8.1) Academic pressure faced by children

Children's academic achievements are heavily emphasised in China and schools are usually evaluated based on academic performance. Therefore, children and parents reported that participation in the trial might be limited by academic commitments. They felt this was a barrier to recruiting participants into a future study as children in China spent the majority of their leisure time working on assignments (see Table 18, quote 8.1.1 to 8.1.4).

8.2) Time constraints on parents

Although parents did acknowledge their positive role in supporting and helping the establishment of children's physical activity behaviours, lack of time was a common reason for parents failing to take part in the trial, and this should be taken into account to accommodate parents' schedule when conducting the future study (e.g., reduce the duration of one session and have a greater number of separate sessions (or weekend/early evening sessions) to help better engage the parents in the health education) (see Table 18, quote 8.2.2).

8.3) Lack of emphasis on physical activity at parental, school, and education department levels

There was a general lack of emphasis on children's physical activity among parents, schools, and the education department in China. Children expressed that their parents prioritized academic attainment ahead of physical activity. On the other hand, parents believed that schools and the education department would need to tackle a top-down approach to reevaluate the importance of physical activity in children (see Table 18, quote 8.3.1 to 8.3.2).

5.4 Discussion

To the researcher's knowledge, this is the first qualitative process evaluation of a physical activity intervention conducted with school children in China. The study used a standardised framework to explore participants' and providers' experiences and perceptions with the intervention and feasibility trial. This could be further used to directly inform the design of the main cluster RCT.

All the intervention components were positively valued by children, their parents, and health education teachers. Children appreciated the tips on how to keep themselves physically active and enjoyed using the step-count log in the activity diary, which induced them to engage in physical activity behaviours and facilitated self-monitoring on steps, respectively.[182] Comparably, the importance and positive efficacy of providing physical-activity-related education materials for children has been suggested in substantial physical activity programmes.[86,162,182,243] In this trial, the perceived benefits of the poster-making

session included opportunities for children to self-reflect on their understanding of physical activity and stimulate their interests in physical activity.[86] This is consistent with published literature suggesting that children can gain a feeling of enjoyment in physical activity interventions which involve engaging and "fun" components.[86,162] Moreover, children's personal interests, feeling of enjoyment, and positive attitudes towards physical activity gained from the poster-making session enhanced their desire to engage in physical activity.[244] As for parents, they appreciated the group activity session which was seen to be a particularly valuable opportunity for them to gain an insight into how children should engage in physical activity and how they could help their own child to be more physically active. The use of group activities to encourage social support networks among parents and parental engagement has been discussed in previous physical activity programmes.[86,182] In agreement, it highlights the need for multicomponent physical activity programmes to incorporate physical activity resources for families.[245] The use of environmental restructuring, self-monitoring, and goal-setting to motivate and engage children in participation in physical activity has been discussed and valued in systematic reviews around effective behaviour change techniques to increase physical activity in children.[246,247] Furthermore, parents in the study suggested a desire for more objective tools (e.g., tracking devices, pedometers) that can provide children with instant and direct feedback on an individual's physical activity level to help children achieve different milestones and accommodate personal goals. This

insight supports the previous research suggesting that the provision of activity tracking tools may reduce attrition among intervention participants.[178,195] It is also in accord with an earlier study indicating that wearable technology (e.g., wristwatch, activity tracker) should be used for physical activity data collection to meet the technology-related expectations of children and parents.[243] These qualitative findings suggest that there was an increased frequency in children's physical activity involvement through the intervention, which may contribute to an increase in participants' overall physical activity levels per day. This also alludes to a potential dose-response relationship (i.e., children are more active if they engage more in the intervention); however, this would need to be explored further in a future full-powered definitive trial. Moreover, future research would need to explore the relationship between children's engagement in the intervention, physical activity, and their academic performance.[248]

The results suggested that participants and providers were receptive and appreciative of both written intervention materials (i.e., activity diary, physical activity booklet) and verbal instructions (i.e., mutual communications between study team, parents, and teachers). Importantly, both parents and teachers suggested that the intervention materials may be best provided electronically, and could include videos (to model activity plans), links to websites, or official accounts for self-exploration of physical activity information among children and parents. These findings are in line with previous studies that suggest the

interactive digital technology could help deliver health information to improve health outcomes.[243,249] Specifically, evidence shows that digital technology can improve communication between researchers and participants, improve participants' knowledge, and encourage behaviour change.[249] In agreement, these additional social and mobile elements may enhance intervention success, and there are a growing number of examples of such methodologies (i.e., mobile interventions) within the physical activity promotion literature.[250-252] In terms of the organisation of the group activity sessions (i.e., venues, timing), we had a mixed reception to the duration and frequency of the group activity sessions. This was similar to other physical activity studies that included an education component whereby some participants found it appropriate (e.g., duration, frequency, location) and others did not.[162,182] Specifically, some parents suggested that the parental group activity session could be made more acceptable by reducing the duration of one session and instead having a greater number of separate sessions to help better engage the parents in the health education. This finding was consistent with the previous work in developing the school-based behaviour change intervention (in chapter 3), in which the researcher found that parents' time constraint is a critical issue, as their work commitment can lead to insufficient parental support and negatively affect the engagement of parents within the group activity session.[178,195] Together, these findings highlight the practical constraints to setting up and running group activity sessions for children and parents.

Overall, participants and providers perceived participation in the trial as a satisfactory and meaningful experience. In this trial, a participatory approach was used in the recruitment of children and their parents by engaging health education teachers as facilitators for the promotion of the trial within the schools. Despite the impact of the COVID-19 pandemic, the results indicate that participants would prefer recruitment via teachers, and suggest that this generates a feeling of safety and formality when approached in the school context. However, the findings differ from previous family-oriented physical activity studies which have reported challenges when recruiting families into intervention research within their pre-agreed timescale.[253,254] Specifically, a recent systematic review and Delphi survey investigating effective and resource-efficient strategies for recruiting families into health-promoting intervention research identified 49 eligible studies, of which only 33% of studies (i.e., *n* = 16) reported a target sample size.[254] Of these 16 studies, it found that only 62% recruited a sufficient number of participants. A subsequent Delphi survey of 107 experts showed that only 38% recruited their target sample size over a median of 12 weeks. In contrast, recruitment periods were extended in 33% of studies with a median extension of 20 weeks.[254] This highlights the importance of "context" in improving recruitment to research studies. For instance, the findings indicate that school is an appropriate place to recruit children and their parents in China,[255] but this may or may not be transferable to other countries and regions due to differences in culture and expectations.

Although a high recruitment rate was achieved, future recruitment strategies may be enhanced further by incorporating vivid illustrations and user-friendly language to attract children to take part. Participants in future trials are likely to express interest if the study team promotes the importance of physical activity to participants and appropriately discusses the research processes and intervention content that participants will experience in the trial.[114,178] Comments from the participants suggest that persuading schools and health education departments about the importance of physical activity and introducing organisations to give more emphasis to physical activity promotion in the school setting would be required to facilitate the implementation of the future cluster RCT.[86] Related to data collection, the results indicate that the assessments were well accepted by children; this is also reflected by the high response rate in completion of data collection in the trial.[235] Therefore, the use of the data collection methods may remain similar in a future cluster RCT. Only one parent reported a lack of understanding of study materials, although this might be avoided in future with opportunity for face-to-face discussion about the trial processes which was not possible here due to the restrictions of the COVID-19 pandemic. The researcher recommends that, in a future cluster RCT, expanding the mode of delivery of recruitment information (i.e., offering face-to-face, offline meetings as well as written materials) may maximise recruitment rate and participant satisfaction.

Strength and limitations

The researcher acknowledged the impact of the preconceptions on the data collection and interpretation of data. However, the involvement of multiple researchers from different backgrounds (physical activity, behaviour change, health psychology, sociology) in the study design, conduct, and analysis improves the credibility of the findings. The qualitative, thematic analysis methodology employed generated rich data, giving a more in-depth understanding of the experiences and perceptions of children, parents, and teachers. To ensure the reliability and validity of the research findings, the researchers were constantly involved in a reflexivity exercise about biases and their effects on decisions related to different phases of data collection and analysis. Participation in the study was voluntary. Thus, the study may have reached the children, parents, and teachers who had a more favourable perception of this intervention and trial, which could lead to over-reporting of positive experiences and perceptions and/or under-reporting of more negative experiences and perceptions. Although the quality of transcripts was ensured through external company transcription and member checking, there is a risk of incorrect details that are most likely only detectable by the interviewees since the researcher did not return transcripts to participants and providers due to time limitations. However, the researcher prepared the interview guides in advance and used reminders (i.e., informing participants and providers that there were no right or wrong answers) to ensure that we included all aspects of

participants' experiences and perceptions. The findings of this study were limited to the views of families recruited from one geographical region and parents who were employed. Future studies should explore intervention engagement in more diverse participant groups, including children with parents who are not employed, those with lower income, different age groups, and those living in rural or remote areas. Although evidence of long-term effects was beyond the scope of this study, key elements of acceptability were identified. Results demonstrated success of the intervention delivery, acceptable research methods and processes as perceived by the participants and providers, and supportive evidence for the short-term efficacy of the intervention in some outcomes. Further exploration of the intervention's effectiveness and sustainability is required in the next stages of MRC framework for developing and evaluating complex interventions (i.e., evaluation phase and implementation phase, respectively).

5.5 Conclusion

The intervention and trial methods were acceptable to children, parents, and health education teachers. School-based behaviour change intervention was perceived to be a useful approach to increase physical activity in children aged 10–12 years in China. Interview participants highlighted the increased frequency of children's involvement in physical activity as a result of the

intervention, which may lead to their achievement of 60 min of MVPA per day. However, there were barriers to intervention delivery and engagement that should be considered when designing a future cluster RCT to assess the intervention efficacy.

In summary, main acceptable components were identified as (a) perceived gains in awareness and frequency of doing more physical activity that enabled by the intervention components, (b) satisfaction with the intervention organisation and researcher's delivery, (c) clarity of intervention's and trial's information and technology instructions, (d) positive experiences related to the trial organisation (e.g., data collection, structure), and (e) participants' positive feeling of safety and formality when approached in the school context and referred by the teachers.

The study identified the following areas that need to be improved by: (a) provision of electronic materials (e.g., include videos, links to websites, or official accounts), (b) incorporation of more wearable technology (e.g., wristwatch, activity tracker) for physical activity data collection to meet the technology-related expectations of participants, (c) incorporation vivid illustrations, user-friendly language and discussion of the research processes and intervention content that participants will experience in the trial to maximise the recruitment, follow-up and adherence, (d) gaining support from the schools and health education departments to facilitate the implementation of the future

study, (e) expanding the mode of delivery of recruitment information (i.e., offering face-to-face, offline meetings as well as written materials), and (f) accommodating parents' schedules in the future study (e.g., reduce the duration of one session and have a greater number of separate sessions (or weekend/early evening sessions) to help better engage the parents in the health education).

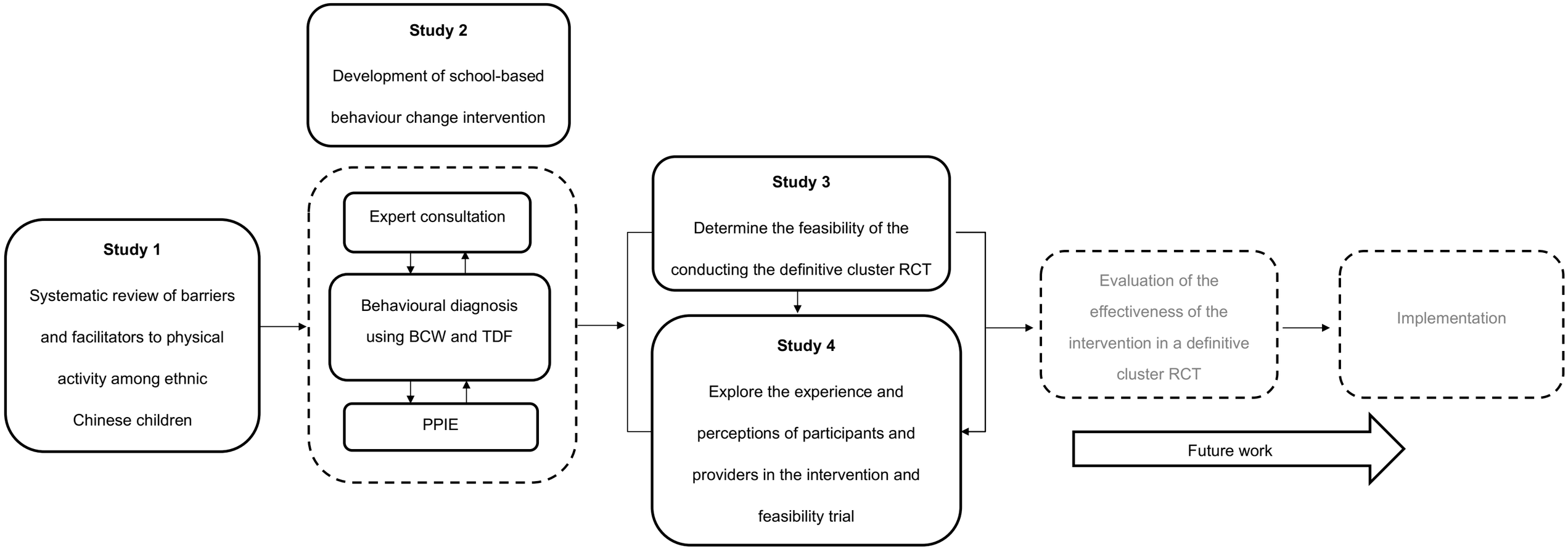
Chapter six

General discussion

6.1 Overview of the thesis

The studies within this thesis followed MRC framework for the development and evaluation of complex interventions.[71] The progress of the research within and beyond this thesis (i.e., future work) is shown in Figure 14, in accordance with MRC guidelines to evaluate and implement the intervention.[71] The implications of the findings contributed to the existing knowledge and understanding of physical activity in ethnic Chinese children and implications of the feasibility study are discussed, followed by the recommendations for practice and future research, reflection of the impact of COVID-19 on this PhD, and the final conclusions.

Figure 15: The thesis studies and anticipated work under the MRC framework on complex intervention development and evaluation



6.2 Implications of thesis findings

6.2.1 Implications of the findings for knowledge and understanding

The implications of the findings have been discussed within each chapter of this thesis. The main implications from the thesis are discussed below and relate to how further research could continue to analyse and target the key influential factors in increasing physical activity levels among children in China.

Informed by the research findings (Chapter two), an important component in behaviour change intervention was the focus on facilitating Chinese children's physical activity environment and resources to assist them in meeting the physical activity recommendation. Similarly, in Australia, the US and the UK, several studies have identified that poor access to facilities, equipment and the crowded school curriculum (e.g., lack of time allocated to the physical education) as barriers to physical activity promotion in schools.[256-258] Given that, evidence suggests that in general schools have not achieved the potential to promote physical activity although it is well positioned to provide children with opportunities to be physically active.[258] One possible reason is that children's physical activity is recognised as unstructured and intermittent while the traditional approaches may not target at it.[259] As such, it is suggested that redesign of the school environment may be considered likely to provide children with more opportunities in addition to the provision of quality, mandated physical education.[258] This is supported by the evidence that positive effects in

MVPA achieved in an environmental intervention (i.e. redesign the physical activity environment).[260]

The parental influences on children's physical activity participation that identified in the systematic review (chapter two) and TDF mapping (chapter three), particularly emphasised the importance of involving parents in order to enable the potential increase in physical activity participation among Chinese children. Previous evidence suggests that children's higher physical activity participation is achieved by the strategies that focus on increasing levels of family cohesion, parental engagement and parent-child communication.[261] Families are encouraged to spend time together, communicate with each other and develop strong bonds whilst children are needed appropriate levels of autonomy. Additionally, by including education for parents in the physical activity interventions they can then act as change-agents for their children's behaviour.[262]

Furthermore, Chinese children's belief and knowledge about physical activity emerged as one of the outstanding components for delivering BCTs in this thesis. This is also consistent with previous evidence that the enhancement of intentions, attitudes in physical activity are important for physical activity promotion in Chinese children.[263] Moreover, a previous study has found that knowledge awareness can lead to positive behaviour modification regarding physical activity among Chinese children.[264] Specifically, there are statistically

significant increases in both physical activity frequency and physical activity time among children who have experienced changes in knowledge awareness of physical activity compared to their counterparts who remained unaware of the knowledge, regardless of grade and gender.[264] Given that, the health education and knowledge dissemination are regarded as an important strategy to help change children's related attitudes and thus lead to the corresponding behaviour modification, such as a better physical activity engagement.[264]

6.2.2 Implications of the feasibility study for a future definitive trial

The final two studies in this thesis (chapter 4 and 5) reported the first feasibility study of a behaviour change intervention to increase physical activity levels for children in Yangzhou, China. The primary purpose was to determine the feasibility of undertaking a cluster RCT in the future and this purpose was satisfied using a range of feasibility outcomes. Specifically, to fulfil the research objectives, two studies were designed and presented in this thesis. The first one was the quantitative assessment (chapter four). It collected the important parameters (e.g., sample size, recruitment, follow-up, intervention adherence, adverse events) to guide the future cluster RCT in China. Results showed that it was feasible to implement this behaviour change intervention in the school setting and the intervention was perceived positively. Second, a qualitative process evaluation (chapter five) aimed to explore the experiences and

perceptions of participants and providers in the intervention and trial, and 2) make recommendations to inform the design of a future intervention and full-scale cluster RCT.

The quantitative evaluation in the feasibility study indicated an improvement in children's self-efficacy, enjoyment and social support for physical activity through the intervention. The qualitative process evaluation provided suggestions for potential benefits of the behaviour change intervention and participants' and providers' experience and perceptions of the intervention and trial. Interviews with participants and providers suggested that god acceptability of the intervention among participants and children's physical activity levels may benefit from the involvement in the programme. Possible mechanisms through which children and parents may benefit were through raised awareness of the importance of physical activity, education for physical activity, ways and options for active participation in physical activity, and immediate feedback about the child's individual's physical activity levels.

These preliminary studies (in chapter 4 and 5) played a significant role in preparing for future cluster RCT to test the intervention effectiveness. The findings from chapters four and five indicate that the behaviour change intervention can be delivered for evaluation of effectiveness in a future definitive trial. The main findings made for future cluster RCT are summarised below:

- The utilisation of recruitment strategy through teachers and schools achieved a high recruitment rate (100%).

- Children were motivated to participate for 'personal motivation' and 'curiosity' and parents were motivated for curiosity, advancing knowledge, interpersonal influences, and perceived physical activity-related benefits.

- The follow-up rate and intervention adherence were high (100% over a 16-week intervention).

- Outcome measures were reported to have no burden for children and the self-reported questionnaires were regarded as feasible and acceptable to detect the changes in levels of physical activity, self-efficacy, enjoyment, and social support. Similarly, the anthropometric measurement was positively evaluated among children and reported no burden.

- Positive evaluations were given by the participants and providers in relation to intervention materials, mode of delivery, characteristics of delivering style of researchers, and communication between participants and the study team.

- Perceived benefits of the behaviour change intervention by participants and teachers were 1) increased awareness of personal physical activity levels, 2) increased knowledge and understanding of physical activity, 3) increased awareness of ways and options to keep physically active, and 4) increased amount of physical activity opportunities and emerge of physical activity-friendly environment.

- No adverse events were reported in the behaviour change intervention.

6.3 Recommendations

6.3.1 Recommendations for future research practice

The following recommendations are based on the researcher's learning over the process of conducting this research:

Given the traditional cultural values and expectations related to academic achievement in China and the impact of major regional or global public health crises (e.g., COVID-19), there is a need to develop physical activity programmes that allow children to allocate time spent on physical activities in home or community settings.

This research used theory-informed frameworks for intervention development and process evaluation. Both the BCW model and process evaluation criteria are found to be relevant and useful in studies. More research using the same theory-based frameworks in similar settings would help accumulate evidence for the generalisability in physical activity promotion for children in China.

Physical activity research as part of a complex intervention development and evaluation process under the MRC guidance, further research is needed to consider process evaluation alongside intervention design. This would

operationalise variables pertaining to the fidelity and quantity of delivery of individual intervention components (e.g. usage, dosage, adherence).

This research, that assesses the feasibility and acceptability of a school-based behaviour change intervention for children, has helped to expand knowledge of its at promoting children's physical activity in China. However, this intervention only lasted for 16 weeks and follow-up data were collected at the end of intervention. Further exploration of the intervention's effectiveness and sustainability is required in the next stages of MRC framework for developing and evaluating complex interventions (i.e., evaluation phase and implementation phase, respectively).

6.3.2 Recommendations for future practice

This study highlights the challenges of conducting physical activity intervention in real-world setting. Physical activity promotion for children in China requires policies' support. However, there is a lack of school-based physical activity policies and initiatives established on a local, provincial or national scale that can effectively promote, impact and sustain school-level physical activities for children inside and outside school settings. Policymakers would benefit from more research in the development and efficacy evaluation of culturally and contextually relevant forms of physical activity. This research has outlined one way of promoting physical activity among children in China.

6.4 Reflections of the impact of COVID-19 on the PhD

The feasibility trial (study 4 and 5) was conducted in the pandemic of COVID-19, which posed great challenges for this PhD project. The pandemic has led to the delay of the feasibility trial implementation and the changes in study design. Specifically, the anthropometric measurement at post-intervention was not conducted by the study team in respective schools as the schools have taken stricter social regulations (e.g., self-distancing, remote learning) to tackle the second spike of COVID-19 that occurred in China during the study period. As such, the validity and reliability of the anthropometric data at post-intervention may be compromised. In addition, the face-to-face semi-structured interviews were reorganised by using telephone interviews, which could result in poor observations of facial expressions, body language and other non-verbal signals during the interviews.[265]

Furthermore, social regulations in China including remote learning and social distancing have hindered children's engagement in physical education, sports, or other forms of school-related or community-based organised physical activity.[266] Notably, the children's physical activity levels were restricted by the COVID-19 pandemic in the intervention group. This was also consistent with another Chinese report that children's participation in physical activity drastically reduced from 540 minutes/week (before the pandemic) to 105 minutes/week (during the pandemic) in China.[267] However, there were some

positive notions among participants. In both groups, children had an increase in self-efficacy, enjoyment, and social support for physical activity. This could be due to the increase of awareness of the benefits of physical activity participation to general health and quality of life through the behaviour change intervention, especially for vulnerable people such as children during the pandemic.[268] Parents appreciated when the study team had telephone interviews with their children and them, which in turn strengthened the communication between the study team and the participants and help successfully finish the feasibility trial.

Schools provide opportunities and facilities for children's physical activity participation through physical education and recess.[269] However, the COVID-19 pandemic has restricted physical activity in children. In many countries including China, both indoor and outdoor sports and recreational facilities, such as gyms, public swimming pools and playgrounds, are closed. Therefore, it is important for the scientific community to learn from this, to provide the appropriate intervention possible in these difficult circumstances. For instance, the qualitative evaluation (findings from chapter five) suggests that objective physical activity monitor (e.g., pedometer) and alternative printed materials (e.g., physical activity booklet, activity diary) proved to be helpful.

6.5 Conclusion

The thesis has highlighted the need for physical activity promotion to Chinese children. It has also identified that the promotion of physical activity among Chinese children is complex and interacted with a range of factors. The thesis has contributed to the body of knowledge about determinants to physical activity participation among Chinese children through the synthesis of existing qualitative evidence. In particular, the thesis has developed an evidence-based and theory-informed intervention to target those determinants, which could be informative to other researchers in the field of physical activity promotion and behaviour change interventions. The developed intervention has demonstrated the feasibility and acceptability among children, their parents, and teachers. In addition, the thesis has offered recommendations to help improve the delivery of intervention in the future full-scale cluster RCT. If the behaviour change intervention is found to be effective in increasing physical activity levels among children in China, these could be used in daily practice and integrated into the health education curriculum in China to promote physical activity among children in China.

7. References

1. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-31.

2. Sellami M, Gasmi M, Denham J, Hayes LD, Stratton D, Padulo J, et al. Effects of acute and chronic exercise on immunological parameters in the elderly aged: can physical activity counteract the effects of aging? Front Immunol. 2018;9:2187.

3. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012;380(9838):219-29.

4. World Health Organization. Global recommendations on physical activity for health. Geneva: World Health Organization; 2010.

5. Concannon LG, Grierson MJ, Harrast MA. Exercise in the older adult: from the sedentary elderly to the masters athlete. PM&R. 2012;4(11):833-9.

6. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. Br J Sports Med. 2011;45(11):886-95.

7. Telama R. Tracking of physical activity from childhood to adulthood: a review. Obes Facts. 2009;2(3):187-95.

8. Direito A, Jiang Y, Whittaker R, Maddison R. Apps for improving fitness and increasing physical activity among young people: the AIMFIT pragmatic randomized controlled trial. J Med Internet Res. 2015;17(8):e210.

9. Gordon-Larsen P, Nelson MC, Popkin BM. Longitudinal physical activity and sedentary behaviour trends: adolescence to adulthood. Am J Prev Med. 2004;27(4):277-83.

10. Hardman AE, Stensel DJ. Physical activity and health the evidence explained. London: Routledge; 2009. p. 207.

11. Veitch J, Bagley S, Ball K, Salmon J. Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. Health Place. 2006;12(4):383-93.

12. Kneeshaw-Price S, Saelens B, Sallis J, Glanz K, Frank L, Kerr J, et al. Children's objective physical activity by location: why the neighbourhood matters. Pediatr Exerc Sci. 2013;25(3):468-86.

13. Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7(1):40-55.

14. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, et al. Evidence based physical activity for school-age youth. J Pediatr. 2005;146(6):732-7.

15. Anderson DM, Bedini LA, Moreland L. Getting all girls into the game: physically active recreation for girls with disabilities. J Park Recreat Admi. 2005;23(4):78-104.

16. te Velde SJ, Lankhorst K, Zwinkels M, Verschuren O, Takken T, de Groot J, et al. Associations of sport participation with self-perception, exercise self-efficacy and quality of life among children and adolescents with a physical disability or chronic disease—a cross-sectional study. Sports Med Open. 2018;4(1):38-48.

17. Wu X, Han L, Zhang J, Luo S, Hu J, Sun K. The influence of physical activity, sedentary behaviour on health-related quality of life among the general population of children and adolescents: A systematic review. PLoS One. 2017;12(11):e0187668.

18. Idler N, Teuner CM, Hunger M, Holle R, Ortlieb S, Schulz H, et al. The association between physical activity and healthcare costs in children–results from the GINIplus and LISAplus cohort studies. BMC public health. 2015;15(1):437-49.

19. Black N, Hughes R, Jones AM. The health care costs of childhood obesity in Australia: an instrumental variables approach. Econ Hum Biol. 2018;31(4):1-13.

20. Zhang Y, Ma S, Chen C, Liu J, Zhang C, Cao Z, et al. Physical activity guide for children and adolescents in China. Chin J Evid Based Pediatr. 2017;12(6):401-9.

21. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9 Suppl):S498-504.

22. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Health. 2020;4(1):23-35.

23. Song C, Gong W, Ding C, Yuan F, Zhang Y, Feng G, et al. Physical activity and sedentary behavior among Chinese children aged 6-17 years: a cross-sectional analysis of 2010-2012 China National Nutrition and health survey. BMC Public Health. 2019;19(1):936.

24. Dong Y, Lau PWC, Dong B, Zou Z, Yang Y, Wen B, et al. Trends in physical fitness, growth, and nutritional status of Chinese children and adolescents: a retrospective analysis of 1·5 million students from six successive national surveys between 1985 and 2014. Lancet Child Adolesc Health. 2019;3(12):871-80.

25. Zhu Z, Yang Y, Kong Z, Zhang Y, Zhuang J. Prevalence of physical fitness in Chinese school-aged children: Findings from the 2016 Physical Activity and Fitness in China-The Youth Study. J Sport Health Sci. 2017;6(4):395-403.

26. Lan Z, Y L. A research on the effect of the physical education at school to students' mentality health education. Journal of Sports and Science. 2003;24(1):72-4.

27. Sun H, Ma Y, Han D, Pan C-W, Xu Y. Prevalence and trends in obesity among China's children and adolescents, 1985–2010. PLoS One. 2014;9(8):e105469.

28. Guo L, Liu R, Chen M, Zhang Y, Sun P, Wang C. Three decades of research on childhood and adolescent obesity. Chinese General Practice. 2014;17(30):3531-5.

29. Ma J, Wu J. Why is the academic burden reduction policy hard to achieve? On the nature and mechanism of time allocation of academic burden. Journal of Beijing Normal University (Social Sciences). 2014;59(2):5-14.

30. Li P, Wang M, Wang-Fu BH. Comparison of physical activity levels between Chinese children and youth and global AHKC reports. Chinese Journal of Health Education. 2017;33(2):99-102+19.

31. Diep CS, Leung R, Thompson D, Gor BJ, Baranowski T. Physical activity behaviours and influences among Chinese–American children aged 9–13 Years: a qualitative study. J Immigr Minor Health. 2017;19(2):358-66.

32. Chomitz VR, Brown A, Lee V, Must A, Chui KKH. Healthy living behaviours among Chinese–American preschool-aged children: results of a parent survey. J Immigr Minor Health. 2018;20(4):926-35.

33. Kao D, Gulati AC, Lee RE. Physical activity among Asian American adults in Houston, Texas: data from the health of Houston survey 2010. J Immigr Minor Health. 2016;18(6):1470-81.

34. Trigwell J, Murphy RC, Cable NT, Stratton G, Watson PM. Parental views of children's physical activity: a qualitative study with parents from multi-ethnic backgrounds living in England. BMC Public Health. 2015;15(1):1005-15.

35. Yang X. Rural–urban migration and mental and sexual health: a case study in Southwestern China. Health Psychol Behav Med. 2014;2(1):1-15.

36. Jiang L, Li C. Attribution and countermeasures of "1-hour" shrinkage of sunshine sports. Journal of Teaching and Management. 2017;33(30):21-4.

37. Lu S, Li Z. Impact of ecological factors on physical activity behaviour of urban youth in China: a case study of Jiangsu Province. Sport. 2016;7(145):6-7+129.

38. Pang B, Macdonald D. Understanding young Chinese Australian's (dis) engagement in health and physical education and school sport. Phys Educ Sport Pedagogy. 2016;21(4):441-58.

39. Suen Y-n, Cerin E, Wu S-l. Parental practices encouraging and discouraging physical activity in Hong Kong Chinese preschoolers. J Phys Act Health. 2015;12(3):361-9.

40. Zhang Z, Tang Y, Chen P, Liu Y, Cao Z, Hu Y, et al. The report card of Chinese city children and youth physical activity based on AHKGA – take Shanghai as example. China Sport Science 2017;37(1):14-27.

41. He Q. Analysis of influential factors to the formation of exercise habits among primary and middle school students. Contemporary Sports Technology. 2015;5(11):252-3.

42. Qian J, Ma D. The review of the exercise and sports among middle school students. Sports World (Scholarly). 2014;43(8):60-2.

43. Liu J, Niu J, Zhan P, Yu X. A summary of the research on the advantages and disadvantages of state-run sports system. Sport World (Scholarly). 2015;44(11):28-30.

44. Ran M. Research on finance and competitive sports under the state-run sports system. China Market. 2016;23(46):110-2.

45. Shao W, Wang J. Financial investment in public sports services. Journal of Chengdu Sport University. 2015;41(3):36-40.

46. Wang J, Chen Y. Status quo, constraints and countermeasures of school sports stadiums and facilities. Journal of Shanghai University of Sport. 2015;39(2):86-9.

47. Dong F, Howard AG, Herring AH, Thompson AL, Adair LS, Popkin BM, et al. Parent–child associations for changes in diet, screen time, and physical activity across two decades in modernizing China: China Health and Nutrition Survey 1991–2009. Int J Behav Nutr Phys Act. 2016;13(1):118-28.

48. Zhang Z, Sun X, Zhano P. Analysis on the reason of the decline of college students' physique under the background of the one-child society. Academic Journal of Shaolin and Taiji(Zhongzhou Sports). 2014;26(3):51-4.

49. Li J. Discussion on sports concept and physical health of contemporary only child in the family. Journal of Guizhou Normal University (Natural Sciences). 2004;22(4):96-8.

50. Fertman CI, Allensworth DD, Stevenson B, Tappe MK. Promoting health in schools and universities. In health promotion programs: from theory to practice. San Francisco, CA, USA: John Wiley & Sons; 2016.

51. Langford R, Bonell C, Jones H, Pouliou T, Murphy S, Waters E, et al. The World Health Organization's health promoting schools framework: a Cochrane systematic review and meta-analysis. BMC Public Health. 2015;15:130.

52. Kriemler S, Meyer U, Martin E, van Sluijs EMF, Andersen LB, Martin BW. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. Br J Sports Med. 2011;45(11):923-30.

53. van Sluijs EM, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. BMJ. 2007;335(7622):703.

54. Dobbins M, DeCorby K, Robeson PH, Tirilis D. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. Cochrane Database Syst Rev. 2013;(2): CD007651.

55. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport. 2000;71(2):1-14.

56. Hollis JL, Williams AJ, Sutherland R, Campbell E, Nathan N, Wolfenden L, et al. A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in elementary school physical education lessons. Prev Med. 2016;86:34-54.

57. Metcalf B, Henley W, Wilkin T. Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). BMJ. 2012;345:e5888.

58. Borde R, Smith JJ, Sutherland R, Nathan N, Lubans DR. Methodological considerations and impact of school-based interventions on objectively measured physical activity in adolescents: a systematic review and meta-analysis. Obes Rev. 2017;18(4):476-90.

59. Love R, Adams J, van Sluijs EMF. Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. Obes Rev. 2019;20(6):859-70.

60. Wang H, Zhai F. Programme and policy options for preventing obesity in China. Obes Rev. 2013;14 Suppl 2:134-40.

61. Guo Q. The influencing factors on physical activity level among children and adolescents in China [PhD thesis]. Shanghai: East China Normal University; 2016.

62. Lu W, Henry I. Historical review of sports policy in rural China (1949–2008). Int J Hist Sport. 2011;28(7):1055-71.

63. Wu H, Huang S. Physical activity intervention in adolescents and children based on schools at home and abroad. Sport Science Research. 2017;38(2):87-98.

64. Zhang X, Song Y, Yang TB, Zhang B, Dong B, Ma J. Analysis of current situation of physical activity and influencing factors in Chinese primary and middle school students in 2010. Zhonghua Yu Fang Yi Xue Za Zhi. 2012;46(9):781-8.

65. Li M, Li S, Baur LA, Huxley RR. A systematic review of school-based intervention studies for the prevention or reduction of excess weight among Chinese children and adolescents. Obe Rev. 2008;9(6):548-59.

66. Gao Y, Griffiths S, Chan EY. Community-based interventions to reduce overweight and obesity in China: a systematic review of the Chinese and English literature. J Public Health (Oxf). 2008;30(4):436-48.

67. Lin F, Wei D, Lin S, Maddison R, Mhurchu CN, Jiang Y, et al. Systematic review and meta-analysis of school-based obesity interventions in mainland China. PLoS One. 2017;12(9):e0184704.

68. Li B, Liu W, Cheng K, Pallan M, Hemming K, Frew E, et al. Development of the theory-based Chinese primary school children physical activity and dietary behaviour changes intervention (CHIRPY DRAGON): development of a cluster-randomised controlled trial. Lancet. 2016;388:S51.

69. He G, Cerin E, Huang W, Wong S. Understanding neighbourhood environment related to Hong Kong children's physical activity: a qualitative study using nominal group technique. PLoS One. 2014;9(9):e106578.

70. Michie S, Van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implementation sci. 2011;6(1):42-53.

71. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. Int J Nurs Stud. 2013;50(5):587-92.

72. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50(2):179-211.

73. Rosenstock I. Why people use health services Milbank Mem Fund Q. 1966;83(4):94-124.

74. Kok G, Schaalma H, Ruiter RA, van Empelen P, Brug J. Intervention mapping: protocol for applying health psychology theory to prevention programmes. J Health Psychol. 2004;9(1):85-98.

75. Brug J, Oenema A, Ferreira I. Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. Int J Behav Nutr Phys Act. 2005;2(1):2.

76. Atkins L, Francis J, Islam R, O'Connor D, Patey A, Ivers N, et al. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. Implement Sci. 2017;12(1):77.

77. Michie S, Atkins L, West R. The behaviour change wheel: a guide to designing interventions. Great Britain: Silverback Publishing. 2014.

78. Francis JJ, Stockton C, Eccles MP, Johnston M, Cuthbertson BH, Grimshaw JM, et al. Evidence-based selection of theories for designing behaviour change interventions: using methods based on theoretical construct domains to understand clinicians' blood transfusion behaviour. Br J Health Psychol. 2009;14(4):625-46.

79. West R. Time for a change: putting the Transtheoretical (Stages of Change) Model to rest. Addiction. 2005;100(8):1036-9.

80. Cane J, O'Connor D, Michie S. Validation of the Theoretical Domains Framework for use in behaviour change and implementation research. Implement Sci. 2012;7(1):37-53.

81. Barker F, Lusignan Sd, Deborah C. Improving collaborative behaviour planning in adult auditory rehabilitation: development of the I-PLAN intervention using the behaviour change wheel. Ann Behav Med. 2017;52(6):489-500.

82. Loft MI, Martinsen B, Esbensen BA, Mathiesen LL, Iversen HK, Poulsen I. Strengthening the role and functions of nursing staff in inpatient stroke

rehabilitation: developing a complex intervention using the Behaviour Change Wheel. Int J Qual Stud Health Well-being. 2017;12(1):1392218.

83. Smits S, McCutchan G, Wood F, Edwards A, Lewis I, Robling M, et al. Development of a behaviour change intervention to encourage timely cancer symptom presentation among people living in deprived communities using the behaviour change wheel. Ann Behav Med. 2017;52(6):474-88.

84. Murtagh E, Barnes A, McMullen J, Morgan P. Mothers and teenage daughters walking to health: using the behaviour change wheel to develop an intervention to improve adolescent girls' physical activity. Public Health. 2018;158:37-46.

85. Oliwa JN, Nzinga J, Masini E, van Hensbroek MB, Jones C, English M, et al. Improving case detection of tuberculosis in hospitalised Kenyan children-employing the behaviour change wheel to aid intervention design and implementation. Implement Sci. 2020;15(1):102.

86. Xu F, Ware RS, Leslie E, Tse LA, Wang Z, Li J, et al. Effectiveness of a randomised controlled lifestyle intervention to prevent obesity among Chinese primary school students: CLICK-obesity study. PLoS One. 2015;10(10):e0141421.

87. O'cathain A, Hoddinott P, Lewin S, Thomas KJ, Young B, Adamson J, et al. Maximising the impact of qualitative research in feasibility studies for

randomised controlled trials: guidance for researchers. Pilot Feasibility Stud. 2015;1:32.

88. Mukund. Why a feasibility study is important in project management. 2017. Available from: https://www.simplearn.com/feasibility-study-article.

89. Chinafolio. Chinese provinces. [Image on internet]. 2018. Available from: http://www.chinafolio.com/provinces/s.

90. Yang Y, Zhao X, Zou H, Chu M, Zhong P, Li X, et al. Phylogenetic and temporal dynamics of human immunodeficiency virus type 1 CRF01_AE and CRF07_BC among recently infected antiretroviral therapy-naïve men who have sex with men in Jiangsu Province, China, 2012 to 2015: a molecular epidemiology-based study. Medicine (Baltimore). 2018;97(6):e9826. Figure 1, Map of Jiangsu Province, China; p. 3.

91. Yangzhou Statistics Bureau. Statistical communiqu for Yangzhou's national economic and social development in 2017. Available from: http://tjj.yangzhou.gov.cn/yztjj/tjjtjgb/201803/68ea9e083c084972ba1ffd90181be5b9.shtml.

92. Chen L, Zou Y, Song Y, Liu Z. Physical activities of primary and middle school students and its influential factors in Jiangsu province. Journal of Sports Adult Education. 2011(04):92-4.

93. Gao J, Chen P. Study of daily physical activity status of adolescents in Jiangsu Province. Journal of Nanjing Sport Institute (Natural Science). 2015;14(2):103-8.

94. CFGUIDE. Geography and climate. 2018. Available from: http://www.cfguide.com/prov/Jiangsu.htm.

95. Zhang R, Li H. Associated factors of physical exercise participation among primary and middle school students in Jiangsu. Chinese Journal of School Health. 2017(12):1793-5.

96. Lu S, Li Z. Analysis of the influence of ecological factors on physical activity behaviour of urban adolescents in China: a case study of Jiangsu. Sports 2016(145):6-7.

97. Chen L, Li Q, Song Y, Ma J, Wang H. Association of physical activities, sedentary behaviours with overweight/obesity in 9-11 year-old Chinese primary school students Journal of Peking University (Health Science). 2016;48(3):436-41.

98. Sutherland R, Campbell E, Lubans DR, Morgan PJ, Okely AD, Nathan N, et al. A cluster randomised trial of a school-based intervention to prevent decline in adolescent physical activity levels: study protocol for the 'Physical Activity 4 Everyone'trial. BMC Public Health. 2013;13(1):57-66.

99. Li L. Investigation and analysis of sunshine sports in secondary schools in Yangzhou [Master thesis]. Yangzhou: University of Yangzhou; 2011.

100. Li B, Lin R, Liu W, Chen J, Liu W, Cheng K, et al. Differences in perceived causes of childhood obesity between migrant and local communities in China: a qualitative study. PLos One. 2016;12(5):e0177505.

101. Li X, Zhou X, Hesketh T. Experiences and perspectives of children attending a weight loss camp in China: a qualitative study. Child Care Health Dev. 2016;42(5):644-51.

102. Guan Y. The physical activity of teenagers and influence factors in big cities in China. Journal of Tianjin University of Sport. 2005;20(3):28-31.

103. Cheng K, Cheng P, Mak KT, Wong S, Wong Y, Yeung EW. Relationships of perceived benefits and barriers to physical activity, physical activity participation and physical fitness in Hong Kong female adolescents. J Sports Med Phys Fitness. 2003;43(4):523-9.

104. Liu F, Xie C. The review of the extracurricular exercise participation among middle school students. Modern Communication. 2011;25(5):117-8.

105. Yuan A, Lei Y. Discussion on the influencing factors and countermeasure of physical health in elementary school students. Journal of Shaoyang University (Natural Science Edition). 2017;14(6):77-83.

106. Lu C, Stolk RP, Sauer PJ, Sijtsma A, Wiersma R, Huang GW, et al. Factors of physical activity among Chinese children and adolescents: a systematic review. Int J Behav Nutr Phys Act. 2017;14(1):36-45.

107. Masoumi HE. Associations of built environment and children's physical activity: a narrative review. Rev Environ Health. 2017;32(4):315-31.

108. McAuley E, Blissmer B. Self-efficacy determinants and consequences of physical activity. Exerc Sport Sci Rev. 2000;28(2):85-8.

109. Riiskjær E, Ammentorp J, Kofoed P-E. The value of open-ended questions in surveys on patient experience: number of comments and perceived usefulness from a hospital perspective. Int J Qual Health Care. 2012;24(5):509-16.

110. O'Cathain A, Thomas KJ. "Any other comments?" Open questions on questionnaires–a bane or a bonus to research? BMC Med Res Methodol. 2004;4(1):25-31.

111. Cunningham M, Wells M. Qualitative analysis of 6961 free-text comments from the first National Cancer Patient Experience Survey in Scotland. BMJ Open. 2017;7(6):e015726.

112. Rich JL, Chojenta C, Loxton D. Quality, rigour and usefulness of free-text comments collected by a large population based longitudinal study-ALSWH. PLoS One. 2013;8(7):e68832.

113. Lockwood C, Porritt K, Munn Z, Rittenmeyer L, Salmond S, Bjerrum M. Chapter 2: systematic reviews of qualitative evidence. In: Aromataris E, Munn Z, editors. Joanna Briggs Institute Reviewer's Manual [Internet] Adelaide (AU): The Joanna Briggs Institute. 2017.

114. Wang H, Blake H, Chattopadhyay K. Barriers and facilitators to physical activity among ethnic Chinese children: a systematic review protocol. JBI Database System Rev Implement Rep. 2019;17(0):1-8.

115. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med. 2009;6(7):e1000100.

116. Dixon-Woods M, Booth A, Sutton AJ. Synthesising qualitative research: a review of published reports. Qualitative Research. 2007;7(3):375-422.

117. Nathan N, Elton B, Babic M, McCarthy N, Sutherland R, Presseau J, et al. Barriers and facilitators to the implementation of physical activity policies in schools: a systematic review. Prev Med. 2018;107(2):45-53.

118. Shields N, Synnot AJ, Barr M. Perceived barriers and facilitators to physical activity for children with disability: a systematic review. Br J Sports Med. 2012;46(14):989-97.

119. Hesketh KR, Lakshman R, van Sluijs EMF. Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. Obes Rev. 2017;18(9):987-1017.

120. Lockwood C, Munn Z, Porritt K. Qualitative research synthesis: methodological guidance for systematic reviewers utilising meta-aggregation. Int J Evid Based Healthc. 2015;13(3):179-87.

121. Munn Z, Porritt K, Lockwood C, Aromataris E, Pearson A. Establishing confidence in the output of qualitative research synthesis: the ConQual approach. BMC Med Res Methodol. 2014;14(1):108-14.

122. Ha AS, Macdonald D, Pang BO. Physical activity in the lives of Hong Kong Chinese children. Sport Educ Soc. 2010;15(3):331-46.

123. Wang Y, Yan AF, Shi X, Wang H, Wang Z, Gittelsohn J, et al. Child and parental perspectives on diet and physical activity decisions: implications for childhood obesity prevention in China. Asia Pac J Clin Nutr. 2017;26(5):888-98.

124. Zhang J, Middlestadt SE, Ji C-Y. Psychosocial factors underlying physical activity. Int J Behav Nutr Phys Act. 2007;4(1):38-47.

125. Zhang M, Fan L. Study on the factors of motivation and influencing sports learning [Master’s thesis]. Linfen: Shanxi Normal University; 2015.

126. Pang B. Promoting physical activity in Hong Kong Chinese young people: factors influencing their subjective task values and expectancy beliefs in physical activity. Eur Phy Educ Rev. 2014;20(3):385-97.

127. Pang BOH, HA ASC. Parental concerns in facilitating children's physical activity participation in Hong Kong. Journal of Physical Education & Recreation (Hong Kong). 2008;14(1):39-46.

128. Pang B, Macdonald D, Hay P. 'Do I have a choice?' The influences of family values and investments on Chinese migrant young people's lifestyles and physical activity participation in Australia. Sport Educ Soc. 2015;20(8):1048-64.

129. Mason J. Qualitative researching. London: Sage; 2002.

130. Woolley K, Edwards K, Glazebrook C. Focus group or individual interviews for exploring children's health behaviour: the example of physical activity. Adv Pediatr Res. 2018;5:11-20.

131. Creswell JW, Poth CN. Qualitative inquiry and research design: choosing among five approaches. London: Sage publications; 2017.

132. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. Nurs Health Sci. 2013;15(3):398-405.

133. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC Med Res Methodol. 2013;13(1):117-24.

134. He L, Wang X, Lin L. Factors associated with physical activity of school age children in Chinese cities: a systemic review based on a social ecological model. Urban Planning International. 2016;31(4):10-5.

135. Taylor IM, Spray CM, Pearson N. The influence of the physical education environment on children's well-being and physical activity across the transition from primary to secondary school. J Sport Exerc Psychol. 2014;36(6):574-83.

136. Just Landed. The American school system. Available from: https://www.justlanded.com/english/United-States/USA-Guide/Education/The-American-school-system.

137. Guo H, Yang Z. Study on time arrangement and daily status of primary school students in Beijing. Educational Science Research. 2008;29(11):31-2.

138. Rebort L. The school day and year (England). London: House of Commons; 2016. p. 16.

139. Yang X. The time distribution of junior students in primary school [Master's thesis]. Huhhot: Inner Mongolia Normal University; 2014.

140. Xue S. The influence of city schools work and rest system on the elementary student extracurricular sports activities - taking Shanxi urban elementary school as an example [Master's thesis]. Linfen: Shanxi Normal University. 2012.

141. Roger P. Yes, Asia is obsessed with white skin Makati City: INQUIRER.net; 2016. Available from: https://business.inquirer.net/215898/yes-asia-is-obsessed-with-white-skin?utm_expid=.XqNwTug2W6nwDVUSgFJXed.1.

142. Ridgers ND, Carter LM, Stratton G, McKenzie TL. Examining children's physical activity and play behaviours during school playtime over time. Health Educ Res. 2011;26(4):586-95.

143. Si Q, Cardinal BJ. The health impact of air pollution and outdoor physical activity on children and adolescents in mainland China. J Pediatr. 2017;180(1):251-5.

144. The Joanna Briggs Institute. New JBI grades of recommendation. 2014. Available from: https://joannabriggs.org/sites/default/files/2019-05/JBI-grades-of-recommendation_2014.pdf.

145. Zhu Z, Tang Y, Zhuang J, Liu Y, Wu X, Cai Y, et al. Physical activity, screen viewing time, and overweight/obesity among Chinese children and adolescents: an update from the 2017 physical activity and fitness in China—the youth study. BMC Public Health. 2019;19(1):197-204.

146. Wang Z, Dong Y, Song Y, Yang Z, Ma J. Analysis on prevalence of physical activity time <1 hour and related factors in students aged 9-22 years in China, 2014. Zhonghua Liu Xing Bing Xue Za Zhi. 2017;38(3):341-5.

147. World Health Organization. Spotlight on adolescent health and well-being: findings from the 2017/2018 Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. Available at http://www.hbsc.org/publications/international/.

148. Scottish Office Department of Health. The Scottish Health Survey 2019. Available at https://www.gov.scot/publications/scottish-health-survey-2019-volume-1-main-report/pages/3/.

149. Hesketh T, Zhen Y, Lu L, Dong ZX, Jun Y, Xing Z. Stress and psychosomatic symptoms in Chinese school children: cross-sectional survey. Arch Dis Child. 2010;95(2):136-40.

150. Zhao X, Selman RL, Haste H. Academic stress in Chinese schools and a proposed preventive intervention program. Cogent Education. 2015;2(1):1000477.

151. Yang X. Rural-urban migration and mental and sexual health: a case study in Southwestern China. Health Psychol Behav Med. 2014;2(1):1-15.

152. He L, Lin L. The tendency of the physical activity level among school-aged urban children in China. Chinese Journal of School Health. 2016;37(4):636-40.

153. Jian Y, Wang B, Yang L, Huang M, Zheng L. The social security for sunny sports in elementary schools. Journal of Jilin Institute of Physical Education. 2013;29(1):109-13.

154. Li Y, Hu X, Schouten EG, Liu A, Du S, Li L, et al. Report on childhood obesity in China (8): effects and sustainability of physical activity intervention on body composition of Chinese youth. Biomed Environ Sci. 2010;23(3):180-7.

155. Liu A, Hu X, Ma G, Cui Z, Pan Y, Chang S, et al. Evaluation of a classroom-based physical activity promoting programme. Obes Rev. 2008;9 Suppl 1:130-4.

156. NIHR INVOLVE. What is public involvement in research? Available at https://www.invo.org.uk/find-out-more/what-is-public-involvement-in-research-2/.

157. Kaisler RE, Missbach B. Co-creating a patient and public involvement and engagement 'how to' guide for researchers. Res Involv Engagem. 2020;6(1):32.

158. NIHR INVOLVE. Briefing note six: Who should I involve and how do I find people? Available at https://www.invo.org.uk/find-out-more/what-is-public-involvement-in-research-2/.

159. Brett J, Staniszewska S, Mockford C, Herron-Marx S, Hughes J, Tysall C, et al. Mapping the impact of patient and public involvement on health and social care research: a systematic review. Health Expect. 2014;17(5):637-50.

160. Hansen S, Kanning M, Lauer R, Steinacker JM, Schlicht W. MAP-IT: a practical tool for planning complex behaviour modification interventions. Health Promot Pract. 2017;18(5):696-705.

161. Davies P, Walker AE, Grimshaw JM. A systematic review of the use of theory in the design of guideline dissemination and implementation strategies and interpretation of the results of rigorous evaluations. Implement Sci. 2010;5:14.

162. Li B, Pallan M, Liu WJ, Hemming K, Frew E, Lin R, et al. The CHIRPY DRAGON intervention in preventing obesity in Chinese primary-school-aged children: a cluster-randomised controlled trial. PLoS Med. 2019;16(11):e1002971.

163. Cao Z, Wang S, Chen Y. A randomised trial of multiple interventions for childhood obesity in China. Am J Prev Med. 2015;48(5):552-60.

164. Wang J, Lau W, Wang H, Ma J. Evaluation of a comprehensive intervention with a behavioural modification strategy for childhood obesity prevention: a nonrandomised cluster controlled trial. BMC Public Health. 2015;15(1):1206.

165. Guo Y, Yin X, Wu H, Chai X, Yang X. Trends in overweight and obesity among children and adolescents in China from 1991 to 2015: a meta-Analysis. Int J Environ Res Public Health. 2019;16(23):4656.

166. Dong Y, Ma J, Song Y, Ma Y, Dong B, Zou Z, et al. Secular trends in blood pressure and overweight and obesity in Chinese boys and girls aged 7 to 17 years from 1995 to 2014. Hypertension. 2018;72(2):298-305.

167. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ. 2014;348:g1687.

168. Bell AC, Ge K, Popkin BM. The road to obesity or the path to prevention: motorised transportation and obesity in China. Obesity. 2002;10(4):277-83.

169. Liu Y, Tang Y, Cao Z, Chen P, Zhang J, Zhu Z, et al. Results from Shanghai's (China) 2016 report card on physical activity for children and youth. J Phys Act Health. 2016;13(11 Suppl 2):S124-S8.

170. Luis AM, Iris P, Wolfgang A. Epidemiology of obesity in children and adolescents: prevalence and etiology. Prevalence and Etiology. New York: Springer;2011.

171. Viner R, Davie M. The health impacts of screen time: a guide for clinicians and parents. Available at

https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch_screen_time_guide_-_final.pdf.

172. Wei H. Growing up under pressure. Beijing Rev. 2000;43:18-21.

173. Sharma Y. Homework pushes mothers into violence. Times Educ Suppl. 1997;42:24.

174. Cai Y, Zhu X, Wu X. Overweight, obesity, and screen-time viewing among Chinese school-aged children: national prevalence estimates from the 2016 physical activity and fitness in China—the youth study. J Sport Health Sci. 2017;6(4):404-9.

175. Owen KB, Parker PD, Van Zanden B, MacMillan F, Astell-Burt T, Lonsdale C. Physical activity and school engagement in youth: a systematic review and meta-analysis. Educ. Psychol. 2016;51(2):129-45.

176. Watson A, Timperio A, Brown H, Best K, Hesketh KD. Effect of classroom-based physical activity interventions on academic and physical activity outcomes: a systematic review and meta-analysis. Int J Behav Nutr Phys Act. 2017;14(1):114-37.

177. Hills AP, Dengel DR, Lubans DR. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. Prog Cardiovasc Dis. 2015;57(4):368-74.

178. Wang H, Swain S, Luo J, Blake H, Chattopadhyay K. Barriers and facilitators to physical activity among ethnic Chinese children: a qualitative systematic review. JBI Evid Synth. 2020;18(12):2445-511.

179. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behaviour change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behaviour change Interventions. Ann Behav Med. 2013;46(1):81-95.

180. Jago R, Sebire SJ, Davies B, Wood L, Banfield K, Edwards MJ, et al. Increasing children's physical activity through a teaching-assistant led extracurricular intervention: process evaluation of the action 3: 30 randomised feasibility trial. BMC Public Health. 2015;15(1):156.

181. Glazebrook C, Batty MJ, Mullan N, MacDonald I, Nathan D, Sayal K, et al. Evaluating the effectiveness of a schools-based programme to promote exercise self-efficacy in children and young people with risk factors for obesity: Steps to active kids (STAK). BMC Public Health. 2011;11:830-6.

182. Quirk H, Glazebrook C, Blake H. A physical activity intervention for children with type 1 diabetes-steps to active kids with diabetes (STAK-D): a feasibility study. BMC Pediatr. 2018;18(1):37-48.

183. Moore CG, Carter RE, Nietert PJ, Stewart PW. Recommendations for planning pilot studies in clinical and translational research. Clin Transl Sci. 2011;4(5):332-7.

184. Department of Health. Start active, stay active: a report on physical activity for health from the four home countries' chief medical officers. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/830943/withdrawn_dh_128210.pdf

185. Chen Y, Ma L, Ma Y, Wang H, Luo J, Zhang X, et al. A national school-based health lifestyles interventions among Chinese children and adolescents against obesity: rationale, design and methodology of a randomised controlled trial in China. BMC Public Health. 2015;15(1):210-9.

186. Jiang J, Xia X, Greiner T, Lian G, Rosenqvist U. A two year family based behaviour treatment for obese children. Arch Dis Child. 2005;90(12):1235-8.

187. Cane J, Richardson M, Johnston M, Ladha R, Michie S. From lists of behaviour change techniques (BCTs) to structured hierarchies: comparison of two methods of developing a hierarchy of BCTs. Br J Health Psychol. 2015;20(1):130-50.

188. British Heart Foundation. Get active, stay active. Available at https://www.bhf.org.uk/-/media/files/publications/being-active/g12_get_active_stay_active.pdf.

189. British Heart Foundation. Physical activity for children and young people, evidence briefing. Available at http://www.ncsem-em.org.uk/wp-content/uploads/2018/07/cyp_evidence_briefing.pdf.

190. Beter Health Channel. Physical activity - staying motivated. Available at https://www.betterhealth.vic.gov.au/health/healthyliving/physical-activity-staying-motivated.

191. Caring for Kids. Physical activity for children and youth. Available at https://www.caringforkids.cps.ca/handouts/physical_activity.

192. World Health Organization. Global health risks-mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.

193. Zhejiang Centre for Disease Control and Prevention. Physical activity and health. Available at https://wenku.baidu.com/view/9be7b5cbcc175527072208e3.html.

194. U.S. Department of Health & Human Services. Youth physical activity guidelines poster. Available at https://www.cdc.gov/healthyschools/physicalactivity/toolkit/poster_pa_guidelines_poster.pdf.

195. Wang H, Blake H, Chattopadhyay K. Development of a school-based intervention to increase physical activity level among Chinese children using the Behaviour Change Wheel and Theoretical Domains Framework. Front Public Health. 2021;9:610245.

196. Meng X. An analysis of the course, mode and prospect of the development of private schools in China. Journal of Jianghan University (Social Sciences). 2004;21(2):97-100.

197. Thabane L, Ma J, Chu R, Cheng J, Ismaila A, Rios LP, et al. A tutorial on pilot studies: the what, why and how. BMC Med Res Methodol. 2010;10(1):1.

198. Sim J, Lewis M. The size of a pilot study for a clinical trial should be calculated in relation to considerations of precision and efficiency. J Clin Epidemiol. 2012;65(3):301-8.

199. Zhu Y, Shao Z, Jing J, Ma J, Chen Y, Li X, et al. Body mass index is better than other anthropometric indices for identifying dyslipidemia in Chinese children with obesity. PLoS One. 2016;11(3):e0149392.

200. Shah NR, Braverman ER. Measuring adiposity in patients: the utility of body mass Index (BMI), percent body fat, and leptin (flawed measurement of adiposity in patients). PLoS One. 2012;7(4):e33308.

201. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 2000.

202. Quak SH, Furnes R, Lavine J, Baur LA. Obesity in children and adolescents. J Pediatr Gastroenterol Nutr. 2008;47(2):254-9.

203. Marfell-Jones MJ, Stewart A, De Ridder J. International standards for anthropometric assessment. Adelaide: International Society for the Advancement of Kinanthropometry; 2001.

204. Stewart A, Sutton L. Body composition in sport, exercise, and health. New York: Routledge; 2012.

205. Addo OY, Pereira MA, Himes JH. Is skinfold thickness as good as DXA when measuring adiposity contributions to insulin resistance in adolescents? Am J Hum Biol. 2012;24(6):806-11.

206. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obes Rev. 2012;13(3):275-86.

207. Song Y, Ma J, Li S, Zhang B, Pan Y, Shi X. A comparative study on three kinds of waist circumference measure methods. Chinese Journal of School Health. 2009;30(9):846-8.

208. Wat N, Lam T, Janus E, Lam K. Central obesity predicts the worsening of glycemia in southern Chinese. Int J Obes. 2001;25(12):1789-93.

209. Song Y, Ma J, Li S, Zhang B, Pan Y, Shi X. Comparative study on three kinds of waist circumference measure methods. Chinese Journal of School Health. 2009(09):846-8.

210. Li H, Chen P, Zhuang J. Revision and reliability validity assessment of Children's Leisure Activities Study Survey. Chinese Journal of School Health. 2011(03):268-70.

211. McNamara E, Hudson Z, Taylor SJ. Measuring activity levels of young people: the validity of pedometers. Br Med Bull. 2010;95(1):121-37.

1212. Ramachandran VS. Encyclopedia of human behaviour. Cambridge: Academic Press; 2012.

213. Samdal GB, Eide GE, Barth T, Williams G, Meland E. Effective behaviour change techniques for physical activity and healthy eating in overweight and obese adults: systematic review and meta-regression analyses. Int J Behav Nutr Phys Act. 2017;14(1):42-55.

214. Liang Y, Lau PWC, Huang WYJ, Maddison R, Baranowski T. Validity and reliability of questionnaires measuring physical activity self-efficacy, enjoyment, social support among Hong Kong Chinese children. Prev Med Rep. 2014;1:48-52.

215. Dishman RK, Motl RW, Saunders R, Felton G, Ward DS, Dowda M, et al. Enjoyment mediates effects of a school-based physical-activity intervention. Med Sci Sports Exerc. 2005;37(3):478-87.

216. Song Y. Losing an only child: the one-child policy and elderly care in China. Reprod Health Matters. 2014;22(43):113-24.

217. International Society of Nephrology. Adverse event identification and reporting. Available from: https://www.theisn.org/in-action/research/clinical-trials-isn-act/isn-act-toolkit/study-stage-iii-conducting-a-trial/adverse-event-identification-and-reporting/#ae.

218. Hankonen N, Heino MTJ, Hynynen S-T, Laine H, Araújo-Soares V, Sniehotta FF, et al. Randomised controlled feasibility study of a school-based multi-level intervention to increase physical activity and decrease sedentary behaviour among vocational school students. Int J Behav Nutr Phys Act. 2017;14(1):37-50.

219. Jago R, Sebire SJ, Davies B, Wood L, Edwards MJ, Banfield K, et al. Randomised feasibility trial of a teaching assistant led extracurricular physical activity intervention for 9 to 11 year olds: Action 3:30. Int J Behav Nutr Phys Act. 2014;11:114.

220. Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355:i5239.

221. Thabane L, Hopewell S, Lancaster GA, Bond CM, Coleman CL, Campbell MJ, et al. Methods and processes for development of a CONSORT extension for reporting pilot randomized controlled trials. Pilot Feasibility Stud. 2016(2):25.eCollection 2016.

222. Campbell MK, Piaggio G, Elbourne DR, Altman D. Consort 2010 statement: extension to cluster randomised trials. BMJ. 2012;345:e5661.

223. Xu F, Ware RS, Tse LA, Wang Z, Hong X, Song A, et al. A school-based comprehensive lifestyle intervention among Chinese kids against obesity (CLICK-Obesity): rationale, design and methodology of a randomised controlled trial in Nanjing city, China. BMC Public Health. 2012;12:316.

224. Li B, Adab P, Cheng KK. Family and neighbourhood correlates of overweight and obesogenic behaviours among Chinese children. Int J Behav Med. 2014;21(4):700-9.

225. Duncan S, McPhee JC, Schluter PJ, Zinn C, Smith R, Schofield G. Efficacy of a compulsory homework programme for increasing physical activity and healthy eating in children: the healthy homework pilot study. Int J Behav Nutr Phys Act 2011;8(1):1-10.

226. Duncan S, Stewart T, McPhee J, Borotkanics R, Prendergast K, Zinn C, et al. Efficacy of a compulsory homework programme for increasing physical activity and improving nutrition in children: a cluster randomised controlled trial. Int J Behav Nutr Phys Act. 2019;16(1):1-12.

227. Salmon J, Brown H, Hume C. Effects of strategies to promote children's physical activity on potential mediators. Int J Obes. 2009;33(1):S66-S73.

228. Mendonça G, Cheng LA, Mélo EN, de Farias Júnior JC. Physical activity and social support in adolescents: a systematic review. Health Educ Res. 2014;29(5):822-39.

229. Vanderwall C, Randall Clark R, Eickhoff J, Carrel AL. BMI is a poor predictor of adiposity in young overweight and obese children. BMC Pediatr. 2017;17(1):135.

230. Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. Pediatrics. 2009;124(Suppl1):S3-22.

231. Kirkwood BR, Sterne JA. Essential medical statistics. New Jersey: Blackwell Publishing; 2003.

232. Moore G, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, et al. Process evaluation of complex interventions: Medical Research Council guidance. BMJ. 2015;350:h1258.

233. Jago R, Sebire SJ. Publishing pilot and feasibility evaluations of behavioural interventions: implications for preventive medicine. Prev Med. 2012;55(6):548-9.

234. Reelick MF, Faes MC, Esselink RA, Kessels RP, Rikkert MGO. How to perform a preplanned process evaluation for complex interventions in geriatric medicine: exemplified with the process evaluation of a complex falls-prevention

program for community-dwelling frail older fallers. J Am Med Dir Assoc. 2011;12(5):331-6.

235. Wang H, Blake H, Chattopadhyay K. A school-based behaviour change intervention to increase physical activity levels among children: a feasibility cluster non-randomised controlled trial in Yangzhou, China. BMJ Open. 2021;11:e052659.

236. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int J Health Care Qual. 2007;19(6):349-57.

237. Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data saturation and variability. Field methods. 2006;18(1):59-82.

238. Guest G, Namey E, Chen M. A simple method to assess and report thematic saturation in qualitative research. PLoS One. 2020;15(5):e0232076.

239. Pears S, Morton K, Bijker M, Sutton S, Hardeman W. Development and feasibility study of very brief interventions for physical activity in primary care. BMC public health. 2015;15(1):1-12.

240. QSR International Pty Ltd. NVivo qualitative data analysis software: version 12. Available from: http://www.qsrinternational.com/nvivo/support-overview/downloads/nvivo-11-for-windows.

241. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77-101

242. Jones I, Brown L, Holloway I. Qualitative research in sport and physical activity. New York: Sage, 2012.

243. Knox E, Glazebrook C, Randell T, Leighton P, Guo B, Greening J, et al. SKIP (Supporting Kids with diabetes In Physical activity): feasibility of a randomised controlled trial of a digital intervention for 9-12 year olds with type 1 diabetes mellitus. BMC public health. 2019;19(1):52.

244. Huang W, Shi X, Wang Y, Li X, Gao P, Lu J, et al. Determinants of student's physical activity: a 12-month follow-up study in Ningxia Province. BMC Public Health. 2021;21(1):512.

245. van Sluijs EM, Kriemler S, McMinn AM. The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. Br J Sports Med 2011;45(11):914-22.

246. Martin J, Chater A, Lorencatto F. Effective behaviour change techniques in the prevention and management of childhood obesity. Int J Obes. 2013;37(10):1287-94.

247. Corepal R, Tully MA, Kee F, Miller S, Hunter RF. Behavioural incentive interventions for health behaviour change in young people (5–18 years old): a systematic review and meta-analysis. Prev Med. 2018;110:55-66.

248. Pesce C. Shifting the focus from quantitative to qualitative exercise characteristics in exercise and cognition research. J Sport Exerc Psychol 2012;34(6):766-86.

249. Rose J, Glazebrook C, Wharrad H, Siriwardena AN, Swift JA, Nathan D, et al. Proactive assessment of obesity risk during infancy (ProAsk): a qualitative study of parents' and professionals' perspectives on an mHealth intervention. BMC Public Health. 2019;19(1):1-10.

250. Fanning J, Mullen SP, McAuley E. Increasing physical activity with mobile devices: a meta-analysis. J Med Internet Res. 2012;14(6).

251. Garde A, Umedaly A, Abulnaga SM, Robertson L, Junker A, Chanoine JP, et al. Assessment of a mobile game ("MobileKids Monster Manor") to promote physical activity among children. Games Health J. 2015;4(2):149-58.

252. Tate E, Spruijt-Metz D, O'Reilly G, Jordan-Marsh M, Gotsis M, Pentz M, et al. mHealth approaches to child obesity prevention: successes, unique challenges, and next directions. Transl Behav Med. 2013;3(4):406-15.

253. Guagliano JM, Armitage SM, Brown HE, Coombes E, Fusco F, Hughes C, et al. A whole family-based physical activity promotion intervention: findings from the families reporting every step to health (FRESH) pilot randomised controlled trial. Int J Behav Nutr Phys Act 2020;17(1):1-14.

254. Guagliano JM, Morton KL, Hughes C, van Sluijs EM. Effective and resource-efficient strategies for recruiting families in physical activity, sedentary behavior, nutrition, and obesity prevention research: a systematic review with expert opinion. Obes Rev 2021;22(4):e13161.

255. Wang L, Tang Y, Luo J. School and community physical activity characteristics and moderate-to-vigorous physical activity among Chinese school-aged children: a multilevel path model analysis. J Sport Health Sci. 2017;6(4):416-22.

256. Morgan PJ, Hansen V. Classroom teachers' perceptions of the impact of barriers to teaching physical education on the quality of physical education programs. Res Q Exerc Sport. 2008;79(4):506-16.

257. Boyle SE, Jones GL, Walters SJ. Physical activity among adolescents and barriers to delivering physical education in Cornwall and Lancashire, UK: a qualitative study of heads of PE and heads of schools. BMC public health. 2008;8(1):273.

258. Barroso CS, McCullum-Gomez C, Hoelscher DM, Kelder SH, Murray NG. Self-reported barriers to quality physical education by physical education specialists in Texas. J Sch Health. 2005;75(8):313-9.

259. Fox KR, Riddoch C. Charting the physical activity patterns of contemporary children and adolescents. Proc Nutr Soc. 2000;59(4):497-504.

260. Ridgers ND, Stratton G, Fairclough SJ, Twisk JW. Children's physical activity levels during school recess: a quasi-experimental intervention study. Int J Behav Nutr Phys Act. 2007;4(1):19.

261. Ornelas IJ, Perreira KM, Ayala GX. Parental influences on adolescent physical activity: a longitudinal study. Int J Behav Nutr Phys Act. 2007;4(1):3.

262. Niemeier BS, Hektner JM, Enger KB. Parent participation in weight-related health interventions for children and adolescents: a systematic review and meta-analysis. Prev Med. 2012;55(1):3-13.

263. Yeung D, Yuan X, Hui S, Feresu S. Determinants of moderate to vigorous physical activity and obesity in children: a structural equation modelling analysis. World J Pediatr. 2016;12(2):170-6.

264. Xu F, Wang X, Xiang D, Wang Z, Ye Q, Robert SW. Awareness of knowledge and practice regarding physical activity: a population-based prospective, observational study among students in Nanjing, China. PLoS One. 2017;12(6):e0179518.

265. Shahidi SH, Stewart WJ, Hassani F. Physical activity during COVID-19 quarantine. Acta Paediatr. 2020;109(10):2147-2148.

266. Bates LC, Zieff G, Stanford K, Moore JB, Kerr ZY, Hanson ED, et al. COVID-19 impact on behaviours across the 24-hour day in children and

adolescents: physical activity, sedentary behaviour, and sleep. Children. 2020;7(9):138.

267. Xiang M, Zhang Z, Kuwahara K. Impact of COVID-19 pandemic on children and adolescents' lifestyle behaviour larger than expected. Prog Cardiovasc Dis. 2020;63(4):531.

268. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F. Coronavirus disease (COVID-19): the need to maintain regular physical activity while taking precautions. J Sport Health Sci. 2020;9(2):103.

269. Ridgers ND, Salmon J, Parrish A-M, Stanley RM, Okely AD. Physical activity during school recess: a systematic review. Am J Prev Med. 2012;43(3):320-8.

8. Appendices

Appendix 1: Search strategy

MEDLINE (1946–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1790

Search strategy

1. exp Physical Fitness/
2. exp Physical Education and Training/
3. exp Exercise/
4. exp Sports/
5. exp Sedentary Lifestyle/
6. (physical adj (fitness OR education OR training OR activit* OR inactivit*)).mp.
7. (exercise* OR sport* OR sedentariness).mp.
8. (sedentary adj (lifestyle OR behavio$r)).mp.
9. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8
10. (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*).mp.
11. exp Qualitative Research/
12. exp Interview/

13. exp Focus Groups/
14. exp Cross-Sectional Studies/
15. exp Surveys and Questionnaires/
16. (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*).mp.
17. 11 OR 12 OR 13 OR 14 OR 15 OR 16
18. 10 OR 17
19. exp Child/
20. exp Adolescent/
21. exp Students/
22. exp Minors/
23. (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*).mp.
24. 19 OR 20 OR 21 OR 22 OR 23
25. exp Asian Continental Ancestry Group/
26. exp China/
27. (Chinese OR China).mp
28. 25 OR 26 OR 27
29. 9 AND 18 AND 24 AND 28

Embase (1947–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1950

Search strategy

1. exp fitness/

2. exp physical education/

3. exp training/

4. exp exercise/

5. exp sport/

6. exp sedentary lifestyle/

7. exp physical activity/

8. exp physical inactivity/

9. (physical adj (fitness OR education OR training OR activit* OR inactivit*)).mp.

10. (exercise* OR sport* OR sedentariness).mp.

11. (sedentary adj (lifestyle OR behavio?r)).mp.

12. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11

13. (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*).mp.

14. exp qualitative research/

15. exp interview/

16. exp cross-sectional study/

17. (qualitative OR interview* OR focus group* OR cross-sectional stud* OR cross sectional OR survey*).mp.

18. 14 OR 15 OR 16 OR 17

19. 13 OR 18

20. exp child/

21. exp adolescent/

22. exp student/

23. exp minor (person)/

24. exp juvenile/

25. (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*).mp.

26. 20 OR 21 OR 22 OR 23 OR 24 OR 25

27. exp Asian continental ancestry group/

28. exp China/

29. exp Chinese/

30. (Chinese OR China).mp

31. 27 OR 28 OR 29 OR 30

32. 12 AND 19 AND 26 AND 31

PsycINFO (1806–December 10, 2018)

Date searched: December 10, 2018

Number of records: 420

Search strategy

1. exp Physical Fitness/
2. exp Physical Education/
3. exp TRAINING/
4. exp EXERCISE/
5. exp SPORTS/
6. exp Sedentary Behaviour/
7. exp Physical Activity/
8. (physical adj (fitness OR education OR training OR activit* OR inactivit*)).mp.
9. (exercise* OR sport* OR sedentariness).mp.
10. (sedentary adj (lifestyle OR behavio?r)).mp.
11. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10
12. (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*).mp.
13. exp Qualitative Research/
14. exp INTERVIEWS/
15. exp SURVEYS/

16. (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*).mp.
17. 13 OR 14 OR 15 OR 16
18. 12 OR 17
19. exp STUDENTS/
20. (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*).mp.
21. 19 OR 20
22. (Chinese OR China OR Asian Continental Ancestry Group).mp
23. 11 AND 18 AND 21 AND 22

CINAHL (1937–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1796

Search strategy

S1. (MH "Physical Fitness+")

S2. (MH "Physical Education and Training"+)

S3. (MH "Exercise+")

S4. (MH "Sports+")

S5. (MH "Life Style, Sedentary")

S6. (MH "Physical Activity")

S7. TX (physical fitness OR physical education OR physical training OR physical activit* OR physical inactivit* OR exercise* OR sport* OR sedentariness OR sedentary lifestyle OR sedentary behavio*)

S8. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7

S9. TX (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle*OR obstruct* OR deter* OR facilitat*)

S10. (MH "Qualitative Studies+")

S11. (MH "Interviews+")

S12. (MH "Focus Groups")

S13. (MH "Cross Sectional Studies")

S14. (MH "Surveys+")

S15. TX (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*)

S16. S10 OR S11 OR S12 OR S13 OR S14 OR S15

S17. S9 OR 16

S18. (MH "Child+")

S19. (MH "Adolescence+")

S20. (MH "Students+")

S21. (MH "Minors (Legal)")

S22. TX (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*)

S23. S18 OR S19 OR S20 OR S21OR S22

S24. (MH "China+")

S25. (MH "Chinese+")

S26. TX (Chinese OR China)

S27. S24 OR S25 OR S26

S28. S8 AND S17 AND S23 AND S27

AMED (1985–December 10, 2018)

Date searched: December 10, 2018

Number of records: 14

Search strategy

1. exp Physical fitness/
2. exp Physical education/
3. exp Exercise/
4. exp Sports/
5. exp Sedentary Lifestyle/
6. (physical adj (fitness OR education OR training OR activit* OR inactivit*)).mp.
7. (exercise* OR sport* OR sedentariness).mp.
8. (sedentary adj (lifestyle OR behavio?r)).mp.
9. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8
10. (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*).mp.
11. exp Interviews/
12. (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*).mp.
13. 11 OR 12
14. 10 OR 13

15. exp Child/
16. exp Adolescent/
17. exp Students/
18. (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*).mp.
19. 15 OR 16 OR 17 OR 18
20. exp China/
21. (Chinese OR China).mp
22. 20 OR 21
23. 9 AND 14 AND 19 AND 22

Scopus (1788–December 10, 2018)

Date searched: December 10, 2018

Number of records: 67

Search strategy

TITLE-ABS-KEY (physical fitness OR physical education OR physical training OR physical activit* OR physical inactivit* OR exercise* OR sport* OR sedentariness OR sedentary lifestyle OR sedentary behavio*) And (TITLE-ABS-KEY (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*) OR TITLE-ABS-KEY (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*)) AND TITLE-ABS-KEY (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*) AND TITLE-ABS-KEY (China OR Chinese)

Web of Science (1900–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1771

Search strategy

#1. TS=(physical fitness OR physical education OR physical training OR physical activit* OR physical inactivit* OR exercise* OR sport* OR sedentariness OR sedentary lifestyle OR sedentary behavio*)

#2. TS=(barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*)

#3. TS=(qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*)

#4. #2 OR #3

#5. TS=(child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*)

#6. TS=(China OR Chinese)

#7. #1 AND #4 AND #5 AND #6

BNI (1993–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1796 (BNI is a subscription included within CINAHL in our institution, the search in total returned 1796 results from BNI and CINAHL)

Search strategy

1. exp Physical fitness/
2. exp Physical education/
3. exp Training/
4. exp Exercise/
5. exp Sports/
6. (physical adj (fitness OR education OR training OR activit* OR inactivit*)).mp.
7. (exercise* OR sport* OR sedentariness).mp.
8. (sedentary adj (lifestyle OR behavio?r)).mp.
9. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8
10. (barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*).mp.
11. exp Qualitative research/
12. exp Interviews/
13. exp Focus groups/
14. exp Polls & surveys/

15. (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*).mp.
16. 11 OR 12 OR 13 OR 14 OR 15
17. 10 OR 16
18. exp Children & youth/
19. exp Teenagers/
20. exp Students/
21. exp Minors/
22. (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*).mp.
23. 18 OR19 OR 20 OR 21 OR 22
24. (Chinese OR China).mp
25. 9 AND 17 AND 23 AND 24

CNKI (1979–December 10, 2018)

Date searched: December 10, 2018

Number of records: 1096

Search strategy

SU ='身体健康' + '体育课' + '身体锻炼' + '训练' + '运动' + '体育' + '静坐行为' + '久坐' + '静坐活方式' + '身体活动' + '体力活动' AND SU =('影响' + '障碍' + '阻碍' + '妨碍'+'阻止' + '挑战' + '决定因素' + '促进' + '推动' + '推进')+('质性' + '采访' + '访谈' + '座谈' + '焦点组' + '横断面' + '调查') AND SU = '儿童' + '小孩' + '少年' + '青少年' + '学生' + '未成年' + '年轻人' AND SU = '中国'+ '我国'

Wanfang (1995–December 10, 2018)

Date searched: December 10, 2018

Number of records: 880

Search strategy

题名或关键词: ("身体健康" + "体育课" + "身体锻炼" + "训练" + "运动" + "体育" + "静坐行为" + "久坐"+ "静坐活方式" + "身体活动" + "体力活动") AND 题名或关键词:(("影响" + "障碍" + "阻碍" + "妨碍" +"阻止" + "挑战" + "决定因素" + "促进" + "推动" + "推进")+("质性" + "采访" + "访谈" + "座谈" + "焦点组" + "横断面"

+ "调查")) AND 题名或关键词:("儿童" + "小孩" + "少年" + "青少年" + "学生" + "未成年" + "年轻人") AND 题名或关键词:("中国" + "我国")

VIP (1989–December 10, 2018)

Date searched: December 10, 2018

Number of records: 720

Search strategy

M=("身体健康" + "体育课" + "身体锻炼" + "训练" + "运动" + "体育" + "静坐行为" + "久坐"+ "静坐活方式" + "身体活动" + "体力活动") AND M=(("影响" + "障碍" + "阻碍" + "妨碍" +"阻止" + "挑战" + "决定因素" + "促进" + "推动" + "推进")+("质性" + "采访" + "访谈" + "座谈" + "焦点组" + "横断面" + "调查")) AND M=("儿童" + "小孩" + "少年" + "青少年" + "学生" + "未成年" + "年轻人") AND M=（"中国" + "我国"）

Gray literature

ProQuest Dissertation and Thesis

Date searched: December 10, 2018

Number of records: 943

Search strategy

ab,ti(physical fitness OR physical education OR physical training OR physical activit* OR physical inactivit* OR exercise* OR sport* OR sedentariness OR sedentary lifestyle OR sedentary behavio*) AND ab,ti((barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*) OR (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*)) AND ab,ti(child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*) AND ab,ti(China OR Chinese)

Open Grey

Date searched: December 10, 2018

Number of records: 13

Search strategy

(physical fitness OR physical education OR physical training OR physical

activit* OR physical inactivit* OR exercise* OR sport* OR sedentariness OR sedentary lifestyle OR sedentary behavio*) AND((barrier* OR imped* OR challenge* OR hinder* OR hindrance* OR obstacle* OR obstruct* OR deter* OR facilitat*) OR (qualitative OR interview* OR focus group* OR cross-sectional OR cross sectional OR survey*)) AND (child* OR adolescen* OR student* OR minor* OR kid* OR teen* OR youth* OR young OR juvenile*) AND (China OR Chinese)

EthOS

Date searched: December 10, 2018

Number of records: 25

Search strategy

physical activity OR physical fitness OR exercise OR sports OR sedentary AND Chinese

CNKI

Date searched: December 10, 2018

Number of records: 943

Search strategy

TI ='身体健康' + '体育课' + '身体锻炼' + '训练' + '运动' + '体育' + '静坐行为' + '久坐' + '静坐活方式' + '身体活动' + '体力活动' AND TI =('影响' + '障碍' + '阻碍' + '妨碍'+'阻止' + '挑战' + '决定因素' + '促进' + '推动' + '推进')+('质性' + '采访' + '访谈' + '座谈' + '焦点组' + '横断面' + '调查') AND TI = '儿童' + '小孩' + '少年' + '青少年' + '学生' + '未成年' + '年轻人'

Wanfang

Date searched: December 10, 2018

Number of records: 105

Search strategy

题名或关键词: ("身体健康" + "体育课" + "身体锻炼" + "训练" + "运动" + "体育" + "静坐行为" + "久坐"+ "静坐活方式" + "身体活动" + "体力活动") AND 题名或关键词:(("影响" + "障碍" + "阻碍" + "妨碍" +"阻止" + "挑战" + "决定因素" + "促进" + "推动" + "推进")+("质性" + "采访" + "访谈" + "座谈" + "焦点组" + "横断面" + "调查")) AND 题名或关键词:("儿童" + "小孩" + "少年" + "青少年" + "学生" + "未成年" + "年轻人") AND 题名或关键词:("中国" + "我国")

Appendix 2: Excluded studies and reasons for their exclusion

Abdullah ASM, Wong CM, Yam HK, Fielding R, Asm A, Cm W, et al. Factors related to non-participation in physical activity among the students in Hong Kong. Int J Sports Med. 2005;26(7):611–5.

Reason for exclusion: Cross-sectional survey without free-text

Aldinger C, Zhang XW, Liu LQ, Pan XD, Yu SH, Jones J, et al. Changes in attitudes, knowledge and behaviour associated with implementing a comprehensive school health programme in a province of China. Health Educ Res. 2008;23(6):1049–67.

Reason for exclusion: Ineligible phenomena of interest

Bu SC, Zhao Y. Ji ning di qu nong cun chu zhong sheng ti yu duan lian xing wei xian zhuang de diao cha yu pei yang dui ce yan jiu [The research on status quo and training strategy of Jining rural junior middle school students' physical exercise behaviours [Master's thesis]]. Jin an shan dong ti yu xue yuan [Jinan: Shandong Sport University]. 2012.

Reason for exclusion: Cross-sectional survey without free-text

Bu YF, Du L, Li SL. Zhong xue sheng tao bi ti yu duan lian xing wei ji ying xiang ji zhi [A study of middle school students' physical exercise evading behaviour and its affecting mechanism]. Ti yu xue kan [Journal of Physical Education]. 2017;24(4):120–7.

Reason for exclusion: Cross-sectional survey without free-text

Cai YH, Wang Y. Wo guo zhong xiao xue xiao yu jia tin ti yu lia dong ji zhi de zhi yue yin su he fa zhan ce lue fen xi [Analysis on the restrictive factors and strategies of the linkage mechanism between primary and secondary schools and family sports in China]. Ji lin sheng jiao yu xue yuan xue bao [Journal of Education Institute of Jilin Province]. 2016;32(4):24–6.

Reason for exclusion: Not a primary study

Cen SH. Pu tian shi cheng qu qing shao nian er tong ke wai ti yu huo dong xian zhuang diao cha fen xi [Investigation and analysis of the present situation of children's extracurricular sports activities in Putian city]. Qin shao nian ti yu. 2017;0(2):116-8.

Reason for exclusion: Cross-sectional survey without free-text

Cen YL, Gong ZW. Ban zhu ren ti yu can yu dui xue sheng ti yu xing wei ying xiang yan jiu [Research into the influence of headteachers' sports involvement upon student' physical behaviour [Master's thesis]]. Chang sha hu nan shi fan da xue [Changsha: Hunan Normal University]. 2008.

Reason for exclusion: Cross-sectional survey without free-text

Chan EWC, Au EYM, Chan BHT, Kwan MKM, Yiu PYP, Yeung EW. Relations among physical activity, physical fitness, and self-perceived fitness in Hong Kong adolescents. Percept Mot Skills. 2003;96(3):787–97.

Reason for exclusion: Cross-sectional survey without free-text

Chang F. Wo guo xue sheng ti zhi jian kang xin ying xiang yin su ji jian kang cu

jin ce lue yan jiu [New Impact Factors and Health promotion strategies of students' physical health in China]. Hu bei ti yu ke ji [Hubei Sports Science]. 2017;36(7):616- 618+654.

Reason for exclusion: Not a primary study

Chen DQ, Xu L. Wo guo qing shao nian xue sheng ti zhi jian kang yin su yan jiu fen xi [Analysis of influencing factors on physical health of adolescent students in China]. He ze xue yuan xue bao [Journal of Heze University]. 2010;32(5):86–9.

Reason for exclusion: Not a primary study

Chen FP. Wo guo qing shao nian ti zhi xian zhuang yu ti yu jiao xue mo shi ce lue [The current situation of teenagers' physical fitness and the strategies of physical education teaching model in China]. Qing shao nian ti yu. 2015;0(8):123-4.

Reason for exclusion: Not a primary study

Chen H, Sun H, Dai J. Peer support and adolescents' physical activity: the mediating roles of self-efficacy and enjoyment. J Pediatr Psychol. 2017;42(5):569–77.

Reason for exclusion: Cross-sectional survey without free-text

Chen H, Sun H, Dai J, Griffin M. Relationships among middle school students' expectancy beliefs, task values, and health-related fitness performance. J Teach Phys Educ. 2017;36(1):40–9.

Reason for exclusion: Cross-sectional survey without free-text

Chen J, Unnithan V, Kennedy C. Exploring Chinese children's physical and sedentary activity. Asian J Nurs. 2006;9(1):17–25.

Reason for exclusion: Cross-sectional survey without free-text

Chen JL, Unnithan V, Kennedy C, Yeh CH. Correlates of physical fitness and activity in Taiwanese children. Int Nurs Rev. 2008;55(1):81–8.

Reason for exclusion: Cross-sectional survey without free-text

Chen ML, Ma XQ. Zhong shen jiao yu bei jing xia wo guo zhong xiao xue ti yu jiao yu mian lin de tiao zhan [Challenges of physical education in primary and secondary schools in China under the background of lifelong education]. Gao deng han shou xue bao zi ran ke xue ban [Journal of Higher Correspondence Education (Natural Sciences)]. 2009;22(6):82–3.

Reason for exclusion: Not a primary study

Chen YF. Wo guo xue sheng ti neng xia jiang yuan yin ji dui ce yan jiu [Research of causations and countermeasures to descending of the students' body ability]. Tian jin ti yu xue bao [Journal of Tianjin University of Sport]. 2005;20(4):82–4.

Reason for exclusion: Cross-sectional survey without free-text

Cheng HL, Yuan JG. Wen zhou xiang zhen jiang qing shao nian ti yu fa zhan xian zhuang ji ying xiang yin su yan jiu [Research and developments status and the effects of physical factor of adolescents in Wenzhou township [Master's thesis]]. Wen zhou wen zhou da xue [Wenzhou: Wenzhou University]. 2014.

Reason for exclusion: Cross-sectional survey without free-text

Cheng J. Wo guo zhong xiao xue xue xiao ti yu jiao xue xian zhuang zhu yao wen ti de diao chao yan jiu [Investigation on the main problems of physical education teaching in primary and secondary schools in China. Ren jian. 2016;202(7):99.

Reason for exclusion: Not a primary study

Cheng KY, Cheng PG, Mak KT, Wong SH, Wong YK, Yeung EW. Relationships of perceived benefits and barriers to physical activity, physical activity participation and physical fitness in Hong Kong female adolescents. J Sports Med Phys Fitness. 2003;43(4):523–9.

Reason for exclusion: Cross-sectional survey without free-text

Cheng L, Li Q, Song Y, Ma J, Wang HJ. Zhong guo 9-11 sui xiao xue sheng ti yu duan lian jin tai xing wei he chao zhong yu fei pang de guan xi [Association of physical activities, sedentary behaviours with overweight /obesity in 9-11-year-old Chinese primary school students]. Bei jing da xue xue bao yi xue ban [Beijing Da Xue Xue Bao Yi Xue Ban]. 2016;48(3):436–41.

Reason for exclusion: Cross-sectional survey without free-text

Cheung PYP, Chow Bik C. Parental mediatory role in children's physical activity participation. Health Education. 2010;110(5):351–66.

Reason for exclusion: Cross-sectional survey without free-text

Cui ZL. Wo guo qing shao nian ti zhi jian kang ying xiang yin su fen xi ji dui ce

tan tao [Analysis on influencing factors of adolescents' physical health in China and discussion on countermeasures]. Zhong guo gao xin qu [Science & Technology Industry Parks]. 2018;18(4):71.

Reason for exclusion: Not a primary study

Dan D. Wo guo qing shao nian ti yu duan lian xing wei xi guan yao cheng de ying xiang yin su [Influencing factors and countermeasures of adolescents' physical activity habits in China]. Ke cheng jiao yu yan jiu [Course education research]. 2018;(19):197.

Reason for exclusion: Cross-sectional survey without free-text

Deng XM, Yang X. Kun ming chu zhong xue sheng ke wai ti yu duan lian dui xue sheng ti zhi jian kang de yan jiu [Study on the effect of extracurricular physical exercise on physical health of junior middle school students in Kunming [Master's thesis]]. Kun ming yun nan da xue [Kunming: Yunnan Normal University]. 2015.

Reason for exclusion: Cross-sectional survey without free-text

Dong F, Howard AG, Herring AH, Thompson AL, Adair LS, Popkin BM, et al. Parent-child associations for changes in diet, screen time, and physical activity across two decades in modernizing China: China Health and Nutrition Survey 1991-2009. Int J Behav Nutr Phys Act. 2016;13(1):118–128.

Reason for exclusion: Cross-sectional survey without free-text

Du S, Popkin BM. Barriers to physical activity among Chinese children and

adolescents, 2000-2009. Obesity. 2011;19(1):S124–5.

Reason for exclusion: Full text unavailable

Duan J, Hu H, Wang G, Arao T. Study on current levels of physical activity and sedentary behaviour among middle school students in Beijing, China. PLoS One. 2015;10(7):e0133544–e0133544.

Reason for exclusion: Cross-sectional survey without free-text

Eves FF, Masters RSW, McManus A, Leung M, Wong P, White MJ, et al. Contextual barriers to lifestyle physical activity interventions in Hong Kong. Med Sci Sports Exerc. 2008;40(5):965–71.

Reason for exclusion: Ineligible phenomena of interest

Fan LR, Gu MR, Wang HZ, Yu X, Liu MJ, Wang XN. Quan guo xue sheng can jia kw wai ti yu huo dong xian zhuang de yan jiu [A national survey on students' physical activity after school]. Ti yu ke xue [Sport Science]. 2000;20(2):7–11.

Reason for exclusion: Cross-sectional survey without free-text

Fan RY, Tang Y. Shang hai shi 13-15 sui qing shao nian chu zhong ke wai ti li huo dong de te zheng ji ying xiang yin su [Intensity characteristics and influencing factors of extracurricular physical activity in adolescents (13-15) in Shanghai [Master's thesis]]. Shang hai shang hai ti yu xue yuan [Shanghai: Shanghai University of Sport]. 2017.

Reason for exclusion: Not a primary study

Fu HL. Zhong guo qing shao nian ke wai ti yu duan lian xian zhaung ji ying

xiang yin su yan jiu [Research on the current situation and influencing factors of Chinese teenagers' extracurricular physical exercise]. Wen zhai ban jiao yu. 2015;0(1):153.

Reason for exclusion: Cross-sectional survey without free-text

Gao YC, Cui HY. Wo guo qing shao nian ti yu duan lian xing wei de zong jie yue si kao [Summary and consideration on influencing factors of youth physical exercise behaviour in China]. Su zhou jiao yu xue yuan xue bao [Journal of Suzhou Education Institute]. 2015;18(1):119–21.

Reason for exclusion: Not a primary study

Ge S, Chi J. Sheng tai yin su dui wo guo cheng shi qing shao nian shen ti huo dong xing wei ying xiang yan jiu [Effect of ecological factors on physical activity of urban adolescents in China [PhD thesis]]. Bei jing ti yu da xue [Beijing: Beijing Sport University]. 2012.

Reason for exclusion: Cross-sectional survey without free-text

Gordon-Larsen P, McMurray RG, Popkin BM. Adolescent physical activity and inactivity vary by ethnicity: the national longitudinal study of adolescent health. J Pediatr. 1999;135(3):301–6.

Reason for exclusion: Cross-sectional survey without free-text

Green J, Waters E, Haikerwal A, O'Neill C, Raman S, Booth ML, et al. Social, cultural and environmental influences on child activity and eating in Australian migrant communities. Child Care Health Dev. 2003;29(6):441–8.

Reason for exclusion: Could not distinguish data about ethnic Chinese children

Guo JQ, Liu YH, Yu YS, Fang YJ, Wei GH. Xin shi ji chu wo guo bu fen cheng shi qing shao nian jia tin ti yu xian zhuang diao cha yan jiu [Survey and research on adolescents family sports of our country in 21th century]. Ha er bin ti yu xue yuan xue bao [Journal of Harbin Institute of Physical Education]. 2010;27(6):22–5.

Reason for exclusion: Cross-sectional survey without free-text

Guo Q, Wang XZ. Zhong guo er tong qing shao nian shen ti huo dong shui ping ji qi ying xiang yin su de yan jiu [The influencing factors on physical activity level among children and adolescents in China [PhD thesis]]. Shang hai hua dong shi fan da xue [Shanghai: East China Normal University]. 2016.

Reason for exclusion: Cross-sectional survey without free-text

Guo X, Dai J, Xu P, Jamieson LM, He K. Sport facility proximity and physical activity: results from the Study of Community Sports in China. Eur J Sport Sci. 2015;15(7):663–9.

Reason for exclusion: Cross-sectional survey without free-text

Guo YH, Shi Y, Zhang YH, Li X. Qing shao nian ti yu duan lian ping jing wen ti ji qi dui ce yan jiu [Bottleneck problems and countermeasure of juvenile physical exercise]. Hu bei ti yu ke ji [Hubei Sports Science]. 2017;36(10):922----924+935.

Reason for exclusion: Cross-sectional survey without free-text

Guo YY, Shi B. Xiao xue liu nian ji xue sheng ti yu su yang diao cha yu fen xi [Analysis of physical education literacy of sixth grade primary school students [Master's thesis]]. Xi an shan xi shi fan da xue [Xi'an: Shanxi Normal University]. 2014.

Reason for exclusion: Cross-sectional survey without free-text

Gu H, Tang Q. Xiao xue er tong ti li huo dong te zheng ji qi xiang guan yinh xiang yin su yan jiu [Study on physical activity characteristics and related influencing factors of primary school children [master's thesis]]. Yang zhou yang zhouo da xue [Yangzhou; Yangzhou University]. 2016.

Reason for exclusion: Cross-sectional survey without free text

He LL, Lin L, Fu YL. Shang hai shi xue lin er tong jiao tong xin ti li huo dong ji ying xiang yin su [Correlates of transport related physical activity of school-age children in Shanghai [Master's thesis]]. Shang hai hua dong shi fan da xue [Shanghai: East China Normal University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Ho KW, Louie LH, Wong WH, Chow CB. Association between overweight and obesity and school asset for physical activity. Obes Facts. 2014;7(Suppl 1):122–3.

Reason for exclusion: Cross-sectional survey without free-text

Hu M. Wo guo zhong xue sheng ti zhi xia jiang yuan yin pou xi yu dui ce [Analysis of the reasons for the physical fitness decline in middle school

students in China and the countermeasures]. Liao ning shi zhuan xue bao [Journal of Normal College (Natural Science Edition)]. 2002;23(4):76-8.

Reason for exclusion: Not a primary study

Hu YM. Zhong xi fang ti yu wen hua cha yi dui wo guo xue xiao ti yu jiao yu ying xiang de yan jiu [A study on the impact of the differences between Chinese and Western sports culture on school physical education in China]. Ke cheng jiao yu yan jiu [Course Education Research]. 2015;4(5):207.

Reason for exclusion: Not a primary study

Huang WY, Wong SH, Salmon J. Correlates of physical activity and screen-based behaviours in Chinese children. J Sci Med Sport. 2013;16(6):509–14.

Reason for exclusion: Cross-sectional survey without free-text

Huang XH, Zhang J, Chen ZJ, Qu XP, Gu F, Ma HY, et al. A transtheoretical model-based analysis of sedentary behaviours in Chinese high school students. Int J Clin Exp Med. 2016;9(2):3820–30.

Reason for exclusion: Cross-sectional survey without free-text

Huang YJ. Socio-environmental correlates of physical activity and sedentary behaviours in primary school children in Hong Kong [PhD thesis]. Hong Kong: The Chinese University of Hong Kong. 2008.

Reason for exclusion: Cross-sectional survey without free-text

Huo XY, Huan CD, Xiao LP. Wo guo qing shao nian ti yu can yu de zhi yue yin

su ji ying dui ce lue [Restrictive factors and countermeasures of teenagers' sports participation in China]. Ti yu wen hua dao kan [Sports Culture Guide]. 2012;30(3):112–6.

Reason for exclusion: Cross-sectional survey without free-text

Jia C. Jia tin ti yu dui wo guo qing shao nian ti zhi de ying xiang fen xi [An analysis of the impact of family sports on physical fitness of adolescents in China]. Wu shu yan jiu 2015;12(5):103–4.

Reason for exclusion: Not a primary study

Jia LJ, Peng XW. Ying xiang wo guo qing shao nian ti zhi jian kang de jiao yu xue yin su fen xi [An analysis of educational factors affecting the physical health of adolescents in China]. He bei ti yu xue yuan xue bao [Journal of Hebei Institute of Physical Education]. 2013;27(1):54–6.

Reason for exclusion: Not a primary study

Jin H. Qing shao nian ke wai ti yu huo dong zai cheng shi guang chang ti yu kai zhan zhong de yan jiu [The research of teenager’s extracurricular physical exercise in the city square sports development [Master’s thesis]]. Shang hai hua dong shi fan da xue [Shanghai: East China Normal University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Jin QY. Wo guo qing shao nian ti yu jian kang cu jin yan jiu jin zhan [Research progress of adolescents’ sports health promotion in China]. Dang dai ti yu ke Ji. 2017;7(18):217–8.

Reason for exclusion: Not a primary study

Jin QY, Jiang YZ. Wo guo chao xian zu zhong xue sheng ke wai ti yu huo dong xian zhuang ji ying xiang yin su de yan jiu [Research on the current situation of extra-curriculum PE and physical activities of middle school students of Chinese Korean middle school and the influential factors]. Bei jing ti yu da xue xue bao [Journal of Beijing Sport University]. 2006;29(4):541–542+551.

Reason for exclusion: Cross-sectional survey without free-text

Jin QY, Jiang YZ. Zhong guo chao xian zu zhong xue sheng ke yu ti yu huo dong xian zhuang ji qi ying xiang yin su yan jiu [Researches on present conditions and factors of the spare-time sports activities among the Korean minority students in China [Master's thesis]]. Yan bian yan bian da xue [Yanbian: Yanbian University]. 2004.

Reason for exclusion: Cross-sectional survey without free-text

Jin SF. Wo guo chao xian cu zhong xue jiao yu xian zhuang diao cha fen xi [Investigation and analysis on the current situation of sports education in Korean middle schools in China]. Shen yang ti yu xue bao [Journal of Shenyang Physical Education Institute]. 2006;25(4):88–90.

Reason for exclusion: Cross-sectional survey without free-text

Lei KC, Yang X. Zhong ri han gao zhong sheng de shen xin jian kang zhi biao xian zhuang ji ying xiang yin su [Physical and mental health of high school students in China, Japan and Korea: indicators, current situation and

influencing factors]. Qing nian yan jiu [Youth Studies]. 2011;34(3):11–21+94.

Reason for exclusion: Cross-sectional survey without free-text

Leung KM, Chung PK, Kim S. Parental support of children's physical activity in Hong Kong. Eur Phy Educ Rev. 2017;23(2):141–56.

Reason for exclusion: Cross-sectional survey without free-text

Li HS. Wo guo qing shao nian ti yu can yu ying xiang yin su fen xi [Analysis of influencing factors of youth sports participation in China]. Fu zhi shi dai [The Fortune Times]. 2017;0(1):358.

Reason for exclusion: Not a primary study

Li K, Wen M. Racial and ethnic disparities in leisure-time physical activity in California: patterns and mechanisms. Race Soc Probl. 2013;5(3):147–56.

Reason for exclusion: Cross-sectional survey without free-text

Li M, Wang XC. Shi jia zhuang gao zhong xue sheng sheng tai ti yu yi shi yu xing wei de diao cha yan jiu [Investigation on the ecological sports consciousness and the physical behaviours of high students in Shijiazhuang [Master's thesis]]. Shen yang shen yang ti yu da xue [Shenyang: Shenyang Sport University]. 2010.

Reason for exclusion: Cross-sectional survey without free-text

Li N. Guan yu cu jin wo guo qing shao nian ti yu can yu de yan jiu [Research on improving teenagers' participation in sports]. Ti yu ke ji wen xian tong bao

[Bulletin of Sport Science & Technology]. 2015;(10):129–30.

Reason for exclusion: Not a primary study

Li PH, Wang M. Zhong guo er tong qing shao nian shen ti huo dong xian zhuang ji xiang guan ying xiang yin su [Investigation on Chinese children and youth physical activity status and influence factors]. Zhong guo xue xiao wei sheng [Chinese Journal of School Health]. 2016;37(6):805–809+813.

Reason for exclusion: Cross-sectional survey without free-text

Li Q, Yu WQ.. Chu zhong ti yu ke xue sheng zhu ti can yu de diao cha yan jiu [Investigation and research on students' participation in physical education in junior middle school [Master's thesis]]. Da lian liao ning shi fan da xue [Dalian: Liaoning Normal University]. 2004.

Reason for exclusion: Cross-sectional survey without free-text

Li S, Wang XX. Da lian shi 14-17 sui cheng shi qing shao nian can jia ke wai ti yu duan lian de xian zhuang yu fen xi [The investigation and analysis of status on youth aged 14-17 to participate in extra-curricular physical activity in Dalian [Master's thesis]]. Da lian liao ning shi fan da xue [Dalian: Liaoning Normal University]. 2009.

Reason for exclusion: Cross-sectional survey without free-text

Li S, Zhao P. The determinants of commuting mode choice among school children in Beijing. J Transp Geogr. 2015;46(1):112–21.

Reason for exclusion: Cross-sectional survey without free-text

Li W, Zhou B. Chu zhong ti yu yu jian kang jiao xue zhong cu jin xue sheng zhu dong can yu de ce lue yan jiu [Strategies for promoting students' active participation in junior middle school physical education and health teaching [Master's thesis]]. Nan jing nan jing shi fan da xue [Nanjing: Nanjing Normal University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Li YY, Xu YY, Hu ML. Yang zhou chu zhong xue sheng ti yu xu qiu de diao cha yan jiu [Investigation and research on sports needs of junior middle school students in Yangzhou city [Master's thesis]]. Yang zhou yang zhou da xue [Yangzhou: Yangzhou University]. 2018.

Reason for exclusion: Cross-sectional survey without free-text

Li YS, Wang J. Tian jin shi nan kai zhong xue xue sheng can yu ti li huo dong fang shi yu ri chang sheng huo xi guan diao cha bao gao [Investigation report on physical activity styles and daily life habits of students in Nankai middle school in Tianjin [Master's thesis]]. Tian jin tian jin ti yu xue yuan Tianjin: Tianjin University of Sport. 2014.

Reason for exclusion: Cross-sectional survey without free-text

Liang X. Ying xiang wo guo qing shao nian ti zhi jian kang de zhu yao yin su ji dui ce yan jiu [Study on the main factors affecting the physical health of adolescents and the countermeasures in China]. Chi feng xue yuan xue bao zi ran ke xue ban. Journal of Chifeng University (Natural Science Edition).

2012;28(10):143–4.

Reason for exclusion: Not a primary study

Liao ZF. Wo guo qing shao nian ti zhi yu jian kang xian zhuang tou xi ji dui ce yan jiu [Analysis and countermeasure on the current situation of physical fitness and health of adolescents in China]. Guang xi jiao yu xue yuan xue bao [Journal of Guangxi College of Education]. 2014;29(3):162–5.

Reason for exclusion: Cross-sectional survey without free-text

Lin L. Leisure-time physical activity, objective urban neighbourhood built environment, and overweight and obesity of Chinese school-age children. J Transp Health. 2018;10(1):322–33.

Reason for exclusion: Cross-sectional survey without free-text

Liu, CQ. Chang chun shi qu chu zhong ke wai ti yu huo dong kai zhan xian zhuang ji fa zhan dui ce yan jiu [Changchun city junior middle school extracurricular sports activities situation and development countermeasures [Master's thesis]]. Chang chun dong bei shi fan da xue [Changchun: Northeast Normal University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Liu W, He MZ, Wang Y, Zhou Y, Wu M, Tang Z, et al. Differences in health-related behaviours between middle school, high school, and college students in Jiangsu province, China. Asia Pac J Clin Nutr. 2017;26(4):731–7.

Reason for exclusion: Cross-sectional survey without free-text

Liu XL, Chen HP. Wo guo qing shao nian jia tin ti yu qian fa da de ying xiang yin su [Analysis of influence factors developed in adolescent family sports in China]. An hui ti yu ke ji [Journal of Anhui Sports Science]. 2014;35(6):13–5.

Reason for exclusion: Cross-sectional survey without free-text

Liu Y, Zhang Y, Chen S, Zhang J, Guo Z, Chen P, et al. Associations between parental support for physical activity and moderate-to-vigorous physical activity among Chinese school children: a cross-sectional study. J Sport Health Sci. 2017;6(4):410–5.

Reason for exclusion: Cross-sectional survey without free-text

Lonsdale C, Sabiston CM, Raedeke TD, Ha AS, Sum RK. Self-determined motivation and students' physical activity during structured physical education lessons and free choice periods. Prev Med. 2009;48(1):69–73.

Reason for exclusion: Cross-sectional survey without free-text

Lu HM. Qing shao nian ti yu huo dong xian zhuang diao cha [Investigation on the current situation of teenagers' sports activities]. Zhong xue sheng. 2007;78(10):4–9.

Reason for exclusion: Cross-sectional survey without free-text

Lu QS. Ji lin shi nong cun chu zhong xue xiao ti yu xian zhuang diao cha yu dui ce fen xi [City junior high school physical education in rural areas investigation and analysis [Master's thesis]]. Chang chun dong bie shi fan da xue

[Changchun: Northeast Normal University]. 2009.

Reason for exclusion: Cross-sectional survey without free-text

Luo GJ, Zheng ZL. Wo guo xue sheng ti zhi xian zhuang diao cha yu dui ce yan jiu [Research on the current situation of students' physical fitness in China and the countermeasures]. Ke ji xin xi [Science & Technology Information]. 2013;30(26):8.

Reason for exclusion: Not a primary study

Luo J, Tang Y, Gong LZ. Xi nan di qu qing shao nian ke wai ti yu duan lian xing wei xian zhuang ji fang ai yin su yan jiu bao gao [Research report on the status-quo and restrictive factors on the extracurricular physical exercises of the teenagers in Southwest China]. Bei jing ti yu da xue xue bao [Journal of Beijing Sport University]. 2012;35(1):80–6.

Reason for exclusion: Cross-sectional survey without free-text

Luo Y, Wang XM. Si chuan sheng zhong xiao cheng shi qing shao nian xiu xian ti yu kai zhan qing kuang diao cha ji dui ce yan jiu [Research on developing situation of leisure sports in small and medium-sized cities of Sichuan province and solutions [Master's thesis]]. Cheng du si chuan shi fan da xue [Chengdu: Sichuan Normal University]. 2010.

Reason for exclusion: Cross-sectional survey without free-text

Lu SW, Li ZR. Sheng tai yin su dui wo guo cheng shi qing shao nain sheng ti huo dong xing wei ying xiang yin su fen xi – yi jiang su sheng wei li [Impact of

ecological factors on physical activity behaviour of urban adolescents in China - take Jiangsu province as an example]. Yun dong [Sport]. 2016;8(17):6–7+129.

Reason for exclusion: Not a primary study

Ma DH, Ji L. Wo guo zhong xiao xue sheng ti zhi jian kang zhong cun zai de wen ti zhi yin ji qi dui ce [Research on causes and countermeasures of Chinese primary and middle school students' physical health problems]. Xi an ti yu xue yuan xue bao [Journal of Xi'an Education University]. 2017;34(2):182–188+236.

Reason for exclusion: Cross-sectional survey without free-text

Mao, J. Cu jin qing shao nian shen xin jian kang yu wo guo jin ji ti yu fa zhan [Improving Youngsters' physical and mental health and the development of China's competitive sports]. Ti yu ke yan [Sport Science Research]. 2014;35(1):25–7.

Reason for exclusion: Not a primary study

Pang JH. Ying xiang wo guo zhong xiao xue sheng ti zhi jian kang de yin su ji dui ce yan jiu [Study on the factors affecting the physical health of primary and secondary school students in China and the countermeasures]. Xin ke cheng gai ge yu shi jian. 2009;4(10):1.

Reason for exclusion: Cross-sectional survey without free-text

Qiu Y. Ying xiang wo guo xue sheng jian kang she hui huai jin yin su ji qi ti yu gan yu dui ce yan jiu [A study on the socio-environmental factors affecting students' health and the intervenient measures of sports]. Bei jing ti yu da xue

xue bao [Journal of Beijing Sport University]. 2004;27(1):85–7.

Reason for exclusion: Not a primary study

Rhodes RE, Macdonald HM, McKay HA. Predicting physical activity intention and behaviour among children in a longitudinal sample. Soc Sci Med.2006;62(12):3146–56.

Reason for exclusion: Cross-sectional survey without free-text

Sang CY. Ti yu jiao shi dui xue sheng ti zhi jian kang xia jiang yuan yin de si kao ji fen [Physical education teachers' consideration and analysis of the reasons for the decline of students' physical fitness]. Shi chang zhou kan li lun yan jiu [Market Weekly]. 2016;39(9):133–6.

Reason for exclusion: Cross-sectional survey without free-text

Sham MKS. How parental attitudes on play affect children in Hong Kong [PhD thesis]. San Francisco Bay: Alliant international University. 2009.

Reason for exclusion: Full text unavailable

Shang KB. Ying xiang wo guo qing shao nian ti yu duan lian can yu yi shi de yin su yu dui ce tan xi [Restricting awareness of youth participation in physical exercise factors and countermeasures in China]. Shan dong ti yu ke ji [Shandong Sports Science & Technology]. 2010;32(4):90–2.

Reason for exclusion: Cross-sectional survey without free-text

Sheng JL, Huang LM, Wang DW, Zhang XH, Liu YY, Dong QG, et al. Zhong

guo hei long jiang ri ben bei hai dao 8-18 sui nan zi xue sheng ti zhi xian zhuang diao cha yan jiu [Investigation on physical fitness of 8-18-year-old male students in Heilongjiang province and Hokkaido, Japan]. Ha er bin xue yuan xue bao jiao yu [Journal of Harbin University. 2001;22(5):61–5.

Reason for exclusion: Inappropriate phenomena of interest

Shi X, Tubb L, Chen S, Fulda KG, Franks S, Reeves R, et al. Associations of health disparities and physical activity with children's health and academic problems. J Exerc Sci Fit. 2014;12(1):7–14.

Reason for exclusion: Cross-sectional survey without free-text

Song C, Yu XP, Ding CC, Liu AL, Zhen, BJ. Shan dong sheng san cheng shi 3-4 nian ji xiao xue sheng xian xia duan lian ji jin tai huo dong fen xi [Status of exercise and sedentary activities in the leisure time among third and fourth grade pupils in three cities of Shandong province]. Wei sheng yan jiu [Journal of hygiene research]. 2015;44(3):398–406.

Reason for exclusion: Cross-sectional survey without free-text

Song XL, Xiao LP. Wo guo xue sheng ti zhi jian kang jiao yu xian zhaung fen xi [Analysis on the current situation of physical health education for students in China]. Ti yu wen hua dao kan [Sports Culture Guide]. 2012;30(5):103–6.

Reason for exclusion: Cross-sectional survey without free-text

Song Y, Zhang X, Yang TB, Zhang B, Dong B, Ma J. 2010 nian quan guo zhong xiao xue sheng ti yu duan lian xing wei xian zhuang ji yuan yin fen xi 2010

[Current situation and cause analysis of physical activity in Chinese primary and middle school students in 2010] . Bei jing da xue xue bao yi xue ban [Beijing Da Xue Xue Bao Yi Xue Ban]. 2012;44(3):347–54.

Reason for exclusion: Cross-sectional survey without free-text

Sun L. Correlates of physical activity and physical activity change among Hong Kong Chinese adolescent girls: a mixed method study [PhD thesis]. Hong Kong: The Chinese University of Hong Kong. 2015.

Reason for exclusion: Cross-sectional survey without free-text

Sun YF, Bao HS. Zhong de qing shao nian xiu xian ti yu wen hua dui bi yan jiu [A contrastive study of Chinese and German youth leisure sports culture]. Ti yu wen hua dao kan [Sports Culture Guide]. 2017;35(6):157–61.

Reason for exclusion: Cross-sectional survey without free-text

Tan XC, Yao HZ. Fu mu wen hua cheng du yu zhi ye di wei dui er tong yu ti yu xing wei de ying xiang yan jiu [A study on influence of parents' education level and occupational status on children's participation of sports [Master's thesis]]. Gui lin guang xi shi fan da xue [Guilin: Guangxi Normal University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Tang MY, Chen PY. Jiang su sheng zhong xiao xue xue sheng ti yu huo dong ji ying xiang yin su yan jiu [Influencing factors of physical activity for primary and secondary school students in Jiangsu province [Master's thesis]]. Nan jing nan jing shi fan da xue [Nanjing: Nanjing Normal University]. 2014.

Reason for exclusion: Cross-sectional survey without free-text

Todorovich J, Smith K. Chinese teachers' beliefs about inclusive physical education. J Phys Health Educ Recreat Dance. 2013;84(2):13.

Reason for exclusion: Cross-sectional survey without free-text

Tu ZC, Wang FX. Bu ji gao ji zhong xue xue sheng ti yu ke xue xi xin qu de diao cha yu yan jiu [Investigation and research on student's interest in physical education in Buji senior middle School [Master's thesis]]. Xi an shan xi shi fan da xue [Xi'an: Shanxi Normal University]. 2018.

Reason for exclusion: Not a primary study

Tudor-Locke C, Ainsworth BE, Adair LS, Du S, Lee N, Popkin BM. Cross-sectional comparison of physical activity and inactivity patterns in Chinese and Filipino youth. Child Care Health Dev. 2007;33(1):59–66.

Reason for exclusion: Cross-sectional survey without free-text

Tudor-Locke C, Ainsworth BE, Adair LS, Du S, Popkin BM. Physical activity and inactivity in Chinese school-aged youth: the China Health and Nutrition Survey. Int J Obes. 2003;27(9):1093–9.

Reason for exclusion: Cross-sectional survey without free-text

Unger JB, Reynolds K, Shakib S, Spruijt-Metz D, Sun P, Johnson CA. Acculturation, physical activity, and fast-food consumption among Asian-American and Hispanic adolescents. J Community Health. 2004;29(6):467–81.

Reason for exclusion: Cross-sectional survey without free-text

Wang CKJ, Liu WC, Sun Y, Lim BSC, Chatzisarantis NL. Chinese students' motivation in physical activity: Goal profile analysis using Nicholl's achievement goal theory. Int J Sport Exerc Psychol. 2010;8(3):284–301.

Reason for exclusion: Cross-sectional survey without free-text

Wang DE, Du FQ, Han YJ. Wo guo cheng shi qing shao nian xiao wai ti yu duan lian xing wei bian hua jie duan yu bian hua cheng xu guan xi de yan jiu [Relationship between the stage and process of exercise behaviour of teenagers]. Guang zhou ti yu xue yuan xue bao [Journal of Guangzhou Sport University]. 2018;38(1):11–6.

Reason for exclusion: Cross-sectional survey without free-text

Wang JX, Lu AM. Nan tong qing shao nian ti yu fa zhan ying xiang yin su diao cha yan jiu [Research on influential factors of sports development among the teenagers in Nantong [Master's thesis]]. Su zhou su zhou da xue [Suzhou: Soochow University]. 2016.

Reason for exclusion: Cross-sectional survey without free-text

Wang L, Qi J. Association between family structure and physical activity of Chinese adolescents. Biomed Res Int. 2016;2016:4278682.

Reason for exclusion: Cross-sectional survey without free-text

Wang L, Tang Y, Luo J, L W, Y T, Wang L, et al. School and community physical activity characteristics and moderate-to-vigorous physical activity among

Chinese school-aged children: a multilevel path model analysis. J Sport Health Sci. 2017;6(4):416–22.

Reason for exclusion: Cross-sectional survey without free-text

Wang Q, Fang XP. Wo guo qing shao nian ti zhi xia jiang you yin fen xi ji gai shan tu jing [Analysis of the causes of the physical fitness decline in Chinese adolescent students and its solutions]. An hui shi fan da xue xue bao zi ran ke xue ban [Journal of Anhui Normal University (Natural Science)]. 2015;38(4):392–6.

Reason for exclusion: Not a primary study

Wang X, Liu QM, Ren YJ, Lv J, Li LM. Family influences on physical activity and sedentary behaviours in Chinese junior high school students: a cross-sectional study. BMC Public Health. 2015;15(1):287–287.

Reason for exclusion: Cross-sectional survey without free-text

Wang W, Shen Y. Shang hai shi xi nan pian qu chu zhong xue sheng yu xian ti yu xian zhuang diao cha ji yan jiu [Investigation on the current situation of leisure sports in junior middle school students in Southwest Shanghai [Master's thesis]]. Shang hai shang hai shi fan da xue [Shanghai: Shanghai Normal University]. 2012.

Reason for exclusion: Cross-sectional survey without free-text

Wang Y, Zheng JF. Zhi yue yan bian chao xian zu zi zhi zhou nong cun xiao xue ti yu jiao yu fa zhan de yin su ji dui ce yan jiu [The study on factors and

countermeasures of restricting the development of rural primary physical education in the Yanbian Korean autonomous prefecture [Master's thesis]]. Chang chun dong bei shi fan da xue [Changchun: Northeast Normal University]. 2010.

Reason for exclusion: Cross-sectional survey without free-text

Wang ZH, Dong YH, Song Y, Yang ZP, Ma J. Zhong guo 2014 nian 9-22 sui xue sheng ti yu duan lian shi jian bu zu 1 xiao shi de liu xing xian zhuang yu ying xiang yin su fen xi [Analysis on prevalence of physical activity time <1 hour and related factors in students aged 9—22 years in China, 2014]. Zhong hua liu xing bin xue za zhi [Chinese Journal of Epidemiology]. 2017;38(3):341-5.

Reason for exclusion: Cross-sectional survey without free-text

Wangfu BH, Wang M, Zhang YF, Wu DM, Feng Q, Cai R, et al. Zhong guo jian tin ti yu duan lian xing wei te dian ji dai ji hu dong guan xi yan jiu [Study on the characteristics and interactive relationship of family physical exercise in China]. Ti yu ke xue [China Sport Science]. 2016;36(11):31–8.

Reason for exclusion: Not a primary study

Wei X, Zang Y, Jia X, He X, Zou S, Wang H, et al. Age, period and cohort effects and the predictors of physical activity and sedentary behaviour among Chinese children, from 2004 to 2011. BMC Public Health. 2017;17(1):353–353.

Reason for exclusion: Cross-sectional survey without free-text

Wei YD, Shi HY. Zhong xue ban zhu ren tai du dui xue sheng ti yu xing wei ying

xiang de diao cha yan jiu [Investigation and research on the effect of middle school headteacher's sports attitude on students' sports behaviour [Master's thesis]]. Xi an shan xi da xue [Xi'an: Shanxi Normal University]. 2015.

Reason for exclusion: Cross-sectional survey without free-text

Wong BY, Ho SY, Lo WS, Cerin E, Mak KK, Lam TH, et al. Longitudinal relations of perceived availability of neighbourhood sport facilities with physical activity in adolescents: an analysis of potential moderators. J Phys Act Health. 2014;11(3):581–7.

Reason for exclusion: Cross-sectional survey without free-text

Wong BYM, Cerin E, Ho SY, Mak KK, Lo WS, Lam T-H. Adolescents' physical activity: competition between perceived neighbourhood sport facilities and home media resources. Int J Pediatr Obes. 2010;5(2):169–76.

Reason for exclusion: Cross-sectional survey without free-text

Wu LM. Ying xiang wo guo qing shao nian ti shi neng shui pin de she hui yin su tan tao [Sociological factors to the physical fitness of adolescents in China]. Ti yu yan jiu yu jiao yu [Sports Research and Education]. 2015;30(3):50–5.

Reason for exclusion: Cross-sectional survey without free-text

Xiang P. Achievement goals and self-perceptions of ability in physical education: a cross-cultural perspective [PhD thesis]. Louisiana: Louisiana State University. 1996.

Reason for exclusion: Cross-sectional survey without free-text

Xie H, Chen LN, Xu GQ. Nong cun xiao xue liu shou er tong ke wai huo dong xian zhuang diao cha ji dui ce yan jiu [Current situation of ex-curricular sports activities in rural primary school left-behind children investigation and countermeasure research - with a Shuangpai county as an example [Master's thesis]]. Guang zhou guang zhou ti yu da xue [Guangzhou: Guangzhou Sport University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Xu F, Li J, Liang Y, Wang Z, Hong X, Ware RS, et al. Associations of residential density with adolescents' physical activity in a rapidly urbanizing area of mainland China. J Urban Health. 2009;87(1):1–10.

Reason for exclusion: Cross-sectional survey without free-text

Xu F, Wang XR, Xiang DD, Wang ZY, Ye Q, Robert SW. Awareness of knowledge and practice regarding physical activity: a population-based prospective, observational study among students in Nanjing, China. PLos One. 2017;12(6):e0179518.

Reason for exclusion: Cross-sectional survey without free-text

Xu YQ. Guan yu wo guo zhong xue sheng sheng ti duan lian xian zhuang diao cha fen xi 关 [Investigation and analysis of physical exercise status of middle school students in China]. Kuai le yue du. 2015;0(2):29.

Reason for exclusion: Cross-sectional survey without free-text

Xu ZS, Wei GH. Zhong xue sheng xue xi xin qu diao cha fen xi – yi hua dongshi da erf u zhong wei li [Investigation and analysis on students' learning interest in physical education - take affiliated junior middle school of second affiliated middle school of East China Normal University as an example]. Ti yu ke ji wen xian tong bao [Bulletin of Sport Science & Technology]. 2017;25(4):83–5.

Reason for exclusion: Cross-sectional survey without free-text

Xue SE, Xiong Y. Si yang di qu liu shou er tong ti yu can yu xing wei diao cha yan jiu [Siyang left-behind children's sports participation survey [Master's thesis]]. Su zhou su zhou da xue [Suzhou: Soochow University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Xue YX, Tang ZY. Zhong dong bu di qu cheng shi gao zhong sheng ti yu huo dong xian zhaung de bi jiao yan jiu – yi he nan sheng xi xia xian he pu tuo qu wei an li [Survey and comparative study of senior high school students' physical activities between central region and the eastern region city of China - Xixia county of Henan province and the Shanghai Putuo district as a case [Master's thesis]]. Shang hai hua dong shi fan da xue [Shanghai: East China Normal University]. 2009.

Reason for exclusion: Cross-sectional survey without free-text

Yan JH, McCullagh P. Cultural influence on Youth's motivation of participation in physical activity. J Sport Behav. 2004;27(4):378–90.

Reason for exclusion: Cross-sectional survey without free-text

Yang J, Luo, J. She hui zhi chi ji can yu dong ji dui qing shao nian huo dong can yu de ying xiang yan jiu [Social support and participation motivation influenced the sport participation of the youth [Master's thesis]]. Ching qing xi nan shi fan da xue [Chongqing: Southwest Normal University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Yang TL, Liu HY, Chen J. Dui wo guo zhong xue key u xun lian xian zhuang diao cha yu fen xi [Investigation and analysis of after-class physical training situations in middle schools in China]. Shou du ti yu xue yuan xue bao [Capital University of Physical Education and Sports]. 2004;16(2):20–3.

Reason for exclusion: Cross-sectional survey without free-text

Yang Y, Chen PJ, Wu YQ, Shao ZY, Peng NN, Zou DH. Shang hai shi xue sheng shen ti su zhi xian zhaung ji qi ying xiang yin su fen xi [Current situation of students' physical fitness in Shanghai and analysis of its influencing factors]. Zhong guo xue xiao wei sheng [Chinese Journal of School Health]. 2012;33(8):1007–10.

Reason for exclusion: Cross-sectional survey without free-text

Yao DL. Wo guo xue sheng ti zhi jian kang zhuang kuang xia jiang de she hui xue yan jiu [The sociology research on the state of decline of physical fitness of students]. Ha er bin ti yu xue yuan xue bao [Journal of Harbin Institute of Physical Education]. 2009;27(1):68–71.

Reason for exclusion: Not a primary study

Yeung DC, Yuan X, Hui SS, Feresu SA. Determinants of moderate to vigorous physical activity and obesity in children: a structural equation modeling analysis. World J Pediatr. 2016;12(2):170–6.

Reason for exclusion: Cross-sectional survey without free-text

Yu SY, Hao ZS, Li XT, Meng PJ. Wo guo nong cun qing shao nian ti zhi zhuang kuang ji qi ying xiang yin su [Review on rural adolescents' physique of China and the influencing factors]. Jia zhi gong cheng [Value Engineering]. 2013;32(27):9–11.

Reason for exclusion: Cross-sectional survey without free-text

Yun FQ, Dong DL, Zhang XG. Qing shao nian ti li huo dong te zheng yu cu jin ce lue yan jiu [A study on physical activity characteristics and promoting strategies of adolescents - take Liaocheng as an example [Master's thesis]]. Yan tai lu dong da xue [Yantai: Ludong University]. 2018.

Reason for exclusion: Cross-sectional survey without free-text

Zhang CC. Qing dao shi nan qu bu fen xue xiao zhong xue sheng jia tin ti yu huo dong xian zhuang de diao cha yu yan jiu [The investigation and research in Qingdao city middle school students of the family sports activities in some schools [Master's thesis]]. Shang hai hua dong shi fan da xue [Shanghai: East China Normal University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Zhang CS. Wo guo qing shao nian ti zhi jian kang ying xiang yin su yu ying dui

ce lue yan jiu [Study on influencing factors and coping strategies of adolescents' physical health in China]. Ti yu shi you. 2016;39(6):53–5.

Reason for exclusion: Not a primary study

Zhang DC, Li M. Ying xiang wo guo zhong xiao xue sheng ti zhi jian kang fa zhan de zhu yao yin su yu dui ce yan jiu [On main influencing factors and countermeasures of development of primary and middle school students' physical health in China]. Bei jing ti yu da xue xue bao [Journal of Beijing Sport University]. 2009;32(11):76----80+83.

Reason for exclusion: Cross-sectional survey without free-text

Zhang F, Wu YH. Xi an shi cheng xiang 6-7 sui er tong ge xing dui ti yu xue xi xin qu tai du ying xiang yan jiu [A study on the influence of personality on sports learning interest and attitude of children aged 6-7 in urban and rural areas of Xi'an [Master's thesis]]. Kun ming yun nan shi fan da xue [Kunming: Yunnan Normal University]. 2013.

Reason for exclusion: Cross-sectional survey without free-text

Zhang F, Xu YY. Cong qing shao nian ti zhi jian kang xian zhuang shi jiao dui zhong xue sheng ti yu jiao xue de diao cha yan jiu [Investigation and research on middle school physical education from the perspective of adolescents' physical health [Master's thesis]]. Yang zhou yang zhou da xue [Yangzhou: Yangzhou University]. 2011.

Reason for exclusion: Cross-sectional survey without free-text

Zhang HH, Liao FX. Qian xi ying xiang wo guo nong cun xiao xue ti yu jiao yu jiao xue gai ge de yuan yin ji dui ce [On the reasons and countermeasures of influencing the reform of physical education in rural primary schools in China]. Zhong guo jiao yu xue kan [Journal of the Chinese Society of Education]. 1989;10(6):52-54.

Reason for exclusion: Not a primary study

Zhang N, Wang HZ. Bei jing cheng qu xiao xue xue sheng jia tin ti yu xian zhuang ji ying xiang yin su [Analysis on present situation and influencing factors of family sports of primary school students in Beijing urban area [Master's thesis]]. Bei jing bei jing ti yu da xue [Beijing: Beijing Sport University]. 2005.

Reason for exclusion: Cross-sectional survey without free-text

Zhang T. Zhong guo qing hsao nian ke wai ti yu duan lian xian Zhuang ji ying xiang yinsu fen xi [Current situation and influencing factors of Chinese youth extracurricular physical exercise]. Shang [Business]. 2016;0(11):102.

Reason for exclusion: Not a primary study

Zhang X, Song Y, Yang TB, Zhang B, Dong B, Ma J. 2010 nian zhong guo zhong xiao xue sheng mei tian ti yu duan lian 1 xiao shi xian zhuang ji ying xiang yin su 2010 [Analysis of current situation of physical activity and influencing factors in Chinese primary and middle school students in 2010]. Zhong hua yu fang yi xue za zhi [Zhonghua Yu Fang Yi Xue Za Zhi]. 2012;46(9):781–8.

Reason for exclusion: Cross-sectional survey without free-text

Zhang Y. Wo guo ming ban zhong xue xue sheng can jia ke wai ti yu huo dong xian zhuang de yan jiu. [Research on the current situation of participation in physical activities after class of managed by the people middle school student of our country]. Shang qiu shi fan xue yuan xue bao [Journal of Shangqiu Teachers College]. 2010;26(9):130----133+136.

Reason for exclusion: Cross-sectional survey without free-text

Zhang Y, Piao W, Ji Y. Social determinants of health behaviours in primary school children: a cross-sectional study of both migrant and resident children in Beijing, China. Journal of Huazhong University of Science and Technology (Medical Sciences). 2016;36(2):289–94.

Reason for exclusion: Cross-sectional survey without free-text

Zhang Y, Wang HT. Jia tin gan yu dui xiao xue sheng ti li huo dong de ying xiang yan jiu – yi qian an shi mu chang kou wu nian ji xue sheng wei li [Effects of family intervention on physical activity of primary school students – a case study of the grade five students in Muchangkou primary school of Qian'an [Master's thesis]]. Shi jia zhuang hei bei shi fan da xue [Shijiazhuang: Hebei Normal University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Zhang ZL, Tang Y, Chen PJ, Liu Y, Cao ZB, Hu YY, et al. Quan qiu shi yu xia wo guo cheng shi er tong qing shao nian sheng ti huo dong yan jiu – yi shang

hai shi wei li [The report card of Chinese city children and youth physical activity based on AHKGA – take Shanghai as example]. Ti yu ke xue [China Sport Science]. 2017;37(1):14–27.

Reason for exclusion: Cross-sectional survey without free-text

Zhang ZL, Tang, Y, Hu YY. Wo guo er tong qing shao nian ti yu huan jin te zheng yu cun zai wen ti yan jiu [Analysis on characters of children & youth's sport environment as well as existing problems in China]. Ti yu ke xue [China Sport Science]. 2017;37(3):21----34+97.

Reason for exclusion: Not a primary study

Zhao JL, Feng HL. Yin chuan shi zhong xiao xue sheng ti zhi xia jiang yuan yin de diao cha fen xi [Analysis of the causes of physical fitness decline of primary and secondary school students in Yinchuan city]. Ning xia da xue xue bao zi ran ke xue ban [Journal of Ningxia University (Natural Science Edition)]. 2010;31(1):98–100.

Reason for exclusion: Cross-sectional survey without free-text

Zhao N, Huang J, Wang QH. Nong cun liu shou er tong ti yu can yu yu xian zhuang diao cha ji dui ce yan jiu [Research and countermeasures on sports conditions of rural stay-at-home children-taking Dong Changfu district of Liaocheng as an example [Master's thesis]]. Yan tai lu dong da xue [Yantai: Ludong University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Zhao YY, Zhang YL. Re dai di qu xiao xue sheng ti yu duan lian qin xu xiao ying de diao cha yan jiu [Research on Emotional effects of physical exercise about pupils in tropical areas]. Hai nan shi fan da xue [Journal of Hainan Normal University (Natural Science)]. 2015;28(3):338–42.

Reason for exclusion: Cross-sectional survey without free-text

Zhong QH, Li XR, Luo XD. Xi bei pin kun min zu ju ju qu xue xiao ke wai ti yu huo dong xian zhuang de diao chao fen xi [Investigation on students' of after-class sports activities in poverty ethnic minority groups in Northwest China]. Xi bei shi fan da xue xue bao zi ran ke xue ban [Journal of Northwest Normal University (Natural Science)]. 2008;44(5):110–3.

Reason for exclusion: Cross-sectional survey without free-text

Zhong YY, Zhu CY. Xiao xue yi nian ji jia tin ti yu xing wei de diao cha yu fen xi [Investigation and analysis of family sports behaviour of primary school students [Master's thesis]]. Fu jian fu jian da xue [Fujian: Fujian Normal University]. 2017.

Reason for exclusion: Cross-sectional survey without free-text

Zhou BQ. Xiao xue ti yu ke cheng kai fa li yong de ying xiang yin su yan jiu [Research on the influencing factors of the exploration and utilisation of PE curriculum resources in primary schools]. Xue sheng zhi you xiao xue ban. 2012;32(19):59.

Reason for exclusion: Cross-sectional survey without free-text

Zhou CY, Zhang ZY. Pin yin xian chu zhong da yuan jiao xue shi jian zhongcu jin xue sheng ti yu xue xi de yan jiu [Research on promoting students' physical education learning in junior middle school's teaching practice in Pingyin county [Master's thesis]]. Ji nan shan dong shi fan da xue [Jinan: Shandong Normal University]. 2013.

Reason for exclusion: Cross-sectional survey without free-text

Zhou HW, Fu GQ. Wo guo qing shao nian hu wai jiao yu kai zhuan xian zhuang diao cha ji fen xi [Investigation and analysis on the current situation of outdoor education for teenagers in China]. Qing shao nian ti yu. 2013;2(4):24–6.

Reason for exclusion: Cross-sectional survey without free-text

Zhou LJ. Guan yu ying xiang zhong mei qing shao nian can jia ti yu huo dong yin su de bi jiao yan jiu [Comparative study on factors affecting on physical activities of adolescents in China and USA]. Zhe jiang ti yu ke xue [Zhejiang Sports Science]. 2000;22(3):14–7.

Reason for exclusion: Cross-sectional survey without free-text

Zhou LJ, Larry DH. Zhong mei qing shao nian can jia ti yu huo dong ying xiang yin su de bi jiao yan jiu [A comparative study on factors impacting on adolescents' physical activity participation with different genders and grades in some selected areas in China and USA]. Bei jing ti yu da xue xue bao [Journal of Beijing Sport University]. 2008;31(9):1247–9.

Reason for exclusion: Cross-sectional survey without free-text

Zhou LJ, Yu KH, Larry DHYing xiang zhong mei liang guo qing shao nian can jia ti yu huo dong yin su de bi jiao yan jiu [Comparative study on the factors impacting on children Student's physical activity participation in China and USA]. Zhong guo ti yu ke ji [China Sport Science and Technology]. 2007;43(4):27–31.

Reason for exclusion: Cross-sectional survey without free-text

Zhou, R, Zhou DS. Bei jing shi cheng qu zhong xiao xue sheng jia tin huan jing dui xue xiao xiao wai ti yu huo dong can yu ying xiang de yan jiu [Study on the effect of the family environment on the participation in physical activity for students in primary and secondary schools in the urban area in Beijing [Master's thesis]]. Bei jing shou du ti yu xue yuan [Beijing: Capital University of Physical Education and Sports]. 2012.

Reason for exclusion: Cross-sectional survey without free-text

Zhou RN, Fu H. Shang hai shi qing shao nian he zhong qing nian shen ti huo dong de ying xiang yin su yan jiu [Influencing factors of physical activity among adolescent and middle-age adults in Shanghai [Master's thesis]]. Shang hai fu dan da xue [Shanghai: Fudan University]. 2013.

Reason for exclusion: Cross-sectional survey without free-text

Zhuo W, Jin Y. Jiang su sheng xin yi shi gao Zhong xue sheng ti yu tai du de xian zhuang diao cha ji dui ce yan jiu [Investigation on the present situation of sports attitude of senior high school students in Xinyi city of Jiangsu province [Master's thesis]]. Yang zhou yang zhou da xue [Yangzhou: Yangzhou

University]. 2012.

Reason for exclusion: Cross-sectional survey without free-text

Zhou Y, Li DG. Xi an shi zhong zhi xue sheng can jia ke wai ti yu duan lian tai du xing wei xian zhuang diao cha yan jiu [Investigation and research on attitudes and behaviours of secondary vocational school students participating in extracurricular physical exercise in Xi'an [Master's thesis]]. Xi an xi an shi fan da xue [Xi'an: Shanxi Normal University]. 2009.

Reason for exclusion: Cross-sectional survey without free-text

Zhu XY, Pan S. Su zhou chu zhong ban zhu ren lao shi de ti yu yi shi dui xue sheng ti yu xing wei ying xiang de yan jiu [A study about influence of junior middle school teachers'-in-charge PE awareness on their students' PE behaviour in Suzhou city [Master's thesis]]. Su zhou su zhou da xue [Suzhou: Soochow University]. 2013.

Reason for exclusion: Cross-sectional survey without free-text

Appendix 3: Characteristics of included studies

Reference and country	Inclusion and exclusion criteria	Design	Phenomena of interest	Context	Participant characteristics	Sample size	Recruitment method	Data collection procedure and tool	Data analysis technique	Authors' conclusion
Diep et al.[31] (2017) Houston, US	Children aged 9–13 years who self-identified as Chinese or Taiwanese (either in part or full); children and their parents provided written informed assent and consent, respectively. Children were excluded if they did not speak, read, and write in English, or were unwilling or unable to complete an interview.	Qualitative study	Chinese-American children's physical activity and its influences	Community	Children (9–13 years) Boys (52.0%), Chinese/Taiwanese alone (88.0%), from households with at least one parent completing post-graduate study (60.0%), and from households with an annual income above $70,000 (56.0%). Based on acculturation factors, a majority were born in the US (60.0%) and self-identified as bicultural (52.0%).	25	Participants were recruited through Houston-area Chinese language schools, a community centre frequented by people of Chinese descent, and the Children's Nutrition Research Center's volunteer database. At the cultural and community settings, information packets were passed out by study staff to interested parents and/or children to review at home.	All interviews were conducted in English by the first author, trained in qualitative data collection methods, in person or over the phone. Before each interview, the interviewer introduced herself, explained the purpose of the interview, informed the participant that interviews would be audio-recorded, and obtained verbal consent. The interviewer followed a semi-structured interview guide with open-ended, non-leading questions and probes, which were guided by constructs from the adapted model of dietary acculturation.	Thematic analysis	Major themes included: (1) team sports, particularly basketball, were commonly listed as favourite sports or activities; (2) physical activity occurred mostly at school or an after-school setting; and (3) family played a major role in physical activity. Some trends/differences were detected based on age, sex, and socioeconomic status. Interventions to promote physical activity among Chinese–American children should emphasise team sports and encourage physical activity in schools, but also explore ways to involves families outside of school.
He et al.[69] (2014) HK, China	A list of eligible residential buildings Children who were in 5th grade and 6th grade, living in a list of eligible residential buildings (i.e., high socio-economic status/high walkability, high socio-	Qualitative study	Identify the environmental facilitators and barriers of physical activity behaviours among Hong Kong Chinese children	School	Children from 5th and 6th grades (aged 10–11 years)	34	Participants were 34 children aged 10–11 years, recruited from three primary schools and living in four types of neighbourhoods varying in socio-economic status (SES) and	1. Introduction of Nominal Group Technique (NGT) purpose and process to the participants. 2. Asking NGT questions of the participants. 3. Individual silent generation of items in writing by participants. 4.	Nominal group technique	Specific physical activity–related environmental facilitators and barriers, which are unique in an ultra-dense city, were identified by Hong Kong children. These initial findings can inform future examinations of

	economic status/low walkability and low socio-economic status/high walkability) will be eligible.						“walkability,” the urban form attributes that might impact travel and activity patterns (Four forms including: high SES/high walkability (HSES/ HW), high SES/low walkability (HSES/LW), low SES/high walkability (LSES/HW), and low SES/low walkability (LSES/ LW)).	Listing of items on a flip chart in a round-robin fashion. 5. Discussion of items listed on the flip chart to clarify the meaning of each item. 6. A preliminary vote on the items to elect the five most important items, which are reserved for final vote. 7. Discussion of the result of preliminary vote. 8. Final vote to establish.		the physical activity–environment relationship among children in Hong Kong and similar Asian cities. A total of 16 neighbourhood environmental factors were identified as either facilitators or barriers to physical activity by Hong Kong children. Future research that examines the association between environmental factors identified in this study and children’s specific types of physical activity in Hong Kong and similar Asian cities is warranted.
Amy et al.[122] (2010) HK, China	Not mentioned	Qualitative study.	To understand the physical activity culture in the lives of Hong Kong Chinese children and their parents	School	Children (9–16 years) (male=24, female=24). 22 parents of the students	70	Participants were from four primary and six secondary schools in the regions of Hong Kong Island, Kowloon and the New Territories. The schools represented a diversity of socio-economic status. After obtaining the written consent of all school principals and parents, the children were purposefully selected by teachers from different socio-economic backgrounds,	(Children) In all cases, the interviews were arranged by the school teachers and were conducted individually at school. The research assistants followed a semi-structured interview schedule that enabled the further probing of responses and a flexible flow of the interview as appropriate. All the parents agreed to be interviewed through telephone at a time most convenient to them.	Using an open coding system	***Junior students (aged 9-12) expressed their interest in physical activities. However, older students (12 or above) in secondary school, think or are told that academic study is the most important aspect of their life and that physical activities are not a priority. When examining parents’ and children’s involvement in physical activity, the barriers to the parents’ involvement in their children’s physical activities included lack

							geographical locations, and attitudes and participation patterns in relation to their physical activity and PE domains. All the parents agreed to be interviewed through telephone at a time most convenient to them			of time and a habitual sedentary lifestyle at home.
Wang et al.[123] (2017) Beijing& Nanjing, China	Not mentioned	Qualitative study	To understand how children and parents in China make eating and physical activity (PA) decisions, considering individual, family, community, social, and environmental factors, and to collect parents' recommendations for interventions to promote healthy eating and physical activity.	School	Children (ages 10–15, n=41) and their parents (n=41)	82	We recruited participants (students and their parents, one parent per child) using a multilevel recruitment process to ensure an adequate and heterogeneous sample, i.e., in each site, we recruited the students from two schools, but from different classrooms, an elementary school and a middle school. At student/parent level recruitment, individual families were given a consent form with a cover letter that explained the importance of the study and expressed the teacher's approval and support for the project. Recruitment flyers were also	Children (n=41, aged 10-15 years) and their parents (n=41) participated in eight semi-structured focus groups (FGs) in Beijing (in North China) and Nanjing (South China). Each site conducted two FGs with children and two FGs with parents.	Framework analysis	In conclusion, the children selected from Beijing and Nanjing, two major cities in China, one in the North and one in the South, reported that they chose food often based on flavour. Their consumption of unhealthy snacks was prevalent. There are inconsistent standards for school lunch services, and school meal services varied across schools. There are mixed perceptions among students and parents toward school meals. Children had limited PA time due to an emphasis on academic performance. The parents made some recommendations for improving school food services and increasing PA for children during

							distributed to students in the classes.			and after school. These findings provide useful insights to help develop future family- and school-targeted health promotion interventions, including childhood obesity prevention. Intervention framing must consider the unique Chinese social and cultural context
Zhang J et al.[124](2007) Beijing, China	One class ranking high and one class ranking low (with respect to the average academic grades) was selected from two school respectively. All the students from each of the four classes were invited to participate in the study; all students who were asked agreed to participate in this study.	Qualitative study	Identify salient consequences, referents, and circumstances about physical activity as perceived by middle school students and to provide suggestions for interventions and quantitative research	School	Children (98%) were aged 13-15 years and about half were male and about half were female	155	Participants were students selected from four classes of two middle schools. In Beijing, middle school or junior high school consists of three grades: Grade 1, 2 and 3.	The self-completion instrument was administered during physical education class by two members of the research the team who were not associated with the school	Content analysis	The results of this qualitative study suggest that student perceptions of the relationship between their participation in physical activity and their school work might be more important factors underlying their decisions to participate in physical activity than their beliefs about the health benefits. Programmes to increase physical activity should address the social and environmental factors underlying these perceptions with the goal of strengthening student engagement in the physical activity and improving learning potentials. Quantitative studies with a larger and representative sample

										and with close-ended items based on the qualitative research are needed to more fully understand middle school students' decisions to engage in daily physical activity. In addition, given the role of the parents as a social referent and the students' perception of the connection between physical activity and academic performance, research is needed to understand the views of parents, teachers, and school administrators.
Zhang MM et al.[66] (2015) Shanxi, China	Not mentioned	Mixed method study	To understand the sports motivation of middle school students in Shanxi	School	Teachers and experts	Not specified	Not specified	Questionnaire, interviews	Not specified	Students are mostly passive in PE class, the reasons are schools don't value PE, parental attitude, Facilitator: build equal student/teacher relationship, adopt course structure.
Pang[126] (2014) HK, China	Not mentioned	Qualitative study	To examine the factors that contribute to Hong Kong Chinese young people's values and expectancy beliefs in physical activity.	School	Children (aged 10-12 years) Boys (n=6) Girls (n=6)	12	The participants were selected purposefully for this qualitative interview study from three government-funded schools that had participated in a larger mixed method study	The semi-structured interviews were conducted in Cantonese by two Chinese Hong Kong-born female researchers who were familiar with the study and primary school contexts. Each interview lasted for approximately 30 minutes to an hour and was conducted in a	Content analysis	The deeply rooted capitalistic economy and the philosophy of Confucianism that act hand in hand in shaping the physical activity values and expectancy beliefs of contemporary Hong Kong Chinese young people.

								classroom environment. Consents were sought from the principals, the young people, and their parents. All agreed and gave consent for the young people to participate in the interview.		
Pang et al.[127] (2008) HK, China	Not mentioned	Qualitative study	Examines the parental concerns in facilitating their children's physical activity participation in Hong Kong	Community	Parents (10 fathers and 12 mothers) of children (aged 10-16)	22	Participants were randomonly chosen from the children's family in a larger study. Informed letter was sent to the principal and delivered by the children to their parents	Parents were contacted by the phone to arrange a mutually convenient time for the interview. All interviews were conducted by the same interviewer through the phone.	An open coding system	Three themes emerged from the interview data and results in relation to Confucianism showed that parental long working hours, safety issues and overemphasis in children's academic pursuits were found to be their major concerns in facilitating children's further engagement in physical activities.
Pang et al.[38] (2016) Queensland, Australia	Not mentioned	Qualitative study	Examining how young Chinese Australians (dis)engaged in HPE and school sport	School	10 girls: (Year 8=5, Year 9=4, Year 10=1) 2 boys: (Year 9)	12	Participants were recruited through two schools (not specified)	Paper drew on the interviews and observations with the students from the full data set. Seven sets of interview were conducted with the young people in two years. All interviews were conducted by the first author, self-identified as a 'young Hong Kong Chinese female Australian'.	Thematic analysis	The results suggest that some aspects of the experiences of culturally diverse groups in HPE and school sport engagement at the practical, everyday level may be inconsistent with multicultural education policies. The discussion and a heuristic of difference model presented in this paper have application beyond promoting the engagement of, and teaching and research in, multicultural

										education in HPE in Australia. We envision a cultural 'contact zone' (Pratt 1992) where multicultural education means drawing on theoretical resources from the East/Chinese (e.g., 'Complementary difference'), the recognition of Chinese students' resources and 'ambivalence habitus', and moving beyond a Western view of exclusive opposites and Anglo-Celtic centred HPE.
Pang et al.[128] (2015) Brisbane, Australia	Not mentioned	Qualitative study	Understanding the young people's experiences in physical activity and health, both in schools and out-of-school contexts	School and community	Children (aged 10-15 years) Boys (n=2) Girls (n=10)	12	The schools were purposively selected on the basis of: their school population, geographical locations, gender structure, likelihood of gaining access and varied socio-economic status, as research showed that these social and cultural factors have an impact on young people's physical activity opportunities and practices	Six sets of interviews were aimed at understanding the young people's experiences in physical activity and health, both in schools and out-of-schools contexts. The interviews were carried out by the first author, a Chinese Hong Kong-born female. The first interviews were conducted individually or in pairs according to the participants' preferences. This arrangement was to initiate the rapport with the students. Each interview lasted for approximately 30 minutes to an hour, and was conducted in either	Inductive content analysis	Dominant discourses in the 'talk' of these young people included their notions of excelling, hyper investment in academic success and, especially for the girls, skin colour and safety. Traditional Chinese family power relations limited the choices these young people had regarding physical activity which was complicated by the cultural and social fluidity of their lived experiences. The inter-generational flow of habitus and capital of these Chinese migrant young people's families tended to privilege a

								a classroom, a quiet environment within the school, or in a coffee shop.		particular set of discourses based on gender, race, social class and hierarchical practices that resonated with traditional Confucian philosophy. Success in promoting and supporting more physically active and healthy lives for Chinese young people in Australia will depend on taking into account several factors. These include traditional Chinese gender structures, the inculcation of preordained trajectories for children's futures, the hyper-investment in economic capital for social mobility, the lack of investment in emotional capital between parents and children and the engagement with a strengths-based approach within the dominant discourses of physical activity and health promotion.
Trigwell et al.[34] (2015) North-West of England, UK	Parents of children aged 4 to 16 years who self-identified their ethnic background as Asian Bangladeshi, Black African, Black Somali, Chinese, White British	Qualitative study	Explore parental views of children's physical activity in a multi-ethnic sample living in a large city	School and community	Parents (5 Asian Bangladeshi, 4 Black African, 7 Black Somali, 6 Chinese, 8 White British, 6 Yemeni).	36	Purposive sampling techniques were employed to select parents who participated in the previous study based on their proximity to	All focus groups were held in local primary schools and community centers after school hours or at weekends based on the preferences of	Inductive analysis	many similarities in parental views across ethnic groups, including a lack of awareness of PA recommendations, challenges of supporting children's PA and a

	and Yemeni were eligible to take part		in the North-West of England				the location of the focus group venue. Letters were sent to parents who had consented to further contact from the research team and were followed up with telephone calls. Where participant numbers were low for particular ethnicities (Asian Bangladeshi, Black Somali, Chinese and Yemeni groups), parents were also recruited through schools and community centres by teaching staff and community workers	participants. Free crèche facilities were provided. Focus groups were conducted using semi-structured topic guides.		perception that children receive sufficient PA whilst at school. parental views might act as barriers to children's PA levels, most notably in those cultures with a strong emphasis on educational attainment (Chinese, Yemeni, Asian Bangladeshi) or with a Muslim faith (Asian Bangladeshi, Black Somali, Yemeni). It is recommended children's PA interventions address influential factors at all levels of the socio-ecological model, and reflect the cultural and religious needs of different ethnic minority groups.

HPE, health and physical education; PA, physical activity; PE, physical education; SES, socio-economic status.

Appendix 4: List of study findings with illustrations

Study	Finding	Illustration
Physical Activity Behaviours and Influences among Chinese-American Children aged 9–13 years: a qualitative study. J Immigr Minor Health. 2017;19(2):358-66.	Team sports, particularly basketball, are commonly listed as favorite sports or activities (C)	"Of the team sports, the most commonly mentioned were basketball and soccer. Other examples were baseball, dodgeball, football, volleyball, badminton, kickball, tennis, hockey, ping pong, and ga–ga (a variation of dodgeball), which were mostly played during physical education (PE), at summer camp, or on an extracurricular team" (p.361)
	Physical activity occurred mostly at school or an after-school setting (U)	"I sometimes play chase with my brother around the house," practicing hockey in the yard, or "we do work outside in the garden." "I'm usually at school during PE or during recess running around" (p.362)
	Family played a major role in physical activity (U)	"My mom and dad … because they're the ones that tell me: okay, you can go to the park or you can go outside and play, so they'd be the ones that control what I do after school" (p.362)
Parental views of children's physical activity: a qualitative study with parents from multi-ethnic backgrounds living in England. BMC Public Health. 2015;15(1):1005-15.	Skill acquisition (U)	"We just hope our children can fully develop their skills, I will let him try everything" (p.1009)
	Parents perceived intrapersonal influences on participation in PA to relate to children's health and overweight status (U)	"For example if a child is already fat, that means he will have less interest in sport" (p.1009)
	Cultural requirement to be active (U)	"Because our nation requires us to pursue all kinds of development including moral, intellectual and physical aspects" (p.1010)
	Educational commitments (U)	"You will understand how to balance and you will make your children have sport, for activities, and have time for study too" (p.1010)
'Do I have a choice?' The influences of family values and investments on Chinese migrant young people's lifestyles and physical activity participation in Australia. Sport Educ Soc. 2015;20(8):1048-64.	Chinese familial investment strategies (C)	"Academics is important because if I don't do well at school, I would let down my Mum and Dad, coz I mean what would it feel like if you were the parent of your child, others will say, oh my god, that person is so dumb, that child is so stupid, you know what I mean? I don't wanna feel that way or have my parents looked down upon by others like that" (p.1053)
Illustration	Parents legitimized a 'Whiter' body (U)	"…all I got was getting tanner and tanner and tanner in my sport and my Dad starts complaining, like oh my gosh, you look like you're getting darker, no no no! They prefer me to be Whiter… they don't really want me to get tanner coz they think it's like the marine people. They just don't want me to be dark, not like a chocolate" (p.1055)
Finding	Surveillance for safety (U)	"I would spend most of the time in my house. I sit in front of the computer, haha. I just do my homework, go on to the Internet, I sometimes go and watch TV. Sometimes when I go outside, I ride my bike but my parents don't want me to ride outside, coz there's more cars in the place where I lived before, the place I lived before was like a circuit" (p.1056)

Illustration	Parents disapproved the child's behaviour once they wanted to become serious with sport (U)	"My parents don't really like me doing fencing…My parents are like whenever I ask to join a new sport, they're like What's the point of that? Are you going to get world champion? Are you going to get number 1 like gold medal in sailing? If not, I don't think you should do it, coz it's not going to get you any money and it's not going to get you an OP1 (highest school leavers academic score)" (p.1056)
Finding	Familial power relations and inter-generational differences (U)	"Pretty stilted, I mean they don't know what to do with me, my problems, like the Asian thing. Basically, to be Asian daughter, it's like I need to get A+ and everything, though they say they don't mind me getting a B in English…Chinese kids wouldn't ask to go out, they'd be too busy studying. I'm meant to like learning, I'm supposed to take what they say without questions, you know, and to look after my sister, just basically be a model daughter…I'm different from this model, I think I'm reasonably ok, because I don't go out and party and drink and stuff like that, a lot of other people do. I'm ok. I mean I'm not ashamed of myself" (p.1059)
Parental Concerns in Facilitating Children's Physical Activity Participation in Hong Kong. Journal of Physical Education & Recreation (Hong Kong). 2008;14(1):39-46.	Parental work commitment (U)	"Both of us need to work six days a week, well… we're not rich and we must work for the money for the family. Sometimes we would go out with the kids on Sundays and we usually go shopping or dining out" (p.41)
	Safety issue (U)	"Some dangerous activities, like skating, it's not too safe for my girl to play. Children usually can't decide what is dangerous for them. They just play for fun but neglect the importance of safety. For example, I won't let him go climbing hills or rock…it's too dangerous. I've seen quite a lot of accidents happened in people climbing, it's definitely not suitable for children, especially girls), it's just not right for her to play such rough sport and Hong Kong don't have much safe climbing places for younger ones and there is a lack of qualified teachers" (p.42)
	High expectation of children's academic success (U)	"My son is now in the soccer team and he practices for many days a week …he comes back home at 7 pm and I think soccer is distracting him from studying well… I'm so afraid that he'll get hurt and I'm thinking not let him play anymore. I usually let him do whatever he wants in sports but if the exam is near, I'd advise him to play less basketball, I think it's better for him to spend more time studying than on playing" (p.42)
Understanding young Chinese Australian's (dis)engagement in Health and Physical Education and school sport. Phys Educ Sport Pedagogy. 2016;21(4):441-58.	Experience as recognition in HPE and school sport-normal (U)	"I have been known in my class to be one of the best long-jumpers . . . I'm really proud of my quick thinking, coz of debating, you do a lot of debating on the spot . . . people say I'm a good public speaker in debating and sometimes in HPE, so I'm really proud of that one" (p.447)
	Experience as recognition in HPE and school sport-complementary (U)	"I like being a perfect but I wouldn't want to be house captain, because if you want to be a house captain, you have to be really active, you always have to cheer up and do this and do that, and I'm not that kind of sporty person, so I signed up for the prefect (role) instead" (p.448)
	Experience as misrecognition/less recognition in HPE and school sport-problematic (U)	"Well, when I was skinny, I just look(ed) so fragile that I'll be pushed over by wind, and now when I'm not that skinny, people just assume that I don't do much exercise anyways . . . they just don't pick me first" (p.449)

	Experience as misrecognition/less recognition in HPE and school sport-adaptive (U)	"I don't really study, because I hate studying, it's boring, I like to have fun . . . I'm having fun and feeling good. I like sports but I'm not good at it because I'm not as fast as everyone else, and I can't swim that well either. I'd like to join an AFL club but I haven't found a club yet that I like. AFL is fun" (p.451)
	Physical activity inequity (U)	"Yeah, well I guess in PE, the captain chooses the boys first, like you know, they are the stronger players, and he kind of chooses the girls last . . . Some of the girls are strong as well, but coz the boys always want those who's able to kick and able to goal. Well, in HPE class, not many girls participate in it, coz like we're girls, we don't want to do it, and the teachers is like, you can walk around the field and do nothing" (p.449)
	Overt forms of racism (U)	"Like back in primary school, you don't notice that much, since your English is not good enough, you won't know what they're saying, but when your English gets better, sometimes, you hear stuff, sometimes in playing sport, they'll say you're Asian and you can't play sport, they like to start things like that" (p.450)
	Exclusion experiences (U)	"I just think they [European] think they are better, my other friends, they used to be in the A team, but then they are too inside, they don't express much things in schools, they don't talk to other people, they're just not used to it, that's why they don't pass the ball to them" (p.450)
Child and parental perspectives on diet and physical activity decisions: implications for childhood obesity prevention in China. Asia Pac J Clin Nutr. 2017;26(5):888-98.	I exercise only during the physical education (PE) class, and I exercise primarily to pass the high school entrance examination, commonly known as "Zhongkao" (U)	"We have a morning recess. Usually we start with group rhythmic gymnastics and then jump roping. We have PE class, and each class content is arranged by teachers for us to run or do items for Zhongkao. We are not given free play time during PE class. I like playing badminton, but my PE teacher said I can only play badminton after I am capable of receiving full credits for all Zhongkao-tested items" (p.894)
	Students were busy with too much homework during weekends (U)	"I do not have time for leisure time exercise at all from Monday to Friday. I came home late from school in the evening, and when I finish my homework, it's time to sleep. I just don't have time to exercise at all" (p.894)
	"Academic-focused" school environment seemed to be a major barrier for PA participation (U)	"I personally think the childhood obesity nowadays is due to the fact that kids eat too much and move too little. The environment now is so different from the environment of my childhood. My kid is sitting there all day studying and no time for exercise. It seems that he does not like exercise at all, and when he has spare time, he watches TV" (p.894)
Physical activity in the lives of Hong Kong Chinese children. Sport Educ Soc. 2010;15(3):331-46.	Confucian beliefs in taking 'good care' of children (U)	"I know doing more physical activity is good for my child, but I'd rather have her study first and only allow her to play for a while if she could finish her school work. You know, too much play will negatively affect her academic performance" (p.338)
	Confucian father played a leading role in determining the different dimensions in his children's life (C)	"Interestingly, within the group we interviewed, only fathers provided actual facilitation of their children's physical activity. One of them acted as an assistant coach regularly in his boy's rugby team, while a few attended their children's sports competitions, such as badminton and swimming during their leisure time, and two parents assisted with transporting children to playgrounds" (p.338)
	Families are an important factor in their physical activity participation (C)	"Doing physical activity is fun and when I see other people playing, I want to be one of them . . . My parents also encouraged me. They would spend time jogging with me and I still remember we had so much fun" (p.390)

	As they grew up, time spent on a particular physical activity increased (U)	"I play table tennis more now and therefore have less time for other activities. I'd rather focus my time on improving in it than spending time doing various sports which seem to be wasting my time" (p.339)
	Physical activity to be another responsibility in their lives (U)	"There was a time a basketball club invited me to join them, and I know this was a chance for me to play in a professional level. However, my mother opposed my decision, and I did not dare to argue with her. Well, actually I don't really feel too regretful as I treated it as an interest. It only matters if I could play basketball happily or not. After practising for a long time, I saw there was not much improvement, and I felt that I had reached the top already. Therefore, I gave up the interest in swimming" (p.340)
	An instrumental orientation to physical activity engagement (U)	"Students in Hong Kong, as far as I know, are not doing much sports and exercise. I'm sure exercise can help my son to be fit and maintain a good shape and weight" (p.341)
	Overly skill-oriented nature of their classes (U)	"It's not very nice because we always learn traditional sports, such as track and field, soccer, basketball, volleyball, and gymnastics. It is no fun at all. Teachers are actually repeating the same content we have already learnt in senior primary schools. I dislike running long distances; it is so boring" (p.343)
	Complained about the teacher and the curriculum (C)	"Having academic subject lessons at the expense of PE lessons, especially when it comes to the senior secondary level" (p.343)
	Other negative feelings (U)	"Too many students in a class (40-45 students sharing one basketball court)" (p.343)
	The importance of PE was linked closely to their children's academic advancement (U)	"PE is important because it makes my son healthier . . . good health may help him study better" (p.342)
Promoting physical activity in Hong Kong Chinese young people: Factors influencing their subjective task values and expectancy beliefs in physical activity. Eur Phy Educ Rev. 2014;20(3):385-97.	Feeling happy and competent and enjoying the sport and movement (U)	"I feel satisfied when I can shoot a basketball into the ring . . . and usually I am able to hit the shuttlecock with a swift sound and therefore I feel really happy and have fun playing with it . . . When I play badminton, I think the sound of hitting a badminton cock is really interesting, I feel very happy when I could hit the cock with that kind of special sound" (p.390)
	High attainment value and high utility in physical activity (U)	"I can boast in front of my teammates in basketball, which I think is important for me to do better in it" (p.390)
	Physical activity was not useful in relation to entering a better secondary school (U)	"Sometimes I think it [physical activity] is not really that useful at all as most schools do not think it is relevant to study" (p.392)
	Physical activity had a lower priority than academic studies (U)	"I would like to excel in my academic studies. I think studies may affect my future but not sport. I always place academic studies first" (p.391)
	Improving on their health (U)	"Physical activity is important because it is good for my health, I get less pain and disease after doing physical activities" (p.390)
	Having positive outcomes for academic and/or career future (U)	"Sport may be useful for my future job because I will find sport-related careers, like being an athlete. I want to be as good as those Olympic athletes, I think they are gorgeous" (p.391)

	Lack of perceived improvement in physical activity (U)	"I do not feel any differences or improvements and I think it is boring. I am always like that, not a bit better" (p.392)
	Lack of social support (U)	"I always do sport alone by myself and this is why sport is not interesting to me. I do not like it because there is no one to compete or compare with me. There is no one to encourage me and I do not feel happy when doing sport" (p.392)
	Insufficient time provision both in the school's physical education curriculum and after school hours (U)	"Well, it seems that during PE lessons, most of the time, about 15 to 20 minutes was allocated to doing stretching and warm up, and the time for us to really learn a sport is not enough" (p.392)
	Feeling too tired after doing physical activity (U)	"I need to put in too much effort in sport. I do not like the feeling of tiredness after doing sport" (p.391)
Understanding Neighbourhood Environment Related to Hong Kong Children's Physical Activity: A Qualitative Study Using Nominal Group Technique. PLoS One. 2014;9(9):e106578.	Safety (crime) (C)	"Afraid of being taken or hurt at night" (p.4)
	Safety (traffic) (C)	"Few cars on roads" (p.5)
	Functionality (C)	"Convenient transportation" (p.5)
	Destination (C)	"Recreation grounds" (p.5)
	Aesthetic (N)	"Fresh air" (p.5)
	Others (C)	"Too many people in recreation grounds" (p.5)
Psychosocial factors underlying physical activity. Int J Behav Nutr Phys Act. 2007;4(1):38-47.	Salient consequences of participating in physical activity (C)	"The most frequently mentioned disadvantage, "will take too much time," was mentioned by 40.6% of the students" (p.43)
	Salient referents (C)	"Clearly, most of the salient referents for this behaviour were family members, including parents, others, fathers, and grandparents." (p.43)
	Circumstances that make physical activity easy and circumstances that make it difficult (C)	"Many of the circumstances (e.g., assignments, time, and weather) were mentioned both as circumstances that make physical activity easy and as circumstances that make it difficult. The most frequently reported facilitator of physical activity, "having fewer assignments", was mentioned by 27.7% of the students. The most frequently mentioned barrier, "having too many assignments", was mentioned by about half (48.4%) of the students. Additionally, "time" was the second most frequently mentioned circumstance; 14.2% of the students mentioned having more time as a facilitator and 18.8% mentioned not having enough time as a barrier. These data also suggest that "having fun activities," "having others to participate with," approval from others" and "making facilities more available" operate as facilitating and hindering circumstances" (p.43)
Shan xi sheng chu zhong xue sheng ti yu xue xi dong ji ying xiang yin su ji pei yang ce lue yan jiu 山西省初中学生体育学习动机影响因素及培养策略研究 [Study on the factors of motivation and	Strengthen the teaching and management regulation (U)	"The PE teachers should respect and care about students rather than criticise students at will. Teachers should equip a positive attitude and be the role model so that the students will feel the equality between themselves and teachers. In addition, they may be attracted to the class. With the

influencing sports learning [Master's thesis]]. Lin fen shan xi shi fan da xue 临汾: 山西师范大学 [Linfen: Shanxi Normal University]. 2015.		establishment of a harmonious relationship between students and teachers, students will thus take the teachers as examples and change their behaviour" (p.25)
Illustration	Make tailored objectives for students (U)	"We should combine the collective goal with an individual goal. Each student's physical quality and individual ability are different. We should fully consider the individual difference of each student when setting the teaching goal. When setting the collective teaching goal, we should make the goal has a certain range of fluctuation, because the requirement is universal for each student. We should ensure that for students whose sports learning ability are not strong enough can improve their sports achievements through hard work and their interest in sports learning can be increased due to the establishment of motivation in sports learning. In the other way, this goal should also apply to those who have higher sports learning abilities" (p.24)

U, Unequivocal; C, Credible; HPE, health and physical education; PA, physical activity; PE, physical education.

Appendix 5: Information sheet (children and parents)

Study Title: A school-based behaviour change intervention to promote physical activity among children in China: intervention development and feasibility study

PARTICIPANT INFORMATION SHEET



We would like to invite you and your child to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. One of our team will go through the information sheet with you and answer any questions you have. Please take time to read this carefully and discuss it with others if you wish. Ask us anything that is not clear.



What is the purpose of the research?

Children are recommended to spend at least 60 minutes doing moderate to vigorous physical activity daily whilst physical inactivity is the risk factor to many chronic diseases such as

obesity and diabetes. The main aim is to establish whether or not a behaviour change intervention can increase physical activity level in Chinese children who are aged 10-12 years old. This will be tested in a future study. Before this, in this small study, we will check with our participants if the future study can be conducted.



Why have I been invited to take part?

You and your child are being invited to take part because your child's school has allowed us to contact you via the School. In addition, your child has been invited because he/she is aged 10-12 years old.

Do I have to take part?

No. It is up to you to decide whether or not to take part in this study.

If you decide to take part in, you will not need to anything and you will be automatically involved in. However, you would still be free to withdraw from the study at any time if you consent to take part in, without giving a reason and without any negative consequences, by advising the researchers of this decision. This would not affect your legal rights.

If you **do not** agree to participate, we will ask you to sign on the attached slip return it to your child's class teacher.



1. What will happen to me if I take part?

1) We will ask for some demographic information related to you and your child.
2) We will measure your child's height, weight, waist circumference and ask him/her to complete two questionnaire booklets (measuring physical activity, enjoyment and self-efficacy of physical activity and feeling of social support) on two occasions, 4 months apart.
3) We will ask your child to wear the provided pedometer for a consecutive 7-day to record his/her steps at baseline and post-intervention, 4 months apart.



4) We will deliver the behaviour change programme to your child and you will be invited to attend a physical activity workshop at school. <u>(Intervention group only)</u>
5) Some of you and your child may be invited to take part in a short individual interview with our researcher who will ask about your thought on the behaviour change programme and the participation in this research study when the programme ends.

2. What will be included in the physical activity programme?

1) We will organise four health education sessions (one month apart).

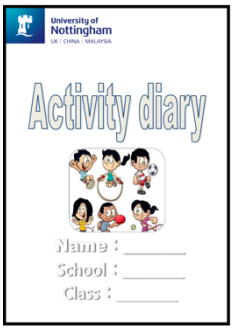
2) We will provide sports equipment with your children and encourage them to use during the class break.

3) We will provide you and your child with a physical activity booklet and a activity diary respectively to read.

4) We will ask your child to wear the pedometer during the study period (except bathing, sleeping) and record their daily step counts in the activity diary.







3. Are there any risks in taking part?

We are not aware of any risks of taking part in the study.

4. Are there any benefits in taking part?

There may be no direct benefits to anyone taking part in this study. The study is being undertaken to find out if the future study (ie, to establish whether or not the behaviour change programme can increase physical activity among school-aged Chinese children) can be conducted. If the feasibility of conducting the future study is promising, it will be conducted and the results may benefit

school-aged children by improving their physical and psychological health via physical activity participation. In addition, it may help parents establish healthy physical activity behaviour as well.

5. Will my time/travel costs be reimbursed?

Participants will not receive an inconvenience allowance to participate in the study as the lead researcher will be going to them. Travel expenses will be offered for any visits incurred as a result of participation.

6. What happens to the data provided?

All the collected data will be stored confidentially and anonymised in the encrypt electronic storage devices/laptop. We will not ask for you or your child's name, simply initials to allow us to match pre- and -post collected data. If this happens that a child or parent tells us that a child is at risk of harm, we would inform the school and ask them to follow their safeguarding plan. You and your child will not be identifiable in any report or publications. Results will be written up in research paper but no names will be used and all identifying information will be removed. All the information will only be accessed by the research team (i.e. research team, supervisor, collaborator/translator/ transcriber), however, we would like your permission to use anonymised data in future studies, and to share data with other researchers (e.g. in online databases) both inside and outside the European Union. All personal information that could identify you will

be removed or changed before the information is shared with other researchers or results are made public. All research data and records will be stored for a minimum of 7 years after publication or public release of the work of the research.

7. What will happen if I don't want to carry on with the study?

Even after you have signed the consent form, you are free to withdraw from the study at any time without giving any reason and without your legal rights being affected. In the event of your withdrawal, your data collected so far cannot be erased and will be used in the final analyses.

8. Who will know that I am taking part in this research?

All information collected about you during this research would be kept strictly confidential. All such data are kept on firewall and password-protected computers and any paper information (such as your opt-out form, contact details and any research questionnaires) would be stored safely in lockable cabinets in a swipe-card secured building and would only be accessed by the research team.

Under UK Data Protection laws the University is the Data Controller (legally responsible for the data security) and the Chief Investigator of this study (named above) is the Data Custodian (manages access to the data). This means we are responsible for looking after your information and using it

properly. Your rights to access, change or move your information are limited as we need to manage your information in specific ways to comply with certain laws and for the research to be reliable and accurate. To safeguard your rights we will use the minimum personally – identifiable information possible.

You can find out more about how we use your information and read our privacy notice at:

https://www.nottingham.ac.uk/utilities/privacy.aspx.

Designated individuals of the University of Nottingham may be given access to data for monitoring and/or audit of the study to ensure we are complying with guidelines.

9. What will happen to the results of the research?

The research will be written up as a thesis for the degree of PhD. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published open access. The thesis may also be used for scientific presentation and publication.

10. Who has reviewed this study?

All research in the University of Nottingham is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests.

This study has been reviewed and given a favourable opinion by the Faculty of Medicine & Health Sciences (FMHS) Research Ethics Committee.

11. Who is organising and funding the research?

This research is being organised by the University of Nottingham and is not being funded by any other party

12. What if something goes wrong?

If you have a concern about any aspect of this project, please speak to the researcher Haiquan Wang or the Principal Investigator Dr Kaushik Chattopadhyay, who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how he intends to deal with it. If you remain unhappy and wish to complain formally, you should then contact the FMHS Research Ethics Committee Administrator, Faculty Hub, Medicine and Health Sciences, E41, E Floor, Medical School, Queen's Medical Centre Campus, Nottingham University Hospitals, Nottingham, NG7 2UH or via E-mail: FMHS-ResearchEthics@nottingham.ac.uk

13. Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Lead Researcher:

Haiquan Wang

Division of Epidemiology and Public Health

School of Medicine

The University of Nottingham

Tel: 0115 8231376

Email: Haiquan.Wang@nottingham.ac.uk

Supervisors:

Dr. Holly Blake

Associate Professor of Behavioural Science, Faculty of Medicine & Health Sciences

School of Health Sciences

The University of Nottingham,

Email Address: Holly.Blake@nottingham.ac.uk

Supervisor:

Dr. Kaushik Chattopadhyay

Assistant Professor in Evidence Based Healthcare

Division of Epidemiology and Public Health

School of Medicine

The University of Nottingham

Email Address: kaushik.chattopadhyay@nottingham.ac.uk

Parent/Caregiver

(only needs signing if you do NOT want your child to take part)

If you are happy for your child to take part in this research, you do not need to complete this form.

If you DO NOT want your child to take part, please sign the form below and ask your child to return the form to the school teacher.

I DO NOT agree to me and my child being involved in this study

Your Name .....

Child's Name .....

Signed.....

Date.....

Appendix 6: Pedometer guide

University of Nottingham
UK | CHINA | MALAYSIA

Pedometer Usage Guide

Your pedometer.



The pedometer sent to you is a small black box that can be worn in your waist to record your step count. We ask you to wear this pedometer **Every day of the study period**.

Please do not remove the pedometer unless:





- You need to be exposed to water (such as swimming, bathing)
- You are going to have a sport that involves intense physical contact (such as taekwondo, etc.)



No matter you're sitting (such as doing homework, eating, reading) or walking around, the pedometer should be worn with you.

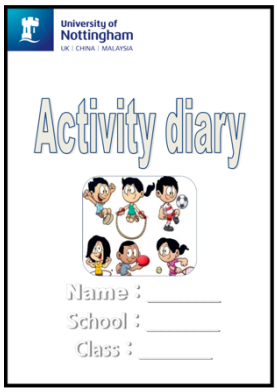
Please note that after you have removed the pedometer, remember to put it back on your waist. Please place it at where you can see to remind you, or you can put a note to remind yourself.



How to carry a pedometer

You can leave the pedometer in your waist (pants or clothes).

Sports Diary



Please record in your sports diary whether you have removed the pedometer during the day and why.

Because the pedometer may not be able to accurately record certain movements, such as cycling, roller skating. If you think you've done an exercise like this during the day and carried a pedometer in motion, please record the time and duration of your exercise in your sports diary.

Please take care of your pedometer.

Please take care of your pedometer, and if you accidentally drop it somewhere (such as at home), please find it and put it back on as soon as

possible. If your pedometer is damaged or missing, Contact your teacher or researcher Haiquan Wang.

Appendix 7: Questionnaire pack

Physical activity promotion questionnaire

Participant ID_____ Participant initials_____

Date of assessment (DD/MM/YYYY) ____/____/20____



Introduction

1. The questions are about your information regarding demographics, physical activity, self-efficacy, enjoyment and social support.

2. Please answer all questions as best you can and all your answers will be completely confidential.

Section 1: Demographics

1. About your child:

Age: _____ Gender: ☐ Male

☐ Female

2. About parents:

Highest educational qualification: ☐ None

☐ Primary school

☐ Secondary school

☐ Undergraduate degree

☐ Postgraduate degree/diploma

☐ Technical/vocational qualification

Employment status ☐ Employed

☐ Unemployed, studying, home duties

☐ Retired

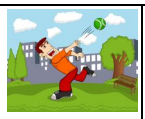
Section 2: Physical activity assessment

We are interested in understanding your physical activity level in a typical week. Please read each statement and circle an option Yes or No. If you have circled Yes, please then provide details of your time spent on that specific activity.

Which of the following physical activities do you usually do during a typical WEEK (from the start of the current school term, do NOT include school holidays)?

	DO you usually do this activity?	MONDAY-FRIDAY		SATURDAY-SUNDAY	
		How many times Monday -Friday	Total hours/minutes Monday -Friday	How many times Saturday & Sunday?	Total hours/minutes Saturday & Sunday
E.g. Bike riding	No (Yes)	2	40 mins	1	15 mins
1. Basketball 	No Yes				
2. Volleyball 	No Yes				

3. Soccer 	No Yes				
4. Badminton 	No Yes				
5. Table tennis	No Yes				
6. Handball 	No Yes				
7. Radio callisthenics 	No Yes				
8. Dance 	No Yes				
9. Aerobics 	No Yes				
10. Gymnastics (e.g. pull-up, sit-up, push-up) 	No Yes				
11. Martial arts (e.g. Taiji) 	No Yes				
12. Jogging or running 	No Yes				
13. High jump 	No Yes				
14. Long jump 	No Yes				

15. Distance casting 	No Yes				
16. Skipping rope 	No Yes				
17. Swimming 	No Yes				
18. Roller blading 	No Yes				
19. Kicking shuttlecock 	No Yes				
20. Group game 	No Yes				
21. Bicycling 	No Yes				
22. Travel to school by walking 	No Yes				
23. Household chores 	No Yes				
24. Climbing stairs 	No Yes				
25.Others（please state）	No Yes				

_____					

Section 3: Self-efficacy assessment



The following questions deal with your perspectives of self-efficacy to physical activity. Please read the following questions and tick the box （√） that matches well.

1=Strongly disagree, 5=Strongly agree

	1 Strongly disagree	2 Mildly disagree	3 Agree	4 Mildly agree	5 Strongly agree
1. I can be physically active on most days of the week.					
2. I can ask my parent or other adult to do physically active things with me.					
3. I can be physically active during my free time on most days even if I could watch TV or play (sedentary) video games instead.					
4. I can be physically active on most days even if it is very hot or cold outside.					
5. I can ask my best friend to be physically active with me on most days.					
6. I can be physically active even at home.					
7. I can do active things because I know how to do them.					

8. I can be physically active during my free time on most days no matter how busy my day is.					

Section 4: Enjoyment assessment

The following questions deal with your perspectives of enjoyment to physical activity. Please read the following questions and tick the box （√）that matches well.

1=Strongly disagree, 5=Strongly agree

When I am active	1 Strongly disagree	2 Mildly disagree	3 Agree	4 Mildly agree	5 Strongly agree
1. I feel bored.					
2. I dislike it.					
3. It's not fun at all.					
4. It makes me depressed.					
5. It frustrates me.					
6. It's not at all interesting.					
7. I feel as though I would rather be doing something else.					





Section 5: Social support assessment



The following questions deal with your perspectives of the family support to physical activity. Please rate how often your family members (parents, siblings, relatives, or anyone living in your household) or your friends (classmates, neighbours, or acquaintances) have said or done what is described during the last three months. Please write one number from the following rating scale in each space:

None	Rarely	A few times	Often	Very often
1	2	3	4	5

During the past three months, my family or friends:	Family	Friends
E.G. Did physical activity with me	3	4
1. Did physical activity with me.		
1. Offered to do physical activity with me.		
2. Gave me helpful reminders to engage in physical activity ("Are you going to exercise tonight?").		
3. Gave me encouragement to stick with my physical activity programme.		
4. Changed their schedule so we could do physical activity together.		
5. Discussed physical activity with me.		
7. Planned for exercise on recreational outings.		
8. Helped plan physical activity.		
9. Asked me for ideas on how they can engage in physical activity.		
10. Talked about how much they like physical activity.		

End of questions



Appendix 8: Ethics approval

University of Nottingham
UK | CHINA | MALAYSIA

Faculty of Medicine & Health Sciences
Research Ethics Committee
Faculty Hub
Room E41, E Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham, NG7 2UH
Email: FMHS-ResearchEthics@nottingham.ac.uk

03 June 2020

Haiquan Wang
PhD Student
c/o Dr Kaushik Chattopadhyay
Assistant Professor in Evidence Based Healthcare
Room B111 Division of Epidemiology & Public Health
Clinical Sciences Building
City Hospital Campus
Nottingham University Hospitals
Hucknall Road
Nottingham, NG5 1PB

Dear Mr Wang

Ethics Reference No: 255-1902 – please always quote	
Study Title: A school-based behaviour change intervention to increase physical activity among children in China: intervention development and feasibility study.	
Location of Study: Yangzhou, China	
Chief Investigator/Supervisor: Dr Holly Blake, Associate Professor, Behavioural Sciences, School of Health Sciences, Dr Kaushik Chattopadhyay, Assistant Professor in Evidence Based Healthcare, Epidemiology and Public Health, School of Medicine.	
Lead Investigators/student: Haiquan Wang, PhD Epidemiology and Public Health, School of Medicine.	
Proposed Start Date: 01/08/2019	**Proposed End Date:** 31/01/2021

Thank you for notifying the Committee of minor amendment no 1: 02.06.2020 as detailed and the following documents were received:

- Notice of minor amendment no 1: 02.06.2020 and supporting documents.

These have been reviewed and are satisfactory and the study minor amendment no 1:02.06.2020 is approved.

Approval is on the understanding that:

1. All appropriate ethical and regulatory permissions are respected and followed in accordance with all local laws of the country in which the study is being conducted and those required by the host organisation/s involved
2. The protocol agreed is followed and the Committee is informed of any changes using a notice of amendment form (please request a form).
3. The Chair is informed of any serious or unexpected event.
4. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely



Dr Bethan E Phillips, Associate Professor
Clinical, Metabolic & Molecular Physiology, Medical Sciences & Graduate Entry Medicine
Acting Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Appendix 9: Interview guides

Interview Guide (children)

Participant ID_____

Introductions

Talk through the participant information sheet for the interview, provide an opportunity for questions about the interview and reconfirm the children's consent to take part.

Experience of taking part in the feasibility study

(1) Recruitment

1. What attracted you to taking part in this particular research study?

2. What was your initial reaction to receiving the invitation to take part in the feasibility study?

Prompts:

- Referred by the teacher, etc.

3. What did you think about the recruitment process (the way that you were recruited to the feasibility study)?

Prompts:

- What did you like/dislike about this process (e.g. referral by the teacher)? How could we improve this?

4. What did you like/dislike about the written information on the study? Whether any of it was easy or difficult to understand?

Prompts:

- Look through the participant information sheet and consent form.
- How could we improve these?

(2) Data collection

5. So far we have asked you to attend two measurement sessions. How have you found these?

Prompts:

- How have you found doing it?
- What has gone well? What has gone less well?

6. What did you think about the questionnaire booklets that we asked you to fill in?

Prompts:

- What was your feeling when you filled in the questionnaire (comfortable/burden)?

7. What did you think about the interview you have attended?

Prompts:

- What helped you to come for the final interview session? If you missed it, what would have helped you to attend? (Time/place etc)
- What did you like/dislike about the interview session?
- How might we improve the session for participants?

Experience of taking part in the intervention （intervention group only）

8. What has been your experience of attending the classroom education curriculum sessions?

Prompts:

- Did you enjoy the sessions? Did you look forward to them? What did you like/dislike about them? (Why/why not?)
- What has gone well/less well? Were they better than you anticipated? Are you satisfied with what you were offered? (Why/why not?)

- How many sessions did you attend? If you did not manage to attend the sessions, why was that?
- Was the 45-minute classroom education curriculum session once a month the right duration and frequency for you – prefer more or less? Why?
- Would you recommend it to other people?
- How can we improve the sessions? (any other ways could be used to provide information about physical activity for school-aged students?)

9. How do you think that taking part in the 15-minute discussion has had an effect on you personally (positive/negative)? Has it helped? In what ways?

Prompt:

- Physically, mentally, etc.

10. How was the overall organisation of the classroom education curriculum sessions?

Prompts:

- Venue/location: Was it suitable for classroom education curriculum sessions? Was it easy to get to? Did you require any special travel arrangements?

11. What has been your experience of attending the poster-making session?

Prompts:

- Did you enjoy the session? Did you look forward to them? What did you like/dislike about them? (Why/why not?)
- What has gone well/less well? Were they better than you anticipated? Are you satisfied with what you were offered? (Why/why not?)
- If you did not manage to attend the sessions, why was that?
- Was one 45-minute poster-making session per semester the right duration and frequency for you – prefer more or less? Why?
- Would you recommend it to other people?
- How can we improve the session?

12. How was the overall organisation of the poster-making session?

Prompts:

- Venue/location: Was it suitable for discussion? Was it easy to get to? Did you require any special travel arrangements?

13. How did you find the educational materials/ posted posters/messages?

Prompts:

- How useful was it in helping you encourage you to do physical activity?
- How did you use the educational materials?

- Which sections of educational materials worked well/less well? (Why/why not?)
- Was there enough support for you? (Why/why not?)
- How can we improve it?

14. Can you talk a bit about your classroom education curriculum/poster-making session instructor?

Prompt:

- Did you get on with the instructor?
- Was the instructor friendly?
- What did you think about the instructor's approach?

15. How might we encourage more participants to come along to the classroom education curriculum/poster-making sessions?

Prompt:

- What encouraged or prevented you from attending the sessions? (Travel reimbursements etc)

16. Finally, is there anything else you want to tell us about the involved programme content?

End interview

Thank the participant and let them know that they will receive a summary of the findings of the study in due course.

Interview Guide (Parents)

Participant ID_____

Introductions

Talk through the participant information sheet for the interview, provide an opportunity for questions about the interview and reconfirm the parents' consent to take part.

Experience of taking part in the feasibility study

(1) Recruitment

1. What attracted you to taking part in this particular research study?

2. What was your initial reaction to receiving the invitation to take part in the feasibility study?

Prompts:

- Referred by the teacher, etc.

3. What did you think about the recruitment process (the way that you were recruited to the feasibility study)?

Prompts:

- What did you like/dislike about this process (e.g. referral by the teacher)? How could we improve this?

4. What did you like/dislike about the written information on the study? Whether any of it was easy or difficult to understand?

Prompts:

- Look through the participant information sheet and consent form.
- How could we improve these?

(2) Data collection

5. What did you think about the interview you have attended?

Prompts:

- What helped you to come for the final measurement session? If you missed it, what would have helped you to attend? (Time/place etc)
- What did you like/dislike about the measurement session?
- How might we improve the measurement session for participants?

Experience of taking part in the intervention （intervention group only）

6. What has been your experience of attending the educational programme?

Prompts:

- Did you enjoy the session? Did you look forward to them? What did you like/dislike about them? (Why/why not?)
- What has gone well/less well? Were they better than you anticipated? Are you satisfied with what you were offered? (Why/why not?)
- If you did not manage to attend the session, why was that?
- Have you got to know the other participants since joining the session?
- Was the 45-minute session per semester the right duration and frequency for you – prefer more or less? Why?
- Would you recommend it to other people?
- How can we improve the session? (any other ways could be used to provide information about physical activity for school-aged students?)

7. How was the overall organisation of the educational programme?

Prompts:

- Venue/location: Was it suitable for discussion? Was it easy to get to? Did you require any special travel arrangements?

8. How did you find the educational materials?

Prompts:

- How useful was it in helping you encourage your children to do physical activity?
- How did you use the materials?
- Which sections worked well/less well? (Why/why not?)
- Was there enough support for you? (Why/why not?)
- How can we improve it?

9. Can you talk a bit about your programme instructor?

Prompt:

- Did you get on with the instructor?
- Was the instructor friendly?
- What did you think about the instructor's approach?

10. How do you think that taking part in the educational programme has had an effect on you and your child personally (positive/negative)? Has it helped? In what ways?

Prompt:

- Physically, mentally, etc.

11. How might we encourage more participants to come along to the educational programme?

Prompt:

- What encouraged or prevented you from attending the session? (Travel reimbursements etc)

12. Finally, is there anything else you want to tell us about the involved programme content?

End interview

Thank the participant and let them know that they will receive a summary of the findings of the study in due course.

Interview Guide (Teachers)

Participant ID_____

Introductions

Talk through the participant information sheet for the interview, provide an opportunity for questions about the interview and reconfirm the physical education teacher's consent to take part.

Experience of taking part in the study

(1) Recruitment

1. What attracted you to taking part in this particular research study?

2. What was your initial reaction to receiving the invitation to take part in the feasibility study?

Prompts:

- Referred by the school, etc.

3. What did you think about the recruitment process (the way that you were recruited to the feasibility study)?

Prompts:

- What did you like/dislike about this process (e.g. referral by the school)? How could we improve this?

4. What did you like/dislike about the written information on the study? Whether any of it was easy or difficult to understand?

Prompts:

- Look through the participant information sheet and consent form.
- How could we improve these?

(2) Data collection

5. What did you think about the interview you have attended?

Prompts:

- What helped you to come for the final measurement session? If you missed it, what would have helped you to attend? (Time/place etc)
- What did you like/dislike about the measurement session?
- How might we improve the measurement session?

6. Overall, what do you think about this study?

Prompts:

- How have you found doing it?
- What has gone well? What has gone less well?

7. How did children respond to the study?

Experience of delivering the intervention （intervention group only）

8. What has been your experience of delivering the classroom education curriculum session/poster-making session/educational programme?

Prompts:

- How have you found doing it?
- What has gone well/less well? (Why/why not?)

9. How was the overall organisation of the classroom education curriculum session/poster-making session/educational programme?

Prompts:

- Venue/location: Was it suitable for the sessions? Was it easy to get to?
- Timings: physical education class or afterschool leisure time?

10. How did you find the educational materials and the programme protocol?

Prompts:

- How useful were they in helping you run the programme?

- How did you use the protocol and educational materials?
- Which sections worked well/less well? (Why/why not?)
- How can we improve them?
- Was there enough support for you? (Why/why not?)

11. How did you go about working with the children to encourage/motivate them to keep on doing physical activity?

Prompts:

- How did that go?
- What worked well/less well? (Why/why not?)

12. How did you go about working with the parents to encourage their children and to find other opportunities for activity for their children?

Prompts:

- How did that go?
- What worked well/less well?

13. Based on the response of participants, which programme component is more effective in increasing their physical activity level than the others?

Prompts:

- Why do you think so?

- Did participants seem to respond more positively to one programme content over the others?

14. How did you feel about the study components compare to the practices you usually did in your work?

15. Can you suggest other ways that could be used to provide information about physical activity for children?

16. Would you recommend this programme to other school-aged children?

Prompts:

- why yes/why not?

17. What sorts of queries children had/asked you about the behaviour change intervention?

18. How do you think we could improve the behaviour change intervention?

19. (In case there are few participants - why do you think so few participants attended?)

20. Finally, is there anything else you want to tell us about the behaviour change intervention or the wider research study?

End interview

Thank the participant and let them know that they will receive a summary of the findings of the study in due course.

Appendix 10: Information sheet (teachers)

Title of study: A school-based behaviour change intervention to increase physical activity among children in China: intervention development and feasibility study

We would like to invite you to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. One of our team will go through the information sheet with you and answer any questions you have. Please take time to read this carefully and discuss it with others if you wish. Ask us anything that is not clear.

What is the purpose of the research?

Children are recommended to spend at least 60 minutes doing moderate to vigorous physical activity daily whilst physical inactivity is the risk factor to many chronic diseases such as obesity and diabetes. The main aim is to establish whether or not a behaviour change intervention can increase the physical activity level of Chinese children who are aged 10-12 years old. This will be tested in a future study. Before this, in this small study, we will check with our participants if the future study can be conducted.

Why have I been invited to take part?

You are being invited to take part because your school has allowed us to contact you via the School.

Do I have to take part?

No. It is up to you to decide whether or not to take part in this study.

If you decide to take part in, you will not need to anything and you will be automatically involved in. However, you would still be free to withdraw from the study at any time if you consent to take part in, without giving a reason and without any negative consequences, by advising the researchers of this decision. This would not affect your legal rights.

If you **do not** agree to participate, we will ask you to sign on the attached slip return it to the researcher.

1. **What will happen to me if I take part?**

We will deliver a behaviour change programme in your class/school and you will be asked to help measure children's weight, height and waist circumference at physical education class on two occasions, four months apart. In addition, you will be asked to help deliver the programme to children and parents with the researcher (intervention group only). After 4 months, you will be asked to take part in a short individual interview with our researcher who will ask about your thought on the behaviour change programme and the participation in this research study.

2. Are there any risks in taking part?

We are not aware of any risks of taking part in the study.

3. Are there any benefits in taking part?

There may be no direct benefits to anyone taking part in this study. The study is being undertaken to find out if the future study (ie, to establish whether or not the behaviour change programme can promote physical activity among school-aged children) can be conducted. If the feasibility of conducting the future study is promising, it will be conducted and the results may benefit school-aged children by improving their physical and psychological health via physical activity participation. In addition, it may help you establish healthy physical activity behaviour as well and provide you with the evidence-based practices for your daily teaching.

4. Will my time/travel costs be reimbursed?

Participants will not receive an inconvenience allowance to participate in the study as the lead researcher will be going to them. Travel expenses will be offered for any visits incurred as a result of participation.

5. What happens to the data provided?

All the collected data will be stored confidentially and anonymised in the encrypt electronic storage devices/laptop. We will not ask for your name and you will not be identifiable in any report or publications. Results will be written up in research paper but no names will be used and all identifying information will be removed. All the information will only be accessed by the research team (i.e. research team, supervisor, collaborator/translator/ transcriber), however, we would like your permission to use anonymised data in future studies, and to share data with other researchers (e.g. in online databases) both inside and outside the European Union. All personal information that could identify you will be removed or changed before the information is shared with other researchers or results are made public. All research data and records will be stored for a minimum of 7 years after publication or public release of the work of the research.

6. What will happen if I don't want to carry on with the study?

Even after you have signed the consent form, you are free to withdraw from the study at any time without giving any reason and without your legal rights being affected. In the event of your withdrawal, your data collected so far cannot be erased and will be used in the final analyses.

7. Who will know that I am taking part in this research?

All information collected about you during this research would be kept strictly confidential. All such data are kept on firewall and password-protected computers and any paper information (such as your consent form, contact details and any research questionnaires) would be stored safely in lockable cabinets in a swipe-card secured building and would only be accessed by the research team.

Under UK Data Protection laws the University is the Data Controller (legally responsible for the data security) and the Chief Investigator of this study (named above) is the Data Custodian (manages access to the data). This means we are responsible for looking after your information and using it properly. Your rights to access, change or move your information are limited as we need to manage your information in specific ways to comply with certain laws and for the research to be reliable and accurate. To safeguard your rights we will use the minimum personally – identifiable information possible.

You can find out more about how we use your information and read our privacy notice at:

https://www.nottingham.ac.uk/utilities/privacy.aspx.

Designated individuals of the University of Nottingham may be given access to data for monitoring and/or audit of the study to ensure we are complying with guidelines.

With your consent, we will keep your personal information on a secure database in order to contact you for future studies. Anything you say during an

interview/focus group will be kept confidential, unless you reveal something of concern that may put yourself or anyone else at risk. It will then be necessary to report to the appropriate persons.

8. What will happen to the results of the research?

The research will be written up as a thesis for the degree of PhD. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be published open access. The thesis may also be used for scientific presentation and publication.

9. Who has reviewed this study?

All research in the University of Nottingham is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given a favourable opinion by the Faculty of Medicine & Health Sciences (FMHS) Research Ethics Committee.

10. Who is organising and funding the research?

This research is being organised by the University of Nottingham and is not being funded by any other party

11. What if something goes wrong?

If you have a concern about any aspect of this project, please speak to the researcher Haiquan Wang or the Principal Investigator Dr Kaushik Chattopadhyay, who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how he intends to deal with it. If you remain unhappy and wish to complain formally, you should then contact the FMHS Research Ethics Committee Administrator, Faculty Hub, Medicine and Health Sciences, E41, E Floor, Medical School, Queen's Medical Centre Campus, Nottingham University Hospitals, Nottingham, NG7 2UH or via E-mail: FMHS-ResearchEthics@nottingham.ac.uk.

12. Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Lead Researcher:

Haiquan Wang

Division of Epidemiology and Public Health

School of Medicine

The University of Nottingham

Tel: 0115 8231376

Email: Haiquan.Wang@nottingham.ac.uk

Supervisor:

Dr. Holly Blake

Associate Professor of Behavioural Science, Faculty of Medicine & Health Sciences

School of Health Sciences

The University of Nottingham,

Email Address: Holly.Blake@nottingham.ac.uk

Supervisor:

Dr. Kaushik Chattopadhyay

Assistant Professor in Evidence Based Healthcare

Division of Epidemiology and Public Health

School of Medicine

The University of Nottingham

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