
**CHILDHOOD OBESITY PREVENTION IN
CHINA: A MIXED-METHODS
APPROACH TO INFORM
DEVELOPMENT OF THEORETICALLY
BASED INTERVENTIONS**

**By
BAI LI**

**A thesis submitted to
the University of Birmingham
for the degree of
DOCTOR OF PHILOSOPHY**

**Unit of Public Health, Epidemiology and Biostatistics
School of Health and Population Sciences
College of Medical and Dental Sciences
University of Birmingham
November 2012**

UNIVERSITY OF
BIRMINGHAM

University of Birmingham Research Archive

e-theses repository

This unpublished thesis/dissertation is copyright of the author and/or third parties. The intellectual property rights of the author or third parties in respect of this work are as defined by The Copyright Designs and Patents Act 1988 or as modified by any successor legislation.

Any use made of information contained in this thesis/dissertation must be in accordance with that legislation and must be properly acknowledged. Further distribution or reproduction in any format is prohibited without the permission of the copyright holder.

ABSTRACT

Background

Childhood obesity is increasing rapidly in China. However, research into environmental contributors to the problem is limited. Formative research that informs theoretically based prevention interventions is also lacking.

Aim and objectives

To inform the development of obesity prevention interventions among urban Chinese primary school students by:

1. exploring *perceived factors* contributing to obesogenic behaviours,
2. exploring *preferred components* and *delivery strategies* for future preventive interventions,
3. examining the relationship of *family and neighbourhood environmental factors*, to child weight status as well as related dietary and physical activity behaviours.

Methods

A mixed-methods study was conducted in two cities in South China. Seventeen focus groups and four personal interviews were conducted with family and primary school members from four socioeconomically distinct districts (objectives 1-2). In each district, height and weight data of 3rd year students (8-10 years) in one primary school was obtained, and linked to data obtained from a questionnaire sent to their parents that enquired about family and neighbourhood environments, as well as child behaviours (objective 3). Data from both studies were combined to inform the development of an

appropriate prevention intervention.

Results

Inter-related social, historical, regulatory, policy, knowledge and economic factors emerged as factors influencing attitudes, social norms and perceptions of control in relation to obesogenic behaviours. Among those, grandparents emerged as a dominant but relatively easy- to- modify theme. Overall, dietary interventions, particularly delivered through or at schools were most popular for future interventions. In parallel, the cross-sectional study (n=497) found that the presence and role of grandparents were significantly correlated with child weight status and snacking behaviour. No relationship was found between the perceived neighbourhood environment and child weight status or behaviours.

Conclusions

The family environment has important influences on childhood obesity and obesogenic behaviours. Drawing on the overall findings, *potential targets, components and delivery strategies* are discussed using a Social Marketing framework for future prevention intervention.



Dedicated to my mother and father

For your generous support in my study in the UK for over 10 years

&

To my husband

For your endless support and love

ACKNOWLEDGEMENTS

I would like to first of all express my sincere gratitude to my supervisor, Dr Peymane Adab for her generous guidance and support in my PhD studies and in my development to be a more mature researcher. I would have been unable to complete this thesis without her support. I also would like to thank my supervisor, Professor KK Cheng for his support, particularly at the start of my PhD study. Both supervisors' valuable advice and encouragement will stay with me for the rest of my life.

I would like to thank the staff at the Unit of School Health and Hygiene (Guangzhou Education Bureau) and Hechi City Government for their support in the study's data collection in China. My sincere thanks also go to all the participants (e.g. children, family members and school staff) in Guangzhou and Hechi cities, for their time and cooperation.

I would like to acknowledge the contribution of University of Birmingham Medical and Dental Sciences College PhD Studentship, which made my research study possible. I have also received excellent peer support during

my study, especially in statistical analysis, from Dr Hubert Lam and Dr Karla Hemming. Outside the University, I would like to thank Professor Nadine Henley (in Social Marketing) for being a very inspirational friend who has given me invaluable encouragement.

I can not express enough gratitude to my parents Professor Jin Bai and Professor Haisheng Li, who have been giving everything they can to enable me to fulfil my own pursuits in study, career and life. Their incredible love, understanding and support made important contributions to who I am today. To them, their only child studying abroad, thousands of miles away for over 10 years, meant far more than their very generous financial sacrifices. Finally, I thank my wonderful husband, Stephen John Ashdown for his endless love and encouragement, and thank my parents in law Valerie and John Ashdown for making up a warm and supportive family in the UK. I could not have done it without any of you.

CONTENTS

1 INTRODUCTION	15
1.1 RATIONALE FOR THIS THESIS	15
1.2 AN OVERVIEW OF THE THESIS	16
2 LITERATURE REVIEW	18
2.1 CHILDHOOD OBESITY EPIDEMIC - AN INTERNATIONAL PERSPECTIVE	18
2.1.1 <i>A global challenge</i>	18
2.1.2 <i>Defining obesity</i>	20
2.1.2.1 Body Mass Index	21
2.1.2.1.1 Measuring BMI in children	22
2.1.2.2 Alternative measures used in epidemiological studies	24
2.1.3 <i>Consequences of childhood obesity</i>	25
2.1.4 <i>Aetiology of childhood obesity</i>	29
2.1.4.1 Genetic and biological determinants	30
2.1.4.2 Children's health behaviour	31
2.1.4.3 Family environment	33
2.1.4.4 Neighbourhood environment	36
2.1.4.5 The wider environment	37
2.1.4.6 Sociodemographic Influences	39
2.1.4.7 Summary	39
2.1.5 <i>Prevention of childhood obesity</i>	40
2.2 EPIDEMIOLOGY AND RESEARCH ON CHILDHOOD OBESITY IN CHINA	44
2.2.1 <i>Defining childhood obesity - the Chinese national standard</i>	44
2.2.2 <i>The prevalence of childhood obesity in China</i>	45
2.2.2.1 Trend in childhood obesity	45
2.2.2.2 Descriptive epidemiology of childhood obesity in China	46
2.2.3 <i>Chinese literature on the aetiology of childhood obesity</i>	48
2.2.3.1 Genetic and biological risk factors	49

2.2.3.2 Behavioural risk factors- dietary behaviours	49
2.2.3.3 Behavioural risk factors - physical activity and sedentary behaviours	51
2.2.3.4 Sleep duration	52
2.2.3.5 Research gaps	52
2.2.4 <i>Childhood obesity prevention research in China</i>	54
2.2.4.1 Current literature and evidence base	54
2.2.4.2 Research gaps	57
2.2.5 <i>Summary</i>	65
2.3 THE OVERALL AIM OF THE RESEARCH PROJECT	66
3 UNDERSTANDING FACTORS INFLUENCING CHILDHOOD OBESITY IN CHINA AND INSIGHTS INTO INTERVENTION DEVELOPMENT	68
3.1 BACKGROUND	68
3.2 RESEARCH AIM AND OBJECTIVES	73
3.3 RESEARCH SETTING	74
3.4 METHODS	80
3.4.1 <i>Participants</i>	80
3.4.2 <i>Focus group process</i>	81
3.4.3 <i>Personal interview process</i>	85
3.4.4 <i>Data trustworthiness for focus groups and interviews</i>	86
3.4.5 <i>Other observational activities</i>	87
3.4.6 <i>Data analysis</i>	88
3.5 RESULTS	92
3.5.1 <i>Factors perceived to influence obesity and related behaviours (objective 1)</i>	93
3.5.1.1 Theme 1: factors influencing attitudes toward healthy behaviours	94
3.5.1.2 Theme 2: factors contributing to low perceived behavioural control	97
3.5.1.3 Theme 3: factors influencing more than one construct of the TPB	106
3.5.1.4 Summary	119
3.5.2 <i>Findings from stakeholder prioritisation exercise (objectives 2-3)</i>	122
3.5.2.1 Interventions prioritised across all focus groups	126
3.5.2.2 Non-prioritised interventions	127

3.5.2.3 Intervention prioritisation by stakeholder identity group	128
3.5.2.4 Cross - group variations in perceived importance and feasibility for prioritised interventions	131
3.5.2.5 Summary	133
<i>3.5.3 Strategies for intervention delivery and insights into barriers and facilitators (objective 4)</i>	<i>134</i>
3.5.3.1 Findings by identity groups	134
3.5.3.2 Summary	147
3.6 DISCUSSION	149
<i>3.6.1 Summary of key findings</i>	<i>149</i>
<i>3.6.2 Strengths and limitations</i>	<i>151</i>
<i>3.6.3 Findings in relation to previous literature</i>	<i>154</i>
3.6.3.1 Perceived factors contributing to childhood obesity and obesogenic behaviours	154
3.6.3.2 Preference for the components and delivery strategies of preventive interventions	159
3.7 CONCLUSION	162

4 CROSS-SECTIONAL STUDY TO IDENTIFY FAMILY AND NEIGHBOURHOOD

ENVIRONMENTAL FACTORS ASSOCIATED WITH CHILDHOOD OBESITY AND

OBESOGENIC BEHAVIOURS 164

4.1 BACKGROUND	164
4.2 RESEARCH AIM AND OBJECTIVES	166
4.3 METHODS	167
<i>4.3.1 Research setting</i>	<i>167</i>
<i>4.3.2 Study sample</i>	<i>168</i>
<i>4.3.3 Measures</i>	<i>169</i>
4.3.3.1 Anthropometric measures (outcome)	169
4.3.3.2 Parent questionnaire	170
4.4 STATISTICAL ANALYSIS	177
4.5 RESULTS	181
<i>4.5.1 Summary of the study sample</i>	<i>181</i>
4.5.1.1 Characteristics of the study sample	182
4.5.1.2 Prevalence of childhood overweight and obesity in the study sample	191
<i>4.5.2 Family and neighbourhood environmental factors and childhood overweight (objective 1)</i>	<i>194</i>

4.5.3 <i>Family and neighbourhood environmental factors and obesogenic behaviours (objective 2)</i>	200
4.5.3.1 Consumption of unhealthy snacks	200
4.5.3.2 Consumption of fruit and vegetables	203
4.5.3.3 Moderate to vigorous physical activity level	205
4.5.4 <i>Potential behavioural mediators (objective 2)</i>	208
4.5.5 <i>Relationship between family environmental factors and children's weight status in fully adjusted analysis</i>	210
4.6 DISCUSSION	212
4.6.1 <i>Summary of key findings</i>	212
4.6.2 <i>Strengths and limitations</i>	213
4.6.3 <i>Findings in relation to the previous literature</i>	215
4.6.4 <i>Implications for future research</i>	220
5 IMPLICATIONS FOR FUTURE PREVENTIVE INTERVENTIONS	222
5.1 IMPLICATIONS FOR FUTURE PREVENTIVE INTERVENTION DEVELOPMENT AND DELIVERY	223
5.1.1 <i>The strategic mix of Social Marketing and its role in intervention development</i>	223
5.1.2 <i>Potential risk factor targets and components for future preventive interventions</i>	226
5.1.3 <i>Potential intervention delivery strategies</i>	233
5.2 CONCLUSION	237
6 CONCLUSIONS.....	239
6.1 SUMMARY OF THE THESIS	239
6.2 CONTRIBUTIONS TO THE LITERATURE	242
APPENDICES	244
REFERENCE LIST	255

LIST OF FIGURES

FIGURE 1 MRC FRAMEWORK FOR DESIGN AND EVALUATION OF COMPLEX INTERVENTIONS TO IMPROVE HEALTH	62
FIGURE 2 THE TOTAL PLANNING PROCESS.....	64
FIGURE 3 THEORY OF PLANNED BEHAVIOUR (AN AMENDED IMAGE OF THE ORIGINAL MODEL PUBLISHED BY AJZEN I IN 1991)[268]	71
FIGURE 4 NON-LICENSED AND LICENSED TRADERS SELLING UNHEALTHY FOOD AROUND SCHOOL GATES....	98
FIGURE 5 SCHOOL MEALS	100
FIGURE 6 WIDESPREAD AVAILABILITY OF INACTIVE TRANSPORT METHODS AND INSUFFICIENT SPACE FOR PHYSICAL ACTIVITY ON CAMPUS AND IN RESIDENTIAL AREAS	103
FIGURE 7 OBSERVATION OF GRANDPARENTS BUYING WESTERN UNHEALTHY SNACKS	109
FIGURE 8 ONE MEAL A DAY	111
FIGURE 9 WESTERN UNHEALTHY SNACKS SOLD IN CHINESE URBAN SUPERMARKETS	115
FIGURE 10 INCREASING CAR OWNERSHIP AND AIR POLLUTION	119
FIGURE 11 A SCHEMATIC WEB DIAGRAM	120
FIGURE 12 CHILDREN'S DAILY MVPA LEVELS MODIFIED THE ASSOCIATION BETWEEN PRESENCE OF GRANDPARENTS AND OVERWEIGHT RISK IN THE STUDY SAMPLE.....	210
FIGURE 13 A SUMMARY OF HOW THIS THESIS COULD CONTRIBUTE TO CHILDHOOD OBESITY PREVENTION IN CHINA	241

LIST OF TABLES

TABLE 1 SUMMARY OF CHARACTERISTICS AND FINDINGS FROM TWO SYSTEMATIC REVIEWS OF CHINESE OBESITY INTERVENTION STUDIES	55
TABLE 2 SCHEDULE AND TOPIC GUIDE FOR FOCUS GROUPS	84
TABLE 3 TOPIC GUIDE FOR HEAD TEACHERS' PERSONAL INTERVIEWS.....	86
TABLE 4 EXAMPLE OF HOW INTERVENTION COMPONENTS WERE SUMMARISED, BY IDENTITY GROUP.....	90
TABLE 5 SUMMARY OF THE CHARACTERISTICS OF STUDY PARTICIPANTS	93
TABLE 6 SUMMARY FOR NUMBER OF GROUPS PRIORITISING EACH INTERVENTION COMPONENT, BY IDENTITY GROUP	123
TABLE 7 SOCIO-DEMOGRAPHIC AND FAMILY ENVIRONMENTAL VARIABLES COLLECTED IN THE PARENT QUESTIONNAIRE	171
TABLE 8 DESCRIPTIONS OF SUBSCALES MEASURING PERCEIVED CHARACTERISTICS OF NEIGHBOURHOOD ENVIRONMENT	173
TABLE 9 QUESTIONNAIRE ITEMS USED TO ESTIMATE FREQUENCY OF CONSUMPTION OF UNHEALTHY SNACKS, AND FRUIT AND VEGETABLES	175
TABLE 10 RESPONSE RATE FOR PHYSICAL MEASURES AND PARENT QUESTIONNAIRES	182
TABLE 11 SUMMARY OF PARTICIPANT CHARACTERISTICS BY SEX AND MOTHER'S EDUCATION LEVEL	183
TABLE 12 OVERWEIGHT AND OBESITY PREVALENCE BY SAMPLE SCHOOL.....	191
TABLE 13 OVERWEIGHT AND OBESITY PREVALENCE BY STUDENT SEX	192
TABLE 14 COMPARISON OF WEIGHT STATUS CATEGORIES AND SEX COMPOSITION IN THE STUDY SAMPLE WITH THE TOTAL ELIGIBLE SAMPLE OF CHILDREN IN YEAR 3 IN GUANGZHOU	194
TABLE 15 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENT FACTORS, AND CHILDREN'S WEIGHT STATUS (UNADJUSTED ANALYSES).....	196
TABLE 16 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S WEIGHT STATUS IN MULTIVARIATE LOGISTIC REGRESSION ANALYSIS	199
TABLE 17 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S CONSUMPTION FREQUENCY OF UNHEALTHY SNACKS (UNADJUSTED ANALYSES).....	201
TABLE 18 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND	

CHILDREN'S CONSUMPTION FREQUENCY OF UNHEALTHY SNACKS IN MULTIPLE LINEAR REGRESSION ANALYSIS.....	202
TABLE 19 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S CONSUMPTION FREQUENCY OF FRUIT AND VEGETABLES (UNADJUSTED ANALYSES).....	204
TABLE 20 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S CONSUMPTION FREQUENCY OF FRUIT AND VEGETABLES IN MULTIPLE LINEAR REGRESSION ANALYSIS.....	205
TABLE 21 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S LIKELIHOOD OF ENGAGING IN AT LEAST 60 MINUTES OF MVPA PER DAY (UNADJUSTED ANALYSES)	206
TABLE 22 ASSOCIATION BETWEEN FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS, AND CHILDREN'S LIKELIHOOD OF ENGAGING IN AT LEAST 60 MINUTES OF MVPA PER DAY IN MULTIVARIATE LOGISTIC REGRESSION ANALYSIS.....	207
TABLE 23 LOGISTIC REGRESSION MODELS TO EXAMINE ROLE OF US CONSUMPTION OR MVPA AS POTENTIAL MEDIATORS IN THE RELATIONSHIPS BETWEEN GRANDPARENTS BEING THE MAIN CARER, OR GRANDPARENTS IN THE HOUSEHOLD, AND CHILD WEIGHT STATUS	208
TABLE 24 RELATIONSHIPS BETWEEN FAMILY ENVIRONMENTAL FACTORS, AND CHILD WEIGHT STATUS IN FULLY ADJUSTED REGRESSION MODEL	211
TABLE 25 POTENTIAL INTERVENTIONS TARGETS, SOURCES OF EVIDENCE AND RELATIVE CHANGEABILITY	227

ABBREVIATIONS

ANGELO	Analysis Grid for Environments Linked to Obesity
BMI	Body mass index
CI	Confidence interval
CDC	Center for Disease Control
CHD	Coronary heart disease
CNSSCH	Chinese National Survey on Students Constitution and Health
DEXA	Dual energy x-ray absorptiometry
FTO	Fat mass and obesity associated gene
FV	Fruit and vegetables
FFQ	Food Frequency Questionnaires
GNP	Gross National Product
GZ	Guangzhou city
HDL	High-density lipoprotein
HPS	Health Promotion School
HBM	Health belief model
HC	Hechi city
IOTF	International Obesity Taskforce
JCJ	Jinchengjiang district
LDL	Low-density lipoprotein
MRC	Medical Research Council
MVPA	Moderate to vigorous physical activity
MET	Metabolic Equivalent of Task
NCD	Non-communicable chronic disease
NCHS	National Central Health Statistics
NEWS-A	Abbreviated-Neighborhood Walkability Scale
OR	Odds ratio
PA	Physical activity
PE	Physical Education
SD	Standard deviation
SES	Socioeconomic status
SPSS	Statistical Package for the Social Sciences
TV	Television
TPB	Theory of Planned Behaviour
TPP	Total Planning Process
US	United States of America
US	Unhealthy snacks and drinks
UK	United Kingdom
WHO	World Health Organization
WC	Waist circumference
WGOC	Working Group on Obesity in China

1 INTRODUCTION

1.1 Rationale for this thesis

Globally, an estimated 200 million school-aged children are overweight or obese[1]. Almost all countries with available epidemiological data have experienced a rise in the prevalence of childhood obesity in recent decades, with the rate of increase being most marked in populations that have undergone more dramatic economic growth and social change[2], including China. The national prevalence of childhood obesity in China increased by 34-fold and 22-fold respectively for boys and girls over the last 20-year period[3]. Childhood obesity has adverse effects on children's psychological and physical wellbeing, as well as increasing the risk of cardiometabolic disease and several cancers in adulthood[4-10].

However, there has been scarce research into the environmental determinants of childhood obesity (particularly utilising qualitative methods), and an omission of effective theoretically-based prevention programmes in China. Those research gaps need to be acknowledged and addressed, if the rapidly increased childhood obesity epidemic in the country is to be better understood, and an improved knowledge base of what and how prevention programmes should implemented is to be achieved.

1.2 An overview of the thesis

This thesis sits within the public health domain of childhood obesity and its prevention. It reports the findings of a study that focused on societal or *environmental determinants* of *childhood obesity* and *obesogenic behaviours* in a mainland Chinese population and used *mixed methods* to provide *theoretically-and evidence-based foundations* for future prevention interventions in that population.

Chapter 2

In this chapter, international and Chinese literature on childhood obesity, its prevalence, aetiology and prevention are reviewed. Some important methodological and theoretical research gaps are highlighted and discussed. This provides a background to the study's overall research aim, which is specified at the end of this chapter.

Chapter 3

This chapter reports a qualitative study exploring perceived factors contributing to Chinese children's obesogenic behaviours. Following an inductive thematic analysis, identified factors are presented and analysed from a consequential perspective using a well-established theoretical framework. A web diagram summarising the findings from an attributive perspective is also presented. The chapter also reports the views and

preferences of a variety of stakeholders in relation to the components and delivery strategies for potential preventive interventions. Similarities and differences across stakeholder groups are identified and discussed.

Chapter 4

This chapter reports a cross-sectional study in the same population that aimed to identify environmental correlates of children's weight status and obesogenic behaviours, with a focus on the family- and neighbourhood-level environments.

Chapter 5

This chapter discusses how the qualitative and cross-sectional findings can be integrated in a complementary way to inform the development of future prevention interventions in the study population. Using a social marketing approach, the targets, segments, components and delivery strategies of potential interventions are described.

Chapter 6

The final concluding chapter summarises the overall key findings from the study. It also discusses several original contributions made by this study to the literature of childhood obesity prevention.

2 LITERATURE REVIEW

This chapter will begin with an overview of the epidemiology of childhood obesity from an international perspective. Then it will discuss the childhood obesity epidemic in China. Prevention research in China will be reviewed and major research gaps in this area will be discussed, in order to provide a background to the current study's research aims.

For the literature review, published primary studies and systematic reviews (between 1990 and 2012) were searched for using the two largest Chinese databases (The China Full Text Database and Wanfang Database) for the Chinese literature, and for the English literature, searches were carried out using Medline.

2.1 Childhood obesity epidemic - an international perspective

2.1.1 A global challenge

Childhood obesity is a pandemic that has received great attention from the World

Health Organisation (WHO), governments and epidemiologists because of its growing prevalence and important consequences on individuals and societies. Almost all countries with available data have experienced a continued rise in prevalence for the recent decades, with largest and fastest increases occurring in nations that have undergone rapid economic growth and social change. Overall, 200 million school-aged children are overweight or obese globally[1].

In developed countries, increases in childhood obesity have been documented extensively in nations such as the US[11-13], the UK[14-16], Germany[17], Sweden[18,19], Finland[20], the Netherlands[21], Canada[22] and Japan[23]. A cross-national study comparing prevalence of childhood overweight and obesity in 34 countries, using self-reported height and weight, found that the highest prevalence was in North America, Great Britain, and south-western Europe[24]. While a positive relationship between children's age and obesity prevalence was observed in some developed countries such as the UK [15], such a pattern was not found in other developed nations such as Sweden[18].

In the developing world where infectious diseases and childhood under nutrition have traditionally been the primary focus for medical services, childhood obesity is rising rapidly especially in urban areas[24-29]. Notably, this increase is significant not only in scope but also in rapidity, surpassing the rate of increase seen in Western countries[27,30-32]. Poland, a developing European country for example, experienced a

two-fold increase in the combined prevalence of overweight and obesity among children between 1971 and 2000 (boys from 7.5% to 15.2% and girls from 6.5% to 11.8%)[28]. China, a developing country in Asia, has also seen rapid increases in this epidemic in the last decades[33], and this will be discussed in more detail later. Unlike in some developed countries, childhood obesity prevalence in both Poland and China are greater in younger children, especially in females [28,30,31], suggesting that the younger generations are at greater risk. According to the WHO, there are more overweight and obese children in developing countries than in developed countries[34].

2.1.2 Defining obesity

The terminology used in everyday life and the medical literature on obesity varies widely. Even when the same term is used (e.g. overweight), inconsistent meanings of the term are denoted. In simple terms, obesity refers to excess body fatness that increases the risk of morbidity and premature death among those with this condition[35-37]. However, justifiably, a majority of studies regarding obesity are based on weight rather than on body fatness[38]. This is partly due to the fact that body fat is not easy to measure. In fact, the determination of the level of body fat accumulation that is unhealthy is also problematic.

2.1.2.1 Body Mass Index

Body Mass Index (BMI) is one of the most widely used indirect measures of body fatness. It is calculated by dividing weight in kilograms by height in metres squared[39]. BMI has been widely utilised in epidemiologic studies for estimating prevalence of obesity and overweight in different populations, and for describing body fatness (or more strictly, weight status) in individuals[39,40].

Despite the popularity of BMI, it has several weaknesses, fundamentally because it does not measure body fatness directly but functions as a proxy measure of it. It has been well documented that the accuracy of BMI as a measure of adiposity varies considerably depending on many factors such as the age[41-44], sex[45-47], ethnicity[47-54], lean muscle mass[43,55] and the degree of fatness[56]. It has been well documented that both Asian children and adults have a higher body fat content than their Caucasians counterparts for a given weight or BMI value[47,48,51-53,57-59]. Therefore, increased risks for cardiovascular-metabolic diseases happen at a lower BMI value in Asians than in Caucasians[49,50].

On the other hand, the usefulness and advantages of BMI, including ease of measurement, popularity of use, documented association between different thresholds and disease risk, and well established definition cut offs, probably outweigh the disadvantages. All these have made it an attractive choice for describing and comparing obesity/overweight

prevalence at population and international levels. Comparing with BMI, direct measures of body fat (to be discussed later on) are more expensive to use at a population level. Prospective studies in adult populations have demonstrated strong associations between increasing BMI and higher overall and cause-specific mortality. A large study using pooled data from 19 prospective studies and including 1.46 million white adults found that obesity/overweight as defined by BMI was associated with increased all-cause mortality[60]. A recent study showed that the relationship between BMI and total mortality was linear, not only above the identified optimal threshold (25 kg/m^2) but also below this[61]. BMI has been shown to be as good or better than other anthropometric measures such as waist circumference, waist-to-hip ratio, waist-to-stature ratio and skin fold thickness, in predicting diabetes incidence[62] and at least as accurate as skin fold thickness (triceps and sub scapular) in identifying metabolic risk among adults[63].

2.1.2.1.1 Measuring BMI in children

As discussed earlier, the relationship between BMI and body fat is age- and sex-dependent. This has made the interpretation of BMI in children particularly challenging. Despite these issues, BMI has been generally agreed as a good measure of childhood overweight and obesity[36,64,65].

Changes in BMI before and during puberty and the variance of this change between sexes

have led to the development and use of age- and sex-specific BMI classification standards in children. Each of these is based on a reference population, with overweight or obesity being defined in relation to the standard population. One of the most influential international references was developed by the International Obesity Taskforce (IOTF)[66] which recommended BMI cut offs for defining children's weight categories based on data pooled from 6 countries: Brazil, Great Britain, China (Hong Kong), the Netherlands, Singapore and the USA. The cut-off points were chosen as the percentiles that matched the adult cut-offs of a BMI of 25kg/m² and 30kg/m² at the age of 18 years. Another widely used reference data was developed by the Centre for Disease Control and Prevention (CDC) in the US, using 5 nationally representative data sets. This reference is often referred to as the CDC 2000 growth charts[67]. The WHO 2007 Child Growth Standards were developed as an international reference for assessing child growth and development based on data collected from a range of developed and developing countries. It recommends age- and sex- specific classification cut offs for children between 5 and 19 years old[68]. Whilst there is a degree of overlap among these various definitions, at the individual level, a child could be classified as overweight using one definition, but not with another, and vice versa.

Differences among those references have implications for research and practice[69-71] and have further complicated the debate on the choice between international and national references[46,72,73]. When choosing a particular reference for defining children's weight categories, it is worth remembering that those references were developed for different purposes. For example, the IOTF cut-offs were not developed for clinical

definition of obesity/overweight but mainly for facilitating international comparative studies[38].

2.1.2.2 Alternative measures used in epidemiological studies

Besides BMI, other methods have been used to estimate body fatness. These include waist circumference (WC), skin fold thickness measurement, bioelectrical impedance, hydro densitometry and dual-energy X-ray absorptiometry (DEXA). Of those alternative measures, the first two are widely applied in epidemiologic studies and so are discussed below.

WC is also an indirect measure of body fatness and is strongly correlated with central obesity[74]. Moreover, in a study assessing whether changes in main measures of adiposity are common during puberty, WC appeared stable while changes in BMI were found common[44]. This might indicate that WC is a more reliable measure of obesity during puberty.

Skinfold thickness measurement is often used to estimate the percentage of body fat through measuring skinfold thickness at certain locations on the body. It is an important tool that helps understanding subjects' body fat distribution. However, like other anthropometry measures, skinfold thickness measurement has limitations. The validity of

using skinfolds for estimating body fatness is influenced more or less by the choice of calliper as well as measurement procedures in which, inter- and intra-observer variations are great concerns[75,76]. Moreover, there has been longstanding criticism concerning the accuracy of equations based on skinfold thickness measures and it has been argued that published formulas often inaccurately underestimate body fat percentage[77-81].

2.1.3 Consequences of childhood obesity

The WHO has placed obesity among the top of its public health agenda. This is not only because of the pandemic's continuous increases at an alarming rate and its preventable nature, but also due to the well evidenced associations between obesity, and major non-communicable chronic diseases (NCDs), several cancers and avoidable economic costs[8,9,82].

Physical health consequences in childhood and adulthood

Overweight and obesity in children is associated with clustering of cardiovascular-metabolic risk factors[83-87]. For instance, in one study involving 2996 American children and adolescents (aged between five to 17 years), central obesity was associated with adverse concentrations of triacylglycerol, LDL and HDL cholesterol and insulin, independent of race, sex, age, weight, and height[88]. In another study of 9167

five to 17-year-old American children and adolescents, participants with a BMI over or equal to the 95th percentile of the US reference data were compared with those with a BMI under or equal to the 85th percentile in terms of their relative risk for developing cardiovascular risk factors[89]. It was found that the odds ratios (ORs) of the former group for elevated level of total cholesterol, diastolic blood pressure, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, systolic blood pressure, triglycerides and fasting insulin were 2.4, 3.0, 3.4, 4.5, 7.1 and 12.6 respectively, and over half of those overweight children and adolescents were suffering from at least one risk factor[89].

Other health implications of obesity in childhood have also been documented. They include respiratory complications[90-92], non-alcoholic fatty liver disease[93,94], musculoskeletal[95-98], gynaecologic[99] and neurologic disorders[100].

In the long term, persistence of obesity from childhood to adulthood has been well evidenced in the literature[101,102]. This phenomenon can be partly explained by tracking of childhood dietary habits, food preference and physical activity pattern from childhood or adolescence into adulthood, which has been extensively described[103-105]. This indicates that obesity related behavioural habits are largely constructed before adulthood, which in turn highlights the importance of preventive obesity interventions targeting children, even infants and their carers such as new parents who have great influences on their offspring's health behaviours. Moreover,

several studies have reported the relationship between childhood obesity and physical morbidity and premature death in adulthood[106-109]. A systematic review of longitudinal studies published between 2002 and 2010[110]. showed that compared to normal weight, overweight children and adolescents had an increased risk of premature mortality (hazard ratios ranging from 1.4 to 2.9) in 4 of the 5 cohorts (and 7/8 studies)[110]. The only study that did not find such an association was based on participants' recalled weight status at adolescence. Thus its results might have been influenced by information bias. Furthermore, all eligible studies examining the association between childhood overweight/obesity and adulthood cardio metabolic morbidity reported that the overweight/obese children were at significantly greater risk for diabetes, stroke, coronary heart disease, and hypertension in adulthood (hazard ratios ranged between 1.1 and 5.1)[110]. There was also fairly consistent evidence that childhood overweight is associated with other morbidity, such as asthma, and polycystic ovary syndrome symptoms[110].

Psychosocial implications

Psychosocial impacts of overweight and obesity are more difficult to measure but have been studied in childhood and adolescence.

Self-esteem, in a common sense, is referred to someone's general evaluation or perception of his or her own worth. Given a large variance of measuring methods used in

the early studies examining the association between children's self-esteem and weight status, previous reviews of those studies generated inconsistent findings[111-114]. However, a recent systematic review with a more comprehensive analytic approach and better defined measures of self-esteem and obesity (the inclusion criteria), has established a stronger and clearer evidence for this psychological impact of obesity on children and adolescents[115]. There is qualitative evidence showing that attitudes toward obesity vary among different ethnical/cultural groups with black populations having a positive view about 'big or fat body' and showing little social pressure to lose weight[116-120].

A systematic review of cross-sectional and intervention studies provided strong evidence that childhood obesity impacts on quality of life, with 9 of 11 included studies showing significantly lower total quality of life scores in obese subjects[115].

Economic costs

There are economic costs associated with obesity and they can be classified into direct costs (e.g. costs to service providers and the state, directly involved in the diagnosis and treatment of obesity), indirect costs (e.g. loss of production due to obesity-related absenteeism from work or premature death) and intangible costs (e.g. reduced quality of life for individuals because of their condition of obesity)[82].

In developed countries estimated figures are available in countries such as the US[121,122], Australia[123], France[124], and Finland[125]. The WHO estimated that for a developed country, the direct economic costs of obesity lie within the range between 2% and 7% of the state's total expenditure in health care[82]. In developing countries, NCDs are now causing more deaths than communicable diseases in these nations[9,126-128] and the actual costs involved in providing medical service for NCDs were found to be higher than that in developed countries[82]. Popkin measured both direct and indirect economic costs of obesity with a particular focus on the case of China estimating that obesity and its related dietary and physical activity patterns will reach an indirect economic effect of 8.73% of the country's gross national product (GNP) in 2025[129].

2.1.4 Aetiology of childhood obesity

Given the important implications of childhood obesity for individuals and societies, much research has focused on improving our understanding of the contributory factors (and their interactions). Whilst at one level it is clear that obesity results from an imbalance between energy intake and energy output, there remains much debate about factors influencing energy balance, which reflects the complicated nature of childhood obesity. One major debate relates to genetic contribution versus that of the environment. It is necessary to review the international literature in this area before developing any

prevention intervention. Thus, the following section reviews literature related to genetic and biological determinants, behaviour-level risk factors, family influences, neighbourhood environment, the wider environment as well as the influences of ethnicity and socio-economic factors.

2.1.4.1 Genetic and biological determinants

Research on genetic determinants of obesity has had a long history with a large body of family, twin and adoption studies[130,131] confirming a strong obesity heritability, estimated between 40% and 70%[132]. Recent studies especially genetic association studies[133,134] and genome-wide association studies[135] continue to provide evidence for genetic influences. Certain biological conditions (of mothers or children) are also believed to be risk factors for childhood obesity. According to recent evidence of prospective, observational or clinical studies, these conditions mainly include child birth weight[136,137], endocrine diseases[138], hypothalamic abnormalities[139] and gestational diabetes[140,141].

Although genetic influences are clearly important, it is generally agreed that the recent increasing trends in obesity are related to environmental rather than genetic factors.

2.1.4.2 Children's health behaviour

Risk factors at the level of children's behaviour or life style have been extensively studied with a large body of the literature focusing on their diet, physical activity and sedentary behaviours.

Diet

While findings of a large cross-sectional study investigating the association between dietary behaviours of youths (10-16 years) and weight status, using data from 34 countries (n=137,593), did not support the conventional belief that consumption of fruits, vegetables and soft drinks affect weight status (based on self-reported height and weight and classified by IOTF)[24], there is evidence from longitudinal studies for a dietary contribution to childhood obesity, especially the influences of high energy intake and high consumption of sugar-sweetened drinks[142]. Associations between children's weight status and other dietary behaviours (e.g. school lunch consumption, eating dinner while watching television, having a low-energy breakfast or having a high-energy dinner and skipping breakfast) have also been reported in cross-sectional studies[142].

Physical activity

A recent systematic review of observational studies of children's physical activity concluded that low levels of objectively measured physical activity are associated with higher childhood obesity risk[143]. Cross-sectional studies of self-reported physical activity patterns also confirmed that overweight respondents had lower physical activity levels than their normal weight counterparts and this pattern was consistently found across many European countries[24].

Sedentary behaviour

In terms of sedentary behaviours, there is good evidence from a meta analysis of observational and experimental studies that excessive screen viewing (e.g. TV watching) is associated with increased risk of childhood obesity[144]. This finding was further supported by an international cross-sectional study which found that TV viewing duration was higher in overweight than normal-weight students among all participating countries[24]. However, it would be neglectful to assume that the impact of screen time on children's weight status is only attributed to the viewing behaviour, or lack of physical activity. TV watching also impacts on children's eating behaviours in at least two ways. First, children are more likely to consume high energy snacks whilst watching TV. Secondly, they are exposed to unhealthy food marketing during viewings. This wider environmental issue (concerning food marketing) will be discussed further in section 2.1.4.5.

Given an increasing number of studies confirming the relation of physical activity and sedentary behaviours, to children's weight status, there is some debate as to which health behaviour (promoting more physical activity versus reducing sedentary behaviours) should be targeted or prioritised in childhood obesity interventions[145].

Sleep duration

There is strong evidence showing that short sleep duration in infancy and childhood is associated with increased risk of childhood obesity across different populations[146,147], although the strength of such an association varied by child gender and age in some studies[147].

2.1.4.3 Family environment

While unhealthy life styles (e.g. diet, physical and sedentary behavior habits) are well evidenced risk factors for overweight and obesity in children, these life styles are largely determined or at least influenced by the wider environment. At the immediate level, this refers to their family.

Influences on children's dietary behaviours

Roles of parents' modeling on children's dietary behaviours have been extensively examined in cross-sectional studies[148-152,152-156]. A systematic review of factors determining consumption of fruits and vegetables among children and adolescents also confirmed the influences of parents[157]. Moreover, using food as a reward for desirable child behaviour and 'forcing' the child to eat perceivably nutritious food for a reward of child preferred food/activity are two typical parenting practices present in both high and low social-economic populations[158,159] in many countries[159]. However, studies have found that using food (often energy-dense but low in nutrition value) as a reward increased children's preference for the rewarded food[160] while forcing children to eat the food perceived by parents as good or nutritious in exchange for a reward (such as watching TV) reduced children's preference to the food eaten under pressure[161]. Those findings illustrate undesired impacts that inappropriate parenting style could have on children. At the same time, positive parental influences on children's diet have also been found in other studies[162]. Other family factors found to be associated with children's dietary behaviours include the availability of healthy food at home[163], parental perception of child weight status[164], poor knowledge of healthy/unhealthy food[165] and healthy eating[166], emotional rather than nutritional attachment to child feeding[167], conflicting child feeding opinions among family adults[164] and parents' education levels (especially mothers)[158,168].

Influences on children's physical and sedentary behavioural habits

Many studies have reported positive associations between parents' physical activity levels and those of their children[169,170]. This indicates that the role of parental modelling impacts on children's energy expenditure as well as energy intake. In terms of sedentary behavioural patterns, a cross-sectional study in Australia used questionnaire surveys in children (n=878, mean age=11.5 years) and parents, and collected children's accelerometer measures for 8 days[171]. They found that both fathers and mothers' TV viewings were highly associated with children's TV viewing[171]. Moreover, children's perceived use of computers by mother, as well as fathers' self reported use of computer games were both associated with children's physical inactivity positively[171]. Furthermore, instrumental and motivational support from parents were identified in some studies as important factors determining children and adolescents' physical activity levels[172,173].

Breastfeeding

Another theme in the study of determinants of childhood obesity at the level of family is breastfeeding. Although two major systematic reviews[174,175] on this topic suggested that lack of breastfeeding contributes to obesity development in children, several recent randomised control trials (RCT)[176,177] found that breastfeeding is unlikely to be causally protective against childhood obesity. Further work is needed to improve the evidence base.

2.1.4.4 Neighbourhood environment

Outside the family environment, factors contributing to childhood obesity or influencing obesogenic behaviours have been identified at both neighbourhood and macro-level environments. While the former primarily refers to physical structures and resources in people's residential areas (e.g. street structure, convenience store, open/green space and neighbourhood safety), the latter concerns societal environment and changes that are either tangible (e.g. automatisation in domestic life and transport) or intangible (e.g. mass media communication and state regulations).

Regarding neighbourhood environment, the international literature has documented availability[178] of and distance[179,180] to food outlets (e.g. convenience stores and restaurants) as correlates of children's weight status and dietary behaviours. For instance, a cross-sectional study administered food frequency questionnaire to 204 boys (aged between 10-14 years) and objectively measured the distance between their home and different types of food shops and restaurants. It was found that proximities to a convenience store and to a fast food restaurant were associated with boys' consumption of fruit and vegetables[180].

Moreover, several studies have also demonstrated neighbourhood environmental influences on children's physical activity levels[172,179,179,181-188]. There is some evidence showing gender differences with respect to the influences of neighbourhood

built environments on adolescents' physical activities. For males, a cross-sectional study found that boys living in a cul de sac and the presence of traffic calming measures were associated with increased physical activity[181]. In contrast, perceived availability of affordable/free recreational facilities[182,184], infrastructure for walking and cycling[182], aesthetics and street connectedness[182] have been found to be positively associated with physical activity in female adolescents.

2.1.4.5 The wider environment

A number of changes in the macro environments are considered to be related to unhealthy dietary patterns of people including children globally. Those changes include stronger productivity and distribution system of food[189,190], cheaper price for food high in fat (e.g. vegetable oils and animal meat)[189,190], intensive and extensive marketing behaviours of food companies mediated by TV[191] and other popular mass media channels[192], as well as the trend towards spending less time at home cooking[193] and reduced frequency of home dining[194,195]. Among those societal changes, marketing of unhealthy food and drinks targeted at children has received growing concerns from academics and state governments in many Western countries, such as Australia[196], the US[197], Switzerland[198], Turkey[199] and in Asia[191], for its dominant proportion in all TV-based food advertisements (often measured by content analysis). Importantly, children's TV viewing does not simply contribute to obesity by competing for children's time for physical activity. This sedentary behaviour

(i.e. children's exposure to TV advertisements for unhealthy food and drinks) has been found to be associated with unhealthy food preference[200] and poor eating behaviours in children[201-203]. There is also qualitative evidence that extensive and intensive unhealthy food marketing has created a negative social norm (peer pressure) among children that encourages the intake of food high in fat and sugar while discouraging the intake of healthier food such as fruits in schools[204]. Given those important implications of unhealthy food marketing through TV, some state governments have responded with specific regulations restricting food advertising targeted at children on TV. In Australia, removing TV adverts of high-fat and/or high-sugar food and drinks to children was estimated to be one of the most cost-effective interventions their government could implement on a population basis[196] to tackle childhood obesity epidemic.

As far as the global trend of decreasing physical activity levels of today's children is concerned, major macro-level forces contributing to this change include automatisations in domestic life[205,206], work and transportation[206] and increase in crime (so reduced neighbourhood safety)[172,186,187,207], reduced and unequal availability of spaces or facilities for physical activity[206] and shift from a traditionally out-door and active entertainment style to sedentary and screen-based and sedentary activities (e.g. TV viewing and computer games)[208].

2.1.4.6 Sociodemographic Influences

Findings from cross-sectional studies show that for a given BMI, children and infants from certain ethnic groups (e.g. south Asia) have higher adiposity than do their counterparts from other ethnicities [209-211]. Country of birth is also a risk factor identified in cross-sectional and ecological studies[212]. The relationship between childhood obesity and socioeconomic status (SES) varies across nations. In developing countries (e.g. China and Russia) children from higher SES are at greater obesity risk, whereas lower SES children are at risk in developed countries (e.g. the US and the UK)[213]. Moreover, childhood obesity prevalence was also found to vary by residential location, another common indicator of SES (i.e. rural versus urban residence)[2,213]. However, differences have been found across countries. As illustrated in an international cross-sectional study, childhood obesity was more prevalent in urban areas of China but in rural areas of Russia[213].

2.1.4.7 Summary

In this section, the complex nature of childhood obesity was seen when I reviewed the literature on its causes. The review covered genetic/biological determinants, child behaviour (diet, physical activity, sedentary behaviour, and sleep), and the physical or societal environments that contribute to children's obesogenic behaviours at family, neighbourhood and the wider environment levels. The sociodemographic contributors

(SES, ethnicity, country of birth, residential location) and the varied influences crossing different countries were also discussed.

2.1.5 Prevention of childhood obesity

The growing epidemic of childhood obesity has been accompanied by attempts at prevention by targeting one or a combination of modifiable childhood obesity risk factors at various level(s) (e.g. individual or environmental level) and setting(s) (e.g. family or school). Dietary intervention, physical activity promotion and sedentary behaviour reduction at the individual level have been the most popular intervention strategies[214,215] and schools are the most common setting for interventions[214,216,217]. In order to synthesise available literature on childhood obesity prevention and to strengthen the evidence base, a number of international systematic reviews have been conducted. However, the results of these reviews were inconsistent and inconclusive. While some systematic reviews conclude that there is insufficient evidence on effective interventions to prevent childhood obesity[214,218-221], other systematic reviews have identified certain characteristics of programmes that are promising[222-225]. To some extent, either conclusion is relatively subjective. First, the heterogeneity among primary studies prevents systematic reviewers from applying meta analysis techniques that can help to reduce the risk of making false negative conclusions[226]. Second, many systematic reviews reported concerns over publication bias[222], methodological weaknesses in primary studies,

especially regarding the validity or reliability of outcome measures[214-216,218], short duration for intervention and/or follow-up[214-216,220], sample size/power calculation[218,220], high participant dropout rate[216,218,222] and unclear description/absence of randomisation procedure[218].

Moreover, in terms of the effectiveness of certain intervention strategies, inconsistent results were reported by different reviews. For example, while a review by Doak showed that trials attempting to reduce TV viewing were all effective (intervention group showed a statistically significant improvement in one obesity measure in comparison to the control group)[222], Connelly et al's review found limited support for positive effect of TV viewing interventions[221]. Furthermore, while many systematic reviews found limited evidence[214,216,220,223] supporting any particular intervention's effectiveness in preventing childhood obesity, one systematic review showed the main factor distinguishing effective interventions from ineffective ones was the provision of moderate to vigorous aerobic physical activity on a compulsory rather than voluntary basis[221].

With a confusing range of evidence, it is important to acknowledge that variations in the results of systematic reviews are largely attributed to the differences in their reviewing/searching strategy or process. Firstly, selection of primary studies was more rigorous in some reviews than in others. For example, reviews conducted respectively by Summerbell et al[214] and Doak et al[222] both searched studies published up to

2006. However the first review limited its study search to trials aimed to prevent overweight, obesity or weight gain with a minimum duration of intervention of 12 weeks[214] but the latter took a broader approach including any study that had a dietary and/or physical activity intervention component with anthropometric measures at baseline and follow-up being reported[222]. As a result, 10 effective studies included in the second review were not included in the former, and the two reviews generated distinct conclusions regarding the effectiveness of intervention programmes. In particular, while Summerbell et al reported that the majority of their included studies were not effective in improving children's weight status[214], Doak et al found encouraging results (68% of included studies were effective)[222]. Such a contrast to some extents can be explained by the effect of 'stainless steel', which as Petticrew described implies that the more rigorous the review, the less evidence that intervention is effective[226]. Secondly, previous systematic reviews did not always define intervention effectiveness in the same way. Those systematic reviews that defined intervention effectiveness by behavioural measures (outcomes)[227] often generate more encouraging conclusions than do others that defined effectiveness in terms of obesity and anthropometric measures[214,218] such as BMI and skin folds.

The most recent systematic review of childhood obesity prevention interventions was conducted in 2010 by Summerbell, Water and colleagues[228]. Compared with their last review[214], over 30 more studies were found with similar inclusion criteria. In addition to intervention effectiveness evaluation, the latest review also had a secondary objective of identifying characteristics of interventions or strategies that were more

likely to bring about positive change in children's weight status. The review showed positive evidence of beneficial effects of prevention interventions on children's BMI, especially among the interventions targeting 6- to 12- years-old children, with children in the intervention group (all age groups) having a standardised mean difference in adiposity (measured as BMI or z BMI) of -0.15kg/m^2 (95% CI: -0.21 to -0.09)[228]. Some of the interventions or strategies that were identified as having promising effects were: school curriculum including healthy eating and physical activity, improving food nutritional quality in schools, supporting school staff in implementing health promotion activities, and parental support and home activities to encourage a healthy life style (be more active, eat more healthy food and engage in less sedentary and screen- based activities)[228].

In sum, although systematic reviews published before 2010 provided inconclusive evidence on the effectiveness of preventing childhood obesity, good evidence on the beneficial effects of prevention programmes on children's weight status was found in the more recent review. The knowledge base of what interventions and strategies would be effective in preventing childhood obesity was also improved. Moreover, there were several points that were commonly found in the results of some reviews. First, several reviews found differential intervention effectiveness by gender[217,219,222,229,230], which reflects a need for tailored intervention strategies for different sex groups. Second, future interventions should include multiple components targeting not only individual but also environmental factors[214,219]. It is also being advocated that primary studies as well as systematic reviews should collect and exploit all types of available data (e.g.

qualitative evaluation) when measuring intervention process and outcomes in order to build up a more practical-relevant evidence guiding future intervention practice[219,220,226,228].

2.2 Epidemiology and research on childhood obesity in China

2.2.1 Defining childhood obesity - the Chinese national standard

It is necessary to understand how childhood overweight and obesity are defined based on BMI in China before describing the prevalence and patterns in this country.

In November 2003, the Working Group on Obesity in China (WGOC) introduced a nation-wide standard (BMI cut offs) for estimating overweight and obesity prevalence in Chinese children and adolescents, which is known as the WGOC BMI reference norm[231]. This BMI reference norm was established based on a nationally representative sample (including 244,200 seven- to 18-years old urban and rural children from across China) that were included in the 2000 Chinese National Survey on Students Constitution and Health[232]. Since its introduction, the reference norm has

been used widely in China for epidemiologic research in Chinese children[233].

2.2.2 The prevalence of childhood obesity in China

This section discusses trends and current prevalence of childhood obesity in China.

2.2.2.1 Trend in childhood obesity

The most comprehensive and accurate report of historical changes in the prevalence of childhood and adolescence overweight and obesity in China was published in 2009[234]. In this study, overweight and obesity were defined based on the WGOB BMI reference norm; data were obtained from five previous rounds[232,235-238] of the Chinese National Survey on Students Constitution and Health (CNSSCH), which used a large nationally representative sample drawn from different regions of China rather than from several affluent areas. In 1985 the national average prevalence of overweight and obesity for seven to 18 years old children were 0.8% and 0.13% for boys, and 1.5% and 0.12% for girls respectively. Significant prevalence rises were first seen in north coastal cities of an upper socio- economic status such as Beijing. The year of 1985 thus was considered to be the beginning of China's epidemic of childhood overweight and obesity. Between 1985 and 1991, rapid increases in prevalence (2 to 3 times) were seen in all

cities of an upper socio-economic position across all sex-age groups. From 1991 to 1995, considerable increase in prevalence was seen in north coastal cities with a moderate or low socio-economic position. Between 1995 and 2000, the prevalence of obesity reached an epidemic level in all other cities as well as affluent rural areas, representing another important point of the epidemic change in China. Since 2000, the combined prevalence of overweight and obesity in North coastal cities has been approaching the level of some developed countries. In 2005, the prevalence of overweight and obesity were 19.8% and 13.2% for boys aged between seven to 18 years living in North coastal upper cities. The corresponding estimations for girls were 10.8% and 6.8% respectively.

Overall, taking into account the regional variations and population size in each region, the estimated prevalence of overweight and obesity in school-aged children (aged 7-18) in China was 11.44%, in 2005, representing around 186,750,000 children[239].

2.2.2.2 Descriptive epidemiology of childhood obesity in China

Using data collected for the 2005 round of the CNSSCH survey, the geographic distribution of childhood overweight and obesity in mainland China was described in a cross-sectional study[239]. The study showed that in 2005, the combined prevalence of overweight and obesity varied largely by geographical location (e.g. coastal versus

inland; North versus South) and the size of city population (e.g. large, medium or small cities).

Overall, overweight and obesity were more prevalent in coastal affluent areas than in inland upper cities. Northern regions had higher combined prevalence than their Southern counterparts. Across all regions, the highest combined prevalence was observed in North coastal big cities (32.5% and 17.6% respectively for boys and girls aged between seven and 18 years). Eastern and middle countryside had the second lowest combined prevalence (10.6% and 7.3% for boys and girls respectively). The lowest combined prevalence (5% and 3.9% for boys and girls respectively) existed in Western rural area[239]. The observed characteristics in the geographic distribution of childhood overweight and obesity in China are mainly attributed to the socio-economic disparity crossing regions. A number of cross-sectional studies in China[213] and in other developing countries[213,240] have shown that children from higher socio-economic areas are at increased risk for obesity compared to those from more deprived areas, which is different to the patterns observed in high-income countries where childhood obesity is negatively associated with socio-economic class[241,242].

Notably, in China the prevalence of childhood overweight and obesity also varied by child gender and age. Boys across all regions and age groups had a higher prevalence in both overweight and obesity than their female counterparts[239]. More interestingly, the prevalence of overweight and obesity was generally higher in children than in

adolescents[239]. This finding was consistent with the pattern observed in a cross-sectional study in Shanghai[31] but different to the case seen in many Western countries (where childhood obesity prevalence increases with age)[37,243-246].

2.2.3 Chinese literature on the aetiology of childhood obesity

Two meta-analyses have been published summarising the evidence on risk factors for childhood obesity based on studies in China, in 2002[247] and 2008[248]. The first review searched case-control studies (among children aged between zero and 14 years) published between 1999 and 2001 in Chinese journals. While quality assessment was mentioned in the article, no descriptions were given for the criteria. The reviewer initially identified 50 studies and 21 of them were finally included for meta-analysis[247]. The 2008 review specified its studies' inclusion and quality evaluation criteria but did not report the results for quality assessment. It searched case-control studies (among children aged between seven and 14 years) published up to 2008 in Chinese journals. In total, 79 studies were identified initially and 18 were included for meta-analysis[248].

Given the absence of some basic information about the two reviews' procedures and their selected primary studies (e.g. how overweight/obesity was defined and how exposures were measured), it is difficult to compare their results and to evaluate the quality of current evidence. Despite those limitations, the two reviews provided the best available

synthesis of Chinese literature on risk factors for childhood obesity.

2.2.3.1 Genetic and biological risk factors

Genetic and biological factors were identified in both reviews as important determinants of obesity among Chinese children, a finding similar to that of overseas studies. According to the 2008 review, the combined OR for being overweight/obese was 2.78 (95% CI:1.73-4.44) for having at least one obese parent, and was 3.14 (95% CI:1.30-7.55) for having a high birth weight[248]. Results from later longitudinal[249], cross-sectional[250], case-control[251] and genetic[252] studies supported those findings.

2.2.3.2 Behavioural risk factors- dietary behaviours

Both reviews highlighted dietary behaviours as important risk factors for obesity in Chinese children. In the 2002 review, good appetite (OR=10.52, 95% CI: 7.22-15.34), high-energy diet (OR=3.3, 95% CI: 3.12-3.56), frequent consumption of food high in fat (OR=2.44, 95% CI: 1.82-3.30), preference for sweet/sugary food (OR=2.23, 95% CI: 1.83- 2.71), high consumption of snacks (OR=1.93, 95% CI: 1.70-2.16) and fast eating (OR: 5.09, 95% CI: 5.17-6.26) were found to be important risk factors for obesity

in Chinese children but picky or unbalanced eating was found to be negatively associated with it (OR=0.40, 95% CI: 0.31-0.53)[247]. Results of the 2008 meta-analysis confirmed good appetite (OR=7.29, 95% CI: 3.82-13.91), fast eating (OR=2.38, 95% CI: 1.76-3.23) and high-energy diet (OR=2.23, 95% CI: 1.24-4.03) as risk factors for childhood obesity. Additionally, introducing solid food too early in infancy (OR=1.36, 95% CI: 1.01-1.83), high consumption of starchy food (OR=3.17, 95% CI: 0.64-15.80) and preference to deeply fried food or food high in fat (OR=2.10, 95% CI: 1.42-3.13) were also found as risk factors[248].

Results of a later cross-sectional study further support the associations between high-energy diet, fast eating and high consumption of deeply fried food, and children's weight status[253]. Moreover, findings from a more recent case-control study also confirmed the positive relation of high consumption of unhealthy snacks with childhood obesity. In particular, compared with children who did not have any unhealthy snacks in the previous week, the risk for being overweight or obese (defined by the IOTF standards) was nearly four times as high for children who consumed at least one serving of healthy snacks (OR=3.94, 95% CI: 1.11-13.99) [251]. Unhealthy snack consumption is therefore a consistent factor associated with children's weight status in Chinese studies, but this is not the case in literature from other countries.

2.2.3.3 Behavioural risk factors - physical activity and sedentary behaviours

Influences of physical and sedentary behaviours on weight status in Chinese children were mentioned by both reviews, although methodological limitations in the primary studies limit firm conclusions. In the first review, the combined OR for overweight/obesity was 2.09 (95% CI: 1.95-2.24) and 3.29 (95% CI: 2.70-3.29) respectively, for long hours of TV viewing every day (the meaning of 'long hours' was not specified in the review article) and disinterest in physical activity[247]. In the second review, spending long hours in TV viewing or playing computer games (OR=1.49, 95% CI: 1.33-1.67) and insufficient physical activity (OR=1.65, 95% CI: 1.38-1.96) were identified as risk factors for childhood obesity[248]. However, again, no information was given regarding the definition of 'long hours' and 'insufficient' in the review. Findings from more recent cross-sectional and case-control studies continue to support screen-based sedentary behaviour[233,251] and physical inactivity[233] as risk factors for obesity in Chinese children.

In summary, the evidence base for diet and physical activity related risk factors for obesity in Chinese children is limited due to methodological weakness in most of the primary studies. Studies most often used self-reported rather than objectively-measured risk factors and outcomes. Moreover, prospective studies are lacking in the literature. A relatively well documented risk factor in the Chinese literature is TV viewing. However, there has been little research examining the mechanisms by which TV viewing impacts

on weight status (e.g. on diet and physical activity patterns) among Chinese children, although such mechanisms are hypothesised in the international literature.

2.2.3.4 Sleep duration

Since 2008, several cross-sectional studies[233,254,255] found negative associations between children's sleep duration and childhood obesity, consistent with overseas literature on this topic. However, longitudinal evidence is lacking.

2.2.3.5 Research gaps

As illustrated above, several Chinese studies have examined genetic and behavioural risk factors of childhood obesity. However, not only is the quality of existing aetiological evidence limited, but the scope is also insufficient. In particular, the environmental dimensions contributing to childhood obesity have received little attention in previous research.

As discussed earlier in the international literature review, children's obesogenic behaviours are likely to be influenced by the immediate and wider environments they

live in. However, the majority of previous studies examining environmental factors were conducted in Western countries. In China, little research has been done to understand societal factors influencing obesogenic behaviours among Chinese children.

Another major research gap in the Chinese childhood obesity prevention literature is the absence of qualitative research to help contextualise the environmental determinants of obesity and related behaviours. Qualitative research aims to achieve an in-depth understanding of human behaviour, experience or social phenomenon in terms of its reasons (why) and process (how) rather than its numerous properties that answer the questions of how many and how often[256]. Increasingly, qualitative research is used to generate explanatory theories that can be tested in, and applied carefully to, similar research settings and populations. It therefore has potential to contribute to explain the modifiable determinants of childhood obesity and inform intervention. In many developed countries, a wide range of qualitative research methods (e.g. focus groups, personal interviews and ethnography) have been exploited to explore not only people's perceptions of the causes[159] and relevance/importance of obesity[120], but also their perceived barriers and facilitators in relation to the adoption of healthy behaviours[257-260] and the delivery of health interventions[258,261,262].

Therefore, studies exploring and examining societal/environmental determinants of childhood obesity and obesogenic behaviours in China are needed. A good understanding of what and how environmental factors influence Chinese children's

health behaviour will allow identification of opportunities for change.

2.2.4 Childhood obesity prevention research in China

As far as childhood obesity is concerned, the majority of Chinese intervention studies have concentrated on treatments among overweight and obese individuals, through promoting physical activity, modifying dietary behaviours and health/nutritional education[263,264]. Most published studies were effective in improving outcome indicators such as body weight and BMI[263,264]. Population-based preventive interventions are relatively lacking in this country. As a result, two systematic reviews that have been conducted to synthesise Chinese intervention studies, included both treatment and prevention trials. In this section, I will review the current literature on childhood obesity prevention in China.

2.2.4.1 Current literature and evidence base

The two systematic reviews of Chinese intervention studies on childhood obesity were both published in 2008[263,264] and did not use meta-analysis because of heterogeneity between studies. A summary of the two reviews is showed in table 1.

Table 1 Summary of characteristics and findings from two systematic reviews of Chinese obesity intervention studies

	Gao et al (2008)	Li et al (2008)
Inclusion criteria	Prevention studies Targeting overweight/obese subjects Children/adolescent-focused Adult-focused Duration \geq 3 months Having a control group Objective anthropometric measures	Prevention studies Targeting overweight/obese subjects Children/adolescent-focused Studies with or without a control group Any duration of intervention or follow up
Exclusion criteria	Drug-based treatment Clinic-based No control group No objective anthropometric outcome measure	Using clinical samples Drug-based treating interventions
Definition of effectiveness	Statistically significant benefits in outcomes in the intervention group compared to the control ($p < 0.05$)	Outcome showed a significant difference in the intervention compared with the control group ($p < 0.05$)
Quality assessment	Based on Quality Assessment Tool for Quantitative studies and the appraisal criteria recommended by Cochrane Effective Practice	Using 'Effective Public Health Practice Project Quality Assessment Tool'
Publication time & searched databases	Studies published by June, 2006, used 3 Chinese databases and 9 English databases	Studies published between 1990 and 2006, used 2 Chinese databases and 2 English databases
Main results	14 children/adolescents studies included, 6 were population-based. Of the 6, 4 were effective in both sexes and 1 was effective in girls only.	22 children/adolescents studies selected, 6 were population-based. Of the 6, 5 were effective by anthropometric measures and 1 was effective in improving knowledge, attitudes and behaviours (KAP) only.

There were inconsistencies in the two reviews' findings, despite both covering the same study period. Those variations might be explained by the differences in the two reviews' inclusion and exclusion criteria, as well as the number of databases used. For instance, the first review only included studies with a control group and with an intervention duration not less than 3 months while these were not required in the second review.

In general, the findings from the two reviews suggest that childhood obesity prevention interventions in China are generally effective. However, publication bias (in favour of studies with significantly positive results or findings that were supportive of research hypotheses) was noted as a limitation by authors of both reviews[263,264]. Moreover, common methodological flaws in Chinese intervention studies (both included and excluded studies) were highlighted. These are inconsistent and unclear definitions of childhood overweight/obesity, lack of a control group, poor reporting or no assessments of intervention results, poor reporting of participation and dropout rates, poorly described or lack of randomisation, limited results on follow up and long term effects (intervention sustainability), and scant attention to research governance issues, such as ethical review and obtaining participant consents[263,264].

Despite the limitations of previous obesity prevention studies in China, some useful clues regarding promising interventions strategies were identified. They inform directions for further research. Firstly, the existing evidence shows that physical activity promotion, dietary interventions (e.g. avoiding sugary drink, snack and western fast food) and health education (encouraging physical activity and a healthier diet, and improving health knowledge) were effective components, especially when they were implemented jointly[263]. Secondly, engaging children's interest and involvement of parents appeared to be a key factor for effective physical activity promotion and dietary intervention respectively[263].

2.2.4.2 Research gaps

Other than the methodological limitations discussed above in relation to the conduct of previous childhood obesity prevention trials in China, interventions were rarely developed, implemented and evaluated following any kind of theoretical models. In contrast, a number of theoretical frameworks and behavioural change theories have been developed and applied to childhood obesity prevention in developed countries.

One recommendation from both of the two Chinese systematic reviews was the urgent need for well-designed and implemented prevention studies in China. However, to my knowledge, none of the prevention trials conducted between 2008 (when the systematic reviews were published) and now was theoretically guided. The most recent and largest multi-centre childhood obesity prevention RCT (completed in 2010)[265] that was conducted in six provinces of China was no exception. This may be due to a lag in the adoption of new concepts from the international literature in China, or may reflect cultural differences and the fact that the obesity epidemic in China is less advanced than in Western countries.

Examples of internationally established theoretical frameworks or models that have been used in childhood obesity prevention are described below.

Psychological and behavioural change theories relevant to childhood obesity prevention

Psychological and behaviour change theories focus mainly on understanding and influencing individuals. They aim to explain cognitive, psychological and practical factors driving certain behaviours, and so provide strategies to alter, promote or discourage the behaviours. Health interventions or programmes applying those theories usually aim to promote people's healthy behaviours through altering or improving their perceptions (e.g. motivation and attitude), intention and efficacy in relation to the behaviours. At the individual level, the most commonly used theories are the Health belief model (HBM), Social cognitive theory, Social learning theory, Transtheoretical (stages of change) model, Theory of trying and Protection motivation theory[266]. As well as focusing on behaviour, some of the models also consider interpersonal factors, recognising that human beings are influenced by as well as influencing the wider society they live in. For instance, the Theory of Planned Behaviour (TPB) assumes that subjective norm is one of the three factors determining one's intention to perform certain behaviours. It also posits that the individual's perceived ability to perform the behaviour directly influences his or her actual behaviour[267,268]. This perceived behaviour control in turn is shaped by a number of factors that can include wider environmental barriers, implied in those environmental models[268].

Environmental models

Environmental models assist our understanding and alteration of individuals' environments at different levels. One example is the analysis grid for environments linked to obesity (ANGELO framework), which was developed to facilitate identification and prioritisation of areas to target for environmental intervention[269]. This conceptual framework helps users understand the obesogenic environment in terms of physical, economic, political and socio-cultural influences at both local and macro levels. Moreover, The IOTF introduced a causal web of societal policies and processes with direct and indirect influences on the prevalence of obesity[270]. This analytical model describes multiple-level environmental impacts on an individual covering family, institutional, community, regional, national and international factors. It is also useful for identifying and targeting intervention areas. The ecological model for health promotion is similar to the above two environmental models. It depicts environmental influences on an individual in five layers: intrapersonal factors (e.g. knowledge and attitude), interpersonal structures (e.g. family, peer groups), organisational factors (e.g. school), community factors (e.g. geographic or political conditions) and public policy (e.g. at local and national levels)[271]. A main feature of this model is its recognition of the interdependency crossing the levels of influence as well as the factors at different levels[272].

The key strength of environmental models is that they help users to identify multiple-level factors contributing to the health behaviour of interest. They also recognise the interrelations among them. However, these models are primarily descriptive in nature so offer limited clues about how to modify or influence identified

factors strategically, especially at the micro and intrapersonal levels[273]. Moreover, environmental interventions often require substantial funding and their impacts are difficult to measure in practice, especially in the short term. Therefore, psychological and behavioural change theories that primarily target individuals are useful in guiding the development of intervention strategies and in fact they have been more commonly applied in intervention programmes than environmental models[274].

Some academics tend to regard the two broad health promotion approaches as alternative or even incompatible to each other. However, recent literature advocates the use of an integrated approach for more effective and sustainable intervention outcomes[214,275-277]. It is also useful to note that an integrated approach does not only mean interventions are needed at both individual and environmental levels. When developing an intervention programme, one can locate and interpret identified influential factors with reference to an environmental model, and then apply one or a combination of behaviour change theories to inform a strategic design and delivery of the intervention. Studies applying multiple but complementary intervention strategies and theories may bring new opportunities and improvement for childhood obesity prevention.

Theoretical frameworks for intervention development and evaluation

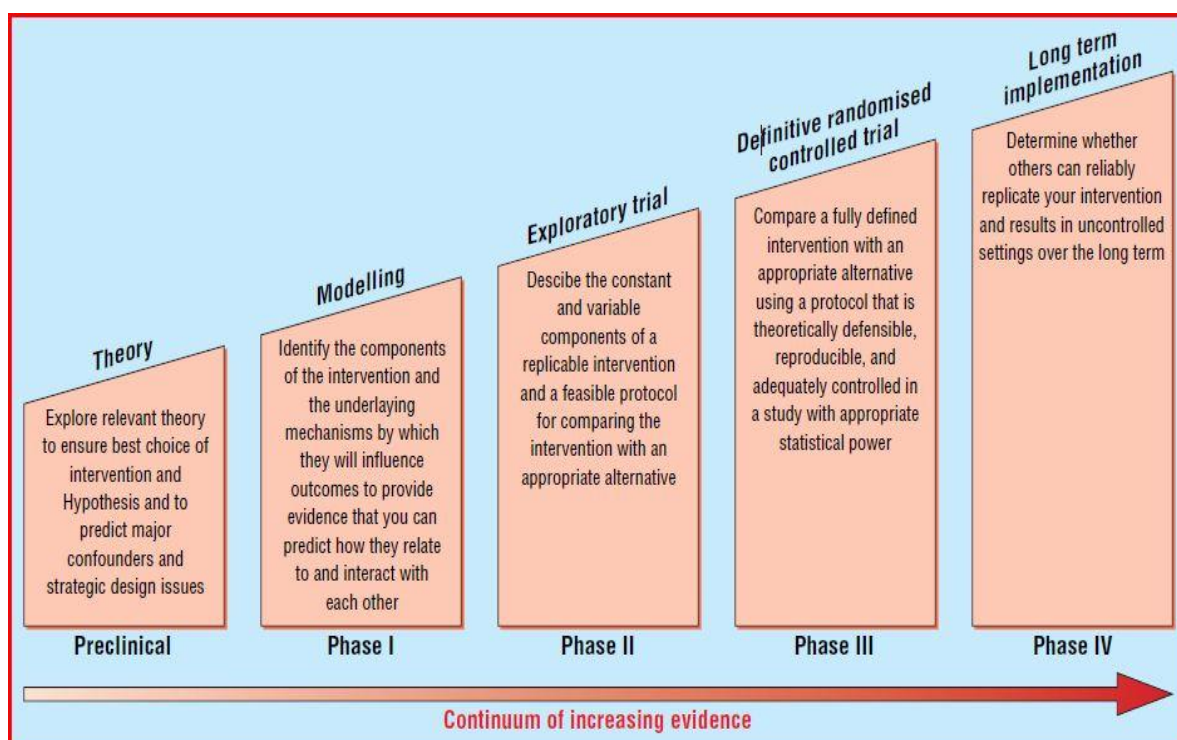
Given the multi-dimensional nature of factors contributing to obesity and the

complexity and diversity of human behaviour, development of obesity prevention interventions are challenging. To support the effective development, implementation and evaluation of complex health intervention programmes like obesity prevention, a number of theoretical frameworks have been developed. I will discuss two of these below: one advocated by the UK Medical Research Council (MRC), the other developed from a social science perspective (Social Marketing).

The MRC Framework

The MRC framework for design and evaluation of complex interventions to improve health (MRC Framework) provides an iterative and phased approach utilising both qualitative and quantitative methods to improve the design, execution, evaluation and generalisability of interventions that involve multiple, independent or interconnecting components[278]. Figure 1 provides an overview of the framework.

Figure 1 MRC Framework for design and evaluation of complex interventions to improve health



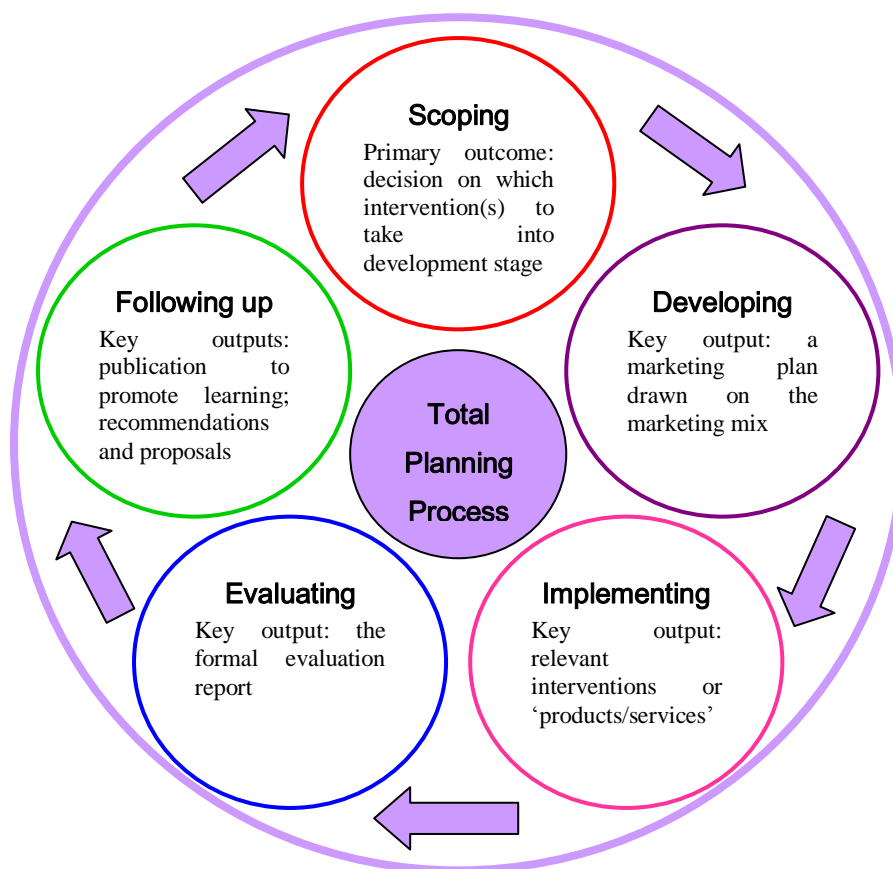
Source (with permission): Campbell et al, 2000[279].

The MRC Framework was developed as a parallel approach to that which has been used in evaluating new drugs, but it recognises and addresses the difficulties associated with complex health interventions[280]. It is stressed that application of the MRC Framework should be flexible, particularly during the first 3 phases, in which literature review/evidence identification, components definition and testing exploratory trial's acceptability and feasibility could be conducted simultaneously or iteratively[280]. This is thought to help understand and define the context of the problem in question, and conceptualise it. In addition, use of psychological and behavioural change theories is also recommended in those research tasks because it can aid understanding of the pathways by which the problem is caused[280].

Social Marketing

Social Marketing is a strategic framework that has been applied by Western governments[281-284] and not-for-profit organisations[285-288] to change or promote individual behaviours for improving social issues such as non-communicable chronic epidemics, climate change, road safety and blood donation since the 1970s[289]. An early definition for Social Marketing was ‘the use of marketing principles and techniques to influence a target audience to voluntarily accept, reject, modify, or abandon a behaviour for the benefit of individuals, groups, or society as a whole’[289]. Specifically to the field of public health promotion, French and Blair-Steve defined health-related Social Marketing as ‘the systematic application of marketing concepts and techniques to achieve specific behavioural goals, to improve health and reduce health inequalities’[290]. Recent advancement in Social Marketing has given more attentions to upstream impacts (i.e. environmental/policy changes), in addition to the traditional downstream focus (i.e. influencing the individuals). This is reflected for example, by Donovan and Henley’s comprehensive interpretation of Social Marketing’s goals: changing population prevalence of undesirable behaviours; changing the products people use that influence health and wellbeing; changing the places people live, work and play to reduce harm and promote wellbeing; changing the political environments to ensure equality of access and opportunity in society[288]. Figure 2 shows one of the established Social Marketing frameworks - TPP, that was developed to guide the cyclical process for designing and improving complex interventions.

Figure 2 The Total Planning Process



Source: French and Blair-Stevens, 2005[291] (an amended version of the original figure).

Implementing social marketing in practice often involves use of well established behaviour change theories such as the Exchange Theory[292], TPB[293], Social cognitive theory[294], Health belief model[295], Persuasion Theory[296] and Stage of change theory[297]. Effectiveness of social marketing in design of obesity prevention interventions, especially in changing related health behaviours has been well demonstrated by community-level[286], national-level[284] and cross-national[298] intervention programmes as well as several systematic reviews[285,299] on this topic.

It is worth noting that while the MRC framework and the TPP for Social Marketing originated from different disciplinary background, they have much in common. For example, both frameworks place a great emphasis on the importance of formative research (i.e. theoretical/modelling phases in the MRC framework match the scoping and developing phases in the TPP) and recognise the continuous characteristic and necessity in developing and evaluating complex interventions. As interdisciplinary research is increasingly valued in public health research, it appears that the differences across various theoretical frameworks are becoming a matter of variations in terminology or tradition/preference about how an idea or concept should be labelled.

2.2.5 Summary

Most of the research on childhood obesity in China focuses on describing *what* Chinese children's obesogenic behaviour consists of (quantifying the range and extent of obesogenic behaviours among Chinese children); reporting the prevalence of childhood obesity; and examining genetic and behavioural risk factors of childhood obesity. However, there has been limited research to explore and investigate *why* Chinese children undertake obesogenic behaviours, in order to inform the development of prevention interventions. Studies focusing on the societal/environmental determinants of childhood obesity are scarce in the Chinese literature. Although environmental factors influencing obesogenic behaviour have been studied in other countries, the distinct historical, cultural and contextual influences as well as lifestyle in China may mean that

health behaviour change barriers may differ and that interventions may need to be tailored accordingly. Moreover, the majority of preventive intervention studies were not theoretically based.

If the childhood obesity epidemic in China is going to be controlled effectively, there is an urgent need to seek a better understanding of factors underlying the development of unhealthy dietary habits and an inactive life style among Chinese children. Tackling obesity, especially childhood obesity is a complicated and challenging task, appropriate application of well established behavioural change theories and intervention frameworks may aid the development and delivery of effective prevention programmes.

2.3 The overall aim of the research project

Based on the identified research gaps discussed, the aim of this study was

1. To provide more detailed information on the perceived causes of childhood obesity, preferred intervention components and delivery strategies, through use of qualitative methods (chapter 3); and
2. To identify family and neighbourhood environmental correlates of child overweight/obesity and obesogenic behaviours using a cross-sectional study (chapter 4).

Detailed research objectives and questions are described at the beginning of chapters 3 and 4. The findings from these two studies were combined to inform the principles for culturally relevant childhood obesity prevention interventions in the research population (chapter 5). Together, the Theory and Modelling phases of the MRC Framework were addressed, with the potential interventions' delivery strategies being discussed with a Social Marketing approach.

3 UNDERSTANDING FACTORS INFLUENCING CHILDHOOD OBESITY IN CHINA AND INSIGHTS INTO INTERVENTION DEVELOPMENT

3.1 Background

The rapidly growing childhood obesity epidemic worldwide and in China has been described in the literature review chapter. In general, the national prevalence of childhood obesity in China grew by 34-fold and 22-fold respectively for boys and girls between 1985 and 2005. Great variation in prevalence by socioeconomic status and geographic location was also discussed earlier, with children in urban areas having the highest prevalence; up to 32.5% of boys living in North coastal upper cities were overweight or obese[239]. However, as discussed before, most research in China in the field of childhood obesity has focused on genetic and behavioural-level risk factors[247,248]. Investigation, especially through qualitative methods, of societal factors underlying children's unhealthy behaviours is lacking. Also the majority of

previous studies assessing obesity preventive interventions in China were not based on formative research nor on well-established theoretical frameworks or models for behaviour intervention or change.

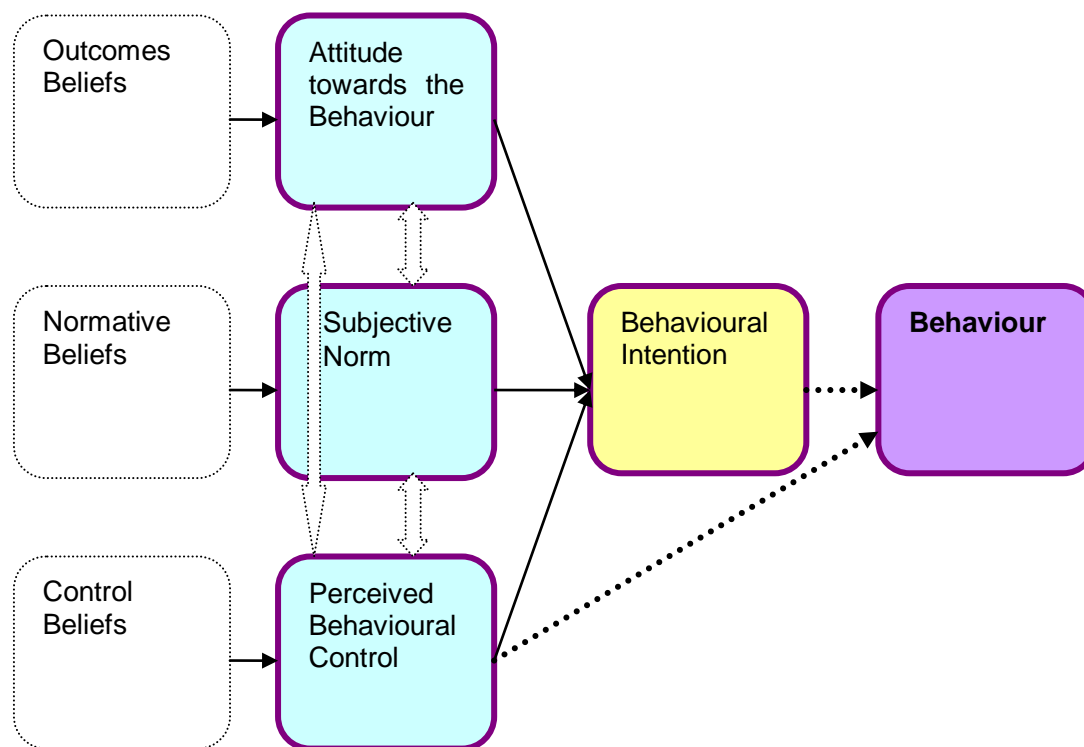
In developed countries, while evidence for the effectiveness of prevention has been inconsistent[214,221,222,224,225], it is generally acknowledged that interventions must address individual and multi-level environmental factors influencing children's health behaviour[214,300]. A growing body of literature has documented factors contributing to children's unhealthy dietary behaviours and physical inactivity or sedentary behaviours. These include findings from qualitative studies and related reviews that aimed to understand the perceived influence of attitudes[167,301,302], social norms[120,167,258,303], behavioural barriers[167,257-259,304-306], the family[159,164,302,307] and the wider environment[167,186,258,302] on children's health behaviour. Epidemiological studies and reviews have also examined the associations between these factors and children's weight status[207,308-310] or related health behaviour[311,312].

In parallel to the advancement in knowledge of the aetiology and better understanding of the factors associated with childhood obesity, a wide range of interventional frameworks and behavioural change theories have been developed and applied to obesity prevention. The various theoretical frameworks arise from different disciplines, but all recognise the diversity of individuals and their communities, and the importance of gaining an in-depth

understanding of factors influencing the adoption of health behaviours in the target populations.

The Theory of Planned Behaviour (TPB) is one of the most widely known and tested behavioural theories[313,314]. TPB posits that the best predictor of a behaviour is behavioural intention, which in turn is determined by attitudes, subjective norms and perceived behavioural control in relation to the behaviour[268] (Figure 3). Attitudes are formed by beliefs about the expected outcomes from undertaking a particular behaviour. Subjective norms relate to a person's perception of social pressure to perform (or not) the behaviour, based on significant others' approval or disapproval of performing the behaviour.

Figure 3 Theory of Planned Behaviour (an amended image of the original model published by Ajzen I in1991)[268]



A considerable body of TPB literature has examined the predictability of the theory and its components on dietary behaviours[293,315,316] and on physical activity[317-320]. The dietary studies are mainly primary studies, and overall suggest that self-efficacy, behavioural control and attitudes are all important in predicting dietary behaviour in adults. In relation to physical activity, there are several meta-analyses of primary studies that have examined the extent to which the components of the theory predict behaviour. Overall, these conclude that components of TPB are good predictors of intention and adherence to physical activity targets. A more recent review, evaluating the ability of several commonly used behavioural change theories (including TPB, Theory of Reasoned Action, HBM and Stages of Change Model) in predicting a range of health

behaviours (including obesogenic behaviours), found that TPB's predictive performance was better than the other theories examined. Overall, the theoretical components of TPB was able to explain up to 34% of observed behavioural variance[321]. However, given the fact that previous TPB studies have predominantly focused on the adult population, the theory's efficacy in explaining children's health behaviours is unclear. It has also been noted that TPB is less frequently used to develop behavioural-change interventions explicitly[322]. Nevertheless, one systematic review reports on behaviour change interventions that applied TPB. The review reported that 11 of 14 interventions identified which used TPB, targeted school and university students, and that one third of those interventions were effective in changing behaviours while the effect sizes varied between small and large[322]. Despite this, the reviewers concluded that there is currently insufficient evidence on whether components of TPB mediate changes in behaviour or intention, and that further research is needed to examine this question.

Although TPB targets individual behaviour change, it is worth remembering that TPB's psychological constructs are interactive, and both influence and are influenced by, the individual's environments. TPB provides a useful tool to understand environmental as well as individual determinants of obesity related health behaviour. It thus can assist in the development of preventive interventions.

Designing and delivering effective childhood obesity preventive interventions in China requires an in-depth understanding of what factors influence Chinese children's health behaviours which promote obesity. In particular, a better understanding of societal and

environmental determinants is needed to inform intervention development. Whilst such studies have been undertaken in other populations the findings may not be directly applicable to the Chinese population[300]. In this chapter, I report the findings from a qualitative study undertaken in South China, to improve our understanding of the factors influencing childhood obesity, and to inform future intervention development.

3.2 Research aim and objectives

Study aim

The aim of the qualitative study was two-fold:

1. To explore factors perceived to be contributing to obesogenic behaviours among urban Chinese primary school age children; and
2. To understand preferences for preventive interventions among important stakeholders relevant to children, in order to inform the *targeting* and *delivery strategies* for future preventive interventions.

TPB was used to assist the transformation of the qualitative findings into the theoretical base for identifying targets of future preventive interventions.

Research objectives

In order to achieve the aims, the following objectives were set:

1. To explore the perceptions of stakeholders in relation to factors influencing obesity,

dietary behaviours and physical activity levels among primary school aged children living in urban China;

2. To derive a prioritised list of interventions (based on group consensus) perceived by stakeholders to have high importance and to be feasible in the target population;
3. To gain understanding of why certain interventions were prioritised by stakeholders and how group consensus was derived; and
4. To understand stakeholders' preferred delivery strategies for prioritised obesity prevention interventions and thus gain insights into perceived barriers and facilitators for intervention delivery.

For the last objective, inevitably the discussion around delivery strategies would be focused around a limited number of interventions prioritised by each group. Nevertheless, the *insights* (e.g. perceived facilitators and barriers) gathered are likely to be applicable to many other interventions with similar target populations, components and settings.

3.3 Research setting

The study consisted of focus groups and interviews with a range of participants relevant to school age children. These were conducted between December 2009 and May 2010 in two urban cities of Southern China: Guangzhou (GZ) and Hechi (HC).

Selection of the sample schools

Data collection took place in four socioeconomically distinct primary school communities. Three in GZ, comprising low, middle and affluent class communities and one affluent class community in HC. The schools were selected following consultations with experienced researchers from local education and healthcare authorities. A key consideration was the diversity and representativeness of the student population (i.e. good representation of the full range of family socioeconomic backgrounds). The four schools selected for the current study had been used by the local Health Bureau as sample schools for routine (every 5 years) school student health monitoring. Therefore, they were considered to represent the diversity of pupils by the city Authorities, and the school staff had a particular strength in facilitating the research fieldwork through their previous cooperative experience in public health research.

Access to the schools was approved by the Guangzhou Education Bureau and Hechi's local government. Ethical approval was obtained from the Life and Health Science Ethical Review Committee at the University of Birmingham.

The cities of Guangzhou and Hechi

Both GZ and HC are geographically located in the South of China. GZ is the capital city of Guangdong province with close to nine million urban residents at the end of

2009[323]. It is a modern industrial city, providing manufacturing and design of goods for many multinational and a significant proportion of Chinese companies. The city comprises of ten urban and two rural districts with an urban area of 3,834.74 square kilometres[323]. HC is based in the north-west of Guangxi province, next to Guangdong. It is made up of several urban districts, towns and villages. Some of these sub-regions are among the least developed in China. Jinchengjiang (JCJ) was home to 377,600 residents at the end of 2006 and it is the largest and most advanced urban district of HC[324]. It used to be a city on its own but since nearby towns and villages were combined to create HC city, it became a district of the new city functioning as the governing, economic and cultural centre. JCJ is 2,340 square kilometres[325] and its economy has experienced rapid development in recent years[326].

Primary education system and relevant national policies in urban China

The system of primary education, particularly in terms of management and everyday running, are very different in China compared to many Western countries. Thus, a brief description of the characteristics of urban Chinese primary schools and national policies that are related to health promotion is provided below, in order to assist understanding of the study setting.

Full time primary education (between age 6/7 and 14/15) has been compulsory in China since 1986 and is provided free of charge. This consists of six years (grades 1-6)

primary and three years of middle school. Official reports suggest that registration rates were close to or equal to 100.00% [327,328] in the 2010/2011 academic year.

In urban areas, primary schools tend to be very large, with each grade (year group) having four to six classes and each class containing 40 to 70 pupils. Traditionally a class-level head teacher is assigned to each class, who stays with the class throughout the six years of primary education, and oversees teaching of core subjects as well as the general wellbeing and development of the children in that class. This class-level head teacher thus knows the individual pupils and their families well. Another role for the class head teacher, is to hold regular classroom meetings with family members of all the children in the class (parents or carers), without the children being present. These meetings tend to have high attendance and are used for communications in relation to children's learning performance (particularly in exams), general behaviour and any new developments or policies in the school.

Most urban primary schools (especially if pupil numbers ≥ 600) also have at least one full time and in-house doctor or nurse, who is responsible for school hygiene planning and management, regular health checks for pupils (including data analysis and storage), first aid, standard vaccinations and delivering the health education curriculum (see below) [329]. Where a school does not have a school doctor or nurse, these tasks are carried out by senior administrative staff in the school. The Chinese Ministry of Education requires delivery of the 'Health and Hygiene Education' curriculum in

primary schools, which includes five themes: healthy behaviour and lifestyle (e.g. eyes, teeth and dietary health), disease prevention (e.g. the importance of vaccination, under-nutrition and overweight), psychological health, body development and wellbeing during puberty, and safety in emergencies. Six to seven lessons (45 minutes each) are expected to be delivered in each academic term and they can be taught by school doctors, or nurses, class teachers and PE teachers. Texts books are not nationally standardised but developed and approved by local education authorities to reflect local resources and contexts[330].

Since 2007, the Chinese Ministry of Education requires primary, middle and high schools to ensure that all students engage in at least one hour of physical activity on campus daily[331]. The PE curriculum standards for primary schools are: four lessons every week for the first and second grade students; and three lessons every week for students of higher grades. For days without a PE lesson, schools are required to organise one hour collective physical activity in the afternoon. In addition, every morning, schools should organise 25 to 30 minutes of physical activities for all students. These lessons are required to be included in the schools' education plans and timetables[331]. However, given inadequate enforcement and surveillance power, the implementation of this national policy has been generally unsatisfactory. In 2010, the Ministry of Education sent out a policy paper to re-emphasise implementation[331]. In 2011, it was made clear that schools' implementation performance are monitored by education authorities as well as society, media and families, and that their evaluation results are to be linked directly to schools' Annual Excellence Evaluation[331].

The Chinese Ministry of Education also requires primary and middle schools to deliver ‘moral, life and society’ curricula[332]. The general aims, curriculum characteristics and implementation recommendations are given but individual regions and schools can design and use locally specific text books. For young students, curriculum content is set to cover four themes: healthy living, happy living, living with responsibility and care, and living with intelligence and creativity[332]. Lessons can be delivered and learnt by classroom activities or through special visits to museums, farms, factories or other relevant venues outside of school. Examples of suggested possible learning methods include group discussion, reference material searches, discussion of personal experience, role play, games, and story reading[332].

Finally, as far as school meal provision is concerned, the two operational models in urban Chinese primary schools are school-run and school-outsourced. With the school-run model, the kitchen and its staff are managed and funded by the school budget. With the out-sourced model, an external catering company that is approved by the local education authority prepares and delivers meals to the school students. Whichever model is adopted in a school, one single menu is available on any school day and cooked meals are packed into food boxes or bowls and delivered to classrooms. Also, the menu and price are always pre agreed by all parties. Moreover, food stores and vending machines are not permitted in Chinese primary schools.

3.4 Methods

3.4.1 Participants

A range of stakeholders relevant to children were identified for participation in the study. These included family members, a range of school staff and retailers working in shops nearby to schools. School staff assisted in purposively identifying and inviting participants in their respective schools. The recruitment process was facilitated by use of standardised participant information sheets and consent forms (Appendix 1). Focus group participants were invited for each school community by identity group to ensure discussion of shared experiences[333]. These included separate groups for i) parents; ii) grandparents; iii) class-level teachers and school nurses; iv) PE teachers; v) catering staff responsible for children's school meals and shop retailers. Inclusion of head teachers in the same focus group as other school staff was likely to introduce a power imbalance and may have impeded discussion. They were therefore invited for individual interviews, following a similar topic guide to that used in the focus groups. All identity groups were included for each school community in GZ, but only family member focus groups and interview with the head teacher were conducted in HC. A minimum of 5 participants with at least 2 males and 2 females were invited for each focus group. Informed consent was sought for all participants.

3.4.2 Focus group process

All focus groups were held in meeting rooms within the sample schools and consisted of 2 sessions, lasting for approximately 90 minutes in total. They were moderated by an experienced native Chinese speaker (myself) and all sessions were audio recorded.

The aim of the first session was to explore participants' perceptions of childhood obesity in China, perceived contributory factors and to facilitate them through a process of prioritising potential components for an intervention to prevent childhood obesity. For the latter process, intervention components used in previous published childhood obesity prevention trials were summarised (by deriving information from five major systematic reviews[214-216,222,223] of childhood obesity prevention studies) and presented to participants. A total of 42 intervention components were identified and categorised into three groups (Appendix 3): interventions aimed at promoting children's i) healthy diet (14 components), ii) physical activity (15 components) and iii) both healthy diet and physical activity (13 components). Intervention components were also categorised according to the target setting: family (14 components), school (23 components) and community (5 components). Participants were asked to individually score from amongst these potential interventions, which three they perceived to be the most important for preventing childhood obesity in China, irrespective of other considerations (Appendix 4). They were then asked to mark the three interventions they believed were most feasible for

implementation in their community, irrespective of how important they believed they were (Appendix 5). Participants were allowed to choose the same intervention component for both tasks if they wished.

During a break for participants, the moderator summarised the individual rankings for the group by assigning a score of 3, 2 or 1 for each component ranked as first, second or third respectively on each prioritisation sheet (Appendix 6). Scores for importance and feasibility were combined with equal weighting. Thus each potential intervention component had a score for importance, feasibility and total score based on the combined group ranking. The three intervention components with the highest combined score for importance and feasibility from the group were identified to discuss during the second session.

The aim of the second session was to gain an understanding of preferred strategies for the delivery and implementation, and to explore perceived barriers for the prioritised interventions. The framework for discussion for this session was informed by the conventional strategic mix (4Ps) of social marketing: Product (e.g. promoted behaviour/concept, tangible/intangible supporting service and materials such as leaflets, handbooks, web content), Price (e.g. various kinds of costs including time, to those receiving or providing the resource, associated with the adoption of the promoted behaviour), Place (e.g. where the promoted behaviour is performed and where supporting service/promotional activities are delivered, e.g. school, home, community) and

Promotion (e.g. strategies used in communication with target audience to give information and maximise participation)[334]. Table 2 summarises the focus group procedure. The working topic guide is presented in appendix 2.

Table 2 Schedule and topic guide for focus groups

Session	Aim	Activities/prompts	Notes
Session One (35 minutes)	<p>1. To explore understanding and perspectives of childhood obesity</p> <p>2. To explore participants’ attitudes toward childhood obesity prevention and perceptions of children’s related health behaviour</p> <p>3. To prioritise potential prevention intervention components</p>	<p>How do you know a child is overweight, obese or normal weight? What do these terms mean to you?</p> <p>1. Do you think that overweight/obesity is an issue for children in China?</p> <p>2. What about in your community, is it an issue here?</p> <p>3. What do you think of primary school children’s dietary behaviour/pattern/habits in general?</p> <p>4. What do you think of primary school children’s physical activity levels in general?</p> <p>1. Participants given time to look through summaries of potential interventions. 2. Each participant is asked to independently rank their first, second and third choice for most important/effective interventions. 3. Participants are asked to independently rank their first, second and third choice for most feasible interventions.</p>	<p>Participants’ discussions often naturally flowed into 3 and 4 after the moderator asked questions 1 and 2.</p> <p>1. Coloured A3 sheet summarises 42 interventions according to target behaviour and setting.</p> <p>2. Participants were told that interventions chosen for sheet 1 can also be chosen for sheet 2, if they wish.</p>
Session Two (40 minutes)	<p>1. To arrive at group consensus for top 3 intervention components.</p> <p>2. To explore perceived barriers to delivery and implementation of prioritised interventions.</p> <p>3. To discuss preferred delivery strategies for prioritised interventions</p> <p>4. To identify additional potential intervention components suggested by participants that were not covered in the summary sheet.</p> <p>Checking to ensure data credibility</p>	<p>Moderator presents summary of collective scores and invites comments.</p> <p>1. Encourage discussion around (1) likely barriers or difficulties in implementing and (2) preferred delivery strategies (e.g. when/what time, where, key message and style) for each of the top 3 interventions.</p> <p>2. If relevant, explore why certain interventions achieved a high collective score for importance but a low score for feasibility or vice versa.</p> <p>Invite participants to suggest additional ideas for potential intervention that were not included in the 42 pre-summarised interventions.</p> <p>Summarise and check agreement on key points</p>	<p>Participants were also asked to describe their media use habits in order to explore whether communication channels and timing are important considerations to ensure that developed communication programmes or adverts reach their target audience efficiently.</p>

3.4.3 Personal interview process

Semi-structured personal interviews with the head teachers from the selected schools took place in their offices. Each interview lasted for approximately 45 to 60 minutes and was moderated by the same researcher who conducted the focus groups (myself). The first part of the interviews followed a similar pattern to that used for session 1 in the focus groups. The remainder of the interview was used to explore the head teachers' views on the role of the school in preventing childhood obesity, to explore what schools do to promote healthy behaviour among pupils, and what the perceived needs are for the school to take a more active role in doing this. Topic guide (Appendix 7) used are summarised in table 3.

Table 3 Topic guide for head teachers' personal interviews

Steps	Aim	Questions
Introduction (5-10 minutes)	<ol style="list-style-type: none"> Welcome; description of procedure; seeking permission for audio recording. To explore understanding and perspectives of childhood obesity 	How do you know a child is overweight, obese or normal weight? What do these terms mean to you?
Topic 1 (5-10 minutes)	To explore participants' attitudes toward childhood obesity prevention and perceptions of children's related health behaviour	<ol style="list-style-type: none"> Do you think that overweight/obesity is an issue for children in China? 2. What about in your community, is it an issue here? What do you think of primary school children's dietary behaviour/pattern/habits in general? What do you think of primary school children's physical activity levels in general?
Topic 2 (5-10 minutes)	To explore the extent to which school head teacher feels that schools should play an active role in promoting and supporting healthy eating and physical activity for the aim of preventing/controlling childhood obesity/overweight?	<ol style="list-style-type: none"> To what extent, do you think primary schools should play an active role in promoting healthy eating and physical activity in children? 2. Why?
Topic 3 (15 minutes)	<ol style="list-style-type: none"> To explore school's current activities regarding healthy eating and/or physical activity promotion (If any) explore plans for future. 	<ol style="list-style-type: none"> Does your school currently have any programme? If any, probe what/how they are going. If none, go directly to Topic 4. Has the school met any difficulties or barriers in implementing the programme(s)? Does the school have any plan for future programmes?
Topic 4 (15 minutes)	<ol style="list-style-type: none"> To explore what schools want/need for playing a better role in children's healthy behaviour promotion Summarising key points discussed and arisen to ensure data credibility 	<ol style="list-style-type: none"> What kinds of resources or support, do you think would make it easier for your school to take an active role? Probe: Have you had any experience in pursuing these resources or support? How was the experience?

3.4.4 Data trustworthiness for focus groups and interviews

Measures taken to ensure trustworthiness of collected data included having the same

moderator and a standardised topic guide for all data collection sessions (maximising reliability), implementing member validation at the end of each session (ensuring credibility), recording detailed minutes during each session and making written summaries after each session (dependability consideration). Moreover, while data analysis was conducted by one researcher (myself), this process involved continuous discussions between she and her supervisor (Dr Peymane Adab) (confirmability) and the research process is documented in detail in this section (transferability).

3.4.5 Other observational activities

Informal observational activities were not necessarily planned or structured but they were performed when they were considered useful (i.e. relevant to the general study aim) and achievable within available resources (expense and time considerations) and support (e.g. access permission).

In each sample school, with the head teacher's permission, the researcher (myself) visited at least two third-year classes during their breakfast or lunch time to observe their meal routine. She talked with the students about their favourite food and activities, and their views on school meals. Hand written notes were made during or immediately after each communication. In GZ, the researcher observed and sat through one school lunch in each of the three sample schools, eating exactly what was provided for the

students (one single menu is provided to all students in most primary schools in China). In two of the schools the researcher also visited their kitchens, observing and photographing the materials and processes used to prepare meals. Moreover, in order to collect information relevant to the children's physical environments, the researcher visited some of the typical supermarkets and residential streets around the schools. With the schools' permission, she also observed a sample of PE lessons, morning playground exercises and class sessions. After 4pm on a typical school day (when students start leaving the school), she observed pupils and their carers' behaviours around school entrances.

3.4.6 Data analysis

All audio records from the focus groups and personal interviews were transcribed verbatim in Mandarin. Thematic analysis using NVivo 8 was conducted to develop an in-depth understanding of factors (perceived by stakeholders or emerging through the data analysis) contributing to unhealthy behaviours among children in relation to childhood obesity.

Preliminary coding

Transcriptions were first coded into Free Nodes (finer codes) and then were assigned to

relevant Case Nodes and Tree Nodes. One Case Node was an identity group (e.g. one particular stakeholder group). Tree Nodes were broad themes with sub-themes (branches) emerging during the data analysis process.

This method had two advantages. First, all coded transcriptions could be moved around freely in the later stage of the analysis process to identify and construct emerging common themes. They would make up of finer themes and provide evidence/examples for emerging broad themes. Second, since each Free Node was also saved as a Case Node under a Case file (e.g. grandparent focus group in XH school was a Case), all discussion or prioritisation data generated from one particular focus group or from several focus groups of the same stakeholder type could be identified and compared with data generated from other groups or stakeholders.

Transcriptions related to the prioritisation exercise were also coded as Free and Case Nodes for later cross-stakeholder-category comparison and overall result synthesis. Nodes made for different focus groups of the same category of stakeholder were grouped together. In order to synthesise results from the prioritisation exercise across all focus groups and to identify similarities and differences between different stakeholder groups, the results were tabulated to show the number of times each intervention component was prioritised as one of the top three, by each of the five identity groups. The methods are described in table 4 below (please refer to table 7 in section 3.5.2 for actual results).

Table 4 Example of how intervention components were summarised, by identity group

Intervention component ID and content	Target factor	Setting	Number of groups prioritising the component					Total No. of prioritising groups (total No. of groups=17)
			Parent FG (total No. of groups=4)	Grand-parent FG (total No. of groups=4)	School teacher & nurse FG (total No. of groups=3)	PE teacher FG (total No. of groups=3)	Catering & local retailing staff FG (total No. of groups=3)	
Example: NO.4	Diet	School	4	3	3	1	2	4+3+3+1+2 = 13
Example: NO.32	Diet +PA	School	1	0	2	0	0	1+2=3

The table provides a simple view of the popularity of certain intervention components *across* and *within* different stakeholder groups.

The data obtained from the focus groups and interviews were analysed to answer three research questions: 1) the perceived causes of childhood obesity; 2) stakeholder prioritisation of intervention components and 3) stakeholder preference for delivery strategies of interventions. In relation to the first analysis, themes were mapped on to the TPB to help contextualise the perceived causes of childhood obesity. This was done in order to facilitate identification of pathways to modify those causes through intervention. TPB was not used for the other two research questions.

Developing broad themes related to perceived causes of childhood obesity and related health behaviours

Since preliminary analysis of the raw data (screening the transcriptions and creating Free Nodes) indicated good representation of each of the constructs within the TPB in relation to perceived causes of childhood obesity and obesogenic behaviours, three broad themes (Tree Nodes) were created to include the three domains of the theory: factors influencing attitudes, factors influencing subjective norms and factors influencing behavioural control. In order to assist the identification of the most influential and modifiable targets for informing future childhood obesity preventive interventions, identified factors were further classified into those influencing one single construct of the theory, and those influencing multiple elements of the theory.

Whilst the analysis and results are mainly focused on using this consequential approach, the data was also analysed from an attributive perspective so as to understand the nature, origins and inter-relationships among those contributing factors. A web diagram was developed to summarise the findings from the attributive perspective.

Analysis related to participants' preference for prevention interventions

Two other sets of results related to participants' preference for prevention interventions were analysed and reported. Firstly, the intervention components that were prioritised were analysed according to their constituent parts (i.e. risk factor target, such as "diet" and setting, such as "home") and by the identity group. Characteristics of non-prioritised components and cross-group variations in perceived importance and

feasibility of prioritised components were also examined. Secondly, preferences for delivery strategies were analysed by type of stakeholder group.

Input from observational findings

In terms of findings from the informal observational activities, important observations that were relevant to the research objectives are reported alongside with related results from focus group and interview (mostly in the format of photographs and fieldwork notes), to provide an epitome about the environment of the study population or further insights into findings from focus groups and interviews.

3.5 Results

Overview of participants and their characteristics

Overall 17 focus groups (15 in GZ) and four personal interviews were conducted with a total of 99 participants (42 male). No new information emerged after the 15th focus group and the 3rd interview. The characteristics of study participants are summarised in table 5.

Table 5 Summary of the characteristics of study participants

Location	Parents' IGs	Grandparents' IGs	Class teacher & nurses IGs	PE teachers IGs	Retailer and catering staff IGs	Head teacher PIs
GZ	18 (9M;9F)	18 (9M;9F)	15 (1M;14F)	16 (9M;7F)	15 (6M;9F)	3(F)
HC	7 (5M;2F)	6 (3M;3F)	0	0	0	1(F)
Total	25 (14M;11F)	24 (12M;12F)	15 (1M;14F)	16 (9M;7F)	15 (6M;9F)	4(F)

Notes: figures represent numbers of participants in different types of focus groups and cities. IG = identity group. PI = personal interview. M = male and F =female.

3.5.1 Factors perceived to influence obesity and related behaviours (objective 1)

Factors influencing one or more constructs of the TPB in relation to children's dietary behaviours and physical activity emerged from the data analysis. They are presented under the three broad themes: (1) factors influencing attitudes toward healthy behaviours, (2) factors contributing to low perceived behavioural control in relation to healthy behaviours and (3) factors influencing more than one construct of the TPB. In this analysis, 'healthy behaviours' refers to healthy eating, physical activity, exercise or reduced sedentary behaviours among children, or action taken by other stakeholders that support and promote the adoption of such behaviours in children. Under each theme, the subjects (e.g. children), the construct(s) and behaviour(s) being influenced are specified. Corresponding quotes from participants are provided to illustrate the themes.

3.5.1.1 Theme 1: factors influencing attitudes toward healthy behaviours

A number of themes emerged suggesting poor or limited understanding and knowledge contribute to unhealthy attitudes towards obesity and related health behaviours. Most importantly, there was poor recognition of obesity in children. Parents and teachers frequently referred to visual assessment and comparison with other children as the method for identifying whether a child is overweight. Only PE teachers and head teachers referred to objective measurements for defining weight status. In fact many parents stated that the annual measurement of children in schools was meaningless, and they did not understand the reports that were sent home or their implications. One father commented: *'We don't understand what the figures and weight status statements mean and it would also be useful if there were some kind of advice at the end of the report about what we can do or a practical guide'*.

Another common theme emerging from the parent and teacher FGs was the belief that children, but also grandparents and some catering staff, do not know about the health consequences of overeating. Similarly they are unaware of the benefits of a healthy diet.

One mother from a middle class area in GZ city said:

'My parents feed lots of meat to my daughter who is already overweight. They say the "3 highs" (high blood sugar, high blood pressure and high cholesterol) do not affect children, as they are the burdens of adults...children can eat freely'.

One class teacher from the same community said:

'Primary school students don't understand the link between diet and health...some young girls are however conscious about their body images...they talk about losing weight but certainly not for health'.

Another factor contributing to negative attitudes towards physical activity promotion among children by school staff related to socio-political influences. School staff frequently discussed numerous safety and regulatory constraints and a general blame culture if anything goes wrong, that prevents them from promoting physically active pursuits among pupils. A perception of high risk of injury and a sense of responsibility for children's safety promoted a negative attitude towards encouraging physical activity inside and outside school. One head teacher said:

'Schools take on a great risk...there is poor understanding of the allocation of responsibility for student safety among different stakeholders...and poor regulation on this...if any accident happens, families complain about us, society and the media all criticise us...schools are scared of arranging collective activities for students after a major accident happened in one school'.

This notion was validated by parents, who believed that contrary to the past, schools engage children in much less non-sedentary activities. One father from HC city said:

'In our time, there were at least 2 seasonal school trips to countryside parks every year...my child hasn't had a school strip for a very long time'.

However, at the same time school staff recognised the benefits and the important role of schools in promoting physical activity in children. One head teacher said:

'I believe physical activity is important for children at this age, it helps to develop them physically and improves their learning ability...a reasonable amount of free play between lessons actually helps the kids to concentrate better in classes...I always say to the parents, we need to share risks for our children...they need physical activity...we need good communication and mutual understanding'.

Concerns over the use of chemicals in food production and farming emerged in all focus groups and interviews. Although food safety is not directly relevant to obesity, people's fears of unsafe food influence their beliefs of what 'healthy eating' is. Food safety was sometimes perceived to be more important than the nutritional content. One mother from the upper class area in GZ illustrated this concept:

'When we heard a food safety incident about fish, we stopped buying any fish...the same for vegetables...we feel insecure...we need stronger regulation and an inspection system to improve this problem for healthy eating'.

With reference to the contaminated milk scare in China, one parent from the middle class area in GZ said:

'Milk is good for her and she loves it but I haven't let her drink milk for more than a year'.

The head teacher from HC school commented that:

'Chinese people at present have to worry about eating safely as well as considering eating healthily...they are both important and for many people who have low awareness of the consequence of overweight, healthy eating is about eating safely and consuming enough nutrients that were previously in shortage or unaffordable'.

3.5.1.2 Theme 2: factors contributing to low perceived behavioural control

Many of the factors identified as contributing to obesogenic behaviours among children were believed to be beyond the control of schools and families. These included social, economic, political and wider environmental influences that prohibit healthy eating, engagement in physical activity or both.

1. Factors contributing to low perceived control in relation to the promotion of healthy eating among children

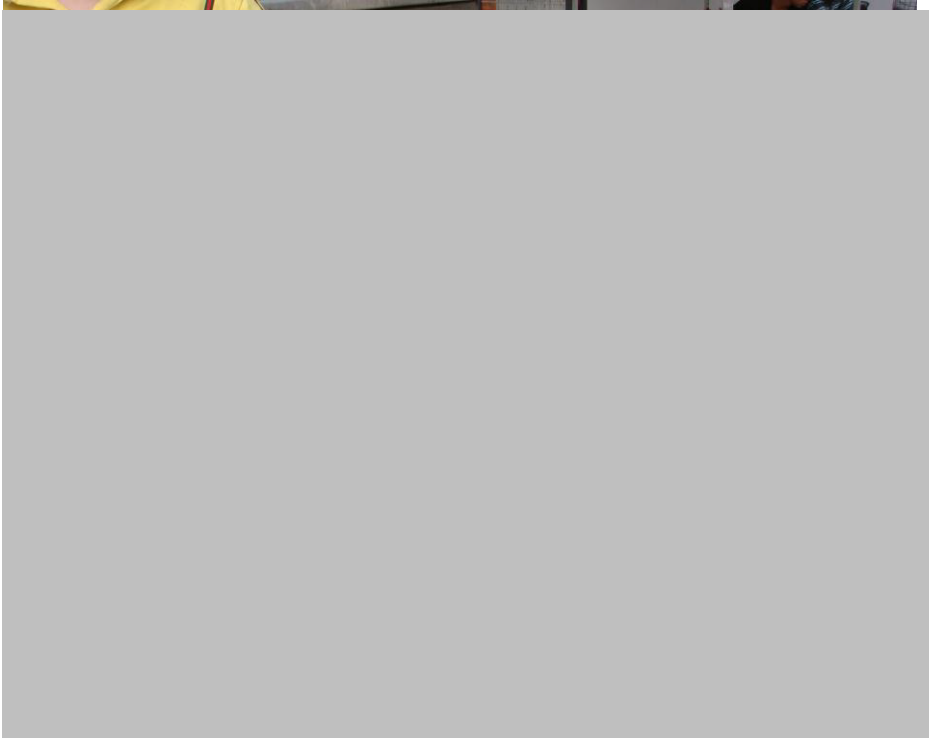
Several issues and themes emerged suggesting perceived lack of control over children's diets. School staff from all sample schools commented on the increasing frequency of non-licensed food traders operating outside of school gates, and their inability to control or regulate these. One head teacher said:

'Students are not allowed to bring in any snack or drink...food stores are not available in schools but we find it difficult to influence healthy eating behaviours as soon as students leave school...we want to deal with the non-licensed businesses selling unhealthy snacks around the entrances, but we have no right to do so...children love them'.

Figure 4 presents a small selection of photographs taken outside the sample schools as part of informal observational activities. They validated the above argument of school staff.

Figure 4 Non-licensed and licensed traders selling unhealthy food around school gates

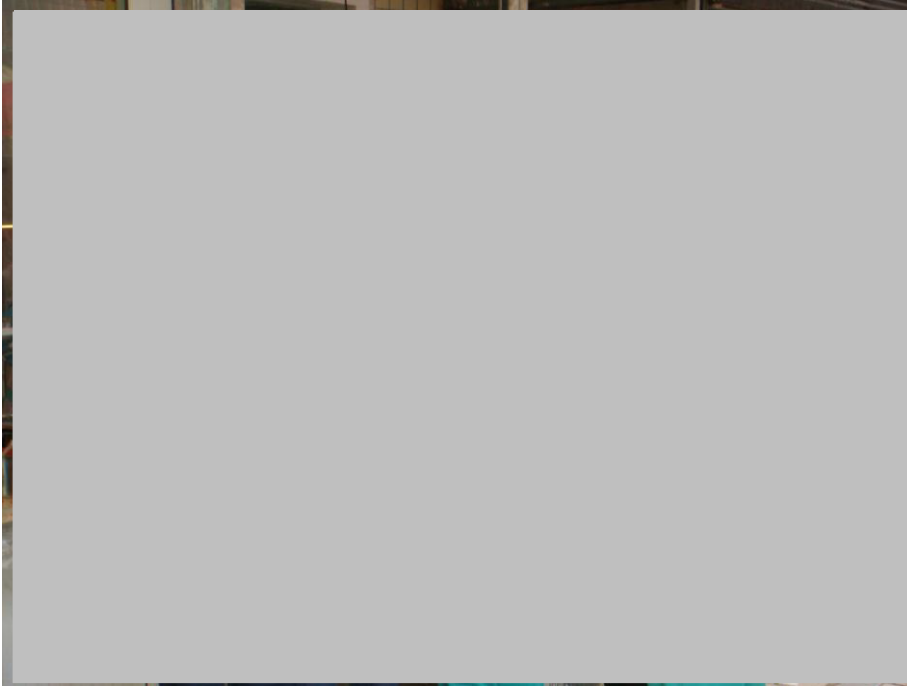
A



B



C



Economic barriers were also cited in a variety of contexts as contributing to poor control on healthy eating in school children. In relation to a suggestion that school catering staff should have training on healthy cooking and nutrition, one school cook said:

'We don't know this stuff (healthy/nutrition knowledge)...we normally consider what food children like and how to make them taste good...our salaries are very low... training fees are too expensive and I can't afford to take time away from work to attend lessons...happy to learn healthy cooking and get a qualification if this helps the kids and helps secure my job'.

Commenting on a potential intervention component, that schools provide a portion of fresh fruit to pupils every day, one head teacher commented:

'I wish to include a portion of fresh fruit as a part of the school's daily food supply but not all families can afford this additional cost...China is still a developing country so the

state is unable to provide fruit for everyone’.

Indeed, observations at school meal time found that none of the sample schools had fruits on their food menu every day. Only one school included a portion of banana in each student’s lunch box once a week, as a substitute for vegetables (the school meal on that day was egg fried rice which did not contain vegetable). Figure 5 shows photographs captured during meal time in a sample school, illustrating how school meals are prepared and served in a typical urban primary school.

Figure 5 School meals

A



Note: School catering staff cooking lunch

B



Note: Lunches being packed into boxes in school kitchen.

C



Note: Single menu school lunch being eaten in classrooms.

In addition to these school based barriers, some parents commented on poor knowledge about healthy eating and cooking as a practical barrier to healthy eating promotion at home.

2. Factors contributing to low perceived behavioural control in relation to the adoption or promotion of physical activity in children

Several social, economic and pragmatic pressures were perceived to encourage low physical activity levels among children. The exam orientated education system, perceived relative importance of academic learning compared to other curricular content and the increasingly intensive competition in the employment market, were all seen as co-drivers limiting children's physical activity level. In schools, although physical education (PE) classes are a requirement, curricular time is in competition with academic subjects such as maths. Some schools replace PE slots with other subjects but do not disclose this to school inspection staff. One PE teacher said:

'Replacing PE lessons is less common than before but still exists in some schools...when inspectors visited, schools just showed the weekly timetable (curriculum) which nicely included the required number of PE lesson...we need stronger inspection powers'. 'It is especially common during exam revision time'.

Parents also collude with this concept, and extend this to the home as well. As one father illustrated:

'As parents, we all know if children don't do well in schools, they can't get to a good university and would find difficulty in competing for employment ...my son knows this so

he goes to weekend lessons which do help his performance in exams but sometimes he wished he could go for swimming instead'.

These pressures were perceived to be further compounded by widespread availability of public methods of transport that discourage walking (social change), high cost of leisure facilities (policy issue) and insufficient space on campus and within residential communities for physical activity resulting from rapid development in the property industry (economic growth). All these influences were perceived to make physical activity promotion among urban children difficult. As illustrated in figure 6 below, observations from the informal activities supported participants' perceptions on discouraging social and economic factors.

Figure 6 Widespread availability of inactive transport methods and insufficient space for physical activity on campus and in residential areas

A



Note: Photograph shows an elevator that is available in a high street, outdoors.

B



Note: Photograph shows typical residential buildings (apartments) with narrow spaces between them and located immediately next to busy roads.

C



Note: Photograph shows that around a residential building there is no space for children to play as the space is being used for car parking.

D



Note: Photograph shows available playground space can only accommodate one year group (containing 6 classes) at a given time, for physical activity.

3. Factor contributing to low perceived behavioural control in relation to both healthy eating and physical activity behaviours

The single-child family structure was discussed by all groups and head teachers as a contributor to obesogenic behaviours. Family members and school staff commented that having only one child at home makes the promotion of healthy eating difficult. One parent said:

'In my childhood, sisters and brothers fought to eat at meal times simply because there were so many children but insufficient food...now each child is cared for by 4 to 6 adults... the only treasure receiving too much love and attention...I wish to change this situation but it is hard to avoid overfeeding the child by grandparents'.

Furthermore, the single child family structure also contributes to low physical activity levels among children. Having a single child in the home limits free play and there are no siblings to join in with. In this context, sedentary screen based activities are used as electronic 'play partners' and 'baby sitters'. Two mothers illustrated this in their conversation:

'My boy has nobody to play with...I have to let him watch the TV or play PC games to keep him quiet and happy'. 'Yes I also do this and feel guilty sometimes...children need and love lots of sweat-inducing movement or play with other kids'.

3.5.1.3 Theme 3: factors influencing more than one construct of the TPB

A number of the themes emerging as important influences on childhood obesity and related behaviours could be seen to exert their effect at several points in the TPB model. These factors have multiple influences on attitudes, subjective norms and perceived control in relation to healthy eating and physical activity. They are described in more detail below.

1. Grandparents as the main child carers in the family

Around half of the parents who participated in the focus groups had at least 1 grandparent living in their households and taking an important role in child care. This is typical of families in urban China and the role and influence of grandparents was discussed by almost all groups, based on either direct experience, or knowledge of others.

One theme that recurred consistently was a preference for fat children by grandparents. This belief influences their own attitudes toward children's diet and physical activity behaviours, as well as subjective norms. Comments similar to the following illustrations were brought up by grandparents, as well as by parents and school members, in all communities.

'In the past, they had underweight, under nutrition and food was not enough...families were also poorer...now fat children are viewed as healthy, strong and well cared for' (Parents from affluent class in GZ). *'Fat means wealthy'* (Grandparents from HC). *'My mother loves seeing my daughter getting big...I said not so much meat and snacks and she should learn swimming but she doesn't understand and thinks I am wrong...'* (A

mother from middle class in GZ). *'I said to my son you need to lose weight, he replied that grandma said I am just strong...only you want me to'* (A mother from lower class in GZ).

There was also a widespread perception among parents and teachers with children that there are misperceptions about healthy eating in relation to children among grandparents, thus influencing subjective norms as well as lowering parents' perceived behavioural control regarding their child's healthy eating behaviours. A number of parents commented:

'I told my boy his diet needs some improvement...my mum said she is happy with his diet, pretty healthy...not picky, not wasteful... eats almost everything...eats enough meat and enough oil is used in cooking...'. 'In their time, meat and oil were treasures so now they feel the more the better'. 'I decided to move out with my wife and son...his grandparents were a big problem...we couldn't change anything when we lived together'.

In addition, the perception that grandparents overindulge their single grandchildren contributes to low perceived behavioural control among parents and school teachers in promoting healthy eating. One parent noted:

'They buy snacks for the child when he/she has behaved well or when they visit us...sometimes in a secret way as I don't allow snacking...but I can't manage my parents'.

And a teacher commented:

'When collecting children, grandparents often bring a sweetened drink or dessert...we educate our pupils don't snack too much...children remember they will get something after school so some of them don't eat properly at lunch'.

Observations around school gates and inside nearby supermarkets frequently supported

these themes on snack-feeding practice beliefs among grandparents (Figure 7).

Figure 7 Observation of grandparents buying Western unhealthy snacks



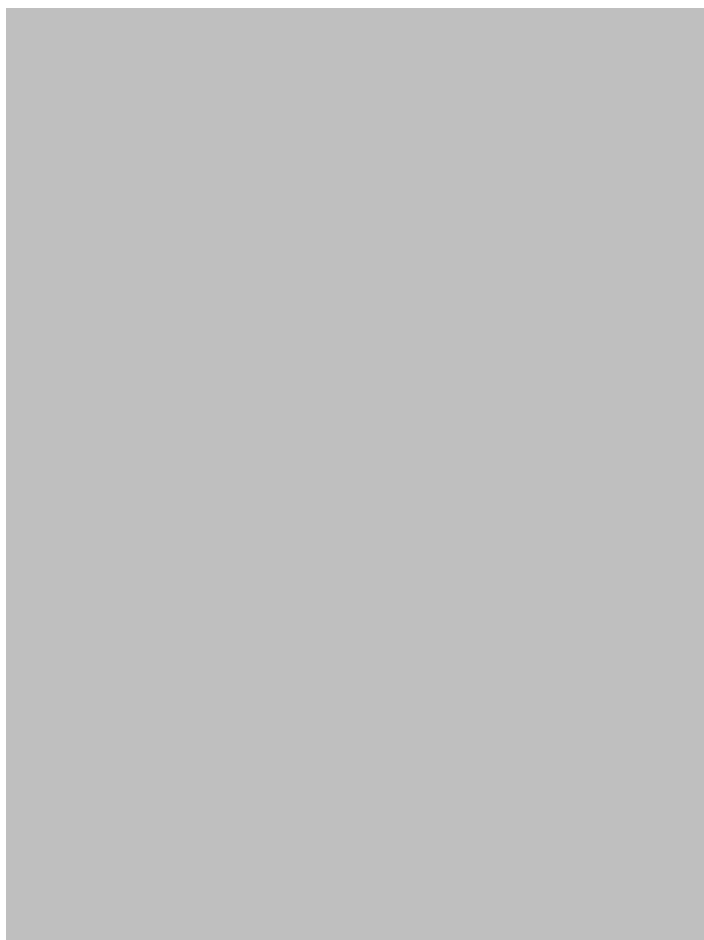
Note: Child's grandparents picking up imported crisps while the child's mother is asking them to stop.

In addition to the influence on dietary habits, grandparents were perceived to over protect children from housework, thus altering subjective norms among children and parents, and contributing to low perceived behaviour control among parents. Several parents made comments on this issue:

'Now a 9 year old child doesn't know how to make his own bed...he knows grandma wouldn't let him do this'. 'My parents told me how many physical tasks they undertook in childhood; so let the child enjoy a pain-free childhood...I can't do anything, I need to respect parents' opinion'.

My observation visit to HC's rural primary schools allowed me to gather further information that enriched the focus group findings, related to the changing attitude and beliefs of grandparents and the contributions that societal change (particularly economic transition) has made to the urban childhood obesity epidemic. The rural areas are economically underdeveloped and a striking finding was the absence of overweight children. Food shortage, under nutrition and underweight is common in these areas, linked to the traditionally labour-intensive life style of these predominantly farming communities. This lifestyle would be similar to that experienced during childhood by the older generation now living in urban areas (the grandparents). Figure 8 is a picture of a typical primary school boy in that village, who explained he had to climb three mountains to get to his school every day. He is showing his typical daily meal (the only meal he has each day), which consists of a bowl of rice with a few slices of cucumber.

Figure 8 One meal a day



Note: Award winning photograph of the 2011 Birmingham Annual Research Image Competition

When asked about their favourite foods, children in the urban schools (GZ and HC) often mentioned food from Western fast food restaurants (such as McDonald's, KFC) or various kinds of meats and processed snacks, in contrast to children from the rural primary schools, who usually mentioned vegetables e.g. carrot and cucumber. The majority of the latter had never tasted meat in their lives, let alone any Western food or snacks.

2. The exam orientated education system

As previously discussed, teachers and parents from all socioeconomic districts particularly value academic education. All groups discussed how schools focus on exams for teaching and all learning is centred around passing exams. This culture has an influence on parents' attitudes toward physical activity and shapes the child's subjective norm that physical activity is not important. Several parents from all districts discussed: *'High school selection basically looks at score'. 'physical exercise at the moment (primary school age) is not very important,' 'time-consuming...if you (a child) exercise a lot you can't spend enough time in study', 'my son goes for meaningful things like English training after school and in the weekends'. 'I told my daughter the most important thing for a student is studying...I never let her worry about housework and travel (walking)'*.

The exam orientated culture also contributes to school staff attitudes and norms. One head teacher explained:

'When we organised lots of physical activities such as for a sports festival, some parents complained we didn't spend enough time on teaching and so affected children's exam performance'.

Furthermore, as illustrated earlier, the exam-oriented education system, together with poor regulatory processes contribute to the national standards for PE not being adhered to in schools. This leads to low perceived behavioural control among PE teachers, who have to meet the national PE curriculum standard. One PE teacher said:

'It's a product (PE slots are replaced by academic lessons) of the exam-oriented education system and supported by the weak inspection power', 'school leaders are passive to some extent so you can't just blame them'.

Similarly behavioural control is lowered among head teachers in relation to healthy eating promotion:

'When there is a limited staffing budget, we can't justify recruiting a nutritionist who can manage a healthy menu...we are in an exam-oriented education atmosphere'.

And among children in relation to physical activity, various stakeholders commented:

'These kids do their homework till 10pm even later' (Mother from middle class in GZ), 'do homework before and after dinner' (Father from affluent class in GZ), 'he loves playing basketball but just has no time' (Grandma from HC), 'some children get additional homework from parents' (Teacher from middle class in GZ).

3. Extensive marketing of unhealthy food and promotion of screen based activities

All groups commented on the role of marketing on influencing increased consumption of Western unhealthy foods, drinks and increased time doing sedentary pursuits. Such marketing was believed to have expanded with the development of new media channels such as the internet and street level advertising screens.

These influences contribute to children and parents' attitudes toward unhealthy behaviours. Parents commented:

'Children are very attracted to beautiful and funny adverts and believe those products are fashionable, super good', 'even I am attracted to them and tend to believe what they say sometimes'.

Furthermore they promote subjective norms among children enhanced through peer pressure. A mother commented:

'Everywhere they are promoting computer games...my boy told me a classmate couldn't do a game then he was laughed at by his peers...someone who passed the highest level became very popular and seen as clever and cool...children are affected by their friends'.

Another important reference among children reinforcing norms and encouraging behaviours is celebrities:

'I hate crisps, fizzy drink and burger adverts using pop stars...children are loyal fans following what celebrities suggested' (Mother from middle class in GZ).

The increasing availability of Western unhealthy snacks and using children's favourite celebrities to promote those products is validated by my observation in local supermarkets (figure 9).

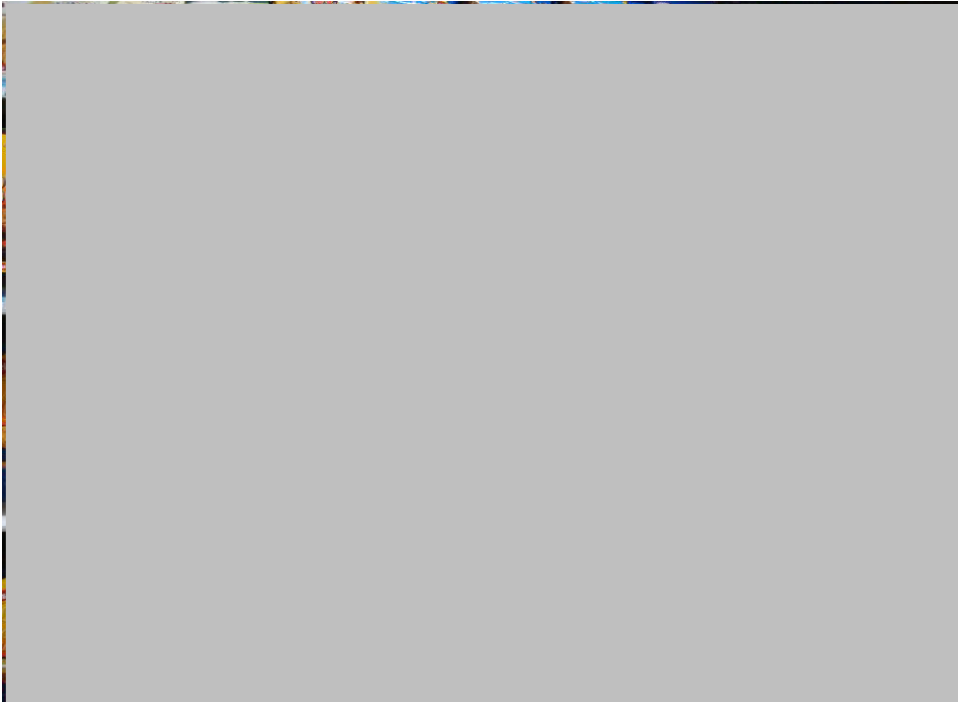
Figure 9 Western unhealthy snacks sold in Chinese urban supermarkets

A



Note: Crisp packaging features a famous Chinese pop star that is popular among children and youth.

B



Note: Part of a large section in a typical Chinese supermarket, selling Western snacks.

Focus group participants were also aware of the link between westernisation of the diet and business globalisation, associated with growth in domestic buying power (the economic driver). A father commented:

'News also talks about food and lifestyle westernisation...foreign companies want to sell to us because we have more to spend nowadays'.

Marketing was also perceived as pervasive and something that made it difficult to eat healthily and to know what is healthy (low perceived behavioural control). Stakeholders believed that commercial advertisements are partly due to lack of media regulation. This has also led to information confusion. Some of the school catering staff commented:

'An advert told me their milk biscuits offer a nutritious breakfast for kids...then an article said biscuits are bad for kids'. 'The advert says their cooking oil is healthy but I also heard cooking oil can cause diseases...what should we do, who should we listen to? There should be more regulation on the media'.

4. Concern about neighbourhood safety

Traditionally, families in urban China lived in large residential communities provided and managed by their work organisations. Nowadays more and more families live in non-organisational properties. Concerns about safety in the neighbourhood contributed to negative attitudes toward allowing outdoor play for children and low perceived behavioural control in relation to promoting this activity. One parent from a middle class area in GZ commented:

'We used to live in an organisational community...I knew everyone around...now living in an open property development area, I feel danger for her to play outside although I wish she could...I heard news about missing children in this city...playing online does not involve exercise but is safer'.

Furthermore such concerns contribute to children's subjective norm about playing in the neighbourhood. This is illustrated by a quote from a father from an affluent area in GZ:

'My boy knows he must go home after school as I don't allow playing outside'.

5. Reduced neighbourhood connectedness

Another consequence of moving away from living within organisational developments has been reduced neighbourhood connectedness, which influences children's affective attitude toward free play. This social change partly explains the growing popularity of individual and screen based sedentary behaviours. Several parents from HC commented: *'Many traditional fun (active) games need several children to play together...since we moved to here, my boy feels playing outside is less interesting...not many children come out,' 'children want to play with friends but households nowadays are far less connected, I can't tell you my neighbours' names...don't visit each other...for single children, they play with computers... families now can afford these electronics'.*

6. Increased private car ownership

Increased car ownership in Chinese urban households not only provides increased opportunities for non-active travel among children, but has led to increased air pollution which further restrains their physical activity. This in turn leads to a negative attitude among parents about children playing outdoors, and children's subjective norm shifting to outdoor play being unacceptable. As several mothers commented:

'We never let our child play and run along the streets next to our building...not nice and harmful... if he breaths in cars' emissions', 'many families now can afford a private car...but they caused unpleasant air', 'unhealthy too if breath in too much it may harm your lung', 'in my childhood I rode a bike or walked... lots of exercise when commuting and the climate was much nicer...nowadays in this city if I leave home with a pair of white shoes, they will definitely become gray by the time I return home'.

The photograph below (figure 10) is a typical image of the main streets in Guangzhou and validates the above comments.

Figure 10 Increasing car ownership and air pollution



3.5.1.4 Summary

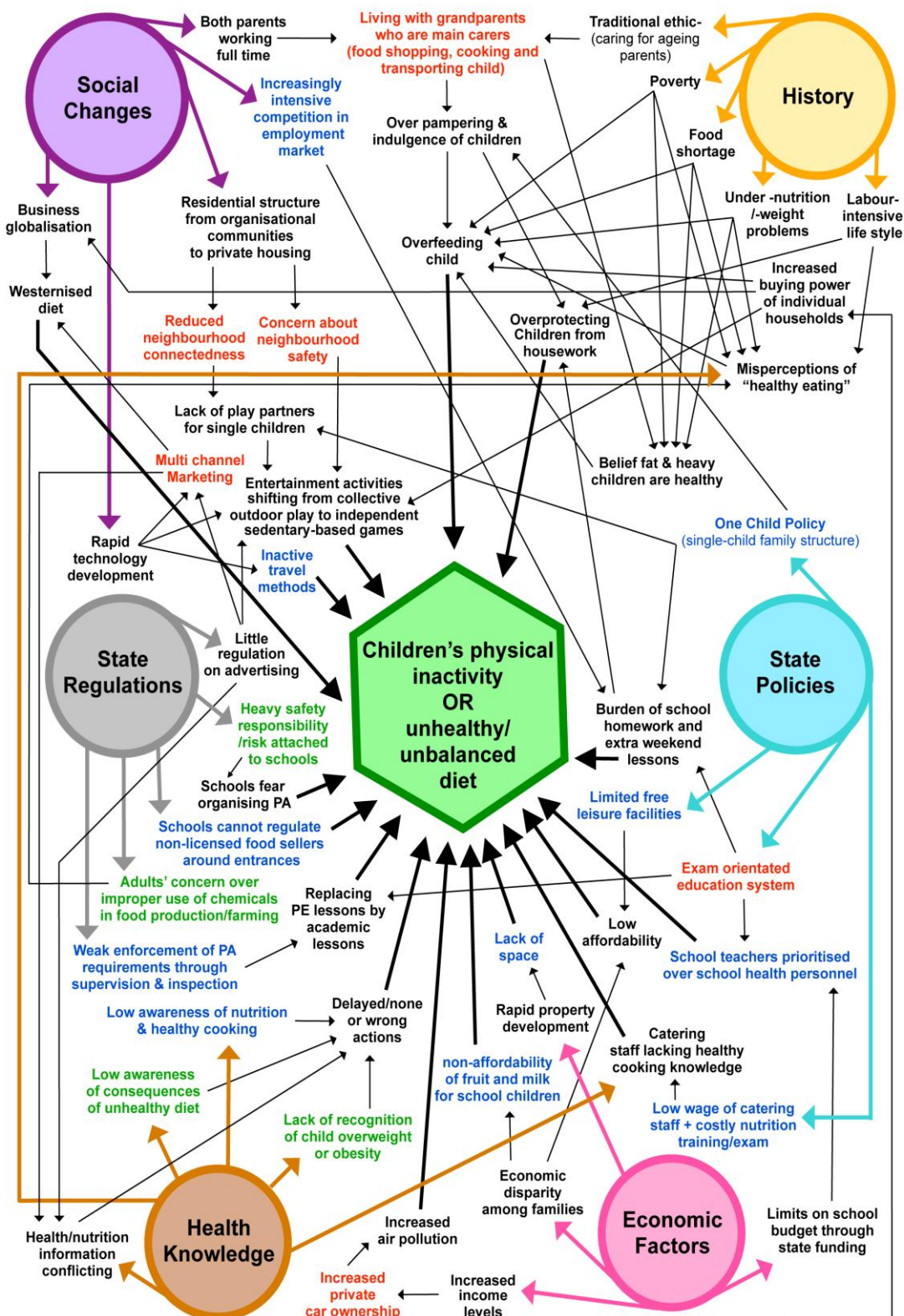
Overall, a complex set of inter-related factors emerged as important perceived contributors to childhood obesity. These are summarised in a web diagram (Figure 11) below, with factors presented under theme 1 (influencing attitude), 2 (influencing perceived behavioural control) and 3 (with multiple influences) shown in green, blue and red texts respectively. Underlying these factors were macro-level influences related to social change, historical influences, economic factors, and state policies and regulations. General poor health knowledge among all stakeholders was also perceived as an

important influence in promoting obesogenic behaviours among children.

Figure 11 A Schematic Web Diagram

Schematic web diagram of perceived contributing factors to obesogenic behaviours among urban primary school children in China

Red: factors influence multiple constructs of Theory of Planned Behaviour in relation to healthy behaviours;
 Green: influence attitude; Dark blue: influence perceived behavioural control



3.5.2 Findings from stakeholder prioritisation exercise (objectives 2-3)

Findings reported under this section provide additional insights into possible intervention components in children. Three out of a possible 42 intervention components were prioritised by each of the 17 focus groups. The results are summarised in table 6.

In general, 22 intervention components were prioritised among the top three by at least one focus group. Table 6 shows the popularity of different type(s) of intervention *across* and *within* different stakeholder groups. Interventions targeting dietary behaviour were generally more likely to be prioritised, and interventions targeting multiple behaviours were more frequently selected than those targeting just physical activity. The majority of prioritised interventions were school based. Characteristics of non-prioritised interventions were summarised also.

Variations in perceived importance and feasibility of some prioritised intervention components were identified among discussions in different stakeholder groups. Therefore, while the synthesis table is useful in terms of providing an overall view of the study population's preference for prevention interventions, the perceived barriers and facilitators towards the adoption of healthy behaviours also needs to be considered.

Table 6 Summary for number of groups prioritising each intervention component, by identity group

ID and content of prioritised intervention	Target factor	Setting	Number of groups prioritising the component					Total No. of groups prioritising (N=17)
			Parent FG (N=4)	Grandparent FG (N=4)	School teacher & nurse FG (N=3)	PE teacher FG (N=3)	Catering & local retailing staff FG (N=3)	
NO.4: promoting healthy school food provision and targeting school food environment	Dietary behaviour	School	3	3	1	1	1	9
NO.5: providing nutrition and healthy cooking training to school meals' catering staff and designing lunch menu to ensure nutritional balance	Dietary behaviour	School	2	1	3	0	2	8
NO.6: delivering healthy eating knowledge and promoting healthy eating behaviours via sign posts and radio etc at school campus	Dietary behaviour	School	2	2	1	0	3	8
NO.1: classroom sessions on food composition, relating calories intake to effort needed to burn them off	Dietary behaviour	School	1	2	1	0	3	7
NO.19: school/teacher requiring students to engage in at least 30 minutes of activity a day, rewarding for time spent doing physical activities plus self/parental monitoring of sedentary activities to reinforce message	Physical activity	School	3	0	1	2	0	6
NO.11: providing guidance for parents/carers on healthy eating and nutrition in children	Dietary behaviour	Family	0	2	1	2	0	5
NO.17: 15-minute walking/running before classes start in the morning or at other time during school hours	Physical activity	School	1	1	0	2	0	4

ID and content of prioritised intervention	Target factor	Setting	Number of groups prioritising the component					Total No. of groups prioritising (N=17)
			Parent FG (N=4)	Grandparent FG (N=4)	School teacher & nurse FG (N=3)	PE teacher FG (N=3)	Catering & local retailing staff FG (N=3)	
NO.33: quizzes and competitions to reinforce dietary- and physical activity- related health message at school	Dietary Behaviour + physical activity	School	0	2	1	0	1	4
NO.15: providing more non-competitive PE activities and, widening their range to include elements such as games and dancing	Physical activity	School	1	1	1	0	0	3
NO.23: doing physical activities that involve all family members	Physical activity	Family	1	0	1	1	0	3
NO.10: providing family with meal plans, recipes and calendars with nutrition tips	Dietary behaviour	Family	0	0	2	0	0	2
NO.30: food, travel or activity diaries and building up peer support network through classroom discussions	Dietary Behaviour + physical activity	School	0	1	0	1	0	2
NO.2: healthy snack contests and/or fruit snacks as rewards	Dietary behaviour	School	0	0	1	0	0	1
NO.3: provide on or off campus experience in growing vegetable and fruit	Dietary behaviour	School	0	0	1	0	0	1
NO.9: cooking demonstrations and food tasting or nutrition workshops	Dietary behaviour	Family	0	0	0	1	0	1
NO.26: promotional campaign for turning off the TV or/ and computer	Physical activity	Family	1	0	0	0	0	1
NO.32: use posters and/ or blackboards in schools to promote physical activity and healthy eating	Dietary Behaviour + physical activity	School	1	0	0	0	0	1

ID and content of prioritised intervention	Target factor	Setting	Number of groups prioritising the component					Total No. of groups prioritising (N=17)
			Parent FG (N=4)	Grandparent FG (N=4)	School teacher & nurse FG (N=3)	PE teacher FG (N=3)	Catering & local retailing staff FG (N=3)	
NO.36: training for teachers by nutritionist and PE specialists about healthy eating and physical activity in children	Dietary Behaviour + physical activity	School	0	0	0	1	0	1
NO.38: 'homework' to promote family-wide healthy behaviours (e.g. family outdoor activities and healthy family meals)	Dietary Behaviour + physical activity	Family	0	1	0	0	0	1
NO.39: send families leaflets on physical activity, nutrition and sedentary behaviour reduction	Dietary Behaviour + physical activity	Family	0	0	1	0	0	1
NO.40: encourage and support whole family to modify their behaviours	Dietary Behaviour + physical activity	Family	0	0	1	0	0	1
NO.41: education on the importance of parental role modelling	Dietary Behaviour + physical activity	Family	0	1	0	0	0	1

3.5.2.1 Interventions prioritised across all focus groups

Target factors

Nine out of the 22 prioritised interventions aim at promoting healthier dietary behaviours of children. Of the nine possible dietary-focused interventions, four represented the four most popular intervention ideas across all focus groups. Intervention No.4 (*promoting healthy food provision and improving food environment at schools*) was the only intervention that was prioritised among the top three in at least one focus group within each identity group and it was ranked overall first. Five out of the 22 prioritised interventions aim at promoting more physical activity in children. Eight out of the 22 prioritised interventions aim at promoting both a healthy diet and more physical activity among children. Thus stakeholders were more likely to prioritise a physical activity intervention component if it was combined together with a dietary component.

Target setting

Of the 22 prioritised interventions, none of them were residential-community based; 13 were based in the school and nine were aimed at the family.

3.5.2.2 Non-prioritised interventions

Twenty out of 42 possible interventions were not prioritised by any stakeholder group participating in the study. Their characteristics are summarised below. The low priority reflected perceived low importance and feasibility of these components in relation to other possible approaches.

Firstly, half of the non-prioritised components target children's physical activity, whilst the other half was equally shared by interventions targeting diet alone or those targeting both diet and physical activity. Secondly, none of the community-based components were prioritised, although most of these target children's dietary behaviour. Only one family based component targeting children's dietary behaviour was not prioritised by any group. This was a component related to providing workshops (healthy cooking demonstration and food tasting) with groups of families (No.9). Thirdly, components that involved school staff organising off-campus activities (e.g. No.21: school trips and No.35: taking students to local farms to let them experience growing fruit and vegetables) were not prioritised by any group. Finally, components that challenged existing social life style trends (No.25: campaign for less car use) or institutional policy (No.8: school written policy to ban the provision of unhealthy food and drinks) and involved commitment or support from a commercial party (No.7: local farms directly supply low-cost and fresh fruit to schools) were not prioritised.

3.5.2.3 Intervention prioritisation by stakeholder identity group

Parents

Among the 4 parent FGs, 10 of the 42 interventions were prioritised in at least one group. In contrast to the overall findings, interventions targeting physical activity behaviours were slightly more frequently prioritised than those targeting diet (five and four respectively) and only one prioritised component targets both diet and physical activity. Most of the prioritised intervention components (7/10) were related to the school setting. It was also noted that parents prioritised interventions targeting children's screen-viewing sedentary behaviours at home more frequently than any other groups did. In particular, three out of four parent groups prioritised component No.19 (school requiring students to engage in at least 30 minutes of activity a day... self/parental monitoring of sedentary activities to reinforce message). Component No.26 (promotional campaign for turning off the TV or/and computer) was prioritised by parents only.

Grandparents

Among the four focus groups with grandparents, 11 out of 42 interventions were prioritised as a top three intervention in at least one focus group. Of the 11 interventions, five of them focus on improving children's dietary behaviours, two of them aim at promoting children's physical activity levels and the remaining four target both dietary

and physical activity. Seven out of the 11 interventions are school-based. Notably, while parents and school teachers frequently prioritised components No.19 (school requiring students to engage in at least 30 minutes of activity a day... self/parental monitoring of sedentary activities to reinforce message) and No.23 (physical activities, e.g. games that involve all family members), none of the grandparent groups prioritised those interventions. On the other hand, grandparents were the only stakeholder group that prioritised components No. 38 ('homework' to promote family-wide healthy behaviours e.g. family outdoor activities and healthy family meals) and No.41 (education on the importance of parental role modelling).

Class teachers and school nurses

In the three focus groups with school class teachers and nurses, 14 out of 42 interventions were prioritised as a top three by at least one focus group, with the majority of them (8/14) targeting children's dietary behaviours and equal numbers of interventions that promote children's physical activity and that target both healthy eating and physical activity. While school based interventions were also most frequently prioritised by this stakeholder groups (9/14), this group placed the heaviest weight on family-based interventions. They were the only group that prioritised components No.10 (providing family with meal plans, recipes and calendars with nutrition tips), No.39 (sending families leaflets on physical activity, nutrition and sedentary behaviour reduction) and No.40 (encouraging and supporting whole family to modify their behaviours).

PE teachers

Among the three PE teacher focus groups, eight out of 42 interventions were prioritised as a top three in at least one group. Of the eight interventions, three of them aim at improving children's dietary behaviours, three of them focus on improving children's physical activity levels and the remaining two target both elements. However, in contrast with the overall prioritisation results, the 2nd, 3rd and 4th most popular components (all focusing on improving children's dietary behaviours) were not prioritised by this stakeholder group. Two of the group's three most frequently prioritised interventions aim at promoting children physical activity (No.19: school/teacher requiring students to engage in at least 30 minutes of activity a day, rewarding time spent doing physical activities plus monitoring of sedentary activities and No.17: 15-minute walking/running before classes start or at other time during school hours) and one aims at providing children's family members with guidance on nutrition and healthy eating in children (No.11). The majority of the groups' prioritised intervention components was also school based (in 5/8).

Catering and retailing staff

Among the three focus groups with catering and retail staff, five out of 42 interventions were prioritised as a top three in at least one group. The most frequently prioritised

interventions among this group are related to children's dietary behaviour, including one aimed at providing nutrition, healthy eating and cooking training to school catering staff (No.5). This group did not prioritise any physical activity-focused intervention components although one intervention targeting both children's diet and physical activity (No.33: quizzes and competitions to reinforce dietary- and physical activity-related health message at school) was prioritised. All prioritised interventions were school based, consistent with other stakeholders' prioritisation.

3.5.2.4 Cross - group variations in perceived importance and feasibility for prioritised interventions

When examining the 22 prioritised interventions by stakeholder groups, differences in perceived importance and feasibility of components were also identified.

Firstly, there was one intervention (No.4: promoting healthy food provision and improving food environment at schools) that was consistently prioritised by all stakeholder groups as important but was not perceived by all groups as equally feasible. In particular, both family members and school staff considered this as important. However, school members were less likely to prioritise this component as feasible compared with family members.

Secondly, there were also some prioritised interventions that were not equally prioritised in both perceived importance and feasibility across different groups. For example, while parents and school teachers all prioritised components No.23 (doing physical activities that involve all family members) as important and feasible, grandparents considered it neither important nor feasible. In addition, parents were the only group that prioritised component No.26 (implementing a ‘Switch off TVs and/or computers’ campaign) as important and feasible. Also only one parent group and one school class teachers group perceived component No.32 (use posters and/ or blackboards in schools to promote physical activity and healthy eating) highly feasible; and only one parents group prioritised it as an important component. Moreover, while PE teachers prioritised component No.36 (providing training in child’s nutrition and physical activity to school class teachers) as important and feasible, school class teachers and other groups did not. Similarly, while grandparents prioritised component No.38 (‘homework’ to promote family-wide healthy behaviours e.g. family outdoor activities and healthy family meals) as important and feasible, parents and other groups did not.

Thirdly, there were two intervention components that were ranked highly in a focus group based on either perceived importance or feasibility, but not both. Component No.3 (providing on or off campus experience in growing vegetable and fruit) was prioritised by one focus group with school class teachers and nurse, and this group perceived it important but not feasible. The group discussed ‘*Limited space on campus*’ and ‘*safety concerns for off campus activities*’ to support their decision. Component

No.10 (providing family with meal plans, recipes and calendars with nutrition tips) was prioritised in another school teachers and nurses group as a feasible but not important component. However, the same group prioritised a similar component No.11 (providing children's family members with guidance on nutrition and healthy eating in children) as both important and feasible. A possible reason for this contradiction, emerging from the group discussion, was that '*component No. 10 can be part of component No. 11*'.

3.5.2.5 Summary

Overall, the most commonly prioritised intervention component (in 9/17 groups) was related to improving the school food provision and environment (No.4) and was prioritised by all groups, although the parent and grandparent groups were relatively more likely to prioritise it than school staff and other groups. The next two most commonly prioritised components were also related to improving dietary behaviour through schools. These related to training of school catering staff, which was prioritised by all the school teacher groups, and promotion of healthy eating using various media within schools, prioritised by all school catering and local food retailer groups. Physical activity intervention components were more likely to be prioritised by PE teachers than other groups. Community-based intervention components were not prioritised by any of the participating groups. School was the most popular setting for interventions across all groups.

School members were more aware of potential barriers (associated with relatively lower perceived feasibility) to school based components while family members were more aware of potential barriers to components targeting family members or implemented in the family setting. These variations in perceived feasibility may reflect limited understanding of different stakeholder groups about the willingness, ability or difficulties in adopting or implementing certain interventions that involve settings that do not directly relate to their participation or contribution.

3.5.3 Strategies for intervention delivery and insights into barriers and facilitators (objective 4)

3.5.3.1 Findings by identity groups

In each FG, participants were encouraged to consider strategies for promoting implementation of the prioritised interventions, and also interventions that would be implemented within their own setting or that target them as instruments of behaviour change (e.g. family setting for parents and grandparents). The analysis has focused on identified barriers and facilitators discussed by participants during this process. The results are presented by identity group to facilitate discussion on targeting of interventions in the final chapter, although some of the factors are common across

groups.

Parents

Parents were asked to focus on family based interventions that had been prioritised by any group. These included activities involving the whole family (No.23), ‘switch off the TV/Computer’ campaign (No.26), providing family meal plans and recipes (No.10), and providing guidance for parents on healthy eating in children (No.11).

Generally, parents commented that family-based interventions would be enhanced by support and leadership from the school. For example, one mother said:

‘Parents are more likely to do it if family activities are arranged by and held in the school...active fun competition among family groups would be very popular but these should take place in the evening, weekend or school holiday...we need to work in the day...alternatively teachers promote family activities by assigning them as homework but again this depends on parents’ time...but the school’s influence does work’.

They also discussed the importance of parents’ awareness of why interventions are necessary and how they affect children’s health, to facilitate implementation. In relation to the “switch off campaign”, parents first need to understand the impact of screen-based sedentary behaviours on children’s health. Again, parents believed

communication and promotion of interventions through school would be very helpful.

One father suggested:

'Maybe the school could invite all parents to attend a meeting...the head teacher could introduce and promote this campaign after explaining about the harms of overuse of TV and computer and importance of parents' role modelling'.

During the parent group's discussion about school meetings, another father expressed:

'I guess most parents would find it difficult to attend school meetings if they have to take absence from work...lose wages...delay scheduled tasks...the government should give employees with young children the right to finish work earlier...say once a week...staff can take turn so parents can join school meetings or other health activities more easily.'

All parents expressed great interest in receiving healthy eating information and materials (intervention components 10 and 11), and the majority thought these should be delivered free of charge. It was also suggested that the content should focus on practical tips rather than scientific knowledge and that the messages should be positive (inspirational and focus on benefits of making changes) rather than negative (focusing on the negative impacts of unhealthy diet). Parents also felt that use of colourful cartoon illustrations and well designed materials would enhance the intervention.

Moreover, media use patterns and habits as well as the aware reasons behind them

provided clues to additional facilitators and barriers to health educational or promotional communication beyond school channels. Although focus groups were not intended to produce generalisable findings, common responses (if any) on media use questions from the participants can support the future design of questionnaires to a larger representative sample. In general, the peak time for parents who took part in the focus groups to watch TV was between 7pm and 10pm. Parents reported watching a wide range of programmes and their favourite channels were not limited to local channels. However, local evening news was most commonly cited as a programme that they watch regularly. Some parents said they were aware of health-related programmes shown on TV but they never watched them because they were on paid channels. Many parents, particularly fathers, also enjoy reading newspapers; but only local ones such as Yanycheng Evening(GZ) and Hechi Daily.

Grandparents

Grandparents were asked to focus particularly on the implementation of two family based components: providing guidance for parents and guardians on healthy eating in children (No.11) and ‘homework’ for children aimed at promoting healthy family behaviours such as family outdoor activities and healthy family meals (No.38). In addition, since almost all participants in the other stakeholder focus groups emphasised the importance of health education for grandparents, they were also guided to consider the best approaches and methods for communicating health messages to them, and how they could be encouraged to promote healthy behaviours in children and healthy eating

in the family.

Grandparents were as interested as parents in receiving healthy eating materials, preferring these to be available free of charge. However, in contrast to parents who felt that cartoon images would be a good means of conveying messages, many grandparents expressed a preference for realistic photographs for the illustration of information or examples. Grandparents also suggested that the health materials would be taken more seriously by family members if they are sent through the school.

Regarding health related homework targeting the family, many grandparents expressed their willingness to take an active or leading role in implementing such activities in their families. As one grandmother said:

'The child's parents are very busy but I have time...I can take my grandson for hiking...we have done this before...the mountain parks are now open to the public free of charge and as old people, we get discounts for buses...some elderly even don't need to pay anything'.

With regards to health education and communication with grandparents, print media such as local newspapers or magazines targeting the elderly (e.g. Elderly Newspaper and The Elderly Journal) were regarded as more popular than TV programmes. However, peak TV viewing times for grandparents, during the day (between drop off and pick up

of children from school) were also identified as suitable opportunities for health promotion. Grandparents also confirmed that they often attended school meetings on behalf of 'busy' parents to receive school information or feedback about children's study performance. Thus school meetings were also considered by them as a potential channel for communication in relation to child health information. Grandparents described one format of school meeting as particularly suitable for communicating with large numbers of family representatives at the same time, given the large school and class sizes in China. They described that several times per year family representatives are invited to a lecture style meeting, where they sit in the classroom and watch a live or recorded video talk from the head teacher (each classroom has a digital TV). One grandparent recommended:

'You (public health professionals or intervention officers) can specially design and create some short films or record health educational talks...the school invites children's grandparents to come for a school meeting, then play the video on each classroom's TV...you can reach all children's grandparents in this way...we can come in the evening or in the weekend'.

School teachers and nurses

Among their prioritised interventions, those that were related to the school setting were selected as the focus for this part of the discussion. These included targeting the school food environment (No.4), providing nutrition training for school catering staff (No.5), curricular material on food and nutrition (No.1), encouraging and promoting a minimum

of 30 minutes of physical activity per day through school (No.19), quizzes and competitions to reinforce healthy messages (No.33), promotion of healthy snacks in school (No.2) and promoting health behaviours through school based media (No.6). Since school teachers have experience in communicating with children's parents and other family members, they were also asked to consider how to maximise participation of the family in activities promoting childhood obesity prevention.

School food environment and nutrition training for school caterers

Teachers commented that many school meals are outsourced to external catering companies and so schools do not have much control over nutrition quality, menu pricing and training of caterers. A typical comment that was given by a classroom teacher and that represented a shared opinion among teachers and head teachers of other sample schools was:

'For schools using outsourced catering, the implementation of any school-meal focused intervention needs commitment from meal providers...for all schools (outsourced or not), the education authority having some sort of monitoring and motivation scheme is important to ensure requirements (for school meals' nutrition quality and catering staff straining) are met.'

School curriculum and school based incentives to promote health behaviours

These intervention components were considered by teachers and nurses as similar in terms of delivery, because they all required teachers and/or nurses to carry out some sort

of classroom-based activities. It was felt that such activities could not be added into existing health education lessons taught by nurses because those lessons are standardised by teaching text books. However, teachers thought they could be incorporated into each class's weekly moral education lessons that aim to facilitate healthy spiritual and behavioural development among primary school students. There was some disagreement among teachers however, as some felt that the large class size would limit the quality of delivery and prevent evaluation of individual behaviours. One teacher commented:

'There are simply too many students in each class...so it is very hard for me to give individual attention to each student...evaluate what and how he has eaten or done and then give personal comments or reward.'

In response to such concerns, other teachers discussed the possibility of establishing peer-based competition and monitoring groups in which the children themselves evaluate and motivate each other to promote healthy diet and physical activity. Teachers also commented on the importance of providing age and sex-appropriate rewards, rather than generic incentives.

Use of school based media to promote health behaviours

Teachers and nurses thought that promoting health behaviour messages through school based media was very feasible in Chinese primary schools. They remarked that sign posts and blackboards were already commonplace within school play areas and classrooms. To use these existing resources, teachers suggested promoting monthly or weekly themed (related to healthy diet and active lifestyle) blackboard competitions

among all classes. Children could be encouraged to search and read suitable reference material and use this to come up with relevant health messages for their classrooms. However, many teachers were concerned that non-regulated traders selling unhealthy snacks at school entrances would undermine any effort the schools make to promote healthy eating. They emphasised the importance of effective regulation from city authorities to support any school-based healthy eating interventions. One teacher, reflecting the views of some others and one of the head teachers said:

'Schools should be given the right to stop those people from selling unclean and junk food at school entrances, say within a distance of 500 metres, for a healthy school environment'.

Approaches to promote participation of family members in supporting healthy behaviour in children

Teachers and nurses suggested that schools could provide a medium for providing material and information to families. They also often commented on the influence that children have on parents' behaviour. One teacher, typifying the comments from other teachers and nurses suggested:

'We should distribute the health materials to family representatives directly at a school's family meeting and then follow up by asking pupils to evaluate the usage (reading /application) of the material by their parents or grandparents'.

In relation to family-focused educational campaigns, several teachers described exploiting the "power of children" as a communication strategy. A typical comment from one teacher was:

'Let a child act in a non-commercial advert, which shows for example, when grandma is picking her up from the school and saying: "to reward your great performance at school today, I am taking you to McDonald's or I can buy you some of your favourite snacks." Immediately but unexpectedly, the girl is looking at her grandmother with very confused and innocent eyes and responding: "the teachers said those things are bad for us, we shouldn't eat them" ...the grandma becomes speechless, but visibly moved'.

Teachers generally believed that such an indirect approach to education would bring about greater influence on family members concepts and behaviours, while avoiding provocation and negative reactions.

PE teachers

Among PE teachers' prioritised interventions, three were selected for more detailed discussion in relation to implementation. These included encouraging and rewarding school based physical activity (No.19), providing children with opportunities to undertake short bursts of physical activity at the start of the school day or other lessons (No.17) and providing training for teachers on healthy eating and physical activity in children (No.36). In addition they were asked to comment on another intervention component which was commonly prioritised by other stakeholder groups, related to increased provision of non-competitive physical activities, such as games and dance in schools (No.15).

In relation to encouraging and rewarding school physical activity, PE teachers, similar to other groups, also had concerns about the delivery of such activities within the existing curriculum. They also pointed out the need for cooperation from family members for successful implementation. One PE teacher commented:

'Awareness among family members of the importance of keeping a sufficient level of activity in the child and their commitment in supporting the child in non-academic activities are crucial...particularly true in a social atmosphere where children's academic study and performance are placed as the top priority'.

With regards to the promotion of physical activity in schools, particularly in relation to short daily bursts of activity, one PE teacher said:

'Allocating a special block of time every day during the school hours for students to engage in physical activity is already present in Chinese schools, particularly since the introduction of the national requirement for one-hour activity for students on campus daily'.

Another teacher commented:

'We all know it is important but the problem is how to implement this programme with limited school space and time'.

PE teachers generally felt that if the existing national requirement for amount of physical education in schools is met, this would be sufficient for children. According to PE teachers, the common approaches used to meet the national one-hour physical activity requirement have been combining the time students spend in PE lessons, traditional collective daily morning exercise, free play between lessons and flexible arrangement of 'long and active class breaks' for all student. For the last contribution component, one PE teacher explained that:

'School has limited space in the play ground so students of different years usually take turns to have a long class break (e.g. students in grade three have it every other day).'

While there are challenges in promoting physical activity in schools, many PE teachers thought the most important area and biggest challenge in promoting physical activity in children is outside of schools. As one PE teacher said:

'Children's activity levels during school hours are not too bad...the area that needs more attention for intervention lies outside school, namely the time after school...primary school students in China are given lots of homework, so little opportunity for physical activities'.

In relation to training of teachers and increasing the range of physical activities offered, PE teachers believed that implementation requires cross-disciplinary cooperation among all teaching staff (e.g. music/dancing teachers working with PE teachers to incorporate new elements into their own teaching activities). Generally, PE teachers felt such cooperation is achievable in primary schools. Participants from one sample school also confirmed that their previous experience demonstrated this. However, the leader of their PE teaching group proposed a major challenge:

'The attitude and support of the head teacher toward first, physical activity promotion in general and second, cross-disciplinary cooperation among teaching staff in promoting physical activities in particular, determines success...not many school head teachers take health promotion as seriously as improving students' academic

outcomes...but this is not the head teachers' problem...an issue of the general education system...there are pressures on head teachers so then on the teachers to focus on the students' academic performance'.

Catering and supermarket staff

No intervention component targeting shops and supermarkets surrounding schools was suggested or prioritised. Among the prioritised interventions, improving the school food environment (No.4) and providing nutrition training for school caterers (No.5) were selected for further discussion in this group, in relation to implementation.

One group discussed the practical challenges of providing a daily serving of fruit to students in school. One of the catering staff commented:

'We have a very heavy workload...start working about 5am...There are only 4 or 5 people in our team responsible for so many pupils' and staff's meals...if fruits were going to be provided to students we might need more people to help...you can't just give fruits to the kids without careful cleaning, peeling or cutting...need to be very careful about agrochemicals left on the fruits as nobody can afford a food safety incident...bananas are more convenient'.

Regarding training for catering staff, the participants provided important information for

designing relevant educational programmes and materials. Firstly, several catering staff discussed the prohibitive cost of nutrition courses, and that any training had to be affordable. The duration and timing of training was also discussed, with most participants agreeing that courses lasting for one to four weeks, providing participants with the opportunity to obtain a certificate or qualification, and taking place during the school holidays were most likely to be acceptable. Secondly, particularly the older catering staff suggested that the content of training courses and materials should focus on practical skills rather than being text-book focused. This was thought to be important because of the limited education that most catering staff has received and inability to read.

3.5.3.2 Summary

Schools were considered by many stakeholders as the right platform from which to facilitate interventions that target family members. Both parents and grandparents were keen to receive free materials from schools that provide information and tools to support healthy lifestyles for children and would contribute to childhood-obesity- prevention. In terms of how such information is conveyed, there was a difference in preferred communication style between parents and grandparents (cartoon illustration versus real object photography). Furthermore, there was a difference between parents and grandparents in terms of their available time (evenings and weekends, versus during the day) and source of media use (e.g. TV and newspapers), if sources outside of school

were used for delivering these messages. This highlights the importance of tailoring the design of communication programmes to the target audience. Furthermore, parents prefer the use of positive appeal to threat appeal in communicating healthy eating/nutritional messages. Many grandparents were keen to take a leading role in supporting busy parents in promoting family-focused healthy activities with the children. This was believed to be facilitated by grandparents having more time and better access (through having free or discounted costs) to public transport and outdoor facilities (e.g. parks). Teachers suggested that the design of motivation certificates and badges for primary school aged children should take into account the various preferences among different age and gender groups. Several existing school resources and a nation-wide health promotion programme (one hour physical activity on campus every school day) can be exploited in childhood obesity preventive interventions. Useful school resources include availability of digital televisions in all classrooms (potentially for playing tailored-made health education videos to family representatives at school meetings) and students' weekly moral education lessons (which can incorporate healthy eating and physical activity educational/promotional activities). School staff recommended using strategic and indirect methods of providing parenting education to promote healthy behaviours in their children. This included use of "child power" to educate carers about healthy eating and child feeding habits. Upstream policy support was considered useful for motivating and monitoring organisational behaviours that aim to improve the nutritional quality of school meals. Effective regulation on traders selling unhealthy snacks to students at school entrances was also considered as essential support for schools in their efforts to promote healthy eating. Finally, school head teachers' attitude and support toward the promotion of healthy eating and physical activity at schools

were viewed by teaching staff as important determinants of the successes of school-based interventions. However, the exam-oriented education system was recognised as a major environmental barrier for head teachers to commit to health-promotion activities.

3.6 Discussion

3.6.1 Summary of key findings

Perceived causes of childhood obesity and obesogenic behaviours

A number of important macro-level environments were identified as contributors to Chinese children's diet and physical activity behaviours that lead to obesity. Social, historical, regulatory, policy and economic forces have multiple and inter-related influences on the attitudes, subjective norms and perceived behavioural control among children and their important stakeholders, leading to obesogenic behaviours. A number of modifiable factors and levers were identified that can inform intervention development.

Poor knowledge among parents, grandparents and school catering staff in relation to healthy diet and nutrition was highlighted by all groups as being an important contributor

to unhealthy eating behaviours. Social change, leading to poorer perceived neighbourhood safety and connectedness were emphasised as contributors to reduced physical activity in children. State policies leading to single child families and focus on examination results in the education sector and weak regulatory processes related to food marketing and schools were perceived to have multiple influences that promote obesogenic behaviours. Historic and social change have also led to grandparents becoming main carers for children in urban China, and all groups drew attention to this as a significant influence on childhood obesity.

Preferences for future interventions

Through the process of prioritisation and discussion of how interventions could be implemented, valuable information for tailoring the design and delivery of preventive interventions was also gained. Similarities and variations in perceived importance and feasibility of components were also identified across different stakeholder groups. These highlight the need for tailored mix and delivery strategies for interventions targeting different population segments. In addition, during this process, some of the major societal and environmental factors influencing obesogenic behaviour discussed previously were again emphasised, in particular in relation to barriers to implementing interventions. Overall, most participants favoured dietary over physical activity interventions and preferred these to be delivered in schools. In addition, schools were believed by both family and school members to have important roles in promoting interventions that target and are implemented in the family. However, upstream policy

support was also highlighted as an important factor influencing the work of schools in promoting healthy eating among students. Differences in potentially effective communication or motivation strategies between grandparent and parent groups and within children of different ages and gender were identified. Existing social (e.g. grandparents' advantages in time and travel cost), policy (i.e. national requirement for students' physical education and activity levels on the campus) and institutional resources (e.g. traditional school meeting for families) that future prevention interventions can exploit were also identified.

Non-prioritised interventions were also examined. The identified characteristics of those components highlight issues to be addressed for future intervention implementation and also aid our understanding of how and why certain types of interventions were prioritised by the study participants.

3.6.2 Strengths and limitations

This is the first qualitative study in China to explore the views of a wide range of stakeholders related to primary school aged children, in relation to obesity. Participants represented a variety of stakeholders, were selected from two urban cities and were from a range of socio-economic backgrounds, thus providing views from a broad perspective and allowing data saturation to be reached. Several steps were taken to ensure data

trustworthiness, and we have provided a transparent description of the methods and analysis approach. A number of important influences on childhood obesity emerged from the data that resonate with findings from previous research in other settings, conferring a level of validity to the findings. We also gained useful insights into contextual barriers to effective delivery of future interventions and explored the study population's preferences for future intervention components and delivery strategies.

Many qualitative studies from different countries have explored different population groups' perceptions regarding causes of childhood obesity. Some have also explored children, family or school staff's preferences for obesity preventive interventions in children. However, few qualitative studies have simultaneously explored perceptions around both causes and intervention preference. The current study went beyond both of these to further explore preferred delivery strategies of future interventions in the target groups. The study might also benefit from the fact that each focus group's prioritisation result was a synthesis of all individual participants' opinions, with little influence from peer pressure or compliance to 'social norm'.

Furthermore, the study provided an example of applying the TPB in formative research in intervention development. Among the three qualitative data sets (perceived contributing factors, prioritisation of effective and feasible interventions, and preference for the delivery of prioritised interventions), identified perceived factors contributing to childhood obesity and unhealthy behaviours (the first data set) were categorised by their

relation to the theoretical domains of TPB. While there were a number of possible theoretical frameworks or approaches that I could have taken to present and analyse this particular group of data, TPB emerged as a suitable choice because the inductive preliminary data analysis stage found a good match between the theory's components and emergent perceived factors. To assist the identification of the most influential targets for potential interventions, identified factors were further grouped into those influencing a single construct of the theory and those influencing multiple components of the theory. Such an approach to data presentation provided one way to transform the qualitative findings into meaningful information that can help develop future interventions based on a theoretical framework.

While strong evidence for using TPB to explain children's health behaviours has not been established, lack of evidence does not equal to lack of applicability. More studies examining TPB's ability in predicting children's obesogenic behaviours are needed. The discussion (of the first data set) in this study had a considerable weight on the behaviours of children's adult stakeholders. This also made TPB a suitable choice of analytical framework.

There were also limitations to this study. Although a broad range of stakeholders were included, China is a vast country with varying geographic conditions and dietary traditions, thus the findings may not be generalisable to other parts of China. We limited the study to urban areas, as this is where the increase in obesity is most marked, but by

doing so we have not included the views of people in rural parts of South China. Although the data analysis method is reported transparently and was continually discussed with another researcher, the analysis was undertaken by only one researcher, who is a native Chinese speaker. We chose to restrict focus groups to identity groups rather than mixing participants, and did not include head teachers in any of these groups to prevent power imbalance. Use of interviews may have limited ideas emerging from this group, although this was not apparent from the data. The scope of issues commented by head teachers were similar to those that arose in focus groups.

3.6.3 Findings in relation to previous literature

3.6.3.1 Perceived factors contributing to childhood obesity and obesogenic behaviours

While some contributing factors identified in this study are similar to those found in other populations, other factors seem to be unique to this setting and population and were not previously reported.

Low awareness and lack of knowledge, particularly in relation to recognition of overweight and in relation to healthy eating and diet, were identified as important

contributors to childhood obesity and have been similarly reported in other contexts. Studies in Australia and North American populations have reported that mothers[167,335] have poor understanding of the consequences of unhealthy diet and several studies across the world have shown that parents often misinterpret children's weight status[334] and have poor understanding of how to recognise obesity[164,167,307]. Lack of knowledge about healthy eating and cooking has also been cited as a contributor to childhood obesity in other populations[166,307].

Several themes emerging from our data related to factors that stakeholders believed they had little or no control over, and these are similarly reported in other contexts as contributors to childhood obesity. The lack of affordability of fruits[336,337], increasing availability of inactive modes of travel[338-340], high cost of leisure facilities[258,304] and insufficient outdoor space for physical activity[183,258,341] highlighted in this study have also been reported in other populations. However, we also identified several other important factors that were not previously reported, and seem to be unique to this context. Although the school environment has been highlighted as an important potential contributor to childhood obesity in other studies[159], this has been mainly related to school food provision. In this study, concerns about unlicensed food traders around schools and poor regulation and enforcement of government requirements for physical education in schools were highlighted as contributors to obesogenic behaviours among children. The great emphasis based on academic education and achievement in exams in China has also resulted in physical activity opportunities being squeezed out both at school and within the home. The phenomenon that Chinese students are exempted from

household chores but under considerably high expectation to perform well in academic learning, was also reported in a previous cross-sectional study[342]. Three previous studies have also reported long study hours among Chinese students[343-345]. In addition, several social and policy influences such as increased competition in the employment market and the single-child family structure were thought to put further pressure on the importance of academic achievement and be a driver for obesogenic behaviours. In contrast to our finding that having a single child reduces interactive physical play opportunities, mothers taking part in focus groups in a study in Canada perceived that having multiple siblings reduced active play, as screen based entertainments were then often used as baby sitters[301].

The international literature has documented the extent[191] and impacts[167,200,203,258] of food marketing on children's eating behaviours. In this study commercial marketing was also highlighted as an important influence on children's diet, but in addition, marketing was seen as exerting an influence on the popularity of digital games and promoting sedentary behaviours. The rise in private car ownership in urban China[346] was perceived to negatively impact on children's physical activity not only through promoting inactive transport, but also through reducing outdoor play because of the resultant air pollution. Similar findings were reported in a qualitative study in Australia also where increased car pollution was a perceived barrier to children's physical activity[258]. lack of neighbourhood connectedness was also found in overseas studies as a correlate of childhood overweight[347] and adults' walking activities[348], and parents' concern over neighbourhood safety[258,349]. In this study, reduced

neighbourhood connectedness was perceived by parents as a barrier to children's active play in the neighbourhood; it was also associated with parents' concern over neighbourhood safety.

We identified grandparents as an important influence on children's weight status, partly through limited understanding of the consequences and risk factors for obesity, through their experiences and through a desire to over-indulge their single grandchildren. Two previous studies including one from China[164,350], have also reported grandparents having an important influence on children's diets, although we found that they are also responsible for limiting children's activity levels. In China grandparents' are often the main carer for their grandchild, whilst both parents are working. Furthermore, with an ageing population and traditional ethic of caring for elders, grandparents often live in the same household as the children, leading to 3-generation households. Thus grandparents were perceived as important targets for intervention. .

Application of Theory of Planned Behaviour to findings

Our findings indicated that childhood obesity in China is influenced by factors at the levels of individuals, family, built and social neighbourhood environments and the wider regulatory and policy environments. In order to tackle childhood obesity, these findings help to inform potential targets for future prevention interventions. By using a well established theoretical model such as the TPB as a framework to group and present our

exploratory findings, we found that while some factors influence a single construct of TPB, other factors impact on multiple domains of TPB in relation to children and their stakeholders' healthy behaviours. Targeting these wide-impact factors, particularly those that are modifiable, would therefore be a sensible first step in future preventive interventions. The important influence of grandparents emerged as a consistent theme within this study and suggests they are an important segment for targeting. They influence Chinese children and other important stakeholders (in the family and in school)'s diet and physical activity behaviours and set social norms.

Another important theme emerging from this study was the lack of information and knowledge about recognition of childhood obesity, its consequences and the importance of healthy eating and exercise. This lack of knowledge and misperception influences a single construct of the TPB but has impacts on the promotion of both healthy eating and physical activity. Chinese grandparents over feed their grandchildren and protect them from physical tasks out of a desire to care and shield them from hardship. Thus educational interventions targeting grandparents in particular, could utilise this desire and channel it towards childhood obesity prevention. At a macro-level, the education system, the neighbourhood and built environment, marketing and increase in car ownership were also identified as factors that influence childhood obesity through multiple pathways. These are potential targets for policy level interventions, but may be more difficult to modify. The single child policy in China was also identified as a factor that has multiple influences on childhood obesity. Although this is not a modifiable factor, the pathway to obesity is through indulgence and pampering the child by overprotective parents and

grandparents who do not perceive obesity as a problem. The lack of knowledge on harms of obesity and confusion about healthy eating and physical activity contribute to this. Thus interventions to tackle beliefs and understanding of childhood obesity and its risk factors could reverse the influence of this policy as a threat, into an opportunity for action.

3.6.3.2 Preference for the components and delivery strategies of preventive interventions

Prior to the current study, there was no report in either the international or Chinese literature regarding Chinese people's preferences for the components and delivery strategies related to childhood obesity preventive interventions.

While such formative research has not been conducted in China so far, many western studies have used qualitative research methods to explore the target populations' perceived facilitators to adopting (by children) or promoting (by stakeholders) healthy eating[258,306,351] and physical activity[258,259,352,353], or to engaging in certain preventive intervention programmes[354-356]. The most widely reported facilitators for healthier behaviours in children or preference for preventive interventions included making healthy snacks and activities more affordable[306,352,353], increasing availability of healthy food at school[306,357] and physical activity facilities[259,353], support and encouragement from family or peers[259,306,351,353], promoting fruit and

vegetables as tasty[351] and physical activities as fun[259,353] rather than healthy in children, delivering practical support or activities rather than theoretical information[159,352], being able to make their own choices[306,351], involving the family in child-focused interventions[262,306,352], and combining school and family-level interventions[258,262]. A large childhood obesity prevention programme (EPODE) that has taken place across European countries, Canada and Australia illustrated the use of positive appeal strategy in promoting healthy behavioural change[298]. An Australian study also showed that health communication maximising health benefits could enhance uptake of recommendations in the obesity context[358]. The current study with Chinese stakeholders identified some unique characteristics about the study population, such as the potential for grandparents to lead family-focused healthy activities, whilst showing that other intervention preferences were similar to those reported in western populations (e.g. using a positive appeal communication strategy, focusing on practical instead of theoretical activities, making health materials/facilities affordable and multiple-level interventions).

The study participants generally favoured dietary interventions over physical activity interventions. Such prioritisation result might be explained partly by our findings on perceived causes of children's obesogenic behaviours. In particular, children's physical activity levels were perceived to be restricted by several fixed environmental factors, such as the exam-oriented education system and limited space for physical activity in the school campus and residential neighbourhoods. Although children's dietary behaviours were also believed to be influenced by several environmental factors, there

was a perception that the most important determinants (e.g. knowledge and attitude of grandparents) among those are relatively more changeable in comparison with, for example, China's education system. The exam-oriented education system in China has been a target of change for nearly two decades. However, limited effects have been achieved, especially in reducing students' workload and study pressure[359-362].

A recent qualitative study involving focus groups with parents from four different European countries found that promoting physical activity in children was viewed by parents as a joint responsibility between schools and themselves and that nutrition was considered as their responsibility with support from the school[262]. However, prevention of sedentary behaviours was seen as parents' sole responsibility[262]. International reviews of childhood obesity preventive interventions showed that the majority of interventions were implemented in school settings[306,353]. This is because schools have continuous and close contacts with children and potentials to influence children through their infrastructure, physical environment, policies and teachers[363]. In this study, neighbourhood community based interventions were not prioritised by any group. Drawing on the findings from the first part of the focus groups, where the perceived causes of childhood obesity were discussed, reduced neighbourhood connectedness may explain the low acceptance of community-based interventions. An international review of school-based prevention studies found inconsistent intervention outcomes but the effectiveness of physical activity interventions in preventing childhood overweight was generally better evidenced than that of dietary interventions[217]. The reviewers also suggested that school-based interventions

combining both elements might be effective in the long term[217]. Since the current study revealed that both family and school stakeholders value and prefer school-based activities, future interventions in China should fully exploit the potential that schools have in delivering educational or promotional programmes, even when non-school stakeholders (e.g. family members) are the primary targets of an intervention.

3.7 Conclusion

Inter-related social, historical, regulatory, policy, knowledge and economic factors were found to contribute to obesogenic behaviours among South-urban Chinese children. They were summarised in a schematic web diagram. A number of potential opportunities for intervention were highlighted and this was facilitated by the use of a theoretical approach to the analysis. Interventions targeting family members, and particularly grandparents, would be likely to impact on several pathways leading to prevention of childhood obesity.

The study participants' perceptions of the importance and feasibility (and their overall prioritisation results) of possible interventions are not the sole basis on which future prevention interventions can be determined. However, they provide insights into the general population and both awareness and barriers to change (in relation to perceived feasibility of interventions) among specific subgroups.

Study participants' discussions on potential delivery strategies for various interventions provided valuable and direct insights into how interventions should be designed and implemented for optimal acceptability and effectiveness in different target segments within the study population.

Moreover, it worth noticing that several findings for different research questions (intervention prioritisation, preferred delivery strategies and perceived causes of children's obesogenic behaviours) were consistent with each other (so mutually explainable). For instance, from the intervention delivery strategy discussion, we found that grandparents were willing and able to help with busy parents and take a leading role in promoting outdoor activities. At the same time, intervention component No.38 (outdoor activities involving family members) was favoured by grandparent groups. Also, our exploration on perceived causes of childhood obesity found that grandparents tend to over pamper their single grandchildren at home. Consistently, intervention component No.19 (control over screen-based entertainment activities) was not favoured by grandparent groups. Intervention components that involve school staff organising off-campus activities were not popular among our study participants. This, to a large extent, might be explained by school staff's negative attitude towards activities associated with high student safety responsibility, which was discovered as a factor influencing physical activity promotion through schools.

4 CROSS-SECTIONAL STUDY TO IDENTIFY FAMILY AND NEIGHBOURHOOD ENVIRONMENTAL FACTORS ASSOCIATED WITH CHILDHOOD OBESITY AND OBESOGENIC BEHAVIOURS

4.1 Background

The literature review chapter has described the rapidly growing epidemic of childhood obesity in China and large socioeconomic and geographic disparities in the epidemic across the country. Therefore, interventions to halt this rising trend and prevent childhood obesity are particularly needed.

Development of effective preventive interventions requires an understanding of the determinants of obesity and related health behaviours among children. However, as discussed in the literature review chapter, whilst some research has been done in Western countries, such research is limited in China. Researchers have emphasised the importance of such research being done outside of the US, Australia and Europe, since environmental correlates of obesity and obesogenic behaviours may differ in other parts of the world, such as Asia[300].

As discussed in section 2.2.3, much research in China over the last 15 years has focused on the genetic[213,247,248,252,364], behavioural[233,247,248,254,255,364] and socioeconomic[213] risk factors of overweight/obesity as well as the prevalence of the epidemic[365], unhealthy dietary behaviours[366-368] and physical activity levels[342,369] among Chinese children. Little research has examined family and neighbourhood environmental determinants of childhood obesity and related health behaviours. However, a better understanding of these environmental influences is important for developing and implementing interventions.

The role of parental behaviour modeling on children's dietary[148-152,157,308] and physical activity[169-171,308] patterns have been well documented in the international literature. Other family factors that have been linked to child weight status in cross-sectional studies include the home environment, such as the number of screen media present in the home[308] and family meal habits, such as frequency of dining

out[195,370,371]. Family factors such as parenting style, including using food (often energy-dense but low in nutrition value) or sedentary activity (such as watching TV) as a reward for desirable behaviour, have also been shown to be associated with children's dietary behaviors[158,159,161] and physical activity patterns[372]. Family structures (e.g. number of parents, and household members) were also found in some Western studies to be predictors of children's health behaviour[372,373].

With regards to neighbourhood environments, as discussed in section 2.1.4.4, the availability[178] of and distance[179,180] to food outlets (e.g. convenience stores and restaurants) are well documented correlates of children's weight status and dietary behaviours in the international literature. The literature demonstrating the relationship between neighbourhood environmental factors and children's physical activity levels was also illustrated earlier. These mainly include road traffic[179,181,374], availability of and accessibility to open/green spaces[179,182,207,374], accessibility to affordable/free recreational facilities[183,184,207], street connectedness[185,207,374] and neighbourhood safety[172,186,187,207,374,375].

4.2 Research aim and objectives

Research aim

The aim of this cross-sectional study was to examine the relationship between the family

and neighbourhood environments with children's weight status and obesogenic behaviours. The overall aim was to identify modifiable risk factor targets and integrate the findings from this study with those from the qualitative study reported in chapter 3, to inform future preventive interventions.

Research objectives

1. To identify family and neighbourhood environmental factors associated with childhood overweight and obesity
2. To identify potential behavioural mediators linking the association between identified environmental factors (if any) and childhood overweight and obesity

For the second objective, three well established behavioural risk factors (potential mediators) were examined: (1) consumption of unhealthy snacks (US), (2) consumption of fruit and vegetables (FV) and (3) daily moderate-vigorous physical activity (MVPA) levels. Each of these factors was examined separately in terms of their relationship with family and neighbourhood environmental measures.

4.3 Methods

4.3.1 Research setting

The research setting for this cross-sectional study was the same as for the qualitative study reported in chapter 3. Data collection took place at the *same time* and in *the same four socioeconomically distinct urban schools* described in section 3.3. Ethical approval was also obtained from the Life and Health Science Ethical Review Committee at the University of Birmingham.

4.3.2 Study sample

Sample size

The size of the study sample was determined pragmatically based on what was achievable within available time and resources and considering the sample size of previous studies that had addressed similar research questions. Based on the achieved sample size ($n=497$), a retrospective calculation of the likely effect size that could be detected for a child being overweight or obese versus being non-overweight, for the primary predictor of interest (number of grandparents living in the household) was undertaken. Using a two sample comparison of proportions approach, the sample of 497 children, where 24% of children were overweight or obese (see page 191), there was 80% power (5% significance) to detect a difference between the probability of being overweight or obese among children who had at least two grandparents living with them in the same household (0.4) and the probability of being overweight in those without 2 live-in grandparents (0.24) equivalent to an odds ratio of 1.78.

The selection process for sample schools was described in section 3.3. In Guangzhou, three primary schools, one located in each of the upper-, middle- and lower-socioeconomic districts were selected to take part in this study. The schools were those used by the local Education Bureau and Health Bureau for their annual child health surveillance programme and are considered to be representative of schools in these districts. In Hechi, one primary school located in the central district was selected given its good coverage of diversified student socioeconomic backgrounds. The school was also used by local Health Bureau in routine student health monitoring research.

From each sample school, three third-year classes (age 8-10) were randomly selected and the parents of children in these classes were invited to complete questionnaires.

4.3.3 Measures

4.3.3.1 Anthropometric measures (outcome)

As part of the child health surveillance programme, children have their weight and height measured annually by trained health professionals from the local education authority, using standard instruments, and according to a set measurement protocol. Data for the

2009/2010 academic year was obtained for all children whose parents responded to the questionnaire and gave signed consent.

4.3.3.2 Parent questionnaire

The questionnaire was first developed in English, incorporating questions from previously validated instruments. This was then translated into Mandarin Chinese and pilot tested for comprehension and any discrepancies (in 10 Chinese parents in China) by myself, a qualified native Chinese cultural and language advisor. The questionnaire was used to collect data on the exposures of interest (the family and neighbourhood environment), the main intermediary outcomes (diet and physical activity levels) and socio-demographic and other potential confounding factors.

Socio-demographic characteristics and family environment

The questionnaire collected data on the child's socio-demographic characteristics, birth weight as well as family composition, child care responsibility allocation, family eating and feeding habits, parental physical activity habits and the availability of cars and electronic media in the household. A summary of these variables is shown in table 7.

Table 7 Socio-demographic and family environmental variables collected in the parent questionnaire

Categories	Variables
Demographic	1) child birthday, 2) age at measurement, 3) school
Socioeconomic position	1) mother's education level, 2) father's education level, 3) main income earner's occupation
Family composition	1) number of children living in the same household 2) number of adults (relationship with the child is specified) living in the same household
Child care responsibility allocation	1) the person who spends the longest time with the child during weekdays outside school, 2) the person with the most influence on everyday food shopping, 3) the person with the most influence on what and how much the child eats
Family eating and feeding habit	1) the place the child usually has breakfast 2) how often the child dines out with family in a typical week
Parental physical activity habits	1) mother's frequency of exercises (examples of what activities are counted as exercises were given) 2) father's frequency of exercises (examples of what activities are counted as exercises were given)
Availability of sedentary commuting and entertainment objects	1) number of cars owned by the family 2) number of televisions, DVD players, computers and digital game players

Perceived neighbourhood environment

The questionnaire assessed parents' perceptions of their neighbourhood environment, using a translated version (English to Mandarin Chinese) of the Abbreviated-Neighborhood Walkability Scale (NEWS-A), which was developed in the US[376]. There is evidence of good concurrent validity[376,377] and test-retest reliability[377] of NEWS-A in Western populations. The 54-item questionnaire has 8 subscales and 4 single-item subscales. It assessed the following environmental

characteristics: a) residential density; b) proximity to non-residential land uses, such as restaurants and retail shops (land use mix-diversity); c) ease of access to non-residential uses (land use mix-access); d) street connectivity; e) walking/cycling facilities, such as pavements and pedestrian/bike trails; f) neighbourhood aesthetics; g) pedestrian traffic safety; h) crime safety i) lack of parking; j) lack of cul-de-sacs ; k) hilliness; and l) physical barriers (e.g. railway lines and rivers) that make getting from place to place difficult. Except for the residential density subscale and the last 4 single-item subscales (from i to l), all other subscales were adopted in the parent questionnaire and they are described in more details in table 9. Methods used to calculate scores for individual subscales followed the proposed guide for NEWS-A[376].

Table 8 Descriptions of subscales measuring perceived characteristics of neighbourhood environment

Subscale	Items included in the subscale	Responses and interpretations
Land-use mix-Diversity	Walking proximity from home to 23 businesses and stores such as convenience store, supermarket, fruit & vegetables market, post office, library, elementary school, coffee place, bank, pharmacy store, park, gym or fitness facility.	Ranging from 1- to 5-min walking distance (coded as 5) to > 30-min walking distance (coded as 1). Higher subscale score indicated closer average proximity.
Land-use mix-Access	Asking participants' opinions on the extent to which 'stores', 'many places' and 'transit stops' are easy to reach by walking (from home). Items were rated on a 4-point Likert scale.	Ranging from 1 (strongly disagree) to 4 (strongly agree). Higher subscale score denoted better access to non-residential uses.
Street connectivity	Asking participants' opinions on the following statements: 1) The distance between intersections in my neighbourhood is usually short 2) There are many alternative routes for getting from place to place in my neighbourhood. Items were rated on a 4-point Likert scale.	Ranging from 1 (strongly disagree) to 4 (strongly agree). Higher subscale score denoted better street connectivity.
Infrastructure and safety for walking	Asking participants' opinions on their neighbourhood's existing infrastructure for walking such as sidewalks, lights, crosswalks and pedestrian signals. Items were rated on a 4-point Likert scale.	Ranging from 1 (strongly disagree) to 4 (strongly agree). Higher subscale score denoted better infrastructure and safety for walking.
Neighbourhood aesthetics	Asking participants' opinions on the presence of natural and built objects such as trees, attractive signs and buildings in their neighbourhood. Items were rated on a 4-point Likert scale	Ranging from 1 (strongly disagree) to 4 (strongly agree). Higher subscale score denoted better aesthetics.
Traffic hazards	Asking participants' opinions on the following statements: 1) There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighbourhood 2) The speed of traffic on most nearby streets is usually slow (30 mph or less) 3) Most drivers exceed the posted speed limits while driving in my neighbourhood. Items were rated on a 4-point Likert scale.	Ranging from 1 (strongly disagree) to 4 (strongly agree). Second item was reverse coded. Higher score denoted higher hazards but lower walkability.
Crime	Asking participants' opinions on the following statements: 1) There is a high crime rate in my neighbourhood 2) The crime rate in my neighbourhood makes it unsafe to go on walks during the day 3) The crime rate in my neighbourhood makes it unsafe to go on walks at night. Items were rated on a 4-point Likert scale.	Ranging from 1 (strongly disagree) to 4 (strongly agree). Higher score denoted higher crime safety concern but lower walkability

Dietary intake assessment

A wide range of methods are available for estimating and quantifying food intake in children and adults. All involve some form of reporting of diet by the subject, or proxy report by a family member such as parents. The most valid method is use of weighed food records, which involves subjects recording and weighing all ingredients in any food or drink consumed during the measurement period. However, this method is complex, places a large burden on participants, and there is generally poor compliance among respondents. The most common approaches for large scale studies include 24-hour recall and Food Frequency Questionnaires (FFQ). There are advantages and disadvantages to using each of these approaches[378], but again, both are cumbersome and time consuming. In this study, I was particularly interested in children's consumption frequencies of certain types of food which have been implicated as contributing to, or protecting against childhood obesity. Therefore a pragmatic approach was taken and I sought to find out about consumption of common unhealthy snacks, sugar-added drinks, fruits and vegetables. A parent reported food frequency questionnaire was developed to capture this information. Parents were asked to recall the child's dietary intake of 16 major food and drink items (with standard serving defined) during the previous week. For each food item, they were asked to indicate how often the child had consumed this in the last week (not at all, once, 2-3 times, 4-6 times, 1-2 times per day, or more than twice per day). Data from the questionnaire was used to estimate the weekly consumption of "unhealthy snacks" (US) and "fruit and vegetable" (FV) by children, weighted by frequency of consumption (using 0, 1, 2.5, 5, 7 and 14 respectively for each response option). Unhealthy snack consumption was estimated as the sum of average servings of

salty high fat snacks (e.g. crisp, deep fried snacks), sweet high fat snacks (e.g. chocolates, cake, ice cream, and biscuits), candies and sugared beverages (e.g. carbonated drinks) in the previous week. Reported weekly consumption of servings of fruit and vegetable in the previous week was summed to estimate FV. More details about the items used are described in table 9.

Table 9 Questionnaire items used to estimate frequency of consumption of unhealthy snacks, and fruit and vegetables

Variable	Food items included
Weekly consumption of US (sum of average servings of each item consumed in the last week)	A chocolate bar or several chocolate sweets; A piece of cake (and other sugary, oily dim sums), or a serving of ice cream, or biscuits; A pack of crisps; A portion of deeply fried snacks; Sugar-added soft drinks (such as coke, milk shake, non-pure juice); A handful of sweets (such as guo dong).
Weekly consumption of FV (sum of average servings of each item consumed in the last week)	A portion of fresh fruit (e.g. an apple, a bunch of grapes, an orange); A portion of vegetables (e.g. a rice bowl size of Pak Choi).

Physical activity assessment

A wide range of objective and subjective methods are available for the assessment of PA in children[379-386]. The main objective method used is through motion sensor devices such as accelerometers, which are used to estimate total activity, duration of different levels of intensity of activity, and energy expenditure[380,382,387]. However, these instruments are costly and using them is resource intensive. Subjective self-report has been used as an alternative in many epidemiologic studies[386]. There are a variety of

instruments available, and some of these have been validated in children and adolescents against direct assessment tools[379,388]. However, despite providing a fair assessment of intensity of activity, subjective measures have a poor to moderate correlation with accelerometry data[383]. Given the limited resource availability for the current study, a subjective method was used for children's PA assessment. Considering that young children have difficulty in recalling information and completing questionnaires[386], a parent-proxy report was used, which has been shown to be more accurate than children's self report[375].

Participating parents were asked to report children's PA levels by estimating the average time the child spends doing sedentary, light (<3 METs), moderate (3-6 METs), and vigorous (>6 METs) activities in both weekday and weekend-days. Examples of activities classed as sedentary, light, moderate and vigorous were provided based on their energy costs measured in metabolic equivalents (METs)[389]. The average amount of time spent by children in those activities each day was estimated by averaging the reported typical week and weekend day activities (average week-day activity * 5 + average weekend activity * 2) / 7). The duration of moderate and vigorous activity was summed (MVPA) and children were categorised into whether or not they engaged in recommended levels of MVPA (at least 60-minutes per day).

Standardised protocol for questionnaires administration

Questionnaires and consent forms (in sealed envelopes) were sent home to parents via the pupils of sampled classes through their schools. Returned questionnaires that had large sections that were incomplete, or that contained illogical or inconsistent responses, were sent back via the pupils with queries (in sealed envelopes). Completed questionnaires were collected through the school.

4.4 Statistical analysis

Sample characteristics description

The characteristics of the study sample (family and perceived neighbourhood environment and health behaviour in relation to childhood obesity) were examined and compared by child sex and mother's education level, using either T test (for comparing continuous variables) or Chi-square Test (for comparing categorical variables). Since mother's educational level has a well documented association with Chinese children's health behaviour[390], it was used in the study as the best proxy measure of participating family's socioeconomic status.

Defining child weight status

The wide range of methods available for measuring and defining children's weight status

and body fatness, and their advantages and disadvantages were discussed in section 2.1.2. The WHO 2007 Child Growth Standards[391] for children aged between 5 and 19 years allow calculation of each individual's sex-and age-specific BMI standard deviation score (also known as z- scores) from their height and weight measure. It thus simplifies analysis in children of mixed sexes and ages[392]. Meanwhile, the Chinese national reference norm introduced by the WGO[231] (described previously in section 2.2.1) does not allow differentiation between under-weight and healthy-weight children. In addition, examination of agreements, among classifications of participating children into healthy-weight, overweight and obese categories, by WHO 2007 standards[391], WGO reference norm[231] and IOTF[66], showed very good to good agreements (reported later in section 4.5.1.2). For those reasons, the WHO 2007 standards were chosen in this study as the definition tool to classify the weight status of participating children into 4 categories for statistical analysis. Each student's BMI SD score was first calculated using the LMS formula[393]:

$$\text{BMI SD score} = \frac{(\text{observed value} \div \mathbf{M})^{\mathbf{L}} - 1}{\mathbf{L} \times \mathbf{S}}$$

Where: M denotes the reference median value which estimates the population mean.
L denotes the power needed to transform the data in order to remove skewness.
S denotes the coefficient of variation.

The four categories created were underweight, healthy weight, overweight and obese, using -2SD, +1SD and +2SD as cut-offs respectively. For some analyses, the “underweight” and “healthy weight” categories were combined as “non-overweight” and the other two categories as “overweight/obese” to produce a binary variable.

Assessment of the association between family and neighbourhood environments, and children's weight status (objective 1)

Firstly, univariate analyses were used to examine the relationship between each of the family and neighbourhood environmental variables, and children's weight status. Multivariate logistic regression was then used, adjusting for the child's sex, age (in months), school, birth weight and mother's educational level, to identify environmental factors associated with childhood overweight and obesity. Given the large number of potential explanatory variables examined in the study, multivariate analysis was confined to variables that were associated with overweight with P-values ≤ 0.1 in the univariate analysis. No adjustment was made for multiple testings in the study, but this is considered in the discussion.

Given that the data obtained came from schools, one could argue that the analysis should take account of the clusters and that multi-level analysis should have been applied. However, statisticians generally recommend that multilevel models should not be fitted to data consisting of fewer than 10 clusters[394]. Thus multivariate analysis was not undertaken. Nevertheless by including 'school' as a co-variate in all multivariate analyses, some adjustment was made for the effect of clustering.

Assessment of the association between family and neighbourhood environments, and children's consumption of US, FV and MVPA (objective 2)

Firstly, univariate analyses were used to examine the relationship between each of the family and neighbourhood environmental variables, and children's US, FV and MVPA. Eligible environmental predictors (following the same criteria described above) were then used in multivariate analyses to examine their relationships with each of the three potential behavioural mediators. Linear regression models were run for US and FV while logistic regression models were run for MVPA (children's likelihood of engaging in at least 60 minutes MVPA per day).

Methods used to examine whether any association between family and/or neighbourhood environments and children's weight status was mediated by diet or physical activity behaviours (objective 2)

If any environmental factor (e.g. A) was found to be associated with both child weight status (e.g. B) and one of the obesogenic behaviours (dietary or physical activity variables) analysed in the study (e.g. C), C was examined further, following the most widely applied methods recommended by Barona and Kenney[395], to assess whether it mediated the association between A and B completely or partially. This was done by adding C (as a co-variate) into the previous multivariate logistic regression model of childhood overweight, in which child birth weight and socio-demographic factors were controlled for.

Assessment of association between family and neighbourhood environments, and child weight status in fully adjusted final model

Finally, a full model was developed where important environmental, dietary, physical activity, and other well established behavioural risk factors (sleep duration, child birth weight) as well as potential confounding factors (socio-demographic variables) were all entered simultaneously. Variables for inclusion in the model were selected based on a combination of existing knowledge (literature on risk factors and confounders) and results of previous analyses. This allowed us to see whether identified associations between any environmental factors and child's weight status remained in the fully adjusted model. The goodness of fit was also estimated using the Nagelkerke Pseudo-R² value from the SPSS output.

4.5 Results

4.5.1 Summary of the study sample

Physical measurement data was available for 751 pupils (98.9% of those eligible) and parent questionnaires were returned by 508 parents (91.7% of those approached) (table 10).

Table 10 Response rate for physical measures and parent questionnaires

	Number of approached with available data (Response rate %)		
	Boys	Girls	Total
Physical measure	385 (98.7)	366 (99.2)	751 (98.9)
Parent questionnaire	262 (91.9)	246 (91.5)	508 (91.7)

Eligible pupils without physical measures were those who had been absent on the measurement day. A total of 497 students (257 boys and 240 girls) had both physical measures and a parent questionnaire completed, and this is the study sample for most of the remaining analyses.

4.5.1.1 Characteristics of the study sample

The characteristics of the study population is summarised in table 11 in four sections: anthropometric measures (table 11a); family environments (11b); perceived neighbourhood environments (11c); and obesogenic behavioural measures (11d) (dietary behaviours, physical & sedentary activity habits and sleep duration).

Table 11 Summary of participant characteristics by sex and mother's education level.

(a) Anthropometric measures [Numbers are Mean (95% CI)]

	Total		Sex		P value (t-Test)	Mother education		P value (t-Test)
	Boys	Girls	High	Low				
Height(m)	1.33(1.33-1.34)	1.34(1.33-1.35)	1.32(1.31-1.33)	<0.01	1.34(1.33-1.35)	1.32(1.31-1.33)	0.01	
Weight(kg)	29.47(28.86-30.08)	30.78(29.89-31.67)	28.08(27.26-28.)	<0.01	30.05(29.15-30.95)	28.78(27.97-29.59)	0.04	
BMI	16.54(16.27-16.81)	17.03(16.62-17.44)	16.02(15.67-16.37)	<0.01	16.69(16.29-17.09)	16.35(15.99-16.71)	0.22	
BMIZ-score (WHO2007)	0.01(-0.11-0.13)	0.25(0.07-0.43)	-0.24(-0.39 to -0.08)	<0.01	0.07(-0.1-0.24)	-0.06(-0.24-0.12)	0.33	
Birth weight(kg)	3.23(3.19-3.27)	3.28(3.22-3.34)	3.18(3.12-3.24)	0.03	3.24(3.18-3.30)	3.23(3.16-3.30)	0.82	

Notes:(1) Education level high denotes university degree (undergraduate or postgraduate), education level low denotes lower than university education (high school, college, primary school or none).

(b) Family environments [Numbers are N (%) unless specified].

	Total	Boys	Sex Girls	P value (Chi Squared)	High	Mother education Low	P value (Chi Squared)
No. of children living in household							
At least 2	101(20.3)	48(18.7)	53(22.1)	0.41	26(9.5)	73(33.3)	<0.01
Single child	396(79.7)	209(81.3)	187(77.9)		248(90.5)	146(66.7)	
No. of grandparents living in household							
0	269(54.1)	130(50.6)	139(57.9)	0.08	141(51.5)	127(58.0)	0.35
1	129(26.0)	66(25.7)	63(26.3)		75(27.4)	53(24.2)	
2/more	99(19.9)	61(23.7)	38(15.8)		58(21.2)	39(17.8)	
Person spending most time with child							
Mother/father/other adult	407(82.4)	212(83.1)	195(81.6)	0.74	232(84.7)	171(79.2)	0.14
Grandparent	87(17.6)	43(16.9)	44(18.4)		42(15.3)	45(20.8)	
Person with most influence on food shopping in the household							
Child	49(9.9)	23(9.0)	26(10.9)	0.73	24(8.8)	25(11.5)	0.03
Mother/father/other adult	309(62.6)	163(63.9)	146(61.1)		161(58.8)	145(66.8)	
Grandparent	136(27.5)	69(27.1)	67(28.0)		89(32.5) *	47(21.7)	
Person with most influence on child's diet							
Child	150(30.5)	81(31.8)	69(29.1)	0.21	78(28.5)	72(33.3)	0.34
Mother/father/other adult	290(58.9)	153(60.0)	137(57.8)		169(61.7)	119(55.1)	
Grandparent	52(10.6)	21(8.2)	31(13.1)		27(9.9)	25(11.6)	
Weekly frequency of dining at home							
7 days	236(47.6)	129(50.4)	107(44.6)	0.41	114(41.6)	121(55.5)	0.01
5-6 days	202(40.7)	102(39.8)	100(41.7)		130(47.4)	70(32.1)	
2-4 days	52(10.5)	23(9.0)	29(12.1)		26(9.5)	25(11.5)	
0-1 day	6(1.2)	2(0.8)	4(1.7)		4(1.5)	2(0.9)	
Usual place for breakfast							
Home	277(55.8)	146(57.0)	131(54.6)	0.75	163(59.5)	114(52.3)	0.26
On street stall/restaurant	18(3.6)	8(3.1)	10(4.2)		10(3.6)	8(3.7)	
School	201(40.5)	102(39.8)	99(41.3)		101(36.9)	96(44.0)	
Do not have breakfast	0(0.0)	0(0.0)	0(0.0)		0(0.0)	0(0.0)	

	Total	Boys	Sex Girls	P value (t- Test)	Mother education High	Low	P value (t-Test)
Mean No. of TVs (95% CI)	1.41(1.35-1.47)	1.42(1.34-1.50)	1.39(1.30-1.48)	0.54	1.45(1.36-1.54)	1.35(1.27-1.43)	0.08
Mean No. of DVD players (95% CI)	1.08(1.03-1.13)	1.08(1.00-1.16)	1.07(1.00-1.14)	0.84	1.10(1.03-1.17)	1.05(0.97-1.13)	0.30
Mean No. of computers (95% CI)	1.36(1.29-1.43)	1.32(1.22-1.42)	1.40(1.29-1.51)	0.29	1.59(1.49-1.69)	1.08(0.98-1.18)	<0.01
Mean No. of game players (95% CI)	0.37(0.30-0.44)	0.39(0.30-0.48)	0.34(0.25-0.43)	0.41	0.42(0.33-0.51)	0.31(0.22-0.40)	0.10
Mean No. of cars (95% CI)	0.56(0.50-0.62)	0.53(0.45-0.61)	0.60(0.51-0.69)	0.25	0.66(0.58-0.74)	0.44(0.35-0.53)	<0.01

Notes:(1) Education level high denotes university degree (undergraduate or postgraduate), education level low denotes lower than university education (high school, college, primary school or none).

(c) Perceived neighbourhood environments.

	Total	Boys	Sex Girls	P value (t Test/ Chi Squared)	High	Mother education Low	P value (t Test/ Chi Squared)
NEWS-A subscales [Numbers are Means (95%)]							
Land-use-Diversity scale (range 1-5)	3.33(3.25-3.41)	3.36(3.26-3.46)	3.29(3.17-3.41)	0.43	3.39(3.30-3.48)	3.21(3.08-3.34)	0.02
Land-used-Access scale (range 1-4)	3.22(3.16-3.28)	3.27(3.20-3.34)	3.17(3.08-3.26)	0.08	3.28(3.20-3.36)	3.15(3.07-3.23)	0.03
Street connectivity scale (range 1-4)	2.81(2.75-2.87)	2.82(2.74-2.90)	2.80(2.71-2.89)	0.74	2.85(2.77-2.93)	2.76(2.67-2.85)	0.11
Infrastructure and safety for walking scale (range 1-4)	3.19(3.13-3.25)	3.17(3.09-3.25)	3.21(3.12-3.30)	0.57	3.27(3.20-3.34)	3.09(2.99-3.19)	<0.01
Neighbourhood aesthetics scale (range 1-4)	2.73(2.66-2.80)	2.71(2.62-2.80)	2.75(2.65-2.85)	0.62	2.70(2.61-2.79)	2.77(2.67-2.87)	0.31
Traffic hazards scale (range 1-4)	2.46(2.41-2.51)	2.48(2.42-2.54)	2.44(2.37-2.51)	0.43	2.50(2.44-2.56)	2.42(2.35-2.49)	0.08
Crime scale (range 1-4)	1.86(1.80-1.92)	1.85(1.77-1.93)	1.87(1.78-1.96)	0.80	1.82(1.74-1.90)	1.92(1.82-2.02)	0.09
Walking distance to food stores and leisure facilities [Number (%)]							
Walking distance to a supermarket							
Over 10 minutes	234(48.5)	119(47.6)	115(49.6)	0.63	126(47.2)	106(50.0)	0.50
6-10 minutes	172(35.7)	94(37.6)	78(33.6)		94(35.2)	77(36.3)	
1-5 minutes	76(15.8)	37(14.8)	39(16.8)		47(17.6)	29(13.7)	
Walking distance to a convenience store							
Over 10 minutes	19(3.9)	4(1.6)	15(6.4)	0.03	8(3.0)	11(5.1)	0.45
6-10 minutes	107(22.1)	55(22.1)	52(22.0)		57(21.3)	48(22.4)	
1-5 minutes	359(74.0)	190(76.3)	169(71.6)		202(75.7)	155(72.4)	
Walking distance to a fruit & vegetable stall							
Over 10 minutes	137(28.1)	66(26.1)	71(30.3)	0.18	68(25.4)	68(31.6)	0.30
6-10 minutes	200(41.1)	114(45.1)	86(36.8)		115(42.9)	82(38.1)	
1-5 minutes	150(30.8)	73(28.9)	77(32.9)		85(31.7)	65(30.2)	

Notes:(1) Education level high denotes university degree (undergraduate or postgraduate), education level low denotes lower than university education (high school, college, primary school or none).

(d) Obesogenic behavioural measures.

	Total	Boys	Sex Girls	P value (t Test/ Chi Squared)	High	Mother education Low	P value (t Test/ Chi Squared)
<i>Dietary behaviours [Numbers are Mean (95% CI)]</i>							
Weekly consumption of Fruit & vegetables	8.71(8.30-9.12)	8.58(8.05-9.11)	8.86(8.24-9.48)	0.50	9.28(8.72-9.84)	8.03(7.43-8.63)	<0.01
Weekly consumption of unhealthy snacks & sugary drinks	6.51(6.03-6.99)	6.32(5.73-6.91)	6.71(5.94-7.48)	0.43	6.20(5.56-6.84)	6.89(6.15-7.63)	0.16
<i>Physical and sedentary activity habits and sleep duration [Numbers are Mean (95% CI unless specified)]</i>							
Average daily duration of MVPA (hour and 95% CI)	2.08(1.96-2.20)	2.11(1.95-2.27)	2.06(1.89-2.23)	0.66	2.06(1.91-2.21)	2.11(1.93-2.29)	0.65
Average daily MVPA level [N (%)]							
Less than 60 minutes	68(15.1)	38(16.0)	30(14.2)	0.67	40(15.2)	28(15.4)	1.00
At least 60 minutes	381(84.9)	199(84.0)	182(85.8)		223(84.8)	154(84.6)	
Average daily duration of sedentary behaviour (hour and 95% CI)	7.26(7.04-7.48)	7.39(7.09-7.69)	7.11(6.79-7.43)	0.21	7.33(7.06-7.60)	7.11(6.75-7.47)	0.34
Average daily duration TV viewing [N (%)]							
Never watches	20(4.0)	11(4.3)	9(3.8)	0.41	17(6.2)	3(1.4)	<0.01
Less than 1 hour	263(52.9)	136(52.9)	127(52.9)		171(62.4)	91(41.6)	
1-2 hours	163(32.8)	89(34.6)	74(30.8)		73(26.6)	88(40.2)	
3-4 hours	40(8.0)	18(7.0)	22(9.2)		12(4.4)	27(12.3)	
4 hours/longer	11(2.2)	3(1.2)	8(3.3)		1(0.4)	10(4.6)	
Average daily sleep duration (hour and 95% CI)	9.66(9.58-9.74)	9.69(9.58-9.80)	9.62(9.50-9.74)	0.41	9.61(9.51-9.71)	9.72(9.58-9.86)	0.23

Notes:(1) Education level high denotes university degree (undergraduate or postgraduate), education level low denotes lower than university education (high school, college, primary school or none). (2) MVPA denotes moderate to vigorous physical activity level.

Physical measures of participating children

Overall, boys were slightly taller, heavier and had higher BMI and BMI z-score compared to girls. Children living with mothers with higher levels of education were also generally taller and heavier than those living with less well educated mothers.

Characteristics of participating families

Around one in five participating families had more than one child (not necessarily a biological brother or sister) living in their households. Just under half lived with at least one grandparent (45.9%) and 17.6% of children spent most of their time after school during the week days, with grandparent(s). All children in the study were reported to eat breakfast every day and more than half (55.8%) had this at home, while 40.5% usually had breakfast at school. Over half of the children had dinner outside of the home (e.g. eating in a restaurant with family) at least once every week. Mothers who had higher education were more likely to live in a single child household and to have a grandparent exerting a dominant influence on what and how much the child ate, compared with mothers who did not have higher education. Most families in the study had at least one television, a DVD player and a computer. 48% of the participating families had a private car. The numbers of computers and cars owned by a household were both positively associated with the mother's education level.

Perceived neighbourhood environments of participating families

Detailed description of the items and mean scores for each of the NEWS-A subscales were summarised in tables 9 and 11 respectively. Scores ranged across the entire scale for all subgroups, although most of the subgroups had a left-skewed distribution of values (most values were over the mean). The mean scores tended to be towards higher walkability in general. Mean scores for “Land-use-mix Diversity” (perceived proximity to businesses and shops), “Land use mix Access” (access to stores and public transport), and “infrastructure and safety for walking” scales all generally suggested high walkability overall, with good access. Scores for “street connectivity”, “Neighbourhood aesthetics” and “traffic hazard” were marginally above the mean, suggesting moderate perceived infrastructure, aesthetics and traffic hazards. The score for perceived crime (1.86) was just below the mean for the scale, suggesting that there was lower concern about crime. Thus all subscales had mean scores that were generally in the direction of perceived high walkability.

Overall, perceived walkability (access to facilities, safety and infrastructure) of the neighbourhood was higher among households where the mother had higher levels of education. There were no real sex differences in perceived neighbourhood environment, although parents of boys tended to perceive that the walking distance to convenience stores was closer than parents of girls.

Diet, physical and sedentary activity habits of participating children

Almost one third (32.4%) of the children were reported to have eaten no fruit and vegetables in the previous week. Only 14.8% were reported to have eaten 14 to 28 servings of fruits and vegetables in the last week (equivalent to two to four servings per day). The average weekly consumption frequency for fruits and vegetables was 8.7 portions (equivalent to just over one portion per day). On the other hand, 40% of the children were reported to eat at least one serving of unhealthy snacks or sugar-added drinks every day in the previous week. The average weekly consumption frequency for this food group was 6.5 portions.

Parents reported high levels of physical activity among children overall, with 84.9% of children reported to engage in at least 60 minutes of MVPA daily. On average, children engaged in two hours of MVPA and were sedentary (not including sleep) for 7.3 hours per day. Children's average daily sleep duration was 9.7 hours. Less than half of the children (43.1%) were reported to watch TV for more than one hour daily. Children in families with mothers who had higher education were reported to watch significantly less TV, compared with those with less educated mothers.

4.5.1.2 Prevalence of childhood overweight and obesity in the study sample

The prevalence of overweight and obesity was calculated using three definitions, based on different systems of classification: WGCO reference norm, WHO 2007 References and IOTF (table 12).

Table 12 Overweight and obesity prevalence by sample school

School	Weight Category	WGCO N (%)	WHO N (%)	IOTF N (%)
WD	Underweight	91(76.5)*	3(2.5)	23(19.3)
	Healthy weight		83(69.7)	70(58.8)
	Overweight	11(9.2)	19(16.0)	16(13.4)
	Obese	17(14.3)	14(11.8)	10(8.4)
XH	Underweight	102(85.7)*	7(5.9)	41(34.5)
	Healthy weight		92(77.3)	63(52.9)
	Overweight	7(5.9)	13(10.9)	10(8.4)
	Obese	10(8.4)	7(5.9)	5(4.2)
CGD	Underweight	89(78.1)*	11(9.6)	28(24.6)
	Healthy weight		74(64.9)	63(55.3)
	Overweight	15(13.2)	20(17.5)	20(17.5)
	Obese	10(8.8)	9(7.9)	3(2.6)
JCJ	Underweight	112(77.2)*	0(0.0)	16(11.0)
	Healthy weight		106(73.1)	102(70.3)
	Overweight	19(13.1)	24(16.6)	20(13.8)
	Obese	14(9.7)	15(10.3)	7(4.8)
TOTAL	Underweight	394(79.3)*	21(4.2)	108(21.7)
	Healthy weight		355(71.4)	298(60.0)
	Overweight	52(10.5)	76(15.3)	66(13.3)
	Obese	51(10.3)	45(9.1)	25(5.0)

Note: *denotes the value does not differentiate between healthy and under weight because WGCO reference norm does not have such a cut off.

The estimated overall combined prevalence for overweight and obesity was highest using the WHO 2007 reference equations (24.4%) and lowest using the IOTF cut-offs (18.3%). The corresponding estimation given by WGCO reference norm was 20.8%. The prevalence estimates for underweight varied much more according to the definition used

(21.7% using IOTF versus 4.2% using the WHO 2007 references). The agreement between measures in terms of classification into overweight/obese versus non-overweight categories was tested using Kappa. There was very good agreement between the WGO and WHO classifications (coefficient=0.83, $p<0.001$), good agreement between WGO and IOTF (coefficient=0.77, $p<0.001$), and between WHO and IOTF (coefficient =0.72, $p<0.001$).

The estimated prevalence, of overweight by sex according to the 3 classification systems, was also compared (table 13). Whichever definition was used, the prevalence of overweight and obesity was higher in boys compared to girls. However, the difference in overweight/obese prevalence estimate by definition was more marked for boys (prevalence 24.1%, 30.8% and 22.2% for WGO, WHO and IOTF respectively) than for girls (17.1%, 17.5% and 14.2% respectively). In contrast, the difference in estimated prevalence of underweight according to IOTF compared to the WHO reference values differed more amongst girls compared to boys.

Table 13 Overweight and obesity prevalence by student sex

Sex	Weight Status Category	WGO N (%)	WHO N (%)	IOTF N (%)
Male	Underweight	195(75.9)*	12(4.7)	40(15.6)
	Healthy weight		166(64.6)	160(62.3)
	Overweight	33(12.8)	47(18.3)	38(14.8)
	Obese	29(11.3)	32(12.5)	19(7.4)
Female	Underweight	199(82.9)*	9(3.8)	68(28.3)
	Healthy weight		189(78.8)	138(57.5)
	Overweight	19(7.9)	29(12.1)	28(11.7)
	Obese	22(9.2)	13(5.4)	6(2.5)

Note: *denotes the value does not differentiate between healthy and under weight because WGO reference norm does not have such a cut off.

Summary of estimation of weight status in study population

Depending on the definition used, between 18.3% and 24.4% students participating in the study were overweight or obese, and between 4.2% and 21.7% were classified as underweight. A higher prevalence of overweight/obesity was found in boys than in girls, regardless the definition used. Despite the identified variation, especially in the classification of students into the underweight category, there was generally very good to good agreement (as measured by Kappa, see above) among the three definitions for the classification of non-overweight, overweight and obese children. Given the study's primary interest is in identifying environmental correlates of childhood overweight and obesity, this suggests that any of the definitions could be used. In order to have consistency with other studies in the region, the WHO 2007 standards were chosen to derive the binary outcome measure (non-overweight versus overweight/obesity) for the remaining analyses.

Sample representativeness

For the three schools in GZ, the height, weight and sex data for all children in the year-3 classes were available (n=588), irrespective of whether they were invited or responded to take part in the study. The weight status and sex composition of the total sample was compared with the data from the study sample (n=352) to assess sample representativeness (table 14).

Table 14 Comparison of weight status categories and sex composition in the study sample with the total eligible sample of children in year 3 in Guangzhou

	Prevalence in GZ study sample N (%)	Prevalence in total GZ sample N (%)
Weight Status Categories		
Underweight		
Boys	12(3.4)	19(3.2)
Girls	9(2.6)	19(3.2)
Total	21(6.0)	38(6.5)
Normal weight		
Boys	117(33.2)	182(31.0)
Girls	132(37.5)	221(37.6)
Total	249(70.7)	403(68.5)
Overweight		
Boys	29(8.2)	54(9.2)
Girls	23(6.5)	37(6.3)
Total	52(14.8)	91(15.5)
Obesity		
Boys	23(6.5)	43(7.3)
Girls	7(2.0)	13(2.2)
Total	30(8.5)	56(9.5)
Sex Composition		
Boys	181(51.4)	298(50.7)
Girls	171(48.6)	290(49.3)
Total	352(100.0)	588(100.0)

The prevalence of underweight, healthy weight, overweight and obese in the two samples was similar. The proportions of boys and girls were also similar in both samples. This suggests that the study sample is representative of the total population in these schools.

4.5.2 Family and neighbourhood environmental factors and childhood overweight (objective 1)

The relationships between the family (including household composition, role of family

members within the household, presence of screen media and car in the home, family feeding habits, and parental physical activity behaviour) and neighbourhood environmental factors, and children's weight status is summarised in table 15 (unadjusted analyses) and 16 (multivariate analysis).

Table 15 Association between family and neighbourhood environment factors, and children's weight status (unadjusted analyses)

Environmental variables	Non-overweight N (%)	Overweight N (%)	Crude Odd Ratio for overweight (95% CI)	P value
Family environmental variables				
No. of children				
2/more	83(22.1)	18(14.9)	1.00	
Only 1	293(77.9)	103(85.1)	1.62(0.93-2.83)	p=0.09
No. of grandparents in the household				
0	210(55.9)	59(48.8)	1.00	
1	99(26.3)	30(24.8)	1.08(0.65-1.78)	p=0.77
2/more	67(17.8)	32(26.4)	1.70(1.02-2.83)	p=0.04*
Main child carer				
Mother/father/other	317(84.5)	90(75.6)	1.00	
Grandmother/grandfather	58(15.5)	29(24.4)	1.76(1.06-2.91)	p=0.03*
Person with the most influence on everyday food shopping				
Grandparent	101(26.9)	35(29.4)	1.00	
The child	39(10.4)	10(8.4)	0.74(0.33-1.64)	p=0.46
Parent/other adult	235(62.7)	74(62.2)	0.91(0.57-1.45)	p=0.69
Person with the most influence on what and how much the child eats				
Grandparent	38(10.2)	14(11.8)	1.00	
The child	106(28.4)	44(37.0)	1.13(0.56-2.28)	p=0.74
Parent/other adult	229(61.4)	61(51.3)	0.72(0.37-1.42)	p=0.35
No. of TVs in household				
2/more	122(32.4)	47(38.8)	1.00	
1	252(67.0)	72(59.5)	0.72(0.48-1.14)	p=0.17
0	2(0.5)	2(1.7)	2.60(0.36-18.96)	p=0.35

Environmental variables	Non-overweight N (%)	Overweight N (%)	Crude Odd Ratio for overweight (95% CI)	P value
No. of DVD players in household				
2/more	45(12.0)	27(22.3)	1.00	
1	297(79.0)	78(64.5)	0.44(0.26-0.75)	p<0.01**
0	34(9.0)	16(13.2)	0.78(0.37-1.68)	p=0.53
No. of computers in household				
2/more	123(32.7)	43(35.5)	1.00	
1	211(56.1)	71(58.7)	0.96(0.62-1.49)	p=0.87
0	42(11.2)	7(5.8)	0.48(0.20-1.14)	p=0.10
No. of game players in household				
1/more	87(23.1)	39(32.2)	1.00	
0	289(76.9)	82(67.8)	0.63(0.40-0.99)	p=0.05*
NO. of cars				
1/more	175(46.5)	66(54.5)	1.00	
0	201(53.5)	55(45.5)	0.73(0.48-1.10)	p=0.13
Father PA habit				
Never/rarely exercised	145(40.7)	50(44.6)	1.00	
Sometimes/frequently exercised	211(59.3)	62(55.4)	0.85(0.56-1.31)	p=0.46
Mother PA habit				
Never/rarely exercised	124(34.4)	37(33.3)	1.00	
Sometimes/frequently exercised	236(65.6)	74(66.7)	1.05(0.67-1.65)	p=0.83
Child's weekly frequency of dining out with family				
None	183(48.8)	53(43.8)	1.00	
At least once a week	192(51.2)	68(56.2)	1.22(0.81-1.85)	p=0.34
Place the child usually had breakfast				
Home	208(55.5)	69(57.0)	1.00	
On the way to school or at school	167(44.5)	52(43.0)	0.94(0.62-1.42)	p=0.76
Perceived neighbourhood environment				
Land-use mix-diversity	3.32(0.73)	3.34(0.71)	1.04(0.73-1.46)	p=0.84
Land-use mix-access	3.19(0.64)	3.31(0.57)	1.37(0.96-1.93)	p=0.08

Environmental variables	Non-overweight N (%)	Overweight N (%)	Crude Odd Ratio for overweight (95% CI)	P value
Street connectivity	2.80(0.66)	2.84(0.67)	1.09(0.79-1.48)	p=0.61
Infrastructure and safety for walking	3.18(0.67)	3.22(0.67)	1.09(0.80-1.49)	p=0.59
Neighbourhood aesthetics	2.72(0.74)	2.75(0.74)	1.04(0.79-1.38)	p=0.77
Traffic hazards	2.46(0.54)	2.47(0.52)	1.02(0.69-1.50)	p=0.93
Crime	1.87(0.69)	1.82(0.73)	0.89(0.66-1.20)	p=0.43
Walking distance to a supermarket				
Over 10 minutes	175(48.1)	59(50.0)	1.00	
6-10 minutes	132(36.3)	40(33.9)	0.90(0.57-1.43)	p=0.65
1-5 minutes	57(15.7)	19(16.1)	0.99(0.54-1.80)	p=0.97
Walking distance to a fruit and vegetable market/stall				
Over 10 minutes	101(27.4)	36(30.3)	1.00	
6-10 minutes	154(41.8)	46(38.7)	0.84(0.51-1.39)	p=0.49
1-5 minutes	113(30.7)	37(31.1)	0.92(0.54-1.56)	p=0.75
Walking distance to a convenience store				
1-5 minutes	272(74.1)	87(73.7)	1.00	
6-10 minutes	81(22.1)	26(22.0)	1.00(0.61-1.66)	p=0.99
Over 10 minutes	14(3.8)	5(4.2)	1.12(0.39-3.19)	p=0.84

Notes: (1)** denotes $P < \text{or} = 0.01$; * denotes $P < \text{or} = 0.05$. (2) PA denotes physical activity.

Table 16 Association between family and neighbourhood environmental factors, and children's weight status in multivariate logistic regression analysis

Environmental variables	Crude Odd Ratio for Overweight (95% CI)	Adjusted Odd Ratio for Overweight (95% CI)	P Value of Adjusted Odd Ratio for Overweight
Family environmental variables			
No. of children			
2/more	1.00	1.00	
Only 1	1.62(0.93-2.83)	1.60(0.86-2.96)	p=0.14
No. of grandparents living in the household			
0	1.00	1.00	
1	1.08(0.65-1.78)	1.09(0.65-1.83)	p=0.75
2/more	1.70(1.02-2.83)*	1.72(1.00-2.94)	p=0.048* p for trend=0.07
Main child carer			
Mother/father/other	1.00	1.00	
Grandmother/grandfather	1.76(1.06-2.91)*	2.03 (1.19-3.47)	p=0.01**
No. of DVD players			
2/more	1.00	1.00	
1	0.44(0.26-0.75)**	0.41(0.23-0.73)	p<0.01**
0	0.78(0.37-1.68)	0.68(0.30-1.55)	p=0.36 p for trend=0.14
No. of computers			
2/more	1.00	1.00	
1	0.96(0.62-1.49)	0.99(0.62-1.58)	p=0.96
0	0.48(0.20-1.14)	0.49(0.18-1.29)	p=0.15 p for trend=0.34
No. of game players			
1/more	1.00	1.00	
0	0.63(0.40-0.99)*	0.60(0.37-0.98)	p=0.04*
Perceived neighbourhood environment			
Land-use mix-access	1.37(0.96-1.93)	1.22(0.85-1.75)	p=0.29

Notes: (1) Child birth weight and socio-demographic variables (child sex, age in month, school and mother education level were adjusted for in each model. (2) * denotes $P \leq 0.05$. (3) PA denotes physical activity.

Among the family factors, the presence of grandparents in the household, and having grandparent(s) as the main carer were significantly associated with child overweight. The presence of DVD players and game players in the home were also significantly associated with increased risk of child overweight. None of the perceived neighbourhood environmental factors examined in the study was associated with children's weight status.

4.5.3 Family and neighbourhood environmental factors and obesogenic behaviours (objective 2)

4.5.3.1 Consumption of unhealthy snacks

Table 17 (unadjusted analyses) and 18 (multivariate analysis) show the relationship between consumption of unhealthy snacks in children, and their family (composition, child care responsibility, family feeding habit and presence of screen and sedentary objects) and neighbourhood environmental conditions.

Table 17 Association between family and neighbourhood environmental factors, and children's consumption frequency of unhealthy snacks (unadjusted analyses)

Environmental variables	Mean (SD)	T Test/ One Way ANOVA
Family environmental variables		
No. of children living in the household		
2/more	6.55(5.71)	t=0.07
One	6.50(5.30)	p=0.95
Main child carer		
A parent or other adult	6.25(5.11)	t= -2.52
Grandparent(s)	7.87(6.42)	p=0.01**
No. of grandparents living in the household		
None	6.35(5.62)	F=0.32
One	6.82(5.77)	p=0.73
At least 2	6.57(4.09)	
No. of DVD players in household		
At least 2	6.75(4.89)	F=0.42
One	6.55(5.64)	p=0.66
None	5.87(3.92)	
No. of computers in household		
At least 2	6.77(5.50)	F=0.55
One	6.29(5.40)	p=0.58
None	6.93(4.84)	
No. of TVs in household		
At least 2	6.30(4.27)	F=1.12
One	6.58(5.90)	p=0.33
None	10.25(4.41)	
No. of digital game players in household		
1/more	6.88(4.65)	t=0.87
None	6.39(5.61)	p=0.38
Person with the most influence on everyday food shopping		
Grandparent	6.60(5.16)	F=0.47
The child	7.14(5.87)	p=0.63
Parent/other adult	6.36(5.41)	
Person with the most influence on what and how much the child ate		
Grandparent	6.82(4.44)	F=0.77
The child	6.90(6.34)	p=0.47
Parent/other adult	6.26(5.00)	
Place the child normally had breakfast		
At home	5.57(4.13)	t= - 4.20
on the way to school/at school	7.72(6.47)	p<0.01**
Weekly frequency of dining out with family		
Never	6.51(5.71)	t=0.01
At least once	6.51(5.09)	p=1.00
Perceived neighbourhood environment		
Walking distance to a supermarket		
Over 10 minutes	6.59(5.54)	F=0.11
6-10 minutes	6.33(5.65)	p=0.89
1-5 minutes	6.53(4.23)	
Walking distance to a fruit and vegetable stall		
Over 10 minutes	6.64(5.94)	F=0.57
6-10 minutes	6.21(4.58)	p=0.57
1-5 minutes	6.82(5.91)	

Environmental variables	Mean (SD)	T Test/ One Way ANOVA
Walking distance to a convenience store		
1-5 minutes	6.16(4.98)	F=2.65
6-10 minutes	7.05(5.56)	p=0.07
Over 10 minutes	8.55(9.23)	

Note: ** denotes $p < 0.01$; * denotes $p < 0.05$.

Table 18 Association between family and neighbourhood environmental factors, and children's consumption frequency of unhealthy snacks in multiple linear regression analysis.

Environmental variables	Standardised Coefficients Beta	Non-standardised Coefficient B (95% CI)	P value
Family environmental variables			
Main child carer (A grandparent, compared with a parent or other adult)	0.15	2.13(0.87-3.40)	<0.01**
Place the child normally had breakfast (On the way to school/at school, compared with at home)	0.14	1.52(0.10-2.95)	0.04*
Perceived neighbourhood environment			
Walking distance to a convenience store - 1 to 5 minutes as reference group			
Over 10 minutes	0.08	2.34(-0.19-4.86)	0.07
6-10 minutes	0.06	0.80(-0.36-1.97)	0.18

Notes: (1) Socio-demographic factors (child sex, child age in month, school and mother education level) were adjusted for in each model. (2) * denotes $p < 0.05$.

Having grandparents as the main child carer was significantly positively correlated with children's consumption of unhealthy snacks in the adjusted model. The results from the linear regression model indicate that compared with children who were mainly cared for by their parents or other adults, those cared for by a grandparent consumed over 2 more servings of unhealthy snacks per week (range 0.9 to 3.4 servings per week). Children who did not normally have their breakfast at home were also more likely to consume unhealthy snacks (around 1.5 more portions). No evidence was found of a significant relationship between any examined neighbourhood environmental factor and children's consumption of unhealthy snacks.

4.5.3.2 Consumption of fruit and vegetables

The relationships between family (composition, child care responsibility and family feeding habits) and neighbourhood environmental factors and children's consumption of fruit and vegetables are summarised in table 19 (unadjusted analyses) and 20 (multivariate analysis).

Table 19 Association between family and neighbourhood environmental factors, and children's consumption frequency of fruit and vegetables (unadjusted analyses)

Environmental variables	Mean (SD)	T Test/ One Way ANOVA
Family environmental variables		
No. of children living in the household		
2/more	9.07(4.69)	t=0.86
One	8.63(4.62)	p=0.39
Main child carer		
A parent or other adult	8.74(4.61)	t=0.16
Grandparent(s)	8.66(4.73)	p=0.87
No. of grandparents living in the household		
None	8.82(4.90)	F=0.25
One	8.71(4.85)	p=0.78
At least 2	8.44(3.47)	
Person with the most influence on everyday food shopping		
Grandparent	8.98(4.30)	F=0.26
The child	8.56(4.85)	p=0.77
Parent/other adult	8.66(4.75)	
Person with the most influence on what and how much the child ate		
Grandparent	9.46(4.72)	F=0.90
The child	8.46(4.97)	P=0.41
Parent/other adult	8.77(4.44)	
Place the child normally had breakfast		
At home	9.44(4.46)	t=3.95
on the way to school/at school	7.81(4.69)	p<0.01**
Weekly frequency of dining out with family		
Never	9.03(4.95)	t=1.40
At least once	8.44(4.32)	p=0.16
Perceived neighbourhood environment		
Walking distance to a supermarket		
Over 10 minutes	8.70(4.74)	F=0.20
6-10 minutes	8.72(4.46)	p=0.82
1-5 minutes	9.08(4.80)	
Walking distance to a fruit and vegetable stall		
Over 10 minutes	8.73(4.96)	F=0.31
6-10 minutes	8.91(4.63)	p=0.74
1-5 minutes	8.51(4.32)	
Walking distance to a convenience store		
1-5 minutes	8.70(4.50)	F=0.03
6-10 minutes	8.70(4.99)	p=0.97
Over 10 minutes	8.45(5.62)	

Note: ** denotes $p < 0.01$.

Table 20 Association between family and neighbourhood environmental factors, and children's consumption frequency of fruit and vegetables in multiple linear regression analysis

Environmental variables	Standardised Coefficient Beta	Non-standardised Coefficient B (95% CI)	P value
<i>Family environmental variables</i>			
Place the child normally had breakfast (on the way to school/at school compared with at home)	-0.19	-1.74(-2.95 to -0.53)	<0.01**

Notes: (1) Socio-demographic factors (child sex, age in month, school and mother education level) were controlled for in each model. (2) ** denotes $P \leq 0.01$.

In the adjusted models, children who have breakfast outside of the home consumed significantly less fruits and vegetables (1.7 servings per week), compared to those who have breakfast in the home. Again, there was no evidence that the perceived neighbourhood environment was associated with children's consumption frequency of fruit and vegetables.

4.5.3.3 Moderate to vigorous physical activity level

The relationship between environmental factors and children's likelihood of engaging in the recommended 60 minutes of MVPA per day are summarised in table 21 (unadjusted analyses) and 22 (multivariate analysis).

Table 21 Association between family and neighbourhood environmental factors, and children's likelihood of engaging in at least 60 minutes of MVPA per day (unadjusted analyses)

Environmental variables	Less than 1 hour of MVPA per day N (%)	At least 1 hour of MVPA per day N (%)	Crude Odd Ratio (95% CI)	P value
Family environmental variables				
No. of children				
2/more	17(25.0)	71(18.6)	1.00	
Only 1	51(75.0)	310(81.4)	1.46(0.79-2.67)	p=0.23
No. of grandparents in the household				
0	44(64.7)	200(52.5)	1.00	
1	11(16.2)	104(27.3)	2.08(1.03-4.20)	p=0.04*
2/more	13(19.1)	77(20.2)	1.30(0.67-2.55)	p=0.44
Main child carer				
Parent/other adult	54(80.6)	320(84.2)	1.00	
Grandparent	13(19.4)	60(15.8)	0.78(0.40-1.52)	p=0.46
No. of DVD players in household				
2/more	13(19.1)	52(13.6)	1.00	
1	48(70.6)	291(76.4)	1.52(0.77-2.99)	p=0.23
0	7(10.3)	38(10.0)	1.36(0.50-3.73)	p=0.55
No. of computers in household				
2/more	23(33.8)	129(33.9)	1.00	
1	40(58.8)	222(58.3)	0.99(0.57-1.73)	p=0.97
0	5(7.4)	30(7.9)	1.07(0.38-3.04)	p=0.90
No. of game players in household				
1/more	11(16.2)	104(27.3)	1.00	
0	57(83.8)	277(72.7)	0.51(0.26-1.02)	p=0.06
No. of cars				
1/more	33(48.5)	186(48.8)	1.00	
0	35(51.5)	195(51.2)	0.99(0.59-1.66)	p=0.97
Mother PA habit				
Never/rarely exercised	63(95.5)	292(80.0)	1.00	
Sometimes/frequently	3(4.5)	73(20.0)	5.25(1.60-17.19)	p<0.01**
Father PA habit				
Never/rarely exercised	54(83.1)	295(80.4)	1.00	
Sometimes/frequently	11(16.9)	72(19.6)	1.20(0.60-2.41)	p=0.61
Perceived neighbourhood environment [Numbers are Mean (SD)]				
Land-use mix-diversity	3.33(0.65)	3.36(0.70)	1.07(0.68-1.68)	p=0.78
Land-use mix-access	3.15(0.69)	3.26(0.58)	1.32(0.87-2.01)	p=0.19
Street connectivity	2.77(0.73)	2.84(0.63)	1.18(0.79-1.77)	p=0.43
Infrastructure and safety for walking	3.07(0.76)	3.21(0.63)	1.36(0.92-2.00)	p=0.12
Neighbourhood aesthetics	2.71(0.66)	2.69(0.73)	0.97(0.68-1.40)	p=0.88
Traffic hazards	2.45(0.51)	2.47(0.53)	1.06(0.65-1.75)	p=0.81

Environmental variables	Less than 1 hour of MVPA per day N (%)	At least 1 hour of MVPA per day N (%)	Crude Odd Ratio (95% CI)	P value
Crime	1.91(0.68)	1.84(0.69)	0.86(0.59-1.25)	p=0.42

Notes: **denotes P< or =0.01; * denotes P< or =0.05. (2) PA denotes physical activity.

Table 22 Association between family and neighbourhood environmental factors, and children's likelihood of engaging in at least 60 minutes of MVPA per day in multivariate logistic regression analysis

Environmental variables	Crude Odd Ratio (95% CI)	Adjusted Odd Ratio (95% CI)	P value of Adjusted Odd Ratio
Family environmental variables			
No. of grandparents in the household			
0	1.00	1.00	
1	2.08(1.03-4.20)	2.15(1.05-4.39)	p=0.04*
2/more	1.30(0.67-2.55)	1.26(0.64-2.50)	p=0.51 p for trend=0.23
No. of game players in the household			
1/more	1.00	1.00	
0	0.51(0.26-1.02)	0.56(0.27-1.13)	p=0.11
Mother PA habit			
Never/rarely exercised	1.00	1.00	
Sometimes/frequently exercised	5.25(1.60-17.19)	4.40(2.49-7.76)	p<0.01**

Notes: (1) Socio-demographic factors (child sex, age in month, school and mother education level) were adjusted for in each model. (2) **denotes P< or =0.01; * denotes P< or =0.05. (3) PA denotes physical activity.

After controlling for potential socio-demographic confounders, children whose mothers reported engaging in exercise were over four times as likely to meet the daily recommended level of MVPA, compared with children whose mothers never or rarely exercised. There was also a tendency for the presence of grandparents in the home to be associated with the outcome, although there was no significant trend with increasing numbers of grandparents.

4.5.4 Potential behavioural mediators (objective 2)

Based on the above results, having a grandparent as a main carer, is associated with childhood overweight as well as higher consumption of unhealthy snacks among children. Moreover, the presence of grandparents in the household was associated with childhood overweight as well as physical activity levels. Therefore, as described in the methods section (section 4.4), further analyses examined: (1) whether the association between a grandparent being the main carer and childhood overweight was potentially mediated by children's consumption of unhealthy snacks (table 23), and similarly, (2) whether the association between the presence of grandparents and childhood overweight was potentially mediated by children's MVPA level (table 23).

Table 23 Logistic regression models to examine role of US consumption or MVPA as potential mediators in the relationships between grandparents being the main carer, or grandparents in the household, and child weight status

Family environmental risk factor	Suspected potential mediator	Adjusted Odd Ratio (95% CI) and p value	
		Previous multivariate model	Suspected mediator additionally entered into model
Main child carer	Consumption of US		
Mother/father/other		1.00	1.00
Grandmother/grandfather		2.03(1.19-3.47), p=0.01	2.00 (1.15-3.49), p=0.02
No. of grandparents living in the household	MVPA		
0		1.00	1.00
1		1.09(0.65-1.83), p=0.75	1.37(0.79-2.39), p=0.27
2/more		1.72(1.00-2.94), p=0.048	2.27(1.29-4.00), p<0.01
		p for trend=0.07	p for trend<0.01

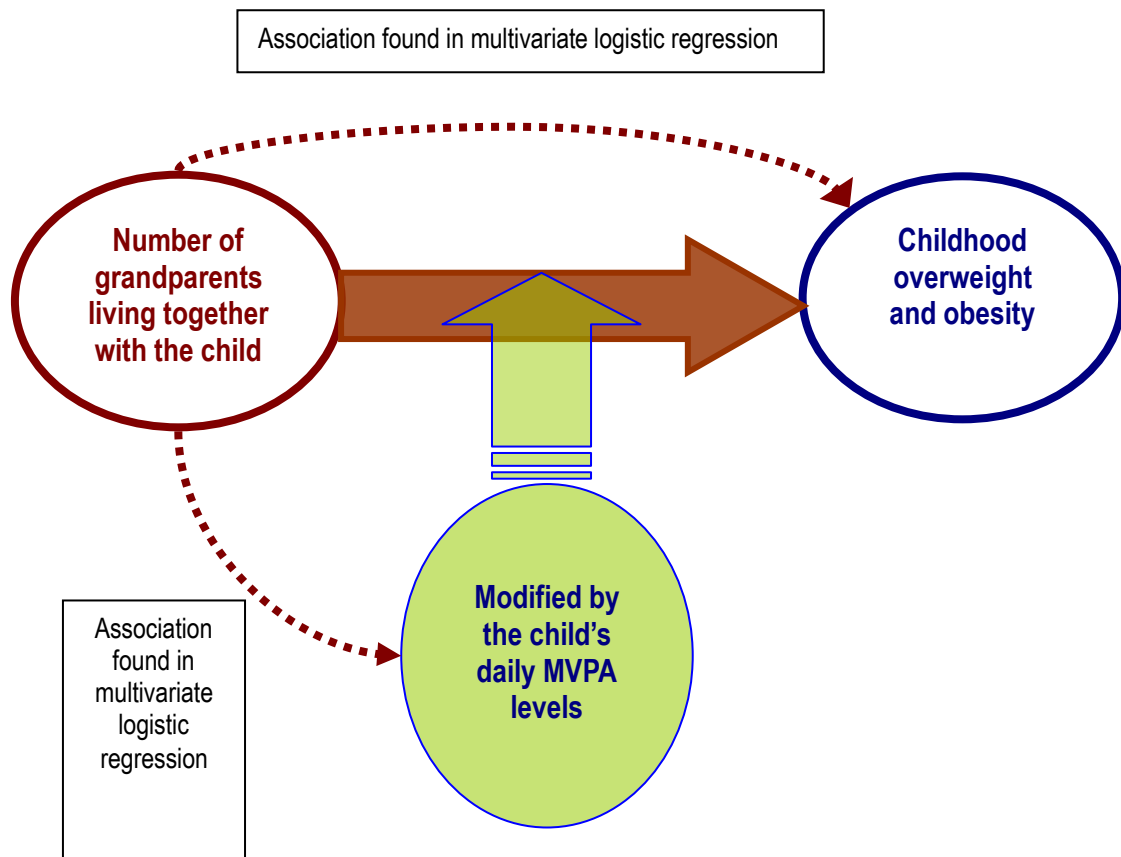
Note: (1) US denotes unhealthy snacks and drinks. (2) MVPA denotes moderate to vigorous physical activity.

For the first analysis, addition of US as a variable in the multivariate model did not alter

the direction or significance of the association, and the risk ratio only reduced by 0.03. This did not provide evidence that the identified association between a grandparent being the main child carer and child's weight status was potentially mediated by children's consumption frequency of unhealthy snacks.

For the second analysis, addition of MVPA as an additional variable in the multivariate model enhanced the association, and greatly increased the risk ratio for overweight, such that the relationship changed from being marginally significant, to clearly statistically significant. This indicated that MVPA did not mediate the identified association but might have modified it. In order to further examine this potential modifier, the study sample was stratified according to their daily MVPA levels (engaging in less than 60 minutes a day versus engaging in at least 60 minutes a day). The previous multivariate model was then run separately to compare the association between the number of grandparents living in the household and childhood overweight. Among children who engaged in less than 60 minutes of MVPA daily, no significant association was found. In contrast, a significant positive association was found among children who engaged in at least 60 minutes of MVPA daily (adjusted OR=2.55, 95% CI: 1.38 - 4.72, $p < 0.01$ for 2 or more grandparents compared to none). Therefore, children's MVPA levels modified the association between presence of grandparent(s) and risk for overweight/obesity in the study sample (figure 12).

Figure 12 Children's daily MVPA levels modified the association between presence of grandparents and overweight risk in the study sample



4.5.5 Relationship between family environmental factors and children's weight status in fully adjusted analysis

Results of the fully adjusted model, examining the relationship between family environmental factors and the primary outcome - child weight status, are summarised in

table 24. The table includes only the results related to the family environment, although the model included a range of other risk factors and potential confounders see methods section in 4.4).

Table 24 Relationships between family environmental factors, and child weight status in fully adjusted regression model

Family environmental variables	Fully adjusted Odd Ratio (95%CI)	P value
No. of children		
2/more	1.00	
Only 1	2.28(0.82-6.33)	p=0.12
No. of grandparents in the household		
0	1.00	
1	1.47(0.66-3.28)	p=0.35
2/more	2.99(1.26-7.08)	p=0.01**
Main child carer		
Parent/other adult	1.00	
Grandparent	1.42(0.55-3.67)	p=0.46
No. of DVD players		
2/more	1.00	
1	0.26(0.09-0.73)	p=0.01**
0	0.73(0.18-2.99)	p=0.66
No. of computers		
2/more	1.00	
1	1.66(0.81-3.41)	p=0.17
0	1.03(0.20-5.47)	p=0.97
No. of game players		
1/more	1.00	
0	0.42(0.20-0.88)	p=0.02*
No. of TVs		
2/more	1.00	
1	1.16(0.49-2.77)	p=0.74
0	2.83(0.13-63.71)	p=0.51

Notes: (1) 294 cases were included in the analysis. (2) Other variables included in this final model were child birth weight, child sex, child age in month, school, mother education level, consumption frequency of unhealthy snacks & fruit and vegetables, daily average sedentary behaviour duration, daily TV viewing duration, daily average sleep duration, daily MVPA level, land use mix-Access, walking distance to a supermarket, walking distance to a convenience store and walking distance to a fruit/vegetable market or stall. (3) * denotes $p \leq 0.05$; ** denotes $p \leq 0.01$.

In this fully adjusted model, compared with the previous multivariate models (section 4.5.2), a grandparent being the main child carer was no longer a significant risk factor for childhood overweight. However, the number of grandparents living in the household remained positively associated with the outcome, with children living with at least two

grandparents being nearly three times more likely to be overweight or obese than children living without a grandparent. Moreover, the previously identified positive association between the presence of screen- and sedentary-based entertainment objects at home (DVD and digital game players) and childhood overweight remained statistically significant in this fully adjusted model. The finding of a stronger association between the presence of grandparents and child overweight (in this fully adjusted model, compared with the early model) is consistent with, and can be explained by, findings of earlier analyses examining effect modification (see section 4.5.4).

The Nagelkerke R^2 was 29.5% for the final model, indicating the total set of explanatory variables was able to explain approximately one third of the variance in children's risk for being overweight or obese.

4.6 Discussion

4.6.1 Summary of key findings

Several family-level environmental factors were associated with childhood overweight and related dietary and physical activity patterns in this sample of primary school-aged children living in Southern urban China. Most consistently, grandparents in the household was associated with child overweight and unhealthy snacking behaviours. The presence

of DVD and digital game players in the home was associated with child overweight. No evidence was found in this study for associations between parents' perceived neighbourhood environmental characteristics, and children's weight status or related health behaviour.

4.6.2 Strengths and limitations

To my knowledge, this was the first study to focus on under-researched but important environmental determinants of childhood overweight and obesogenic behaviours in a mainland Chinese population. The study collected data on the family and neighbourhood environments, in addition to children's socioeconomic, dietary, physical and sedentary behavioural measures. Although environmental determinants of childhood obesity and related behaviours have been given increasing attention internationally, many previous studies focused on one single environmental context only[300]. We also used objective anthropometric measures to assess the children's weight status.

The assessment of perceived neighbourhood environment was done using a self-translated version of a previously validated tool. While the validity of the tool in mainland Chinese population has not been tested, the tool was translated and used in a previous study among residents living in Hong Kong, and good construct validity and test-retest reliability were reported[396]. Further research is needed to examine the extent

to which the tool is also applicable to a mainland Chinese setting.

The study population was limited to a sample of children from urban schools within two major cities. However, the sample included schools from a range of socioeconomic districts, and the children who took part in the study were similar to others in the year group in their schools in relation to weight status and sex composition. The most recent estimation (based on WGCO reference norm) of the combined prevalence of overweight among Guangzhou's 6- to 15- year old students was 21.11% for males and 15.45% for females in 2009[364]. This is similar to our estimation among the study sample in the same year using the same definition, suggesting that the sample is representative of the wider population. Confirmation in this study of previously reported associations, between children's weight status and dietary behaviours with certain socio-demographic factors such as sex and mother's education level, provides further validity to the study findings.

One major limitation of the study was that children's diet and physical activity behaviours were assessed by parent report. It is widely known that both self- and parent- reports tend to miss-estimate (mostly under-report) dietary intake[397-399] and over-report physical activity levels[383,386]. However, comparing with a dietary assessment questionnaire that contains a long list of items, the current study included a much smaller number of items. Therefore, the chance of reporting error might be lower. Moreover, since the study examined child diet and physical activity behaviour's relationship with environmental factors, potential implications of reporting error were

less important in this study. In addition, a review of methods for assessing physical activity patterns in children concluded that parent-proxy reports were more accurate than children's self reports[375].

Another limitation in this study was the use of multiple testing, (given that around 24 predictor variables for childhood obesity were tested within the main analysis) without adjustment to the alpha level (5%) or application of any corrections. However, in retrospect, application of a more conservative alpha level would not have altered the main findings. The four identified family environmental correlates of child overweight or obesogenic behaviours were all highly statistically significant [i.e. number of DVD players ($p=0.002$); grandparent being the main child carer ($p=0.001$); place of breakfast consumption ($p=0.005$); and mother's physical activity pattern ($p<0.001$)]. Thus the main conclusions remain unchanged.

4.6.3 Findings in relation to the previous literature

Family environment

Qualitative studies in Chinese[400] and other[159] populations have identified that grandparents can have an adverse influence on children's dietary behaviours. In this study, children who were mainly cared for by their grandparents were more likely to be

overweight and to consume more unhealthy snacks and sugar-added drinks. However, further analysis in the study did not find evidence that the latter mediated the observed association between a grandparent being the main child carer and childhood overweight. Probably, there was or were other factor(s) that the study did not exam but played mediation roles. It should be noted that, this study (cross-sectional) was not designed for mediation analysis, and that the above inference was based on the assumption that consumption of unhealthy snacks and drinks was associated with childhood overweight (the mediator must be associated with the outcome variable). Although this assumption might be partly supported by findings of previous studies showing that consumption of sugar-added drinks increases the risk of childhood overweight[142,401,402], the international literature on the link between unhealthy snack consumption and childhood overweight is less clear, with many previous studies finding no association[142,403]. However, one meta analysis of previous Chinese case-control studies on obesity risk factors among children under 14 years[247] and a large cross-sectional study in Beijing[233] using a representative sample of 21,198 2- to 18- year olds, found positive associations between frequency of unhealthy snack consumption in children and risk of obesity. Future studies using a validated dietary assessment tool, preferably in a longitudinal design (so that causal association can be established), would allow better evaluation of potential mediators.

Moreover, I found that the number of grandparents living in the household was positively associated with children's weight status, even after adjustment for potential confounders. I also demonstrated that this association was modified by children's MVPA levels. MVPA

level is a well evidenced determinant of childhood overweight[145,404,405]. In the study sample, when this important risk factor was not present (among the children meeting the recommended daily MVPA level), the number of grandparents was significantly associated with children's risk for overweight positively. In contrast, among the inactive children (who did not engage in the recommended MVPA level daily), this association was not present.

One potential explanation for why the presence of grandparents may lead to obesogenic behaviours and overweight is the fact that the majority of Chinese households have only one child who usually lived with their grandparents. The findings from the previous chapter, suggest that single children tend to be pampered with unhealthy food and avoidance of labour intensive activity. This is further supported by the finding in this cross-sectional study, suggesting a trend towards overweight among children living in single child household families, compared to those living with other children.

The finding in this study of a relationship between screen-viewing behaviours and childhood overweight are also in keeping with those reported both in the Chinese[344,406] and international literature[347,403,407,408].

In terms of obesogenic risk factors, this study showed that increasing physical activity levels in mothers was associated with a greater likelihood that their children met the

recommended daily MVPA levels. This influence of parental modelling is consistent with findings from previous studies conducted in other populations[169-171,308].

Cross-sectional[409] and prospective studies[410,411] in Western populations have shown that increasing frequency of a child eating meals with the family is associated with higher consumption of fruits and reduced risk of overweight/obesity. A recent cross-sectional study in the US found that the frequency of sourcing family meals away from the home (e.g. dining in or taking away from a restaurant) was positively associated with overweight/obesity risk among adolescents[370]. Although the study questionnaire did not ask exactly the same questions, we also found that Chinese children who usually had breakfasts on the way to school or at school were more likely to consume unhealthy snacks and were reported to eat less fruit and vegetables, compared with children who usually had breakfasts at home.

Neighbourhood environment

Perceived neighbourhood environmental characteristics examined in the study were not associated with either child's weight status or their obesogenic behaviours. This was different to many studies conducted in other populations that found neighbourhood environmental factors were associated with child weight status, dietary [179,186,187,412-414] or physical activity[172,181,184-187] behaviour. A possible explanation for the absence of association in the current study could be the limitations

in the current study methods (i.e. validity of the measure was not tested in the study population and small sample size). Future studies should re-consider and examine the suitability of using a foreign-validated neighbourhood environment assessment tool in mainland Chinese population. Findings of the qualitative study (chapter 3) on study participants' perception of neighbourhood environmental influences on childhood obesity provide useful information for redesigning or refining the questionnaire for future research.

It is also worth noting that current literature on neighbourhood environmental determinants of childhood obesity and obesogenic behaviours have limitations and the research is associated with methodological challenges. Several systematic reviews have highlighted that the majority of previous studies on this topic were cross-sectional so strong empirical evidence is not yet established[311,374]. In addition, among the studies that examined child BMI as the outcome measure, around 30% of them did not measure height and weight objectively[374]. Variations in the definition of neighbourhood environmental variables (e.g. inconsistent number and type of subscales) and geographical boundary (or buffer size) were also noted by systematic reviewers[374]. These factors have made repetition, comparison studies and meta analysis impossible. Moreover, existing literature on this topic is predominantly focused on adults[207,311,374]. For those studies that were conducted among child populations, the majority of them examined the neighbourhood environment's relationship with physical activity. As a result, there has been a lack of systematic reviews for studies about the neighbourhood environment's association with children's dietary

behaviour[374].

In general, the association between neighbourhood environmental characteristics, and childhood obesity and related health behaviour varied by socio-demographic (e.g. age and sex)[311,374] and geographical factors (e.g. population density)[374], methods of measurement (e.g. child report versus parent report)[311,374] and study design (cross-sectional versus longitudinal)[374].

4.6.4 Implications for future research

The results of this study confirm some important risk factors for childhood obesity in China, but also provide information on some environmental level risk factors in the community, which can be targets for future intervention. Furthermore, the findings correspond with some of the findings in the previous qualitative chapter, particularly in relation to the role of grandparents in promoting obesogenic behaviours.

The findings from this study extend beyond previous research in China, which has focused on genetic and behavioural determinants of childhood obesity. Identifying and understanding modifiable factors underlying the behavioural risk factors (such as snacking and physical inactivity) are essential steps toward effective interventions

promoting behavioural change.

The study has also highlighted the need for improving our understanding of influences on childhood obesity beyond the family. We did not find any relationship between perceived neighbourhood environments and childhood obesity, but this may relate to limitations of the instrument used for this population, and further research needs to address this.

5 IMPLICATIONS FOR FUTURE PREVENTIVE INTERVENTIONS

The findings from chapters 3 (qualitative study) and 4 (cross-sectional study) are complementary and help to inform the development of future childhood obesity preventive interventions.

The absence of theoretically based interventions to prevent childhood obesity in China was discussed in chapter 2. Alongside, two well known theoretical frameworks that have been applied in developed countries for health interventions were introduced (the MRC framework for designing and evaluating complex interventions and the Total Planning Process (TPP) framework for social marketing). The findings presented in the last two chapters fulfil the first two phases in the MRC framework. In addition, they address the “Scoping” and “Development” steps in the TPP framework. Thus either of these frameworks could be used to further develop this work for intervention planning.

5.1 Implications for future preventive intervention development and delivery

In this chapter, I will use a Social Marketing approach to inform the targets for intervention, potential intervention components, and possible delivery strategies for future childhood obesity preventive interventions. This will be done by combining findings from the cross-sectional study (i.e. modifiable risk factors for childhood overweight and obesogenic behaviours) and the qualitative study (i.e. perceived contributing factors, important and feasible intervention components, as well as preferred delivery approaches). Incorporating an application of Social Marketing that emphasises the psychological and practical dimensions of behavioural change can support the design of targeted interventions for optimal acceptability and adoptability.

5.1.1 The strategic mix of Social Marketing and its role in intervention development

The application and development of Social Marketing was discussed in chapter 2. In practice, marketing of the desired behaviour is targeted at different subgroups. Thus the larger population is usually “segmented” into more homogenous subgroups, which have common needs and characteristics. These segments may be determined through formative research (e.g. through qualitative exploration or epidemiological studies).

Social marketers will design a tailored strategic package, using a “marketing mix” of the Product, Price, Promotion and Place (4Ps) to promote the desirable behaviour(s) in the targeted audience[289]. By optimising the marketing mix (reducing barriers and increasing the benefits), the uptake of the behaviour is more likely in contrast to competing behaviours. The 4P’s are discussed in more detail below in relation to childhood obesity prevention.

The Product P has three elements: core product (benefits of desired behaviour, e.g. improved weight status), actual product (the desired behaviour, e.g. engaging in more physical activities) and augmented product (tangible objects and services that support the desired behaviour)[289]. In the case of childhood obesity preventive intervention, if a core product is healthy weight, the corresponding actual product could be providing and promoting healthy eating at home, and augmented product could be providing a nutrition and healthy cooking guide and training to the child’s family.

The Price P in Social Marketing has a goal of decreasing actual and/or perceived costs (i.e. money, time and effort, e.g. fees associated with the use of leisure centres) of adopting the desired behaviour (exercise) while increasing actual and/or perceived benefits of adopting the desired behaviour[289]. In practice, this can be achieved by delivering coordinated Product (e.g. opening a community leisure centre or park), Place (e.g. leisure centre is located within walking distance) and Promotion (e.g. positioning the new facilities as opportunities for sociable and joyful time).

Promotion P addresses the questions related to the delivery of the message to the target audience. This includes how the message is delivered, by choosing the most suitable media channels, when it is conveyed, as well as the message content[298]. In terms of content, this should consider the needs of the target audience in relation to the sought benefits, costs, preferences, culture and habits.

Place P is about making the desirable behaviour as convenient, accessible and pleasant as possible for the target audience[289]. Ideally, if possible and justifiable, social marketers should also make the competing behaviours less popular and more inconvenient.

Additional elements of Social Marketing's strategic mix have been recommended. A widely known one is the Policy P, which for social marketers often refers to the involvement of policy makers in promoting the adoption/change of the desired behaviours. The cross-national social marketing programme, EPODE[298] was an example of involving local governmental officials in childhood obesity prevention programmes.

Below, I will use the findings from chapters 3 and 4 within the framework discussed

above, to consider the components for a childhood obesity prevention intervention suitable for South China.

5.1.2 Potential risk factor targets and components for future preventive interventions

A number of perceived causes and correlates of childhood obesity/related unhealthy behaviours were identified in both studies. They indicated potential interventions to prevent childhood obesity in the study population. Table 25 presents a summary for this and indicates sources of evidence as well as considerations on relative changeability of each potential intervention. Ideally, future preventive interventions should address all of them, either independently (e.g. focusing on one factor in one trial) or collectively (e.g. improving multiple factors in one trial). However, given limited resources and an urgent need for preventing childhood obesity, likely interventions need to be prioritised, based on their potential impact and modifiability.

Table 25 Potential interventions targets, sources of evidence and relative changeability

Potential prevention interventions	Key Social Marketing strategies (4 Ps) *	Sources of evidence			Changeability in the Chinese context
		Findings from qualitative study	Findings from cross-sectional study	Previous literature	
Family setting					
1. Grandparents: knowledge, attitude and childcare behaviours, in relation to childhood obesity	Product (e.g. nutrition guide sent home; health-related quizzes with grandchildren) Promotion (e.g. 'child power'; use of realistic photographs in health educational materials) Price (e.g. educational materials are free; fun time spent with grandchildren at quizzes)	√	√	√	Modifiable. No policy-level, institutional or infrastructure change is required
2. Mothers: physical activity or exercise habits	Product (e.g. school arranged family friendly activities) Price (e.g. school activities run in the weekend)	√	√	√	Modifiable. No policy-level, institutional or infrastructure change is required
3. Parents: practical knowledge in healthy cooking and understanding the child's weight status	Product (e.g. healthy cooking guide)	√		√	Modifiable. No policy-level, institutional or infrastructure change is required. Targeting grandparents (their key reference group) is a good entrance point and lever for intervention on this group
4. Children: sedentary or screen-viewing behaviours at home	Promotion (e.g. integrated with other components)	√	√	√	Modifiable. No policy-level, institutional or infrastructure change is required

Potential prevention interventions	Key Social Marketing strategies (4 Ps)*	Sources of evidence			Changeability in the Chinese context
		Findings from qualitative study	Findings from cross-sectional study	Previous literature	
5. Children: health knowledge in relation to childhood obesity and dietary behaviours	Product (e.g. health related quizzes involving both children and grandparents) Place (e.g. quizzes are run at the weekly moral education classes) Price (fun time spent with peers and grandparents)	√		√	Modifiable. No policy-level, institutional or infrastructure change is required
School setting					
6. School food environment: unregulated traders selling unhealthy snacks around schools and no fruit consumption or provision on campus	Policy (see description on the right)	√	√	√	Potentially modifiable. Regulatory and policy support from local government is required; little infrastructure change is required
7. School staff: negative attitude toward physical activity promotion in students	Policy (e.g. improve the insurance system) Promotion (e.g. better communication between school and family)	√			Hard to modify. Policy support, change of the exam-oriented education system and development in the awareness and provision of insurance (to schools, families and individuals) are required
Community setting					
8. Concern about neighbourhood safety	Policy (see description on the right)	√		√	Modifiable but regulatory support from local government is required
9. Reduced neighbourhood connectedness	Product (e.g. community social activities) Place (community based events)	√		√	Modifiable but low changeability, given the increasing popularity of non-workplace-based residency

Potential prevention interventions	Key Social Marketing strategies (4 Ps) *	Sources of evidence			Changeability in the Chinese context
		Findings from qualitative study	Findings from cross-sectional study	Previous literature	
Wider policy targets					
10. Single child family structure	Policy	√	√		Hard to modify. Change is inappropriate in the Chinese context
11. Exam-oriented education system and strong social value in academic attainment: (limiting opportunities for physical activity especially after school)	Policy	√		√	Hard to modify. Limited effects have been achieved despite efforts for 20 years to reduce students' workload and study pressure
12. Increasingly intensive competition in the employment market	Policy	√			Hard to modify, especially in the short term.
Wider policy targets					
13. Extensive marketing of unhealthy food and promotion of screen based activities	Policy	√		√	Modifiable but regulation from the government is required
14. Widespread availability of public transport and increased private car ownership	Policy/Product (e.g. development of walking and cycling infrastructures) Promotion (e.g. increase awareness of recommended physical activity level)	√		√	Hard to modify given the country's rapid economic and social transition
15. Insufficient space or facilities for physical activity on campus and in residential community	Policy (see description on the right)	√	√	√	Hard to modify. Long-term planning, policy and financial commitments from local government are required
16. High cost of leisure facilities	Policy (see description on the right)	√		√	Modifiable but significant policy and financial support from the government are required

Note *: Detailed discussion on social marketing/delivery strategic mix for each of the four prioritised potential interventions is the focus of section 5.1.3.

Findings from the focus groups also provide useful additional insight about how interventions could be prioritised and delivered, and what barriers should be considered in intervention development. The use of TPB in classifying my qualitative findings on influencing factors from a consequential perspective and the use of mixed methods in the overall study, enable the identification of factors that exert influence through multiple pathways, and were implicated in both the cross-sectional and qualitative studies. Generally, interventions that target government policy, or the community more widely are harder to modify, particularly in the short term. The main modifiable intervention targets identified through the above process are discussed below.

1 Interventions targeting grandparents

In both the qualitative and cross-sectional study, grandparents clearly emerged as having an important influence on childhood obesity. The cross-sectional study demonstrated a clear and positive association between the presence of grandparents and likelihood of overweight and obesity. Furthermore, having a grandparent, compared to a parent as a main carer, was associated with children consuming more servings of unhealthy snacks or drinks. This finding was supported by the qualitative study which consistently suggested that grandparents are frequently involved in care of children, and influence what they do and eat. Their historical experiences of food scarcity and hard labour, limited health knowledge, and desire to protect children, particularly within the context of the one-child policy, were identified as pathways through which they promote childhood obesity, negatively influencing all domains of the TPB. They were implicated

as influencing norms for children, and lowering perceived control over children's behaviour among parents and school teachers. Therefore grandparents would be an obvious target for future preventive interventions. Stakeholder focus groups provided further support for this, as grandparents were identified as a group with great interest in the health and happiness of their grandchildren.

From the potential interventions, two emerged as important and feasible which are relevant to this target group. These related to *providing guidance to carers on healthy eating and nutrition in children* (no. 11) and having *quizzes and competitions to reinforce dietary- and physical activity- related health message at school* (no. 33).

2 Interventions targeting mothers

Data from both the cross-sectional study and the focus groups, suggested that interventions to increase physical activity in children would benefit from involving parents. The cross-sectional study showed that children whose mothers engaged in exercise regularly were much more likely to meet the recommended one hour MVPA daily than children whose mothers did not (adjusted OR=4.40, 95% CI: 2.49-7.76). In the focus groups, parents prioritised intervention components related to *activities involving the whole family* as important and feasible. Thus, family interventions that aim to engage parents (particularly mothers) to undertake physical activity with their children would be worth pursuing.

3 Intervention targeting the family environment

In the cross-sectional study, the number of sedentary media (particularly DVD and digital game players) available in a household was found to be positively associated with children's risk for overweight. In the focus groups, sedentary media were identified as a cause of childhood obesity (being often used by parents to pacify children) and an intervention targeting modification of sedentary behaviour in children (*'switch off the TV/Computer' campaign*) was prioritised as important and feasible among parent stakeholders. Therefore, controlling screen-viewing should be considered as a component of future preventive interventions.

4 Interventions targeting the school food environment

The cross-sectional study suggested that children who skip breakfast at home were more likely to consume unhealthy snacks and drinks, and less likely to consume fruits and vegetables. The findings from the focus groups provide some possible pathways to explain this finding. The availability of unhealthy snacks sold around school entrances, and the absence of fresh fruits in the school breakfast menus, would limit the choice for children who skip breakfast at home. My informal research activities in the sample schools also found that fruits are not provided in schools; and students are not allowed to bring any food to schools (including fruits). Furthermore, interventions targeting the school food environment were prioritised as important and feasible in at least one focus

group across all stakeholder categories (refer to table 27), and was the intervention that was prioritised most commonly overall. Therefore, interventions that target the food environment in and around schools should be considered in future interventions.

5.1.3 Potential intervention delivery strategies

Using data from the focus groups and the Social Marketing approach, below I will outline potential delivery strategies for each target intervention highlighted above.

1 Interventions targeting grandparents

1.1 Educational intervention for grandparents

Based on the above analysis, a potential intervention would be the provision of information and guidance for grandparents or other main child carer, on healthy eating and nutrition in children. Such information would be best received in the form of practical material covering both scientific (e.g. sugar and fat contents of children's common food) and practical information (e.g. examples of home made meals with nutritionally balanced ingredients), and emphasising the importance of healthy eating and benefits to children. Such material could be disseminated through schools, using classroom based educational meetings. Such meetings were identified as a natural medium that is traditionally used by schools to communicate with the children's

families, and where there is usually high attendance.

In order to increase acceptability and participation, the meetings should be held at a time most convenient to intended attendees, focus on motivational messages with positive appeal, and any materials provided should be given out free of charge. Considering that grandparents are interested in the happiness and health of their grandchildren, the messages should focus on how the desired behaviours would result in these outcomes. The format of materials could include both a short video and film to convey the required messages during the classroom session, and practical written material, including recipes and facts on healthy eating and its benefits.

1.2 Educational intervention and use of competitions and incentives for primary school children and their grandparents

In order to re-enforce educational messages, a possible intervention would be the development of educational material for children themselves, which could be delivered during existing weekly moral education classes, as part of the curriculum. Children and their grandparents or guardians could be encouraged to use the material and implement changes through the use of competitions that test knowledge or reward families demonstrating evidence of healthy eating or increased physical activity. Educational material could be made appealing by using children's favourite (age-specific) cartoon characters as illustrations. Joint learning through delivery of messages to children and their grandparents and creating a shared goal through competitions, the

grandparent-grandchild relationship could be enhanced.

2 Physical activity intervention for primary school children and their mothers (or guardian)

Based on the findings from both the cross-sectional study and the focus groups, physical activities involving both the child and his/her mother would be beneficial. Such an intervention could be delivered through school by providing information and providing opportunities for joint activity for mother and child in school. Information should include the importance and benefits of physical activity, the importance of mothers as role models, when and how to participate in activities, examples of the range of activities they can do with the child at home or in other setting and how to encourage and motivate children to be more physically active. School based activity opportunities could be offered at weekends, to make these accessible to working mothers and allows children the opportunity to have time away from studies. In addition such an intervention could reduce parental concerns about accidents and injury in children taking part in physical activity. Schools and parents could be rewarded for taking part, in order to encourage participation. The range of activities offered should be varied, simple, inspirational and fun.

3 Home based ‘switch off the screens’ campaign

Availability of screen based media including television sets, computers, digital game and DVD players were implicated as contributors to childhood obesity, and limiting their use was suggested as a potential feasible intervention. Furthermore, there was suggestion of a link between screen media availability and obesity in the cross-sectional study. Therefore, a potential intervention component could be having a campaign to switch off, or limit screen use at home. Such an intervention could be incorporated within educational sessions delivered to grandparents, children and mothers. Furthermore, implementation could be encouraged through competitions and rewards, and through substitution of time saved with physical activity interventions.

4 Interventions targeting the school food environment

4.1 Regulation of the food environment around school entrances

Based on the above analyses, regulation of sales of unhealthy food around school entrances emerged as an important intervention component to promote healthy eating and healthy weight in children. Unlike other potential interventions discussed above, this component would require strong policy support from local government (e.g. devolving authority to primary schools to regulate and monitor non-licensed traders around the campus), and great cooperation between local government and participating schools (e.g. school reports offenders to the authority). Direct policy support from local government would remove or at least reduce this perceived barrier to healthy eating and the perceived lack of control, which in turn would encourage schools to continue their efforts in healthy eating promotion. To further motivate school participation, local

government could recognise and award schools with the best achievement in this regard (increasing perceived benefits of action).

4.2 Promotion of fruit consumption inside school

Since pupils are not allowed to bring any food and drink (including fruits) to their schools at the moment, this potential intervention component would require schools to change existing policy and make children and their families aware of this change. Intervention delivery may benefit from integrating its introduction with other potential intervention components, so that it is viewed as part of a whole school change in healthy eating policy.

However, in implementing this intervention, one potential barrier identified in the focus groups, was financial disparity among urban families, which may prevent some families buying and providing fruit for their children. To address this economic barrier, government support would be needed, to extend their current subsidy programme for economically disadvantaged families, to this intervention.

5.2 Conclusion

Drawing on the findings from the two main research chapters, and using a Social

Marketing approach, potential targets and components for a prevention intervention programme and strategies for delivery of such a programme were discussed. Overall, four potential intervention targets, and six likely components and respective delivery strategies were highlighted. This theoretically informed intervention programme could now be tested within a feasibility study, before being fully evaluated within a randomised controlled trial.

6 CONCLUSIONS

6.1 Summary of the thesis

This thesis used a mixed-methods approach to inform the development of a theoretically- and evidence-based childhood obesity prevention intervention that can be tested among urban Southern Chinese primary school children. The qualitative and cross-sectional studies produced complementary and largely consistent findings, highlighting the importance of environmental factors (especially the family environment) in shaping the behaviour of children and key adults that associate with them, in relation to promoting childhood obesity.

In a nutshell, while the qualitative study found a range of inter-related social, historical, regulatory, policy, knowledge and economic factors that influence attitudes, subjective norms and perceived control over obesogenic behaviours among children and people around them, the important influence of grandparents emerged as a dominant and relatively easy-to-modify segment contributing to childhood obesity. In parallel, the cross-sectional study found that the presence of grandparents was associated with children's weight status as well as their unhealthy snacking behaviours, independent of socio-demographic, family and neighbourhood environmental and

obesogenic-behavioural factors. Other themes of contributing factors, as evidenced in both qualitative and cross-sectional studies included parents (especially mothers) physical activity levels; access to sedentary screen-based entertainment resources; and children's unhealthy snacking behaviours and the school food environment.

Basing on the findings, a potential intervention programme would include:

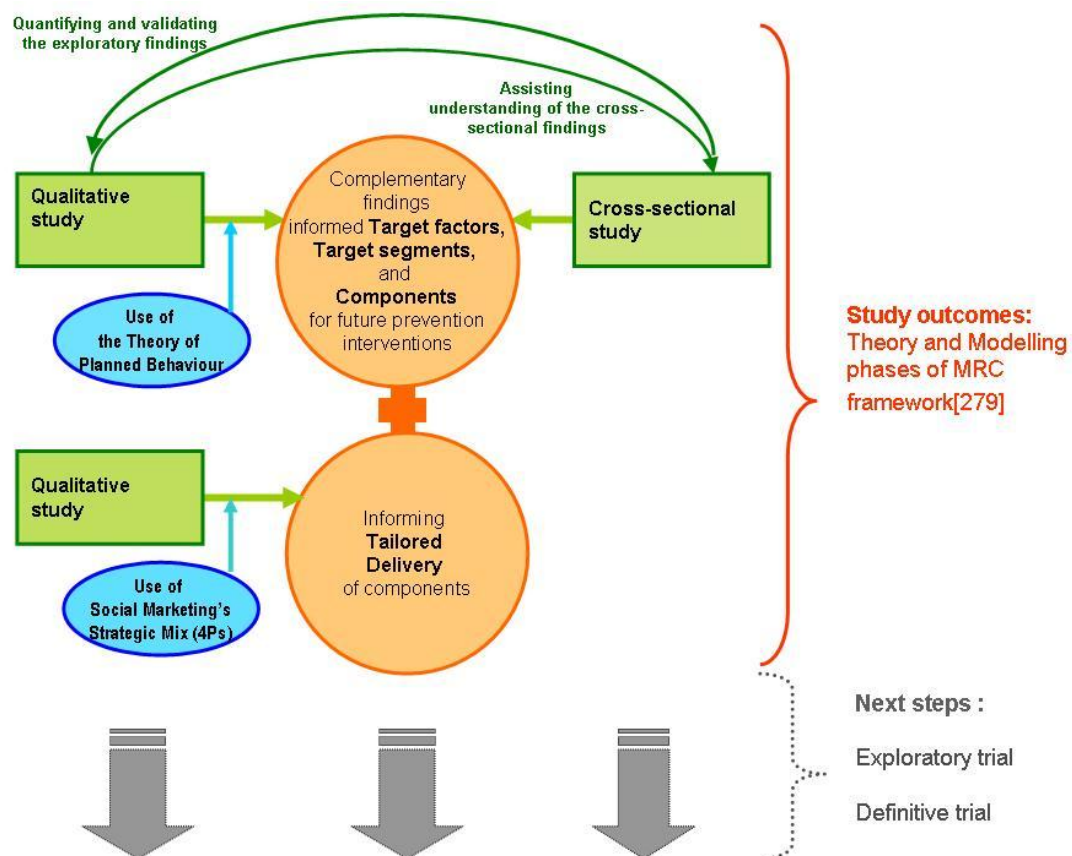
1. Interventions targeting grandparents. This may include two components, first, providing them with education on health, nutrition and feeding in children; and second, involving them in health quizzes with their grandchildren.
2. Intervention targeting mothers. This may focus on promoting physical activity in mothers with their children.
3. Intervention targeting all family members. This could include a 'Switch off the screens campaign'.
4. Intervention targeting the school food environment. Two potential components were identified, first, improving regulation on unhealthy snack traders around school entrances; and second, promoting children's consumption of fruit on campus.

In addition, likely delivery strategies among different target segments were also suggested for each of the six potential components, drawing on each segment's characteristics and preferences that were learnt through focus groups and personal interviews. The goal was to maximise target intervention components' acceptability and feasibility among their core segments and to exploit available tangible (e.g. TV and

radio player at classrooms), institutional (e.g. traditional family meetings at schools) and policy (e.g. government children nutrition aids to financially disadvantaged families) resources.

The methods (green), theoretical frameworks (blue) and outcomes (orange) informing the intervention are summarised in Figure 13. The figure also shows where this thesis fits within an overall plan of preventing childhood obesity in China.

Figure 13 A summary of how this thesis could contribute to childhood obesity prevention in China



As indicated in the above figure, the next step will be an exploratory trial, to test the feasibility of the intervention in the study population, which would also inform a definitive randomised controlled trial.

6.2 Contributions to the literature

Although it is already known that childhood obesity is a common public health issue across almost all nations and that this condition is determined primarily by the same biological, behavioural, environmental and socio-economic factors, contextual information is needed for developing and tailoring prevention interventions. This study confirmed the importance of some sociodemographic, behavioural and environmental risk factors for childhood obesity, but also helps us understand contextual factors. By exploring the contextual influences that encourage or discourage obesogenic health behaviours in populations living within different social, cultural and policy environments, interventions can be modified and tailored to that population. For instance, the important role of grandparents in Chinese families and the One-Child Family Planning Policy in China are relatively unique contributors to the obesity epidemic in this country. They represent both threats and opportunities for childhood obesity prevention. Without an in-depth understanding of societal factors like those, an intervention aiming to change children's obesogenic behaviours simply through health education on children is unlikely to produce the desired outcomes. While good

intervention models or frameworks can be developed in one place and transferred to the other, appropriate adaption and localisation are required for local applications. This study provided the first example of how the MRC Framework can be applied for the development of childhood obesity prevention interventions in a Chinese population and how other well established theories (e.g. TPB and Social Marketing) and mixed research methods can be used complementarily within the theoretical framework.

APPENDICES

Appendix 1

The information letter with a consent form for participations of a focus group or personal interview in English

Dear.....(e.g. teacher, parent, head teacher),

A research on childhood obesity prevention is being undertaken by Ms Bai Li from the University of Birmingham with support from the city's education bureau. Your voluntary participation in..... (focus group or interview) is invited so the researcher could continue the study. The(focus group or interview) will take approximately.....minutes and include.....(number and general occupation/identity of the participants). A break with complimentary drink and snacks will be offered at the half way of each focus group or personal interview. The discussion is mainly concerned about primary school children's everyday life behaviours in your opinion or experience. It will be audio recorded by a digital device in order to help the researcher remembering your important comments. Your name will not be shown in any type of research report or publication and your responses/conversations will be anonymous.

Again, your participation is voluntary and you have the right of choosing not to answer any question asked and withdrawing from the discussion at anytime even after signing this consent form. If you are willing to participate, please sign this form.

If you have any questions about this study, please contact Ms Li by.....(Chinese mobile number)

Thank you very much for your assistance.

Participant's signature:

Date:

Appendix 2

Focus group topic guide

Phase One

Introduction and Ice-breaking questions

Thank you very much for coming today and providing us with such a great opportunity to hear more about children's everyday life behaviour. As you know, our current research aims to develop a practical and effective intervention programme to promote children's healthier behaviour for the purpose of preventing or controlling obesity/overweight rate among children. Therefore, we really like to have your help. Your views and thoughts are very important to us. Our discussion will first surround your thoughts about children's current dietary and physical activity behaviour. Then I will present a range of ideas/interventions of improving and promoting healthier diet and PA of children and invite you to prioritise them. These will make up of the first phase of our discussion. Before we moving into the second phase, there will be a break with drinks and snacks. In the second phase, we will discuss your top-prioritised ideas one by one to consider how we can make those interventions most practical and appealing.

For a simple start, how do you know a child is overweight, obese or normal weight? Or what do these terms mean to you? There is no right or wrong answer. We are simply sharing ideas.

Broad Topic 1: to explore participants' attitudes toward childhood obesity prevention and perceptions of children's behaviour related to childhood obesity/overweight

PS: Not all questions listed below need to be asked one by one. Also they can be addressed in different order. That is because those participants' discussion may move smoothly in its way and still cover the same topics. The interviewer needs to be flexible at all stages. However, it is important to ensure a certain degree of consistency among different groups.

Question 1: Do you think that overweight/obesity is an issue for children in China?

Question 2: What about in your community, is it an issue here?

Question 3: What do you think of primary school children's dietary behaviour/pattern/habit in general?

Help: Do you think primary school children's dietary behaviour/pattern/habit is healthy enough?

Probe: Why?

Question 4: What do you think of primary school children's physical activity level in

general?

Help: Do you think primary school children are physically active enough?

Probe: Why?

Broad Topic 2: to invite participants to prioritise pre-summarised intervention ideas (identifying Product Ps)

First of all, the interviewer will present pre-summarised intervention ideas to the participants (using visual materials). This list of intervention ideas will be kept visible throughout the whole session. In addition to this material, every participant will be given a piece of paper showing the same content of the visual material.

Then the interviewer asks the participants to choose 3 ideas from the list (containing 42 intervention ideas) as his/her **perceivably most IMPORTANT components for an intervention package** (for preventing childhood obesity in the city). The interviewer then will hand out a ranking sheet to each participant. Participants fill in the sheet indicating their independent priority choices.

Following that, the interviewer will hand out another ranking sheet to each participant asking them to look at the 42 intervention ideas again to pick up 3 intervention components that **are perceivably by them as most PRACTICAL/ achievable**. Participants fill in the sheet indicating their independent priority choices. Before participants return their two sheets to the interviewer, they are encouraged to overview and double check their choices in both ranking sheets.

Having done two rounds of prioritisation, participants are given a break time during which, the interviewer will calculate the combined scores for each intervention being selected. The calculation method/process is described elsewhere.

Break Time: offering fruits, healthy snacks and drink.

Phase Two

At the beginning of phase two, the top 3 intervention ideas with highest combined scores of importance and practicability will be presented back to the group. The interviewer should listen to the group to **check if a consensus has been made** about their top priorities. Participants are also encouraged to suggest interventions that have not been mentioned so far but with high collective preference. When a final consensus (top priorities) has been reached, they are also Product P(s) for further discussion (in the second phase of each focus group) from a social marketing perspective.

Broad Topic 3: to understand participants' perceived barriers and facilitators to the adoption of (or support for) the identified interventions (Product P) for the optimal intervention delivery and effectiveness (to generate discussions around Price P, Promotion P, Place P).

Broad Topic 3.1: to explore perceived costs/barriers (Price P) and benefits in adopting, supporting or implementing the identified intervention components (Product P). Sometimes, the **Products** may need to be further defined to make them more specific (tailored designed).

Broad Topic 3.2: to explore perceived best ways/strategies to introduce/communicate/promote (**Promotion P**) the identified intervention components (e.g. what message/information to be delivered, through what channels and when for the best acceptability, awareness level and a suitable intervention's brand image). This also includes exploring parents' preferred tangible and intangible facilitators/incentives.

Broad Topic 3.2: to explore preferred locations (**Place P**) in which, each of those identified intervention components should take place for optimal accessibility/practicability.

In each focus group (both phases), participants' discussion as well as their prioritised results will be recorded.

Appendix 3

Pre-selected and categorised interventions (3 parts shown in one A3 table)

Part 1

Interventions promoting healthy dietary behaviours in children		
School-based	Family-based	Community-based
1. Classroom sessions on food composition, relating calories intake to effort needed to burn them off, Information on drinking water, sugar-sweetened drink, food tasting	9. Cooking demonstrations and food tasting/ nutrition workshops	12. Healthy food/ cooking demonstrations, and tasting events in residential community
2. Healthy snack contests and/or fruit snacks as rewards.	10. Providing family with meal plans, recipes and calendars with nutrition tips	13. Distribute healthy family menu to households in the residential community; healthy food and menu's tasting points in local groceries
3. Provide on or off campus experience in growing vegetable and fruit	11. Provide guidance for parents/guardians on healthy eating and nutrition in children	14. Provide healthy-eating related work shops or lecturers in residential community
4. Increase fruit and vegetable content, decrease fat, salt and sugar content, alter portion sizes in school meals; favourable pricing of fruit/vegetables and other healthy food ; adjust the availability and displace of unhealthy food and drink if more than one menus are provided for choice at school meals; increase provision of drinking water while discouraging selling sugar-sweetened drink if there is a food store		
5. Provide healthy-nutrition and healthy-cooking training to school catering staff. Ensure school breakfast and/or lunch are appropriately designed for a good nutritional balance		
6. Healthy-eating/food blackboards/displace windows/posters on campus/classrooms; encouraging less consumption of sugary and fried food/snacks/drink.		
7. Local businesses providing fresh and lower-cost fruit to school		
8. Written school policy to ban provision and sales of unhealthy food and drink		

Part 2

Interventions promoting physical activity in children		
School-based	Family-based	Community-based
<p>15. Provide more fitness-based, non-competitive physical education, and widening the range of PE's physical activities to include elements such as games and dancing</p> <p>16. Walking bus (organised route to school so that children walk to school escorted)</p> <p>17. 15 minutes walking before classes start in the morning or at other time during school day</p> <p>18. 5 minute structured and fun exercise breaks between classes and during lunch time, adding into the curriculum</p> <p>19. School/teachers require children to engage in minimum 30 minutes activity a day; rewards (e.g. collecting certificate/badge every time at the leisure facility used) for time spent doing physical activities; self/parental monitoring of sedentary activities to reinforce message</p> <p>20. Every student use a Pedometer to monitor and set goals (increase by x steps/ day)</p> <p>21. School liaises with local bodies to develop and arrange students collective travels</p> <p>22. Promote more walking, less standing/sitting in teachers</p>	<p>23. Do physical activities that all family members can take part in.</p> <p>24. Provide exercise sessions for parents or parents do more exercise/physical activity</p> <p>25. Promotional campaign for reducing car use</p> <p>26. Promotional campaign for turning off the TV/ computer</p> <p>27. During spare time, students collect certificates/badges at the leisure facility visited for regular classroom-based discussions, experience sharing, teachers recognise students' achievements</p> <p>28. Provide parents with guidance on how to encourage children to do a wide range of activities</p>	<p>29. Non-competitive individual or collective exercise sessions</p>

Part 3

Interventions promoting both healthy eating and physical activity in Children		
School based	Family based	Community based
<p>30. Food, travel or activity diaries and classroom discussion. Building up and encouraging peer support network</p> <p>31. Self-esteem activity workshop</p> <p>32. Use posters blackboards in schools to promote physical activity and healthy eating.</p> <p>33. Quizzes and competitions to reinforce healthy messages</p> <p>34. Children paint on school playground in bright colours (healthy eating and physical activity related themes)</p> <p>35. Develop and use school garden so students can grow vegetables while having fun activities</p> <p>36. Training for teachers by nutritionist and PE specialist about healthy eating and physical activity in children</p>	<p>37. Family "fun" nights/ workshops with healthy theme.</p> <p>38. 'Homework' to promote family-wide healthy behaviours (e.g. family outdoor activities and healthy family meals)</p> <p>39. Send families leaflets on physical activity, nutrition and sedentary behaviour reduction</p> <p>40. Encourage / support whole family to modify their behaviours for example (1): target setting, providing cues and prompts, monitoring and feedback; (2)rewarding (e.g. TV time for physical activity)</p> <p>41. Education on the importance of parental role modelling</p>	<p>42. Weekly or monthly "fun" night activities or workshops in residential community</p>

Appendix 4

Importance prioritization sheet

Please read every item. When you have completed reading all 42 items, please choose according to your own opinions:

- 1, the most important/effective intervention (write the assigned code).....
- 2, the 2nd most important/effective intervention (write the assigned code).....
- 3, the 3rd most important/effective intervention (write the assigned code).....

If you have any question, please hand up, the moderator will come to you.
Please return your completed sheet to the moderator.
Thank you very much for your time and efforts!

Appendix 5

Feasibility prioritization sheet

Please read the 42 interventions again considering each intervention's feasibility rather than importance or effectiveness. Please choose according to your own opinions:

- 1, the most feasible intervention (write the assigned code).....
- 2, the 2nd most feasible intervention (write the assigned code).....
- 3, the 3rd most feasible intervention (write the assigned code).....

Note: interventions chosen by yourself to be included in the first prioritisation sheet can or can not be included in this sheet, purely depending on their own judgement of their feasibility. You can choose any 3 from the 42 interventions.

If you have any question, please hand up, the moderator will come to you.
Please return your completed sheet to the moderator.
Thank you very much for your time and efforts!

Appendix 6

Synthesising 42 interventions' prioritisation results

(Date: Focus group:)

Importance/effectiveness prioritisation

Code of selected interventions	Frequency of being selected as the most important (each time is given 3 credits)	Frequency of being selected as the second most important (each time is given 2 credits)	Frequency of being selected as the third most important (each time is given 1 credit)	The total times being selected	Each selected intervention's sum score for importance
Example: Intervention NO.4	4 times	2 times	0 times	4+2+0=6 times	4*3+2*2+0=16

Feasibility/practicability prioritisation

Code of selected interventions	Frequency of being selected as the most feasible (each time is given 3 credits)	Frequency of being selected as the second most feasible (each time is given 2 credits)	Frequency of being selected as the third most feasible (each time is given 1 credit)	The total times being selected	Each selected intervention's sum score for feasibility
Example: Intervention NO.4	1 times	3 times	2 times	1+3+2=6 times	1*3+3*2+2*1=11

Overall results (combining importance and feasibility's sum scores)

	Top 1	Top 2	Top 3	Top 4	Top 5	Top 6
Intervention code		Example: NO.4				
Overall score		16+11=27				

Other consideration: combining total times being selected

	Top 1	Top 2	Top 3	Top 4	Top 5	Top 6
Intervention code		Example: NO.4				
Total times		6+6=12				

Note:

If any intervention that was rank overall within top 6 was not included in the top 6 by total times being selected, the moderator should feed back to the group and encourage them to discuss for a consensus as if it should be kept as a top prioritised intervention. In fact, whether an intervention is prioritised or not did not matter, it was the process of discussing that generated meaningful data on stakeholders' perceptions.

Appendix 7

Topic guide for head teachers' personal interviews

Introduction

Thank you very much for providing me with such a great opportunity to have a chat with you about children's everyday behaviours. As you know, our current research aims to develop a practical and effective intervention programme to promote children's healthier behaviour for the purpose of preventing obesity in among them. Therefore, your views and thoughts, experience or suggestions are very important to us.

Ice breaking question

For a simple start, would you tell me 'how do you decide a child is overweight, obese or normal weight?

Broad Topic 1: to explore school head teacher's attitude towards childhood obesity prevention and perceptions of children's behaviours related to obesity/overweight

Question 1: Do you think that overweight/obesity is an issue for children in China?

Probe: Why?

Question 2: What about in your school, is it an issue here?

Question 3: What do you think of primary school children's dietary behaviour/pattern/habit in general, from your observation?

Help: Do you think primary school children's dietary behaviour/pattern/habit is healthy enough?

Probe: Why?

Question 4: What do you think of primary school children's physical activity level in general, from your observation?

Help: Do you think primary school children are physically active enough?

Probe: Why?

Broad Topic 2: To what extent do school head teacher feel that schools should play an active role in promoting and supporting healthy eating and physical activity for the aim of preventing/controlling childhood obesity/overweight?

Question 1: To what extent, do you think primary schools should play an active role in promoting healthy eating and physical activity in children?

Probe: (If the answer is positive) What should be the roles of schools in particular?
(If the answer is negative) Why?

Question 2: (if the answer to the first question is positive)

In your opinion, what else could the school do for the purpose of promoting healthy eating and physical activity in children, in addition to those you mentioned above?

(if the answer to the first question is negative)

In your opinion, what could the school do for the purpose of promoting healthy eating and physical activity in children, whether or not you think they are the roles of your school.

Broad Topic 3: What and how is the school currently doing? Any plan for future?

Question 1: Do your school currently have any programme regarding healthy eating and/or physical activity?

Probe: (If yes) Can you describe what is it/what are they? Why/how did it come?

(If no) Does the school have any plan for future regarding children's healthy diet and physical activity? It can be led to **Topic 4** directly.

Question 2: (if the answer to question 1 is YES) What do you think the programme(s)?

Probe: Has the school met any difficulties or barriers in implementing the programme(s)?

Question 3: Does the school have any plan for future regarding children's healthy diet and physical activity?

Broad Topic 4: What do schools want/need for playing a better role in children's

healthy behaviour promotion?

Question 1: What kinds of resources or support, do you think would make it easier for your school to take an active role in promoting healthy diet and physical activity in children?

Probe: Have you had any experience in pursuing these resources or support? How was the experience?

Question 2: What other things/people, outside of the school setting, do you think would help with promoting children's healthy diet and physical activity?

Appendix 8

Submitted Research Article and Conference Presentations Of the Study's Findings At the Time of the Thesis's Submission

Li B, Adab P, Cheng KK, *Family and neighbourhood environmental correlates of overweight and obesogenic behaviours among Chinese children*, Manuscript submitted to the International Journal of Behavioural Medicine on 24th February 2013 (under review).

Li B, Adab P, Cheng KK, *Family and neighbourhood environmental correlates of weight status and obesogenic behaviours among Chinese primary school children*, Conference abstract published in the International Journal of Behavioural Medicine, 19 (Suppl 1), S226, 2012.

Li B, Adab P, Cheng KK, *Why is childhood obesity growing in China and what should we target for future preventive interventions*, Universitas 21 Healthy Living Poster Conference, 2011, Birmingham

Li B, Adab P, Cheng KK, *An integrative approach to the development of an intervention to prevent childhood obesity in China - The qualitative dimension of the study*, Poster presented at the 55th Annual Scientific Meeting for the Society of Social Medicine, 2011, Warwick.

Li B, *Understanding the growing childhood obesity epidemic in China: the relevance of social changes, state's history, policies and regulation*, Verbal presentation for ECR workshop at the 55th Annual Scientific Meeting for the Society of Social Medicine, 2011, Warwick.

Li B, Adab P, Cheng KK, *Why is childhood obesity growing in China?* Poster presented at the Annual Poster Conference of the University of Birmingham, 2011, Birmingham.

REFERENCE LIST

Reference List

1. International Obesity Taskforce: *The Global Epidemic*. 2011.
2. Wang Y, Lobstein T: **Worldwide trends in childhood overweight and obesity**. *Int J Pediatr Obes* 2006, **1**:11-25.
3. Ji CY, Cheng TO: **Epidemic increase in overweight and obesity in Chinese children from 1985 to 2005**. *Int J Cardiol* 2009, **132**:1-10.
4. Mossberg HO: **40 year follow up of overweight children**. *The Lancet* 1989, **334**:491-493.
5. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH: **Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard Growth Study of 1922 to 1935**. *N Engl J Med* 1992, **327**:1350-1355.
6. Serdula MK, Ivery D, Coates RJ, Freedman DS, Williamson DF, Byers T: **Do Obese Children Become Obese Adults? A Review of the Literature**. *Prev Med* 1993, **22**:167-177.
7. Gunnell DJ, Frankel SJ, Nanchahal K, Peters TJ, vey Smith G: **Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort**. *Am J Clin Nutr* 1998, **67**:1111-1118.
8. WHO: *Obesity: preventing and managing the global epidemic. Report of a WHO Consultation*. Geneva; 2000.
9. WHO: *Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation*. Geneva; 2003.
10. Friedlander SL, Larkin EK, Rosen C, Palermo T, Redline S: **Decreased quality of life associated with obesity in school-aged children**. *Arch Pediatr Adolesc Med* 2003, **157**:1206-1211.
11. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL: **Overweight Prevalence and Trends for Children and Adolescents: The National Health and Nutrition Examination Surveys, 1963 to 1991**. *Arch Pediatr Adolesc Med* 1995, **149**:1085-1091.
12. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM: **Prevalence of Overweight and Obesity in the United States, 1999-2004**. *JAMA* 2006, **295**:1549-1555.
13. Levine S, Stein R. **'Catastrophe' of earlier deaths, higher health costs**. *Washington Post*, 1. 5-18-2008.
14. Hughes JM, Li L, Chinn S, Rona RJ: **Trends in growth in England and Scotland, 1972 to 1994**. *Arch Dis Child* 1997, **76**:182-189.

15. Reilly JJ, Dorosty AR: **Epidemic of obesity in UK children.** *The Lancet* 1999, **354**:1874-1875.
16. Chinn S, Rona RJ: **Prevalence and trends in overweight and obesity in three cross sectional studies of British children, 1974-94.** *BMJ* 2001, **322**:24-26.
17. Frye C, Heinrich J: **Trends and predictors of overweight and obesity in East German children.** *Int J Obes Relat Metab Disord* 2003, **27**:963-969.
18. Petersen S, Brulin C, Bergstrom E: **Increasing prevalence of overweight in young schoolchildren in Umea, Sweden, from 1986 to 2001.** *Acta Paediatrica* 2003, **92**:848-853.
19. Werner B, Bodin L: **Obesity in Swedish Schoolchildren is Increasing in Both Prevalence and Severity.** *J Adolesc Health* 2007, **41**:536-543.
20. Kautiainen S, Rimpela A, Vikat A, Virtanen M: **Secular trends in overweight and obesity among Finnish adolescents in 1977-1999.** *Int J Obes* 2002, **26**:544-552.
21. Fredriks AM, Van BSTEf, Urgmeijer RJF, eulmeesiter JF, euker RJ, rugman EMIL, oede MJ, erloove VSP, it JM: **Continuing Positive Secular Growth Change in the Netherlands 1955-1997.** *Pediatr Res* 2000, **47**.
22. Tremblay MS, Katzmarzyk PT, Willms JD: **Temporal trends in overweight and obesity in Canada, 1981-1996.** *Int J Obes* 2006, **26**:538-543.
23. Murata M: **Secular trends in growth and changes in eating patterns of Japanese children.** *The American Journal of Clinical Nutrition* 2000, **72**:1379S-1383S.
24. Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C, Currie C, Pickett W, The Health Behaviour in School-Aged Children Obesity Working Group: **Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns.** *Obesity Reviews* 2005, **6**:123-132.
25. de Onis M, Blossner M: **Prevalence and trends of overweight among preschool children in developing countries.** *The American Journal of Clinical Nutrition* 2000, **72**:1032-1039.
26. Strauss RS, Pollack HA: **Epidemic Increase in Childhood Overweight, 1986-1998.** *JAMA* 2001, **286**:2845-2848.
27. Raymond SU, Leeder S, Greenberg HM: **Obesity and cardiovascular disease in developing countries: a growing problem and an economic threat.** *Curr Opin Clin Nutr Metab Care* 2006, **9**:111-116.
28. Chrzanowska M, Koziel S, Ulijaszek SJ: **Changes in BMI and the prevalence of overweight and obesity in children and adolescents in Cracow, Poland, 1971-2000.** *Economics & Human Biology* 2007, **5**:370-378.
29. Ji Chengye, Working Group on Obesity in China (WGOC): **The prevalence of childhood overweight/obesity and the epidemic changes in 1985-2000 for Chinese school-age children and adolescents.** *Obesity Reviews* 2008, **9**:78-81.
30. Ji Chengye, Sun Junling, Chen Tianjiao: **Dynamic analysis on the prevalence of obese and overweight school-age childhood and adolescents in recent 15 years in China.** *Chinese Journal of Epidemiology* 2004, **25**:103-108.

31. Luo FH, Shen SX, Tu YZ: **Obesity prevalence of Shanghai's children aged between 6 and 18 years.** *Chinese Journal of Diabetes* 2004, **12**:427-429.
32. Ma Jun, Wu Shuang Sheng: **Trend Analysis of the Prevalence of Obesity and Overweight Among School age Children and Adolescents in China.** *Chinese Journal of School Health* 2009, **30**.
33. Ji Chengye, Cheng Tsung O: **Epidemic increase in overweight and obesity in Chinese children from 1985 to 2005.** *Int J Cardiol* 2009, **132**:1-10.
34. WHO: *Population-based prevention strategies for childhood obesity: report of a WHO forum and technical meeting.* Geneva; 2009.
35. Burton BT, Foster WR, Hirsch J, Van Itallie TB: **Health implication of obesity: An NIH consensus development conference.** *Int J Obes* 1985, **9**:155-169.
36. WHO: *Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee.* 1995.
37. Reilly JJ: **Descriptive epidemiology and health consequences of childhood obesity.** *Best Practice & Research Clinical Endocrinology & Metabolism* 2005, **19**:327-341.
38. Flegal KM, Tabak CJ, Ogden CL: **Overweight in children: definitions and interpretation.** *Health Educ Res* 2006, **21**:755-760.
39. National Institutes of Health: **Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report.** *Obesity Research* 1998,**5**1S-209S.
40. World Health Organization: *Obesity: preventing and managing the global epidemic. WHO Technical Report Series number 894.* Geneva; 2000.
41. Cohn SH: **New concepts of body composition.** In *In Vivo Body Composition Studies The Institute of Physical Sciences in Medicine.* Edited by Edited by Ellis KJ, Yasumura S, Morgan WD. London: 1987:1-14.
42. Pietrobelli A, Faith MS, Allison DB, Gallagher D, Chiumello G, Heymsfield SB: **Body mass index as a measure of adiposity among children and adolescents: A validation study.** *The Journal of Pediatrics* 1998, **132**:204-210.
43. Willett WC: *Nutritional epidemiology.* New York: Oxford University Press; 1998.
44. Mihalopoulos NL, Holubkov R, Young P, Dai S, Labarthe DR: **Expected Changes in Clinical Measures of Adiposity During Puberty.** *J Adolesc Health* 2010, **47**:360-366.
45. Reilly JJ, Dorosty AR, Emmett PE: **Identification of the obese child: adequacy of the body mass index for clinical practice and epidemiology.** *Int J Obes* 2000, **24**.
46. Reilly JJ: **Diagnostic accuracy of the BMI for age in paediatrics.** *Int J Obes* 2006, **30**:595-597.
47. Navder KP, He Q, Zhang X, He S, Gong L, Sun Y, Deckelbaum RJ, Thornton J, Gallagher D: **Relationship between body mass index and adiposity in prepubertal children: ethnic and geographic comparisons between New York City and Jinan City (China).** *J Appl Physiol* 2009, **107**:488-493.

48. Banerji MA, Faridi N, Atluri R, Chiken RL, Lebovitz HE: **Body composition, visceral fat, leptin, and insulin resistance in Asian Indian men.** *J Clin Endocrinol Metab* 1999, **84**:137-144.
49. Deurenberg-Yap M, Yian TB, Kai CS, Deurenberg P, van Staveren WA, Yap M: **Manifestation of cardiovascular risk factors at low levels of body mass index and waist-to-hip ratio in Singaporean Chinese.** *Asia Pac J Clin Nutr* 1999, **177**-183.
50. Hsieh SD, Yoshinaga H, Muto T, Sakurai Y, Kosaka K: **Health risks among Japanese men with moderate body mass index.** *Int J Obes Relat Metab Disord* 2000, **24**:358-362.
51. WHO: *The Asia-Pacific Perspective: Redefining Obesity and its Treatment.* Sydney; 2000.
52. He M, Tan KC, Li ET, Kung AW: **Body fat determination by dual energy X-ray absorptiometry and its relation to body mass index and waist circumference in Hong Kong Chinese.** *Int J Obes Relat Metab Disord* 2001, **25**:748-752.
53. Chang CJ, Wu CH, Chang CS, Yao WJ, Yang YC, Wu JS, Lu FH: **Low body mass index but high percent body fat in Taiwanese subjects: implications of obesity cutoffs.** *Int J Obes Relat Metab Disord* 2003, **27**:253-259.
54. Xu Yiqun, Yeji Cheng, COOPERATIVE STUDYON CHILDHOOD OBESITY, WORKING GROUPON OBESITYIN CHINA: **Report on Childhood Obesity in China (7) Comparision of NCHS and WGO.** *Biomedical and Environmental Sciences* 2008, **21**:271-279.
55. Prentice AM, Jebb SA: **Beyond body mass index.** *Obesity Reviews* 2001, **2**:141-147.
56. Freedman DS, Wang J, Maynard LM, Thornton JC, Mei Z, Pierson RN, Jr., Dietz WH, Horlick M: **Relation of BMI to fat and fat-free mass among children and adolescents.** *Int J Obes Relat Metab Disord* 2004, **29**:1-8.
57. Daniels SR, Khoury PR, Morrison JA: **The Utility of Body Mass Index as a Measure of Body Fatness in Children and Adolescents: Differences by Race and Gender.** *Pediatrics* 1997, **99**:804-807.
58. Yanovski JA, Yanovski SZ, Filmer KM, Hubbard VS, Avila N, Lewis B, Reynolds JC, Flood M: **Differences in body composition of black and white girls.** *The American Journal of Clinical Nutrition* 1996, **64**:833-839.
59. Freedman DS, Wang J, Thornton JC, Mei Z, Pierson Jr RN, Dietz WH, Horlick M: **Racial/ethnic Differences in Body Fatness Among Children and Adolescents.** *Obesity* 2008, **16**:1105-1111.
60. Berrington de Gonzalez A, Hartge P, Cerhan JR, Flint AJ, Hannan L, MacInnis RJ, Moore SC, Tobias GS, nton-Culver H, Freeman LB et al.: **Body-Mass Index and Mortality among 1.46 Million White Adults.** *N Engl J Med* 2010, **363**:2211-2219.
61. Prospective SC: **Body-mass index and cause-specific mortality in 900[punctuation space]000 adults: collaborative analyses of 57 prospective studies.** *The Lancet* 2009, **373**:1083-1096.
62. Nyamdorj R, Qiao Q, Soderberg S, Pitkaniemi JM, Zimmet PZ, Shaw JE, Alberti KGMM, Pauvaday VK, Chitson P, Kowlessur S et al.: **BMI Compared With Central Obesity Indicators as a Predictor of Diabetes Incidence in Mauritius.** *Obesity*

2008, 17:342-348.

63. Freedman David S, Katzmarzyk PT, Dietz WH, Srinivasan SR, Berenson GS: **The relation of BMI and skinfold thicknesses to risk factors among young and middle-aged adults: the Bogalusa Heart Study.** *Ann Hum Biol* 2010, 37:726-737.
64. Cole TJ, Power C, Preece MA: **Child obesity and body-mass index.** *The Lancet* 1999, 353:1188.
65. Committee on Nutrition: **Prevention of Pediatric Overweight and Obesity.** *Pediatrics* 2003, 112:424-430.
66. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, 320:1240.
67. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL: *2000 CDC Growth Charts for the United States: methods and development.* 2002.
68. WHO: *The WHO child growth standards.* 2007.
69. Flegal KM, Ogden CL, Wei R: **Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index.** *Am J Clin Nutr* 2001, 73:1086-1093.
70. Kain J, Uauy R, Vio F, Albala C: **Trends in overweight and obesity prevalence in Chilean children: comparison of three definitions.** *Eur J Clin Nutr* 2002, 56:200-204.
71. Shan XY, Xi B, Cheng H, Hou DQ, Wang Y, Mi J: **Prevalence and behavioral risk factors of overweight and obesity among children aged 2G□?8 in Beijing, China.** *International Journal of Pediatric Obesity* 2010, 5:383-389.
72. Cheng Tsung O: **Using WHO's body mass index cutoff points to classify as overweight and obese underestimates the prevalence of overweight and obese among the Chinese.** *Int J Cardiol* 2005, 103:343.
73. Ji Chengye, Working Group on Obesity in China (WGOC): **Report on childhood obesity in China (1) - body mass index reference for screening overweight and obesity in Chinese school-age children.** *Biomedical and Environmental Sciences* 2005, 18:390-400.
74. Goran M.I., Gower B.A., Treuth M., Nagy T.R.: **Prediction of intra-abdominal and Subcutaneous abdominal adipose tissue in healthy pre-pubertal children.** *International Journal of Obesity* 1998,549-558.
75. Pollock ML: **Research progress in validation of clinical methods of assessing body composition.** *Med Sci Sports Exerc* 1984, 16:606-615.
76. Ulijaszek SJ, Kerr DA: **Anthropometric measurement error and the assessment of nutritional status.** *Br J Nutr* 1999, 82:165-177.
77. Reilly JJ, Wilson J, Durnin JV: **Determination of body composition from skinfold thickness: a validation study.** *Arch Dis Child* 1995, 73:305-310.
78. Wells JCK: **A critique of the expression of paediatric body composition data.** *Arch*

Dis Child 2001, 85:67-72.

79. Peterson MJ, Czerwinski SA, Siervogel RM: **Development and validation of skinfold-thickness prediction equations with a 4-compartment model.** *The American Journal of Clinical Nutrition* 2003, 77:1186-1191.
80. Lazzar S, Boirie Y, Meyer M, Vermorel M: **Which alternative method to dual-energy X-ray absorptiometry for assessing body composition in overweight and obese adolescents?** *Arch Pediatr* 2005, 12:1094-1101.
81. Yeung DC, Hui SS: **Validity and reliability of skinfold measurement in assessing body fatness of Chinese children.** *Asia Pac J Clin Nutr* 2010, 19:350-357.
82. World Health Organization: *Obesity: preventing and managing the global epidemic. Report on a WHO consultation on obesity.* 1997.
83. Freedman D: **Clustering of coronary heart disease risk factors among obese children.** *Journal of Pediatric Endocrinology Metabolism* 2002, 15.
84. Cook S, Weitzman M, Auinger P, Nguyen M, Dietz WH: **Prevalence of a Metabolic Syndrome Phenotype in Adolescents: Findings From the Third National Health and Nutrition Examination Survey, 1988-1994.** *Arch Pediatr Adolesc Med* 2003, 157:821-827.
85. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, Allen K, Lopes M, Savoye M, Morrison J et al.: **Obesity and the Metabolic Syndrome in Children and Adolescents.** *N Engl J Med* 2004, 350:2362-2374.
86. Viner RM, Segal TY, Lichtarowicz-Krynska E, Hindmarsh P: **Prevalence of the insulin resistance syndrome in obesity.** *Arch Dis Child* 2005, 90:10-14.
87. Liu WJ, Lin R, Liu AL, Du L, Chen Q: **Prevalence and association between obesity and metabolic syndrome among Chinese elementary school children: a school-based survey.** *BMC Public Health* 2010, 10:780.
88. Freedman DS, Serdula MK, Srinivasan SR, Berenson GS: **Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study.** *The American Journal of Clinical Nutrition* 1999, 69:308-317.
89. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS: **The Relation of Overweight to Cardiovascular Risk Factors Among Children and Adolescents: The Bogalusa Heart Study.** *Pediatrics* 1999, 103:1175-1182.
90. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJH: **Health consequences of obesity.** *Arch Dis Child* 2003, 88:748-752.
91. Kopel SJ, Klein RB: **Childhood asthma and obesity.** *Medicine & Health Rhodelsland* 2008, 91:160-164.
92. Choudhary AK, Donnelly LF, Racadio JM, Strife JL: **Diseases associated with childhood obesity.** *American Journal of Roentgenology.* *Am J Roentgenol* 2007, 188:1118-1130.
93. Sathya P, Martin S, Alvarez F: **Nonalcoholic fatty liver disease (NAFLD) in children.** *Curr Opin Pediatr* 2002, 14:593-600.

94. Fishbein MH, Miner M, Mogren C, Chalekson J: **The spectrum of fatty liver in obese children and the relationship of serum aminotransferases to severity of steatosis.** *J Pediatr Gastroenterol Nutr* 2003, 36:54-61.
95. Chmell M, Dvonch VM: **Adolescent tibia vara.** *Orthopedics* 1989, 12:295-297.
96. Henderson RC: **Tibia vara: a complication of adolescent obesity.** *J Pediatr* 1992, 121:482-486.
97. Craig JG, Holsbeeck MV, Zaltz I: **The utility of MR in assessing Blount disease.** *Skeletal Radiol* 2002, 31:208-213.
98. Taylor ED, Theim KR, Mirch MC: **Orthopedic complications of overweight in children and adolescents.** *Pediatrics* 2006, 117:2167-2174.
99. DiMartino-Nardi J: **Pre- and postpuberal findings in premature adrenarche.** *J Pediatr Endocrinol Metab* 2000, 13:1265-1269.
100. Kesler A, Fattal-Valevski A: **Idiopathic intracranial hypertension in the pediatric population.** *J Child Neurol* 2002, 17:745-748.
101. Caprio S, Hyman LD, Limb C, McCarthy S, Lange R, Sherwin RS, Sherwin RS, Tamborlane WV: **Central adiposity and its metabolic correlates in obese adolescent girls.** *Am J Physiol Endocrinol Metab* 1995, 269:118-126.
102. shmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS: **Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study.** *Eur J Clin Nutr* 2005, 60:48-57.
103. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, 84:1121-1126.
104. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: **Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study.** *Br J Nutr* 2005, 93:923-931.
105. Patterson E, Warnberg J, Kearney J, Sjostrom M: **The tracking of dietary intakes of children and adolescents in Sweden over six years: the European Youth Heart Study.** *International Journal of Behavioral Nutrition and Physical Activity* 2009, 6:91.
106. Lauer RM, Lee J, Clarke WR: **Factors affecting the relationship between childhood and adult cholesterol levels: The Muscatine Study.** *Pediatrics* 1988, 82:309-318.
107. Lauer RM, Lee J, Clarke WR: **Childhood risk factors for high adult blood pressure: The Muscatine Study.** *Pediatrics* 1989, 84:633-641.
108. Srinivasan SR, Bao W, Wattigney WA, Berenson GS: **Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors: the Bogalusa Heart Study.** *Metabolism* 1996, 45:235-240.
109. Freedman DS, Khan LK, Dietz WH, Srinivasan SR, Berenson GS: **Relationship of Childhood Obesity to Coronary Heart Disease Risk Factors in Adulthood: The Bogalusa Heart Study.** *Pediatrics* 2001, 108:712-718.
110. Reilly JJ, Kelly J: **Long-term impact of overweight and obesity in childhood and**

- adolescence on morbidity and premature mortality in adulthood: systematic review.** *Int J Obes* 2010.
111. French SA, Story M, Perry CL: **Self-esteem and obesity in children and adolescents: a literature review.** *Obes Res* 1995, 3.
 112. Miller CT, Downey KT: **A Meta-Analysis of Heavyweight and Self-Esteem.** *Personality and Social Psychology Review* 1999, 3:68-84.
 113. Blaine BE, Rodman J, Newman JM: **Weight Loss Treatment and Psychological Well-being: A Review and Meta-analysis.** *Journal of Health Psychology* 2007, 12:66-82.
 114. Lowry KW, Sallinen BJ, Janicke DM: **The Effects of Weight Management Programs on Self-Esteem in Pediatric Overweight Populations.** *J Pediatr Psychol* 2007, 32:1179-1195.
 115. Griffiths LJ, Parsons TJ, Hill AJ: **Self-esteem and quality of life in obese children and adolescents: A systematic review.** *International Journal of Pediatric Obesity* 2010, 5:282-304.
 116. Kumanyika S, Wilson JF, Guilford-Davenport M: **Weight-related attitudes and behaviors of black women.** *J Am Diet Assoc* 1993, 93:416-422.
 117. Striegel-Moore RH: **Weight-related attitudes and behaviours of women who diet to lose weight: a comparison of black and white dieters.** *Obeisty Research* 1996, 4:109-116.
 118. Flynn K, Fitzgibbon M: **Body images and obesity risk among Black females: A review of the literature.** *Ann Behav Med* 1998, 20:13-24.
 119. Siervo M, Grey P, Nyan OA, Prentice AM: **A pilot study on body image, attractiveness and body size in Gambians living in an urban community.** *Eating and Weight Disorders* 2006, 11:100-109.
 120. Barroso CS, Peters RJ, Johnson RJ, Kelder SH, Jefferson T: **Beliefs and Perceived Norms Concerning Body Image among African-American and Latino Teenagers.** *J Health Psychol* 2010, 15:858-870.
 121. Colditz GA: **Economic costs of obesity.** *Am J Clin Nutr* 1992, 55:503S-507S.
 122. Wolf AM, Colditz GA: **The costs of obesity: the U.S. perspective.** *PharmacoEconomics* 1994,34-37.
 123. National Health and Medical Research Council: *Economic issues in the prevention and treatment of overweight and obesity.* Canberra; 1997.
 124. Levy E: **The economic cost of obesity: the French situation.** *Int J Obes Relat Metab Disord* 1995, 19:788-793.
 125. Hakkinen U: **The production of health and the demand for health care in Finland.** *Soc Sci Med* 1991, 33:225-237.
 126. WHO: *Conquering suffering, enriching humanity.* Geneva; 1997.
 127. Murray DJ, Lopez AD: *The global burden of disease.* Boston: Harvard University Press; 1996.

128. WHO: *Global strategy on diet, physical activity and health*. 2004.
129. Popkin BM, Kim S, Rusev ER, Du S, Zizza C: **Measuring the full economic costs of diet, physical activity and obesity-related chronic diseases**. *Obesity Reviews* 2006, 7:271-293.
130. Stunkard AJ, Harris JR, Pedersen NL, McClearn GE: **The Body-Mass Index of Twins Who Have Been Reared Apart**. *N Engl J Med* 1990, 322:1483-1487.
131. Maes HHM, Neale MC, Eaves LJ: **Genetic and Environmental Factors in Relative Body Weight and Human Adiposity**. *Behav Genet* 1997, 27:325-351.
132. Barsh GS, Farooqi IS, O'Rahilly S: **Genetics of body-weight regulation**. *Nature* 2000, 404:644-651.
133. Farooqi IS, O'Rahilly S: **Genetics of Obesity in Humans**. *Endocr Rev* 2006, 27:710-718.
134. Han JC, Liu QR, Jones M, Levinn RL, Menzie CM, Jefferson-George KS, dler-Wailles DC, Sanford EL, Lacbawan FL, Uhl GR et al.: **Brain-Derived Neurotrophic Factor and Obesity in the WAGR Syndrome**. *N Engl J Med* 2008, 359:918-927.
135. Willer CJ, Speliotes EK, Loos RJF, Li SX, Lindgren CM, Heid AUJ, Berndt SI, Elliott AL, et al: **Six new loci associated with body mass index highlight a neuronal influence on body weight regulation**. *Nat Genet* 2009, 41:25-34.
136. Ong KK, Loos RJF: **Rapid infancy weight gain and subsequent obesity: Systematic reviews and hopeful suggestions**. *Acta Paediatr* 2006, 95:904-908.
137. Rogers IS, Ness AR, Steer CD, Wells JC, Emmett PM, Reilly JR, Tobias J, Smith GD: **Associations of size at birth and dual-energy X-ray absorptiometry measures of lean and fat mass at 9 to 10 y of age**. *The American Journal of Clinical Nutrition* 2006, 84:739-747.
138. Weaver JU: **Classical endocrine diseases causing obesity**. *Front Horm Res* 2008, 36:212-228.
139. Lee M, Korner J: **Review of physiology, clinical manifestations, and management of hypothalamic obesity in humans**. *Pituitary* 2009, 12:87-95.
140. Dabelea D: **The Predisposition to Obesity and Diabetes in Offspring of Diabetic Mothers**. *Diabetes Care* 2007, 30:S169-S174.
141. Lawlor A, Fraser A, Lindsay R, Ness A, Dabelea D, Catalano P, vey Smith G, Sattar N, Nelson S: **Association of existing diabetes, gestational diabetes and glycosuria in pregnancy with macrosomia and offspring body mass index, waist and fat mass in later childhood: findings from a prospective pregnancy cohort**. *Diabetologia* 2010, 53:89-97.
142. Moreno LA, Rodriguez G: **Dietary risk factors for development of childhood obesity**. *Curr Opin Clin Nutr Metab Care* 2007, 10:336-341.
143. Jimenez-Pavon D, Kelly J, Reilly JJ: **Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review**. *International Journal of Pediatric Obesity* 2010, 5:3-18.
144. Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I: **Relationships between**

- media use, body fatness and physical activity in children and youth: a meta-analysis.** *Int J Obes Relat Metab Disord* 2004, 28:1238-1246.
145. Steele RM, van Sluijs EM, Cassidy An, Griffin SJ, Ekelund U: **Targeting sedentary time or moderate- and vigorous-intensity activity: independent relations with adiposity in a population-based sample of 10-y-old British children.** *The American Journal of Clinical Nutrition* 2009, 90:1185-1192.
146. Cappuccio FP, Taggart FM, Kandala NB, Currie A, Peile E, Stranges S, Miller MA: **Meta-analysis of short sleep duration and obesity in children and adults.** *Sleep* 2008, 31:619-626.
147. Chen X, Beydoun MA, Wang Y: **Is Sleep Duration Associated With Childhood Obesity? A Systematic Review and Meta-analysis.** *Obesity* 2008, 16:265-274.
148. Duncker K: **Experimental modification of children's food preferences through social suggestion.** *Journal of Abnormal and Social Psychology* 1938, 33:489-507.
149. Harper LV, Sanders KM: **The effect of adults' eating on young children's acceptance of unfamiliar foods.** *J Exp Child Psychol* 1975, 20:206-214.
150. Birch LL: **Effects of peer models' food choices and eating behaviors on preschoolers' food preferences.** *Child Dev* 1980, 51:489-496.
151. Cutting TM, Fisher JO, Grimm-Thomas K, Birch LL: **Like mother, like daughter: familial patterns of overweight are mediated by mothers' dietary disinhibition.** *The American Journal of Clinical Nutrition* 1999, 69:608-613.
152. Fisher JO, Mitchell DC, Smiciklas-Wright H, Birch LL: **Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes.** *J Am Diet Assoc* 2002, 102:58-64.
153. Brown R, Ogden J: **Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence.** *Health Educ Res* 2004, 19:261-271.
154. Sylvestre MP, O'Loughlin J, Gray-Donald K, Hanley J, Paradis G: **Association Between Fruit and Vegetable Consumption in Mothers and Children in Low-Income, Urban Neighborhoods.** *Health Education & Behavior* 2007, 34:723-734.
155. Coulthard H, Blissett J: **Fruit and vegetable consumption in children and their mothers. Moderating effects of child sensory sensitivity.** *Appetite* 2009, 52:410-415.
156. Papas MA, Hurley KM, Quigg AM, Oberlander SE, Black MM: **Low-income, African American Adolescent Mothers and Their Toddlers Exhibit Similar Dietary Variety Patterns.** *Journal of Nutrition Education and Behavior* 2009, 41:87-94.
157. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies.** *Int J Behav Nutr Phys Act* 2006, 3:22.
158. Vereecken CA, Keukelier E, Maes L: **Influence of mother's educational level on food parenting practices and food habits of young children.** *Appetite* 2004, 43:93-103.

159. Pocock M, Trivedi D, Wills W, Bunn F, Magnusson J: **Parental perceptions regarding healthy behaviours for preventing overweight and obesity in young children: a systematic review of qualitative studies.** *Obes Rev* 2010, 11:338-353.
160. Birch LL, Zimmerman S, Hind H: **The influence of social-affective context on the formation of pre-school children's food preferences.** *Child Dev* 1980, 51:856-861.
161. Birch LL, Marlin DW, Rotter J: **Eating as the means activity in a contingency: effects on young children's food preferences.** *Child Dev* 1984, 55:431-539.
162. Klesges RC, Stein RJ, Eck LH, Isbell TR, Klesges LM: **Parental influence on food selection in young children and its relationships to childhood obesity.** *The American Journal of Clinical Nutrition* 1991, 53:859-864.
163. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C: **Availability, Accessibility, and Preferences for Fruit, 100% Fruit Juice, and Vegetables Influence Children's Dietary Behavior.** *Health Education & Behavior* 2003, 30:615-626.
164. Jain A, Sherman SN, Chamberlin DPA, Carter Y, Powers SW, Whitaker RC: **Why Don't Low-Income Mothers Worry About Their Preschoolers Being Overweight?** *Pediatrics* 2001, 107:1138-1146.
165. Jimenez-Cruz A, Bacardi-Gascon M, Castillo-Ruiz O, Mandujano-Trujillo Z, Pichardo-Osuna A: **Low income, Mexican mothers' perception of their infants' weight status and beliefs about their foods and physical activity.** *Child Psychiatry Hum Dev* 2010, 41:490-500.
166. Pham KL, Harrison GG, Kagawa-Singer M: **Perceptions of diet and physical activity among California Hmong adults and youths.** *Prev Chronic Dis* 2007, 4:A93.
167. Pagnini DL, Wilkenfeld RL, King LA, Booth ML, Booth SL: **Mothers of pre-school children talk about childhood overweight and obesity: The Weight of Opinion study.** *J Paediatr Child Health* 2007, 43:806-810.
168. Hupkens CLH, Knibbe RA, van Otterloo AH, Drop MJ: **Class differences in the food rules mothers impose on their children: a cross-national study.** *Social Science & Medicine* 1998, 47:1331-1339.
169. Moore LL, Lombardi DA, White MJ, Campbell JL, Oliveria SA, Ellison RC: **Influence of parents' physical activity levels on activity levels of young children.** *The Journal of Pediatrics* 1991, 118:215-219.
170. Fogelholm M, Nuutinen O, Pasanen M, Myohanen E, Saatela T: **Parent-child relationship of physical activity patterns and obesity.** *Int J Obes Relat Metab Disord* 1999, 23:1262-1268.
171. Salmon J, Timperio A, Telford A, Carver A, Crawford D: **Association of family environment with children's television viewing and with low level of physical activity.** *Obes Res* 2005, 13:1939-1951.
172. Hume C, Salmon J, Ball K: **Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study.** *Health Educ Res* 2005, 20:1-13.
173. Trost SG, Sallis JF, Pate RR, Freedson PS, Taylor WC, Dowda M: **Evaluating a model**

- of parental influence on youth physical activity. Am J Prev Med 2003, 25:277-282.**
174. Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG: **Effect of Infant Feeding on the Risk of Obesity Across the Life Course: A Quantitative Review of Published Evidence. Pediatrics 2005, 115:1367-1377.**
 175. Arenz S, Ruckerl R, Koletzko B, von Kries R: **Breast-feeding and childhood obesity—a systematic review. Int J Obes Relat Metab Disord 2004, 28:1247-1256.**
 176. Kramer MS, Matush L, Vanilovich I, Platt RW, Bogdanovich N, Sevkovskaya Z, Dzikovich I, Shishko G, Collet JP, Martin RM et al.: **Effects of prolonged and exclusive breastfeeding on child height, weight, adiposity, and blood pressure at age 6.5 y: evidence from a large randomized trial. The American Journal of Clinical Nutrition 2007, 86:1717-1721.**
 177. Kramer MS, Matush L, Vanilovich I, Platt RW, Bogdanovich N, Sevkovskaya Z, Dzikovich I, Shishko G, Collet JP, Martin RM et al.: **A Randomized Breast-feeding Promotion Intervention Did Not Reduce Child Obesity in Belarus. The Journal of Nutrition 2009, 139:417S-421S.**
 178. Veugelers P, Sithole F, Zhang S, Muhajarine N: **Neighborhood characteristics in relation to diet, physical activity and overweight of Canadian children. Int J Pediatr Obes 2008, 3:152-159.**
 179. Hackett A, Boddy L, Boothby J, Dummer TJB, Johnson B, Stratton G: **Mapping dietary habits may provide clues about the factors that determine food choice. J Hum Nutr Diet 2008, 21:428-437.**
 180. Jago R, Baranowski T, Baranowski J, Cullen K, Thompson D: **Distance to food stores & adolescent male fruit and vegetable consumption: mediation effects. Int J Behav Nutr Phys Act 2007, 4:35.**
 181. Carver A, Timperio A, Crawford D: **Neighborhood Road Environments and Physical Activity Among Youth: The CLAN Study. J Urban Health 2008, 85:532-544.**
 182. Mota J, Almeida M, Santos R, Ribeiro JC, Santos MP: **Association of perceived environmental characteristics and participation in organized and non-organized physical activities of adolescents. Pediatr Exerc Sci 2009, 21.**
 183. Veugelers P, Sithole F, Zhang S, Muhajarine N: **Neighborhood characteristics in relation to diet, physical activity and overweight of Canadian children. Int J Pediatr Obes 2008, 3:152-159.**
 184. Santos MP, Page AS, Cooper AR, Ribeiro JC, Mota J: **Perceptions of the built environment in relation to physical activity in Portuguese adolescents. Health & Place 2009, 15:548-552.**
 185. Bungum T, Lounsbery M, Moonie S, Gast J: **Prevalence and Correlates of Walking and Biking to School Among Adolescents. J Community Health 2009, 34:129-134.**
 186. Pearce A, Kirk C, Cummins S, Collins M, Elliman D, Connolly AM, Law C: **Gaining children's perspectives: A multiple method approach to explore environmental influences on healthy eating and physical activity. Health & Place 2009, 15:614-621.**
 187. Lindsay AC, Sussner KM, Greaney ML, Peterson KE: **Influence of Social Context on**

Eating, Physical Activity, and Sedentary Behaviors of Latina Mothers and Their Preschool-Age Children. *Health Educ Behav* 2009, 36:81-96.

188. Larsen K, Gilliland J, Hess P, Tucker P, Irwin J, He M: **The Influence of the Physical Environment and Sociodemographic Characteristics on Children's Mode of Travel to and From School. *Am J Public Health* 2009, 99:520-526.**
189. Drewnowski A, Popkin BM: **The nutrition transition: new trends in the global diet. *Nutr Rev* 1997, 55:31-43.**
190. Popkin BM: **The nutrition transition: an overview of world patterns of change. *Nutr Rev* 2004, 62:S140-S143.**
191. Kelly B, Halford JCG, Boyland EJ, Chapman K, Bautista-Castano I, Berg C, Caroli M, Cook B, Coutinho JG, Effertz T et al.: **Television Food Advertising to Children: A Global Perspective. *Am J Public Health* 2010, 100:1730-1736.**
192. Kelly B, Bochynska K, Kornman K, Chapman K: **Internet food marketing on popular children's websites and food product websites in Australia. *Public Health Nutrition* 2008, 11:1180-1187.**
193. Nielsen SJ, Siega-Riz AM, Popkin BM: **Trends in energy intake in U.S. between 1977 and 1996: similar shifts seen across age groups. *Nutr Rev* 2002, 10:370-378.**
194. Nielsen SJ, Siega-Riz AM, Popkin BM: **Trends in Food Locations and Sources among Adolescents and Young Adults. *Prev Med* 2002, 35:107-113.**
195. Gillman MW, Rifas-Shiman SL, Frazier AL, Rockett HRH, Camargo CA, Jr., Field AE, Berkey CS, Colditz GA: **Family Dinner and Diet Quality Among Older Children and Adolescents. *Arch Fam Med* 2000, 9:235-240.**
196. Magnus A, Haby MM, Carter R, Swinburn B: **The cost-effectiveness of removing television advertising of high-fat and/or high-sugar food and beverages to Australian children. *Int J Obes* 2009, 33:1094-1102.**
197. Powell LM, Szczypka G, Chaloupka FJ: **Exposure to Food Advertising on Television Among US Children. *Arch Pediatr Adolesc Med* 2007, 161:553-560.**
198. Keller SK, Schulz PJ: **Distorted food pyramid in kids programmes: A content analysis of television advertising watched in Switzerland. *The European Journal of Public Health*.**
199. Guran T, Turan S, Akcay T, Degirmenci F, Avci O, Asan A, Erdil E, Majid A, Bereket A: **Content analysis of food advertising in Turkish television. *J Paediatr Child Health* 2010, 46:427-430.**
200. Dixon HG, Scully ML, Wakefield MA, White VM, Crawford DA: **The effects of television advertisements for junk food versus nutritious food on children's food attitudes and preferences. *Soc Sci Med* 2007, 65:1311-1323.**
201. Halford JCG, Gillespie J, Brown V, Pontin EE, Dovey TM: **Effect of television advertisements for foods on food consumption in children. *Appetite* 2004, 42:221-225.**
202. Halford JCG, Boyland EJ, Hughes G, Oliveira LP, Dovey TM: **Beyond-brand effect of television (TV) food advertisements/commercials on caloric intake and food choice of 5-7-year-old children. *Appetite* 2007, 49:263-267.**

203. Harris JL, Bargh JA, Brownell KD: **Priming effects of television food advertising on eating behavior.** *Health Psychol* 2009, 28:404-413.
204. MRD Human Research Nutrition C, Department of Health: *The 'Healthy Living' Social Marketing Initiative: A review of the evidence.* 2007.
205. Lanningham Foster L, Nysse LJ, Levine JA: **Labor saved, calories lost: the energetic impact of domestic labor-saving devices.** *Obes Res* 2003, 11:1178-1181.
206. Popkin BM, Duffey K, Gordon-Larsen P: **Environmental influences on food choice, physical activity and energy balance.** *Physiology & Behavior* 2005, 86:603-613.
207. Galvez MP, Pearl M, Yen IH: **Childhood obesity and the built environment.** *Curr Opin Pediatr* 2010, 22:202-207.
208. Atlantis E, Salmon J, Bauman A: **Acute effects of advertisements on children's choices, preferences, and ratings of liking for physical activities and sedentary behaviours: A randomised controlled pilot study.** *J Sci Med Sport* 2008, 11:553-557.
209. Whincup PH, Gilg JA, Papacosta O, Seymour C, Miller GJ, Alberti KGMM, Cook DG: **Early evidence of ethnic differences in cardiovascular risk: cross sectional comparison of British South Asian and white children.** *BMJ* 2002, 324:635.
210. Yajnik CS, Lubree HG, Rege SS, Naik SS, Deshpande JA, Deshpande SS, Joglekar CV, Yudkin JS: **Adiposity and Hyperinsulinemia in Indians Are Present at Birth.** *Journal of Clinical Endocrinology Metabolism* 2002, 87:5575-5580.
211. Freedman DS, Khan LK, Serdula MK, Ogden CL, Dietz WH: **Racial and Ethnic Differences in Secular Trends for Childhood BMI, Weight, and Height.** *Obesity* 2006, 14:301-308.
212. de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J: **The WHO Multicentre Growth Reference Study: planning, study design, and methodology.** *Food Nutr Bull* 2004, 25(suppl1):S15-S26.
213. Wang YF: **Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status.** *Int J Epidemiol* 2001, 30:1129-1136.
214. Summerbell SD, Waters E, Edmunds L, Kelly SA, Brown T, Campbell KJ: **Interventions for preventing obesity in children (Review).** *Cochrane Database Syst Rev* 2005.
215. Sharma M: **School-based interventions for childhood and adolescent obesity.** *Obesity Reviews* 2006, 7:261-269.
216. Hardeman W, Griffin S, Johnston M, Kinmonth AL, Wareham NJ: **Interventions to prevent weight gain: a systematic review of psychological models and behaviour change methods.** *Int J Obes* 2000, 24:131-143.
217. Brown T, Summerbell C: **Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence.** *Obesity Reviews* 2009, 10:110-141.

218. Reilly JJ, McDowell ZC: **Physical activity interventions in the prevention and treatment of paediatric obesity: systematic review and critical appraisal.** *Proceedings of the Nutrition Society* 2003, 62:611-619.
219. Mulvihill C., Quigley R.: *The management of obesity and overweight: an analysis of reviews of diet, physical activity and behavioural approaches. Evidence briefing.* 2003.
220. Livingstone MBE, McCaffrey TA, Rennie KL: **Childhood obesity prevention studies: lessons learned and to be learned.** *Public Health Nutrition* 2006, 9:1121-1129.
221. Connelly JB, Duaso MJ, Butler G: **A systematic review of controlled trials of interventions to prevent childhood obesity and overweight: A realistic synthesis of the evidence [abstract].** *Public Health* 2007, 121:510
222. Doak CM, Visscher TLS, Renders CM, Seidell JC: **The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes.** *Obes Rev* 2006, 7:111-136.
223. Flodmark CE, Marcus C, Britton M: **Interventions to prevent obesity in children and adolescents: a systematic literature review.** *Int J Obes* 2006, 30:579-589.
224. Gonzalez-Suarez C, Worley A, Grimmer-Somers K, Dones V: **School-Based Interventions on Childhood Obesity: A Meta-Analysis.** *Am J Prev Med* 2009, 37:418-427.
225. Gracia-Marco L, Vicente-Rodriguez G, Borys JM, Le Bodo Y, Pettigrew S, Moreno LA: **Contribution of social marketing strategies to community-based obesity prevention programmes in children.** *Int J Obes* 2010, 35:472-479.
226. Petticrew M: **Why certain systematic reviews reach uncertain conclusions.** *BMJ* 2003, 326:756-758.
227. Campbell KJ, Hesketh KD: **Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature.** *Obesity Reviews* 2007, 8:327-338.
228. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, Armstrong R, Prosser L, Summerbell CD: **Interventions for preventing obesity in children.** *Cochrane Database Syst Rev* 2011.
229. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H: **Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis.** *Int J Obes* 2008, 32:1780-1789.
230. Kropski JA, Keckley PH, Jensen GL: **School-based Obesity Prevention Programs: An Evidence-based Review.** *Obesity* 2008, 16:1009-1018.
231. Group of China Obesity Task Force: **Body mass index reference norm for screening overweight and obesity in Chinese children and adolescents.** *Chinese Journal of Epidemiology* 2004,97-102.
232. CNSSCH Association: *Report on the 2000 National Survey on Students' Constitution and Health.* Beijing: China College & University Press; 2002.
233. Shan XY, Xi B, Cheng H, Hou DQ, Wang Y, Mi J: **Prevalence and behavioral risk factors of overweight and obesity among children aged 2-18 in Beijing, China.** *International Journal of Pediatric Obesity* 2010, 5:383-389.

234. Ji Chengye, Cheng Tsung O: **Epidemic increase in overweight and obesity in Chinese children from 1985 to 2005.** *Int J Cardiol* 2009, 132:1-10.
235. CNSSCH Association: *Report on the 1985 National Survey on Students' Constitution and Health.* Beijing: People's Educational Publication; 1987.
236. CNSSCH Association: *Report on the 1991 National Survey on Students' Constitution and Health.* Beijing: Beijing Technical and Science Press; 1993.
237. CNSSCH Association: *Report on the 1995 National Survey on Students' Constitution and Health.* Changchun: Jilin Technical and Science Publication; 1997.
238. CNSSCH Association: *Report on the 2005 National Survey on Students' Constitution and Health.* Beijing: China College & University Press; 2007.
239. Ji CY, Cheng TO: **Prevalence and geographic distribution of childhood obesity in China in 2005.** *Int J Cardiol* 2008, 131:1-8.
240. Rosas L, Guendelman S, Harley K, Fernald L, Neufeld L, Mejia F, Eskenazi B: **Factors Associated with Overweight and Obesity among Children of Mexican Descent: Results of a Binational Study.** *J Immigr Minor Health* 2011, 13:169-180.
241. Li L, Pinot de Moira A, Power C: **Changing influences on childhood obesity: a study of two generations of the 1958 British birth cohort.** *J Epidemiol Community Health* 2009, 63:27.
242. Shrewsbury V, Wardle J: **Socioeconomic Status and Adiposity in Childhood: A Systematic Review of Cross-sectional Studies 1990-2005.** *Obesity* 2008, 16:275-284.
243. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM: **The Epidemiology of Obesity.** *Gastroenterology* 2007, 132:2087-2102.
244. Stamatakis E, Zaninotto P, Falaschetti E, Mindell J, Head J: **Time trends in childhood and adolescent obesity in England from 1995 to 2007 and projections of prevalence to 2015.** *J Epidemiol Community Health* 2010, 64:167-174.
245. NHS Information Centre for Health & Social Care: *Health Survey for England 2008: physical activity and fitness.* London; 2009.
246. NHS Information Centre for Health & Social Care: *National Child Measurement Programme: England, 2008/09 school year.* Leeds; 2009.
247. Yuan P, Luo L: **Meta Analysis of Risk Factor on Simple Obesity of Children Under Age 14 in China.** *Chinese Journal of Child Health Care* 2002, 10:161-163.
248. Jing R, Han LT, Liu XD, Li L, Li XY, Yang SX: **Meta-analysis of risk factors of childhood simple obesity among school age children in China .** *Chinese Journal of Hospital Statistics* 2008, 15:307-309.
249. Zhang XY, Liu EQ, Tian Z, Wang W, Ye T, Liu GS, Li YM, Wang P, Yang XL, Yu ZJ et al.: **High birth weight and overweight or obesity among Chinese children 3-6 years old.** *Prev Med* 2008, 49:172-178.
250. Maimaiti R, Lin FM, Muzhapaer D: **Risk factors for simple obesity in preschool children from four kindergartens of Urumqi City.** *Zhongguo Dang Dai Er Ke Za Zhi* 2008, 10:73-76.

251. Li X, Liao B, Liu J, Tan H, Huang W, Benjamin A, Liu W, Huang X, Wen S: **Prevalence and risk factors for childhood obesity in Changsha and Shenzhen in China.** *Zhong Nan Da Xue Xue Bao Yi Xue Ban* 2010, 35:11-16.
252. Wu L, Xi B, Zhang M, Shen Y, Zhao X, Cheng H, Hou D, Sun D, Ott J, Wang X et al.: **Associations of Six Single Nucleotide Polymorphisms in Obesity-Related Genes With BMI and Risk of Obesity in Chinese Children.** *Diabetes* 2010, 59:3085-3089.
253. Wu J, Mo J, Huang CW, Peng LW, Yang XC, Yu X: **Obesity and its influencing factors in primary school students from Kaifu District of Changsha City.** *Zhongguo Dang Dai Er Ke Za Zhi* 2008, 10:231-235.
254. Jiang F, Zhu S, Yan C, Jin X, Bandla H, Shen X: **Sleep and Obesity in Preschool Children.** *The Journal of Pediatrics* 2009, 154:814-818.
255. Wing YK, Li SX, Li AM, Zhang J, Kong APS: **The Effect of Weekend and Holiday Sleep Compensation on Childhood Overweight and Obesity.** *Pediatrics* 2009, 124:e994-1000.
256. *The SAGE Handbook of Qualitative Research.* London: Sage; 2005.
257. Gordon-Larsen P, Griffiths P, Bentley ME, Ward DS, Kelsey K, Shields K, Ammerman A: **Barriers to physical activity: Qualitative data on caregiver-daughter perceptions and practices.** *Am J Prev Med* 2004, 27:218-223.
258. Hesketh K, Waters E, Green J, Salmon L, Williams J: **Healthy eating, activity and obesity prevention: a qualitative study of parent and child perceptions in Australia.** *Health Promot Int* 2005, 20:19-26.
259. Brunton G, Harden A, Rees R, Kavanagh J, Oliver S, Oakley A: *Children and Physical Activity: A systematic Review of Barriers and Facilitators.* London, EPPICentre, Social Science Research Unit, Institute of Education, University of London; 2003.
260. O'Dea JA: **Why do kids eat healthful food? Perceived benefits of and barriers to healthful eating and physical activity among children and adolescents.** *J Am Diet Assoc* 2003, 103:497-501.
261. Della Torre Swiss SB, Akr 茅 C, Suris JC: **Obesity Prevention Opinions of School Stakeholders: A Qualitative Study.** *J Sch Health* 2010, 80:233-239.
262. Van Lippevelde W, Verloigne M, De Bourdeaudhuij I, Bjelland M, Lien N, Fernandez-Alvira J, Moreno L, Kovacs E, Brug J, Maes L: **What do parents think about parental participation in school-based interventions on energy balance-related behaviours? a qualitative study in 4 countries.** *BMC Public Health* 2011, 11:881.
263. Gao Y, Griffiths S, Chan EYY: **Community-based interventions to reduce overweight and obesity in China: a systematic review of the Chinese and English literature.** *J Public Health* 2008, 30:436-448.
264. 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.** *Obesity Reviews* 2008, 548-599.
265. LI YP, HU XQ, Zhang Q, Liu AL, Fang HY, Hao LN, Duan YF, Xu HQ, Shang XW, Ma J et al.: **The nutrition-based comprehensive intervention study on childhood obesity in China (NISCOC): a randomised cluster controlled trial.** *BMC Public*

Health 2010, 10:229.

266. Blair-Stevens C, Reynolds L, Christopoulos A: **Behavioural theory: understanding the key influences on human behaviour.** In *Social Marketing and Public Health: theory and practice*. 1st edition. Edited by Edited by French J, Blair-Stevens C, McVey D, Merritt R. New York: Oxford University Press; 2010:45-65.
267. Ajzen I: **From intentions to actions: A theory of planned behaviour.** In *Action control: From cognition to behaviour*. Edited by Edited by Kuhl J, Beckmanne J. New York: Springer-Verlag; 1985.
268. Ajzen I: **The theory of planned behaviour.** *Organisational Behaviour and Human Decision Process* 1991, 59:179-211.
269. Swinburn B, Egger G, Raza F: **Dissecting Obesogenic Environments: The Development and Application of a Framework for Identifying and Prioritizing Environmental Interventions for Obesity.** *Prev Med* 1999, 29:563-570.
270. Kumanyika S, Jeffery RW, Morabia A, Ritenbaugh C, Antipatis VJ: **Obesity prevention: the case for action.** *Int J Obes* 2002, 26:425-436.
271. McLeroy KR, Bibeau D, Steckler A, Glanz K: **An ecological perspective on health promotion programs.** *Health Education Behaviour* 1988, 15:351-377.
272. Ammerman AS, Samuel-Hodge CD, Sommers JK, Leung MM, Paxton AE, Vu MB: **Community-based approaches to obesity prevention: the role of environmental and policy change.** In *Handbook of obesity prevention: a resource for health professionals*. Edited by Edited by Kumanyika S, Brownson R. New York: Springer; 2007:263-284.
273. Ogilvie D, Bull F, Powell J, Cooper AR, Brand C, Mutrie N, Preston J, Rutter H, on behalf of the iConnect Consortium: **An Applied Ecological Framework for Evaluating Infrastructure to Promote Walking and Cycling: The iConnect Study.** *Am J Public Health* 2011, 101:473-481.
274. Orleans CT, Gruman J, Ulmer C, Emont SL, Hollendonner JK: **Rating our progress in population health promotion: report card on six behaviours.** *Am J Health Promot* 1999, 14:75-82.
275. Hastings G, Donovan RJ: **International Initiatives: Introduction and Overview.** *Social Marketing Quarterly* 2002, 8:3-5.
276. Neiger B., Thackeray R., Barnes M., McKenzie J.: **Positioning social marketing as a planning process for health education.** *American Journal of Health Studies* 2003, 18:75-82.
277. Griffiths J., Blair-Stevens C., Thorpe A.: *Social marketing for health and specialised health promotion: Stronger together weaker apart.* 2008.
278. Medical Research Council. **A framework for development and evaluation of RCTs for complex interventions to improve health.** 2000. London, Medical Research Council.
279. Campbell M, Fitzpatrick R, Haines A, Kinmonth AL, Sandercock P, Spiegelhalter D, Tyrer P: **Framework for design and evaluation of complex interventions to improve health.** *BMJ* 2000, 321:694-696.

280. Campbell NC, Murray E, Darbyshire J, Emery J, Farmer A, Griffiths F, Guthrie B, Lester H, Wilson P, Kinmonth AL: **Designing and evaluating complex interventions to improve health care.** *Br Med J* 2007, 334:455-459.
281. Department of Health: *Choosing Health, Making Healthy Choices Easier - Executive Summary.* 2004.
282. Centres for Disease Control and Prevention: *Communication at CDC, Practice Areas: Social Marketing. USA;* 2005.
283. Stead M, Hastings G, McDermott L: **The meaning, effectiveness and future of social marketing.** *Obesity Reviews* 2007, 8:189-193.
284. Department of Health: *Change4Life One Year On.* website of the department of health; 2010.
285. McDermott L, Stead M, Hastings GB, Hastings GB, Banerjee S, Rayner M: *A Systematic Review of the Effectiveness of Social Marketing Nutrition and Food Safety Interventions:final report prepared for safefood.* Stirling; 2005.
286. Gordon R, McDermott L, Stead M, Angus K: **The effectiveness of social marketing interventions for health improvement: What's the evidence?** *Public Health* 2006, 120:1133-1139.
287. Sowers W, French J, Blair-Stevens C: **Lessons Learned from Social Marketing Models in the United Kingdom.** *Social Marketing Quarterly* 2007, 13:58-62.
288. Donovan R, Henley N: *Principles and Practice of Social Marketing: an international perspective.* Cambridge: Cambridge University Press; 2010.
289. Kotler P, Roberto N, Lee Nancy: *Social Marketing - Improving the Quality of Life.* London: Sage Publications; 2002.
290. National Social Marketing Centre: *Why Is Social Marketing Important.* 2006.
291. French J, Blair-Stevens C: *Social Marketing Pocket Guide.* London: National Consumer Council; 2005.
292. Maibach E: **Social marketing for the environment:using information campaigns to promote environmental awareness and behaviour change.** *Health Promot Int* 1993, 3:209-224.
293. Della LJ, DeJoy DM, Lance CE: **Explaining Fruit and Vegetable Intake Using a Consumer Marketing Tool.** *Health Educ Behav* 2009, 36:895-914.
294. Okin G, Sangster V, Thurner R, Adam F: **CABWISE: Creating a Brand to Help Prevent Rapes.** In *Advertising Works 17: Proving the Payback on Marketing Investment.* Edited by Edited by Dawson N. Henley on Thames: World Advertising Research Centre; 2009.
295. Abraham C, Sheeran P: **Health Belief Model.** In *Predicting Health Behaviour: Research and Practice with Social Cognition Models.* 2nd edition. Edited by Edited by Conner M, Norman P. Buckingham: Open University Press; 2005:28-80.
296. Petty RE, Calioppo JT: *Communication and Persuasion: Central and peripheral routes to attitude change.* New York: Springer- Verlag; 1986.

297. Prochaska JO, DiClemener CC, Norcross JC: **In search of how people change.** *Am Psychol* 1992, 47:1102-1114.
298. Henley N, Raffin S: **Social marketing to prevent childhood obesity: The EPODE Program.** In *Prevention Childhood Obesity: Evidence Policy and Practice*. Edited by Edited by Waters E, Swinburn B, Seidell J, Uauy R. Wiley-Blackwell; 2010:243-252.
299. Gordon R, McDermott L, Stead M, Angus K, Hastings G: *A review of the effectiveness of social marketing physical activity interventions.* National Social Marketing Centre; 2006.
300. Ball K, Timperio AF, Crawford DA: **Understanding environmental influences on nutrition and physical activity behaviors: where should we look and what should we count?** *Int J Behav Nutr Phys Act* 2006, 3:33.
301. He MZ, Irwin JD, Sangster Bouck LM, Tucker P, Pollett GL: **Screen-Viewing Behaviors Among Preschoolers: Parents' Perceptions.** *Am J Prev Med* 2005, 29:120-125.
302. Dwyer G, Higgs J, Hardy L, Baur L: **What do parents and preschool staff tell us about young children's physical activity: a qualitative study.** *Int J Behav Nutr Phys Act* 2008, 5:66.
303. Jebb S, Steer Toni, Holmes C: *The 'Healthy Living' Social Marketing Initiative: A review of the evidence.* 2007.
304. Styles JL, Meier A, Sutherland LA, Campbell MK: **Parents' and caregivers' concerns about obesity in young children: a qualitative study.** *Fam Community Health* 2007, 30:279-295.
305. Hart KH, Herriot A, Bishop JA, Truby H: **Promoting healthy diet and exercise patterns amongst primary school children: a qualitative investigation of parental perspectives.** *J Hum Nutr Diet* 2003, 16:89-96.
306. Shepherd J, Harden A, Rees R, Brunton G, Garcia J, Oliver S, Oakey A: *Young People and Healthy Eating: A systematic review of research on barriers and facilitators.* London; 2001.
307. Borra ST, Kelly L, Shirreffs MB, Neville K, Geiger CJ. **Developing health messages: Qualitative studies with children, parents, and teachers help identify communications opportunities for healthful lifestyles and the prevention of obesity.** *Journal of the American Dietetic Association* 103(6), 721-728. 6-1-2003.
308. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M: **Familial correlates of adolescent girls' physical activity, television use, dietary intake, weight, and body composition.** *Int J Behav Nutr Phys Act* 2011, 8:25.
309. Poortinga W: **Perceptions of the environment, physical activity, and obesity.** *Social Science & Medicine* 2006, 63:2835-2846.
310. Powell L, Ault C, Chaloupka K, et al: **Associations between access to food stores and adolescent body mass index.** *Am J Prev* 2007, 33:301-307.
311. Durand CP, Andalib M, Dunton GF, Wolch J, Pentz MA: **A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning.** *Obes Rev* 2011,no.

312. Rahman T, Cushing RA, Jackson RJ: **Contributions of Built Environment to Childhood Obesity.** *Mt Sinai J Med* 2011, 78:49-57.
313. Montano DE, Kasprzyk D: **Theory of reasoned action, theory of planned behavior, and the integrated behavioral model.** In *Health Behavior and Health Education: Theory, Research, and Practice*. 4th Ed edition. Edited by Edited by Glanz K, Rimer BK, Viswanath K. Jossey-Bass; 2008:68.
314. Eves F, Hoppea R, McLaren L: **Prediction of Specific Types of Physical Activity Using the Theory of Planned Behavior.** *J Appl Biobehav Res* 2003, 8:77-95.
315. Povey R, Conner M, Sparks P, James R, Shepherd R: **Application of the Theory of Planned Behaviour to two dietary behaviours: Roles of perceived control and self-efficacy.** *Br J Health Psychol* 2000, 5:121-139.
316. Blanchard CM, Fisher J, Sparling PB, Shanks TH, Nehl E, Rhodes RE, Courneya KS, Baker F: **Understanding Adherence to 5 Servings of Fruits and Vegetables per Day: A Theory of Planned Behavior Perspective.** *J Nutr Educ Behav* 2009, 41:3-10.
317. Hausenblas HA, Carron AV, Mack DE: **Application of the theories of reasoned action and planned behavior to exercise behavior: A meta analysis.** *J Sport Exerc Psychol* 1997, 19:36-51.
318. Downs DS, Hausenblas HA: **Elicitation studies and the theory of planned behavior: a systematic review of exercise beliefs.** *Psychol Sport Exerc* 2005, 6:1-31.
319. Hagger M, Chatzisarantis N, Biddle S: **A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: predictive validity and the contribution of additional variables.** *Journal of Sport & Exercise Psychology* 2002,3-32.
320. Symons D, Hausenblas H: *Applying the theories of reasoned action and planned behavior to exercise: a meta-analytic update. Paper presented at the Association for the Advancement of Applied Sport Psychology.* Orlando, Florida; 2001.
321. Taylor D, Bury M, Campling N, Carter S, Garfied S, Newbould J, Rennie T: *A Review of the use of the Health Belief Model (HBM), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Trans-Theoretical Model (TTM) to study and predict health related behaviour change.* 2006.
322. Hardeman W, Johnston M, Johnston DW, Bonetti D, Wareham NJ, Kinmonth AL: **Application of the Theory of Planned Behaviour in Behaviour Change Interventions: A Systematic Review.** *Psychol Health* 2002, 17:123-158.
323. The Official Statistics Website of Guangzhou: *A brief introduction to Guangzhou.* 2009.
324. The people's government of Jinchengjia district: *The People and their lives and traditions.* 2011.
325. The people's government of Jinchengjia district: *Jinchengjiang district's geography.* 2011.
326. The people's government of Jinchengjiang district: *2009 report on the economic and social developments in Jinchengjiang district, Hechi.* 2010.
327. Guangzhou Education Bureau. **Education Status in Guangzhou.** 2011. Guangzhou, Guangzhou Education Bureau.

328. Jinchengjiang Education Bureau. **Jinchengjiang education overview**. 2011. Hechi, Hechi City Government.
329. Ministry of Health of The People's Republic of China. **National School Health and Hygiene Principles**. 1990. Beijing, Ministry of Health of The People's Republic of China.
330. Ministry of Education of People's Republic of China. **National Guiding Principles for Health and Hygiene Education in primary, middle and high schools**. 2008. Beijing, Ministry of Education of People's Republic of China.
331. Ministry of Education of People's Republic of China. **Ensuring the implementation of the national policy of One-Hour Physical Activity On Campus Daily in primary and middle schools**. 2011. Beijing, Ministry of Education of People's Republic of China.
332. Ministry of Education of People's Republic of China. **Standards for Moral and Life Curriculum in primary schools**. 2003. Beijing, Ministry of Education of People's Republic of China.
333. Kitzinger J. **Qualitative research. Introducing focus groups**. *BMJ* 311(7000), 299-302. 1995.
334. Doolen J, Alpert PT, Miller SK: **Parental disconnect between perceived and actual weight status of children: a metanalysis of the current research**. *J Am Acad Nurse Pract* 2009, 21:160-166.
335. Jimenez-Cruz A, Bacardi-Gascon M, Castillo-Ruiz O, Mandujano-Trujillo Z, Pichardo-Osuna A: **Low Income, Mexican Mothers' Perception of Their Infants' Weight Status and Beliefs About Their Foods and Physical Activity**. *Child Psychiatry & Human Development* 2010, 41:490-500.
336. Omar MA, Coleman G, Sharon H: **Healthy Eating for Rural Low-Income Toddlers: Caregivers' Perceptions**. *J Community Health Nurs* 2001, 18:93-106.
337. Monge-Rojas R, Garita C, Sanchez M, Munoz L: **Barriers to and Motivators for Healthful Eating as Perceived by Rural and Urban Costa Rican Adolescents**. *J Nutr Educ Behav* 2001, 37:33-40.
338. Landsberg B, Plachta-Danielzik S, Much D, Johannsen M, Lange D, Mueller M: **Associations between active commuting to school, fat mass and lifestyle factors in adolescents: the Kiel Obesity Prevention Study (KOPS)**. *Eur J Clin Nutr* 2008, 62:739-747.
339. Cooper AR, Andersen LB, Wedderkopp N, et al: **Physical activity levels of children who walk, cycle or are driven to school**. *Am J Prev Med* 2005, 29:179-184.
340. US Centers for Disease Control and Prevention: *Kids Walk-to-School: Then and now-barriers and solutions*. 2010.
341. Babey SH, Hastert TA, Yu H, et al: **Physical activity among adolescents. When do parks matter?** *Am J Prev Med* 2008, 34:345-348.
342. 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 Relat Metab Disord* 2003, 27:1093-1099.

343. Zhang J, Middlestadt S, Ji CY: **Psychosocial factors underlying physical activity.** *Int J Behav Nutr Phys Act* 2007, 4:38.
344. Zhang J, Seo DC, Kolbe L, Middlestadt S, Zhao WH: **Associated Trends in Sedentary Behavior and BMI Among Chinese School Children and Adolescents in Seven Diverse Chinese Provinces.** *Int J Behav Med* 2011,1-9.
345. Shi ZM, Lien N, Kumar BN, Holmboe-Ottesen G: **Physical activity and associated socio-demographic factors among school adolescents in Jiangsu Province, China.** *Prev Med* 2006, 43:218-221.
346. Cheng Tsung O: **Price of Modernization of China.** *Circulation* 2001, 103:e131.
347. BeLue R, Francis LA, Rollins B, Colaco B: **One Size Does Not Fit All: Identifying Risk Profiles for Overweight in Adolescent Population Subsets.** *J Adolesc Health* 2009, 45:517-524.
348. Wen M, Kandula N, Lauderdale D: **Walking for Transportation or Leisure: What Difference Does the Neighborhood Make?** *J Gen Intern Med* 2007, 22:1674-1680.
349. Beets MW, Foley JT: **Association of father involvement and neighborhood quality with kindergartners' physical activity: a multilevel structural equation model.** *Am J Health Promot* 2008, 22:195-203.
350. Jiang Jing Xiong, Xia Xiu Lan, Cui Shao Zhen, Song Qing Su, Yuan Quan Lian: **Influence of grandparents on eating behaviors of young children in Chinese three-generation families.** *Chinese Journal of Child Health Care* 2006, 14:46-48.
351. Thomas J, Sutcliffe K, Harden A, Oakley A, Oliver S, Rees R, Brunton G, Kavanagh J: *Children and Healthy Eating: A systematic review of barriers and facilitators.* London, EPPI-Centre, Social Science Research Unit, Institute of Education, University of London; 2003.
352. Tucker P, Irwin JD, Sangster Bouck LM, He M, Pollett G: **Preventing paediatric obesity; recommendations from a community-based qualitative investigation.** *Obesity Reviews* 2006, 7:251-260.
353. Rees R, Harden A, Shepherd J, Brunton G, Oliver S, Oakley A: *Young People and Physical Activity: A systematic review of research on barriers and facilitators.* London; 2001.
354. Bellows L, Anderson J, Gould SM, Auld G: **Formative Research and Strategic Development of a Physical Activity Component to a Social Marketing Campaign for Obesity Prevention in Preschoolers.** *J Community Health* 2008, 33:169-178.
355. Burroughs E., Peck L.E., Sharpe P.A., Granner M.L., Bryant C.A., Fields R.: **Using Focus Groups in the Consumer Research Phase of a Social Marketing Program to Promote Moderate-Intensity Physical Activity and Walking Trail Use in Sumter County, South Carolina.** *Preventive Chronic Disease* 2006, 3.
356. Van Duyn M, McCrae T, Wingrove B, Maibach E: **Adapting Evidence-Based Strategies to Increase Physical Activity Among African Americans, Hispanics, Hmong, and Native Hawaiians: A Social Marketing Approach.** *Prev Chronic Dis* 2007, 4.
357. Findholt NE, Michael YL, Jerofke LJ, Brogoitti VW: **Environmental Influences on Children's Physical Activity and Eating Habits in a Rural Oregon County.** *Am J*

Health Promot 2011, 26:e74-e85.

358. Henley N, Ganeshasundaram R, Nosaka K. **Promoting physical activity with 'response efficacy' strategies: Convincing people that being physically active will have specific, beneficial effects on their health.** *Report to Faculty of Business & Law, Centre for Applied Social Marketing Research, Edith Cowan University, Perth.* 2007. Centre for Applied Social Marketing Research, Edith Cowan University, Perth.
359. Dai GL. **Problems in current Quality Education and improving solutions.** *Examination Weekly* (11). 2008.
360. Gao QG. **The problems in and recommendations for the implementation of Quality Education in China.** *Journal of Zhengzhou Economics and Management College* (1). 2007.
361. Yan GC. **Quality Education: Seeking, Dilemma and Outlet.** *Exploration and Free Views* (2). 2007.
362. Xiao YJ, Li CL. **An analysis of the causes of the distortion in the implementation of burden-reduction policy in primary and high schools.** *Journal of Zhejiang Education Institute* (6). 2007.
363. Stone EJ, McKenzie TL, Welk GJ, Booth ML: **Effects of physical activity interventions in youth: Review and synthesis.** *Am J Prev Med* 1998, 15:298-315.
364. Lin R, Du L, Liu WJ, Lin L, Wu JG, Liu W, Zhang WW, Jing J: **Influencing factors of overweight and obesity among children in Guangzhou urban district.** *Chinese Journal of Child Health Care* 2011, 19:409-411.
365. Ji CY, Cheng TO: **Prevalence and geographic distribution of childhood obesity in China in 2005.** *Int J Cardiol* 2008, 131:1-8.
366. Adair LS, Popkin BM: **Are child eating patterns being transformed globally.** *Obesity Reviews* 2005,13-17.
367. Zhai FY, Ge KY, Jin SG: **Summary report of China Health and Nutrition Survey.** *Journal of Hygiene Research* 1996, 22:16-25.
368. Yu D, Zhang B, Zhao L: **Snacks consumption in Chinese children and adolescents at the ages of 3-17 years.** *Chinese Journal of Healthcare Research* 2008, 37:710-713.
369. Waller CE, Du S, Popkin BM: **Patterns of overweight, inactivity, and snacking in Chinese children.** *Obes Res* 2003, 11:957-961.
370. Fulkerson JA, Farbakhsh K, Lytle L, Hearst MO, Dengel DR, Pasch KE, Kubik MY: **Away-from-Home Family Dinner Sources and Associations with Weight Status, Body Composition, and Related Biomarkers of Chronic Disease among Adolescents and Their Parents.** *J Am Diet Assoc* 2011, 111:1892-1897.
371. Taveras EM, Rifas-Shiman SL, Berkey CS, Rockett HR, Field AE, Frazier AL, Colditz GA, Gillman MW: **Family dinner and adolescent overweight.** *Obes Res* 2005, 13:900-906.
372. Schmitz KH, Lytle LA, Phillips GA, Murray DM, Birnbaum AS, Kubik MY: **Psychosocial Correlates of Physical Activity and Sedentary Leisure Habits in Young**

- Adolescents: The Teens Eating for Energy and Nutrition at School Study.** *Prev Med* 2002, 34:266-278.
373. Gillander Gadin K, Hammarstrom A: **Can school-related factors predict future health behaviour among young adolescents?** *Public Health* 2002, 116:22-29.
374. Dunton GF, Kaplan J, Wolch J, Jerrett M, Reynolds KD: **Physical environmental correlates of childhood obesity: a systematic review.** *Obes Rev* 2009, 10:393-402.
375. Ferreira I, Van Der Horst K, Wendel-Vos W, Kremers S, Van Lenthe FJ, Brug J: **Environmental correlates of physical activity in youth - a review and update.** *Obes Rev* 2007, 8:129-154.
376. Cerin E, Saelens BE, Sallis JF, Frank LD: **Neighborhood Environment Walkability Scale: validity and development of a short form.** *Med Sci Sports Exerc* 2006, 38:1682-1691.
377. Leslie E, Saelens B, Frank L, Owen N, Bauman A, Coffee N, Hugo G: **Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study.** *Health & Place* 2005, 11:227-236.
378. Gibson RS: *Principles of nutritional assessment.* Oxford University Press; 2005.
379. Sirard JR, Pate RR: **Physical Activity Assessment in Children and Adolescents.** *Sports Med* 2001, 31.
380. Rowlands AV: **Accelerometer Assessment of Physical Activity in Children: An Update.** *Pediatric Exercise Science* 2007, 19:252-266.
381. Bjornson KF, Belza B: **Ambulatory activity monitoring in youth: state of the science.** *Pediatr Phys Ther* 2004, 16:82-89.
382. De Vries SI, Van Hirtum HW, Bakker I, Hopman-Rock M, Hirasig RA, Van Mechelen W: **Validity and reproducibility of motion sensors in youth: a systematic update.** *Med Sci Sports Exerc* 2009, 41:818-827.
383. Janz KF, Witt J, Mahoney LT: **The stability of children's physical activity as measured by accelerometry and self-report.** *Med Sci Sports Exerc* 1995, 27:1326-1332.
384. Armstrong N, Welsman JR: **The Physical Activity Patterns of European Youth with Reference to Methods of Assessment.** *Sports Med* 2006, 36.
385. Bryant MJ, Lucove JC, Evenson KR, Marshall S: **Measurement of television viewing in children and adolescents: a systematic review.** *Obesity Reviews* 2007, 8:197-209.
386. Welk GJ, Corbin CB, Dale D: **Measurement issues in the assessment of physical activity in children.** *Res Q Exerc Sport* 2000, 71:S59-S73.
387. Trost SG, McIver KL, Pate RR: **Conducting accelerometer-based activity assessments in field-based research.** *Med Sci Sports Exerc* 2005, 37:S531-S543.
388. Crocker PR, Bailey DA, Faulkner RA, Kowalski KC, McGrath R: **Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children.** *Med Sci Sports Exerc* 1997, 29:1344-1349.

389. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, O'Brien WL, Bassett DR Jr, Schmitz KH, Emplaincourt PO et al.: **Compendium of physical activities: an update of activity codes and MET intensities.** *Med Sci Sports Exerc* 2000, 32:S498-S504.
390. Lu.B, Zhan F, Jin S, Popkin BM: **The impact of maternal education on the dietary and nutritional status of preschool children--a case study in 8 provinces of China.** *Hygiene Research* 1998, 27:328-331.
391. World Health Organisation: *Growth reference data for 5-19 years (WHO Reference 2007).* Geneva; 2007.
392. World Health Organisation: *Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee.* 1995.
393. World Health Organisation: *Training Course on Child Growth Assessment.* Geneva, WHO; 2008.
394. Snijders T, Boskers R: *Multilevel Analysis: An introduction to basic and advanced multilevel modeling.* Thousand Oaks, CA: Sage Publications Inc; 1999.
395. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, 51:1173-1182.
396. Cerin E, Macfarlane DJ, Ko HH, Chan KC: **Measuring perceived neighbourhood walkability in Hong Kong.** *Cities* 2007, 24:209-217.
397. Burrows TL, Martin RJ, Collins CE: **A Systematic Review of the Validity of Dietary Assessment Methods in Children when Compared with the Method of Doubly Labeled Water.** *J Am Diet Assoc* 2010, 110:1501-1510.
398. Buzzard M: **24-Hour dietary recall and food record methods.** In *Nutritional Epidemiology.* Edited by Edited by Willett W. New York: Oxford University Press; 1998:50-73.
399. Heitmann BL, Lissner L, Osler M: **Do we eat less fat, or just report so?** *Int J Obes Relat Metab Disord* 2000, 24:435-442.
400. Jiang JX, Xia XL, Cui SZ, Song QS, Yuan QL: **Influence of grandparents on eating behaviors of young children in Chinese three-generation families.** *Chinese Journal of Child Health Care* 2006, 14:46-48.
401. Swinburn BA, Caterson I, Seidell JC, James WPT: **Diet, nutrition and the prevention of excess weight gain and obesity.** *Public Health Nutrition* 2004, 7:123-146.
402. Phillips SM, Bandini LG, Naumova EN, Cyr H, Colclough S, Dietz WH, Must A: **Energy-Dense Snack Food Intake in Adolescence: Longitudinal Relationship to Weight and Fatness.** *Obesity* 2004, 12:461-472.
403. te Velde SJ, van Nassau F, Uijtdewilligen L, van Stralen MM, Cardon G, De Craemer M, Manios Y, Brug J, Chinapaw MJM, ToyBox-study group: **Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies.** *Obesity Reviews* 2012, 13:56-74.
404. Deforche B, De Bourdeaudhuij I, D'hondt E, Cardon G: **Objectively measured physical activity, physical activity related personality and body mass index in 6-**

- to 10-yr-old children: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity* 2009, 6:25.**
405. Li L, Li K, Ushijima H: **Moderate vigorous physical activity and body fatness in Chinese urban school children. *Pediatr Int* 2007, 49:280-285.**
 406. Xu F, Li JQ, Ware RS, Owen N: **Associations of television viewing time with excess body weight among urban and rural high-school students in regional mainland China. *Public Health Nutr* 2008, 11:891-896.**
 407. Dubois L, Farmer A, Girard M, Peterson K: **Social factors and television use during meals and snacks is associated with higher BMI among pre-school children. *Public Health Nutr* 2008, 11:1267-1279.**
 408. Hesketh K, Wake M, Graham M, Waters E: **Stability of television viewing and electronic game/computer use in a prospective cohort study of Australian children: relationship with body mass index. *Int J Behav Nutr Phys Act* 2007, 4:60.**
 409. Fulkerson JA, Kubik MY, Story M, Lytle L, Arcan C: **Are There Nutritional and Other Benefits Associated with Family Meals Among At-Risk Youth? *J Adolesc Health* 2009, 45:389-395.**
 410. Gable S, Chang Y, Krull JL: **Television Watching and Frequency of Family Meals Are Predictive of Overweight Onset and Persistence in a National Sample of School-Aged Children. *J Am Diet Assoc* 2007, 107:53-61.**
 411. Sen B: **Frequency of Family Dinner and Adolescent Body Weight Status: Evidence from the National Longitudinal Survey of Youth, 1997. *Obesity* 2006, 14:2266-2276.**
 412. Skidmore P, Welch A, van Sluijs E, Jones A, Harvey I, Harrison F, Griffin S, Cassidy A: **Impact of neighbourhood food environment on food consumption in children aged 9-10 years in the UK SPEEDY study. *Public Health Nutr* 2010, 13:1022-1030.**
 413. Timperio A, Ball K, Roberts R, Campbell K, Andrianopoulos N, Crawford D: **Children's fruit and vegetable intake: Associations with the neighbourhood food environment. *Prev Med* 2008, 46:331-335.**
 414. Jennings A, Welch A, Jones AP, Harrison F, Bentham G, van Sluijs EMF, Griffin SJ, Cassidy A: **Local Food Outlets, Weight Status, and Dietary Intake: Associations in Children Aged 9-10 Years. *Am J Prev Med* 2011, 40:405-410.**