The epidemiology and prevention of childhood obesity in Tehran, Iran

By

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Abstract

Introduction

The relationship between childhood obesity and later chronic diseases is evident. In Iran, whilst childhood obesity is a recognised increasing public health problem, no evidence for effective prevention strategies are available.

Aim and objectives

The aim was to inform the development of an obesity prevention intervention for Iranian school children, which could be later tested as part of a randomised controlled trial.

Objective included:

- To develop and validate a semi-quantitative food ticklist to estimate energy intake in children.
- To examine the pattern, and factors associated with obesity in school children.
- To explore contextual influences on childhood obesity and to gain insights on barriers and facilitators that would help tailor the intervention.
- To identify and prioritise potential intervention components to help children maintain a healthy weight.

Methods

A dietary assessment tool was developed and compared with a 24-h semi-weighed food diary. For the second objective, a cross-sectional study of Tehrani school children (n=319) aged 6-8 yrs from a range of socio-economic backgrounds was undertaken. Participants underwent anthropometric and blood pressure measures, completed validated questionnaires to assess their body image perception and quality of life, and their parents completed questionnaires related to socio-demographic, diet and physical activity habits. For the remaining objectives, a series of focus groups and interviews were undertaken with parents and school staff.

Results

There was good agreement in estimated energy intake between the food ticklist and more resource intensive 24-h food diary. Overall 28.2% of the study children were overweight or obese, with those from higher socio-economic areas being at greater risk. Body Mass Index and other measures of body fat were highly positively correlated with blood pressure. There was a tendency for increasing energy intake with higher weight status, although this was not statistically significant. There was generally accurate body size perception. Quality of life scores were generally similar by weight status.

Focus group participants identified a range of obesity risk factors related to diet and physical activity at the micro and macro levels. In terms of interventions, the importance of macro level educational activities, and better provision of physical activity at school were highlighted. The importance of cooperation between schools and families and the substantial contribution of the government in providing a supportive environment were emphasised.

Conclusion

The study confirms that childhood obesity is an important health problem in Tehran and highlighted socio-economic variations in prevalence, which will inform the targeting of prevention interventions. Important contextual information was obtained

to inform the development of a prevention intervention. The feasibility and acceptability of applying a range of physical and psychological outcome measures in a population setting was also demonstrated. These could be used for a future population based trial of childhood obesity prevention.

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Abbreviations

BMI	Body Mass Index
CDC	Centres for Disease Control
CT	Controlled Trials
DLW	Doubly Labelled Water
DXA	Dual Energy X-ray Absorptiometry
FFQ	Food Frequency Questionnaire
FG	Focus group
IOTF	International Obesity Taskforce
MVPA	Moderate to vigorous physical activity
OB	Obese
OW	Overweight
PA	Physical Activity
PE	Physical Education
RCT	Randomised Controlled Trials
RT	Randomised Trials
SES	Socio-economic status
WHO	World Health Organization

Overview

This thesis relates to childhood obesity prevention, and presents the first steps for the development of an appropriate intervention for school aged children in Iran. The fieldwork was undertaken in Tehran, Iran, and chapters 2-4 relate to different aspects of this work, within the context of intervention development. Chapter 1 sets the scene and rationale for the study, and the final chapter draws together how the thesis can contribute to the overall aim. A brief overweiw of each chapter is given below.

Chapter 1

This chapter provides an overview of the epidemiology of obesity, focusing on a review of the literatue related to the prevention of childhood obesity and methods of assessment of dietary intake, physical activity, and obesity in children.

Chapter 2

This chapter outlines the development and validation of a food ticklist which was later used to assess dietary intake in children in the main study.

Chapter 3

This chapter relates to the results of a cross-sectional study of a random sample of primary school children drawn from 3 socioeconomically distinct regions of Tehran. The chapter serves a dual purpose; first to describes the prevalence and correlates of childhood obesity in the city, and secondly to test the feasibility of undertaking a range of measures among free living children. These measures (anthropometric measures, blood pressure, energy intake, physical activity, and psychological measures) are the potential outcome measures for a future randomised controlled trial of obesity prevention.

Chapter 4

This chapter presents the results of qualitative studies undertaken with parents and teachers of primary school children. The aim of the focus groups and interviews was to identify participants' views on the causes of childhood obesity, perceptions on important and feasible activities to help children maintain a healthy weight, and potential barriers to implementation and sustainability of any intervention prgramme. These findings provide important contextual information for intervention development.

Chapter 5

The final chapter reviews the overall findings and discusses the implications within the context of Iran. Recommendations for further research are discused.

1 Introduction

1.1 Tehran city

1.1.1 Population

Tehran city, located at the foot of the Alborz Mountain, is the capital and largest city of Iran (Figure 1.1) with a population of 7,705,036, according to the latest official census in 2006 [1] comprising 11% of the total population of Iran [2]. The population has approximately doubled twice over the last 40 years and the current yearly population growth is 1.6% [2]. Children (6-10 yr) consist of 8% of the total population [2] and the population structure is very young with a large cohort of 15-19 and 20-24 yr olds. Based on this, the country is expected to face a "baby boom" which is likely to last for about ten years. There is therefore a critical need to target children's health.

The official language of Iran is Persian and the population is classified as one of the 16 branches of the Aryan race [1]. However substantial immigration to Tehran, both from within and outside the country over the past thirty years, mainly by those seeking better living standards subsequent to the Iran-Iraq war in 1980s and Afghanistan civil war in 1990s, has changed the population distribution towards a more multi-ethnic-culture [3]. Modern day Tehran is therefore a cosmopolitan city housing an ethnically and linguistically diverse group of people [3].

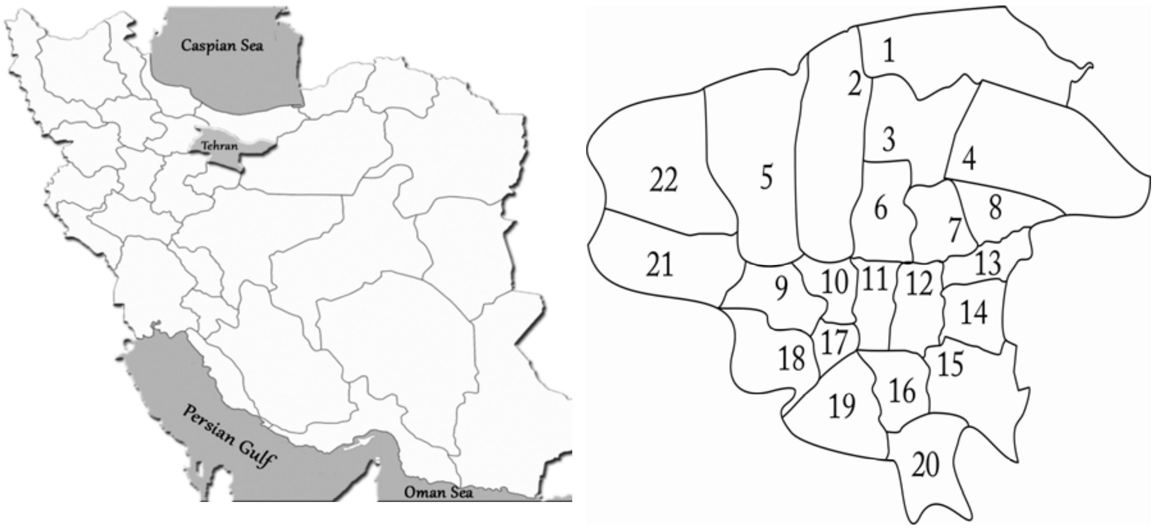

Figure 1.1 Maps of Iran/ Tehran

1.1.2 Climate

Tehran's climate is hot and dry in the summer and moderate to cold in winter, although the northern parts are milder in the summer and colder in winter. Average humidity is about 40% and in the cold seasons Tehran is affected by high-pressure Siberian systems which results in cold, dry, and polluted winters. During the warm months, low pressure systems from the central desert create dry and warm weather. The highest recorded temperature is +43°C and the lowest -15°C during the last 45 years [1]. The polluted and inhospitable weather in almost half of the year prevent people from attending outdoor activities.

1.1.3 Socio-economic and nutritional status

During the past 30 years, after the Islamic revolution in 1979, social gain including improvement in infrastructure (roads, electricity, and safe water) has been made [4] and health indices including coverage of vaccination, life expectancy, infant and under 5 yr mortality rate have improved remarkably [5]. Literacy has also increased, but mainly because of the eight-year war with Iraq, the downturn in oil price, and trade sanctions, there has been poor economic growth over the last two decades which has left Iran as a lower middle-income country despite some economic recovery [4]. Annual inflation over the last 20 years has been tremendously high, especially for food. This, combined with the characteristics of the Iranian diet which tends to be energy dense, and further subsidies for energy dense foods (bread, wheat flour, and sugar) has meant that these foods predominate and are more available [4]. Moreover, social inequity such that families in the highest decile of per capita income have 15-20 times the income of those in the lower decile, has aggravated the situation. These factors have resulted in a considerable imbalance in dietary intake which is characterised by over-consumption at higher income levels and low nutrient density in the whole population [4]. In 2008, only one quarter of Tehrani households consumed the recommended energy intake (90-110% of recommended), while 15% and 26% of households consumed less than 70% and 70-90% of recommended intake [6]. Another feature of social inequity is the double burden of disease as shown by the existence of under- and over-nutrition in a range of sub-populations [4;7].

1.1.4 Geopolitical factor

On the other hand the Muslim theocratic government in Iran has put restrictions on social relations and the way people should behave and women should dress. The regulations have exerted dramatic impact on social life leading to eating as almost the only way of socialising and limited occasions for other activities.

1.2 Epidemiology of obesity

1.2.1 Worldwide prevalence and trends of obesity

Obesity has been identified as a public health problem globally [8] and is continuing to increase. In 2005, at least 1.1 billion adults were overweight [9]. During the past 40 years, the prevalence of obesity has increased about 20% in adult populations in the US, such that about one third of the population were obese in 2003 [10;11]. The prevalence of obesity has also trebled in the last 30 years in the UK in a way that about 25% of the population were obese in 2008 [8;11]. Similar prevalence and trends of obesity are seen in other developed countries, including Australia and Canada, which seem to be about a decade behind the trends experienced in the US [8;11]. Trend data for European countries shows that regardless of prevalence, a continuing population shift upwards from the healthy range of body mass index is apparent [12]. Among selected countries from the Eastern Mediterranean Region, including Lebanon, Cyprus and United Arab Emirates, the prevalence rates are comparable to the US regardless of the trend [8]. It should be also noted that despite an accelerating trend, in some countries including Ghana, Mali, China, and Japan, the current situation would not include obesity on the list of public health problems [11]. The definition of obesity, and the cut-offs used differ widely, accounting partly for variation in obesity rates from different studies. However the international data referred to in this paragraph are all based on WHO recommended cut-offs for adulthood obesity [8] which enable international comparisons.

1.2.2 Prevalence of overweight and obesity in Iran

Overweight and obesity has been recently recognised as a public health problem of considerable significance in a range of sub-populations in Iran [13]. Findings of the latest Iranian National Household Food Consumption and Nutritional Status Survey showed that 32.4% of the adult population were overweight and 10% and 24.1% of Iranian men and women were obese, respectively [14]. The survey, which includes a random representative sample of Iranian households, has been periodically carried out since 1980. The latest survey was conducted during 2001-2003 in all 28 provinces of Iran at urban and rural levels. Trained nutritionists complete a questionnaire on household food and beverage consumption, and household food security, and trained nutritionists undertake anthropometric measurements of all household members, using standard protocols, from which BMI can be calculated. All measures are quality controlled by local and provincial superintendents. Whilst this survey is considered to provide a valid estimate of weight status at national and provincial level, the figures for Tehran province may be less representative. Measures were from Tehran city, whereas the province has great diversity among its 13 districts, 55 cities, and 80 villages [15]. Findings of a longitudinal study in one of the 22 districts of Tehran, revealed that obesity increased by 7.6% in men and by 4.3% in women over a four year period [16], such that about 40% and 20% of adult men and women were obese in 2002. Although these trends relate to Tehran city, they are not likely to be generalised to Tehran province, where the trend is likely to be attenuated. The prevalence of overweight in 2003, using similar definitions (BMI: 25-29.9 kg/m^2), was comparable in the US and Iranian adults (34.1% and 32.4% respectively) [11;14]. The prevalence of obesity among Iranian women is comparable to that reported for women in the UK, Canada, and Australia. The prevalence of obesity was reported between 22.2 to 25.2% [11].

1.2.3 Socio-economic and ethnic risk factors for obesity

The above section demonstrates that almost all regions and countries have been experiencing an increasing burden of overweight and obesity during the past three decades. Whilst the epidemic is worst in the US, many developing countries including Iran show similarities in either trend or prevalence of overweight and obesity, making this a public health priority. Moreover, the burden of obesity is shifting towards the poor [17] and changes are occurring at greater speed and at earlier stages of economic and social development in developing countries.

Within countries, prevalence and trends in obesity differ among ethnic and SES sub-groups. For example, in the US, there are considerable differences between non-Hispanic white, non-Hispanic black, and the Mexican American population, with higher levels of obesity in black (45%) followed by Mexican (36.8%) and non-Hispanic (30%) populations [10]. Findings of surveys from a range of western countries has shown that people from lower socio-economic groups are at greater risk of obesity [18]. In the UK, health survey data suggested higher obesity rates among adults with fewer years of education and lower level of SES [19;20]. Moreover, in the US, a strong inverse association between SES and obesity has been documented for female adults [21]. Data from Tehran also shows that after adjustment for age, higher educational level (>12 vs ≤12 yr of education) is negatively associated with BMI among women [22].

Among children there are also some ethnic and socio-economic differences in obesity prevalence. In the US, Mexican American and non-Hispanic black children are at higher risk of being overweight than white children [23]. There is an inverse relationship between SES and childhood adiposity in a range of European countries [24]. Studies from the UK showed that children from a lower social class were at higher risk of developing obesity and have not benefited from the recent stabilised trend of obesity [25;26]. Higher level of overweight and/or obesity has been reported in Afro-Caribbean and Pakistani girls and Indian and Pakistani boys than British children from other ethnic backgrounds [27].

1.2.4 Global prevalence of childhood obesity

Evidence of an alarming increase in childhood obesity in developed countries has been followed by reports of considerable occurrence of obesity in the developing world [28-31] with at least 155 million overweight or obese children worldwide [9]. A range of normal reference values, cut-offs, and indicators are available to define childhood overweight and obesity, which has made within and between population comparisons quite challenging. Nevertheless, all data suggest an increasing trend in most populations.

In 2003 the prevalence of obese children aged 6 to 11 years in the US was estimated to have more than doubled since the 1960s [32]. Analysis of NHANES (the National Health and Nutrition Examination Survey) data over 20 years has indicated that the prevalence of childhood obesity in the US increased steadily since 1988 and reached 16.3% in 2003-2006 [33;34]. Applying the IOTF criteria for defining overweight, relevant data has been collected from a range of countries [35]. These show that the prevalence of childhood overweight and obesity varies widely across countries, ranging from a low of around 6% for parts of the WHO African Region (excluding South Africa and Seychelles) [35] to prevalence of 35% in the US. For most countries, including England, Canada, Cyprus, Australia, and UAE, at least 25% of children have been identified as overweight or obese [35]. Prevalence rates might not be completely comparable because of differences in age range, year of survey, and study population. However it seems that the pattern of overweight and obesity in children is similar to that observed in adults [35].

Racial/ethnic differences in prevalence and trend of childhood obesity over four time periods from 1999 to 2006 has been found among US children [33]. In UK, higher level of obesity among low social classes and a range of minorities including South Asian population, and in Scotland and Wales was reported [36].

1.2.5 Prevalence of childhood overweight and obesity in Iran

Childhood and adolescent overweight and obesity in Iran has recently been recognised as a public health issue [37-39]. The National Household Food Consumption and Nutritional Status Survey in 2003 revealed that 16.3% of 5-10 yr children in Tehran province were classified as obese, which is 2.5 fold greater than the national average (6.5%) [14] (Figure 1.2).

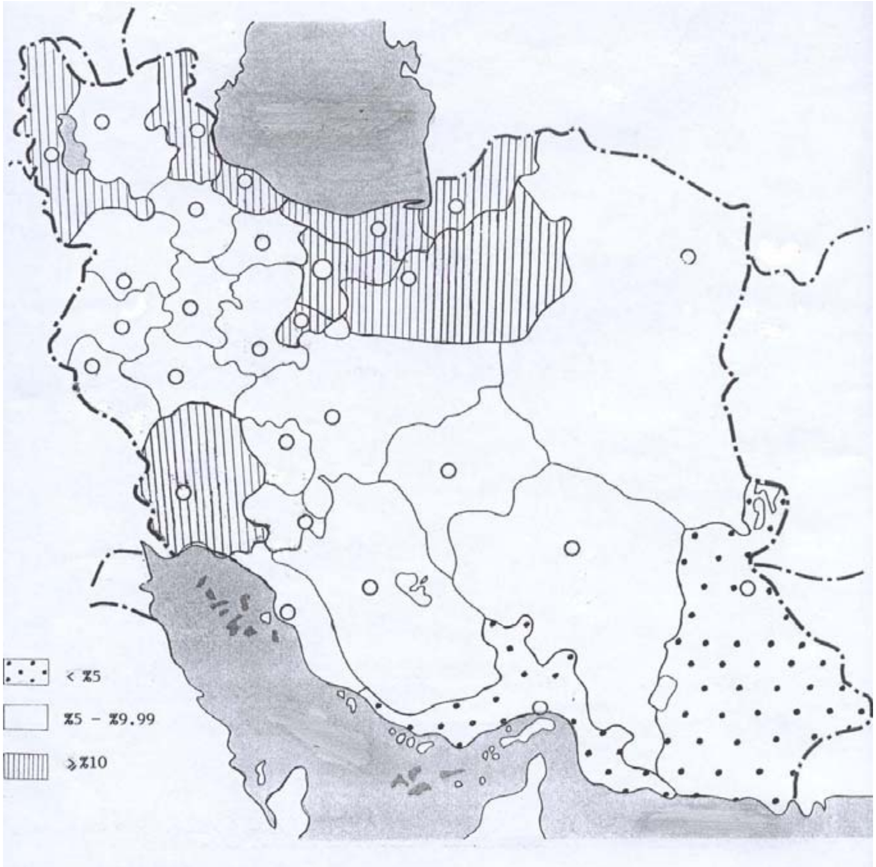

Figure 1.2 Geographical distribution of overweight prevalence among 5-19 yr children in Iran, 2003[1]

This finding is similar to those from a range of studies completed over a four year period, applying similar references and cut-offs to define overweight. For example, two studies using similar methodology among 11-16 yr school children in Tehran and Urmia (city in north-west Iran) in 2001, showed the prevalence of overweight among boys and girls was considerably higher in Tehran (18.8% and 23.1%) compared with Urmia (13.6% and 14.4%) [37;40]. Findings of a cross-sectional study in Tehran city revealed that the prevalence of overweight among high school girls differed by 11.5% between two districts of Tehran, with a lower prevalence in the more affluent area (15.2%) [41]. These findings conform with those from Habicht in 1974, who showed

[1] Adopted from Mohammadpour-Ahranjani B, Rashidi A, Karandish M, Vafa MR. Magnitude and possible contributors of childhood obesity in Iran: Implications for action . In: Flamenbaum R, editor. Global dimensions of childhood obesity. 1st ed. 2006. p. 101-30.

that the differences between height and weight of well nourished preschool children from different ethnic backgrounds are relatively small in comparison with the difference observed between poor and privileged children from the same ethnic background [42].

1.2.6 Cost of obesity

Direct costs of treatment, intangible costs including the impact on overall health, and indirect costs including work-related absenteeism and premature death need to be considered in estimating the total cost of health conditions [8]. The economic cost of obesity in developed countries was estimated as 2-7% of total health care costs in the 1990s [8]. This conservative estimate related to the cost of obesity defined as of BMI>30 kg/m^2 and did not include all direct nor societal costs. The health burden of obesity has been estimated to be greater in transitional societies because of the high absolute number of people at risk, the large loss in life expectancy as non-communicable disease deaths occur at a younger age than in developed countries, and the societal role of those affected population who has key role in economic development [8].

1.2.7 Factors influencing the development of overweight and obesity

Obesity is a consequence of energy imbalance in favour of higher energy intake compared to energy expenditure [8]. The balance is basically maintained by food intake and level of PA which in turn is influenced by a range of factors including susceptibility of individuals to environmental and social influences.

Genetic factors contribute to the development of syndromatic obesity in a few children. Moreover, monogenetic disorders such as mutations in the leptin gene could rarely resulted in hyperphagia and obesity in early childhood. The close correlation in body weight between biological parents and their children in the absence of such a relationship between adopted children and their parents, might indicate the influential role of genetic factors on developing obesity [43]. However, the recent growing trend of obesity could not be explained by alteration in genetic profile of the population.

1.2.8 Potential contributors to overweight and obesity in Iran

1.2.8.1 Dietary factors

Rapid nutrition transition in Iran has been documented [4] suggesting significant socio-economic, demographic, and dietary changes towards a sedentary lifestyle and over-consumption dietary patterns including consumption of energy dense foods which are low in fibre, and high in sugar. In the early 2000s, over a third of Iranian households consumed more than 120% of their energy requirement, and fat and sugar provided 25% and 9% of total energy intake, respectively [14]. Furthermore, over a 10 year period, average energy intake in urban areas increased by 65 Kcal/day/capita [44]. These changes in dietary habit are therefore important contributors to obesity, especially among residents of big cities. Rapid and continuing expansion of fast food restaurants during the past decade also need to be included on the list of dietary and social related issues at community level.

1.2.8.2 Physical activity pattern

There is no systematic data to show changes in level of PA in the Iranian population; however, poor public transport systems and high reliance on private transport, investment in education which has resulted in fewer manual occupations, and higher level of access to computers are among contributing factors in limiting PA. Moreover, strict governmental regulations regarding dress code, especially for women, and segregated activity centres has resulted in limited out-door gathering which usually accompanied with food, but not PA [4].

1.2.8.3 Environmental and social contributors

The growing trend in obesity prevalence globally in recent years indicates that environmental factors are a leading contributor. Host related factors should be also taken into account in estimating the size of the environment-individual impact on obesity occurrence, but the rapid increase in obesity rates over past decades indicates that environmental transition has played the leading role.

The home environment has been influenced by changes at higher levels. An increase in the percentage of working women, full-day working fathers, and limited time for doing leisure activities as well as availability of unhealthy foods and heavy marketing of junk foods have all been implicated as contributors to undesirable patterns of food intake and PA, especially in children. Moreover, it has been suggested that children living in obesogenic environments may not perceive obesity as a serious problem, nor be able to participate in obesity prevention intervention programmes [45].

1.2.9 Consequences and morbidity associated with obesity

A range of associated health consequences of obesity in adults has been identified. Causal association between increasing obesity and increased risk of cardiovascular disease (risk ratios (RR)= 2-3) and some cancers (including endometrial and colon cancer) has been well documented in adults [46-49]. Other conditions including non-insulin dependent diabetes mellitus, dyslipidaemia, gallbladder disease, and insulin resistance are also strongly associated with obesity (RR>3). Overweight in children and adolescents is also associated with intermediate metabolic consequences and risk factors including increased blood pressure and impaired glucose tolerance [23]. Other health problems such as reproductive hormone abnormalities, and low back pain are also associated with obesity (RR= 1-2) [8]. Obesity also increases risk of all cause mortality [50].

The health effects of obesity confirm the urgent need to address childhood obesity and pursue preventive interventions [51-55]. Moreover, its relation with a wide range of preventable disorders in childhood and later years has resulted in considerable attention to manage childhood obesity. Childhood overweight and obesity are strong predictors of later coronary heart disease and also associated with adult obesity, increased blood pressure, hyperlipidemia, and type 2 diabetes [56-59]. There are also psychological consequences including diminished quality of life, decreased self-esteem in girls, and being subjected to teasing and discrimination [60-63]. There is evidence to suggest that overweight in childhood tracks into adulthood, although this is not universal, and not all obese children become obese adults [64;65]. However, the possibility of becoming obese adult is higher in children older than 8 yr, those who are more overweight even as young as 6 yr, and for those who have an obese parent [23]. The pattern of vascular dysfunction in overweight children has also been found to be similar to that seen in adults [66]. The rise in childhood obesity has been associated with an increase in a range of complications including metabolic syndrome, polycystic ovarian syndrome, and non-alcoholic fatty liver disease [67].

In the UK, modelling of trends in obesity over 50 years, has predicted that by 2050, 25% of all children could be obese [68]. Thus there is a huge potential for formulating appropriate plans for prevention of this year on year increase which could lead to health benefits during childhood and later stages in life.

1.3 Treatment of obesity in childhood

A range of weight management interventions including pharmacotherapy and surgery as well as behavioural, dietary, and PA programmes have been employed to prevent or reverse metabolic comorbidities, to reduce the risk of long-term complications, and to improve psychological function and quality of life [69]. Systematic reviews have shown inconsistency with regards to applied approaches. However very few interventions are successful, and longer term success has not been clearly demonstrated.

1.3.1 Surgical interventions

Limited evidence has been documented regarding surgical interventions in childhood [70;71]. Small case series have shown moderate to substantial weight loss in morbidly obese adolescents who underwent bariatric surgery. Some related health benefits including relief of sleep apnoea and asthma have been achieved [72]. Harmful consequences more than one year after surgery has been reported rarely, but short-term severe and minor complications were reported in 5% and 10-39% respectively [72]. Outcome of bariatric surgery among 9-21 yr old age group up to one year post surgery has shown sustained and clinically significant BMI reduction. Surgery also has been shown to resolve some medical conditions including diabetes and hypertension [73]. It is not possible to make reliable estimate mainly because of loss to follow-up and inadequate reporting of outcomes and complications; however, experts agree that surgical intervention is better to limit to treatment of morbid obesity in adolescents [23].

1.3.2 Pharmacotherapy

Drug treatment in children is more complex than in adults. Guidelines recommend treatment decisions should be made in consultation with parents, evaluating the child's metabolic status, response to behavioural therapy, family history, and considering potential adverse effects of medication [69] and only be used after behavioural therapy failure to success [23]. Pharmacotherapy is usually combined with lifestyle change interventions to limit rebound weight gain. Although there is no definitive guideline, expert opinion is that medication should be introduced when either complications (impaired glucose tolerance, hepatic steatosis, dyslipidaemia or severe menstrual dysfunction) develop, or the risk of comorbidities is very high, or the family history for a major comorbidity like type 2 diabetes is strong [69].

Small to moderate reductions in BMI (0.85-2.6 kg/m^2) has been reported where medication and behavioural therapy were combined in adolescents, but follow-up data is not available [74]. In a meta-analysis, effectiveness of short-term medication on BMI (0.7-2.4 kg/m^2 reduction) has been reported [75]. However, combined behavioural lifestyle interventions in adolescents also result in a reduction in overweight up to one year follow-up, with or without the addition of medications [70]. This suggests that the observed effect of pharmacotherapy may be attributed to lifestyle modifications rather than the medication.

1.3.3 Behavioural interventions

Behavioural interventions in schools or health care settings have been shown to improve weight and weight related comorbidities, the effect varying by treatment intensity and setting. Limited evidence suggests that the improvements could be maintained for one year [74].

Assessing the effectiveness of dietary interventions for weight loss in obese children and adolescents is difficult because of a lack of high-quality studies, heterogeneity of designs, treatment combinations, outcome measures, and follow-up [76]. In many cases, dietary interventions are part of a lifestyle intervention package, including PA and other behavioural modification as well. The effect of a minimum stay of 10 days at weight loss camps on childhood obesity has been the subject of a recent systematic review [77]. Interventions from 22 studies included controlled diet, activities, nutrition education, and behaviour therapy and/or education. Reduction in percent of overweight during the intervention was reported in all studies and follow-up evaluation was completed for half of the studies. In comparison with out-patient treatment, the included immersion programmes had lower attrition rate and they produced greater reductions (191% at post-treatment and 130% at follow-up) in percent prevalence of overweight. Including a cognitive-behavioural therapy component further improved the outcomes at follow-up (30% reduction in percent overweight vs. 9%).

In a recent review of lifestyle interventions, it has been shown that even relatively brief interventions in youth population could be effective in weight management and eating habits in a range of settings [78]. Inclusion of a family component and participation of parents have been identified as key factor in intervention success [78-80]. The evidence suggests that PA interventions reduce percent body fat and fat-free mass in overweight children and adolescents, but the effect on BMI is negligible [75].

Findings from the reviews suggest that combined behavioural lifestyle interventions could produce significant reductions in childhood and adolescence obesity in comparison with standard care or self-help interventions [70].

Atlantis et al. (2006) reviewed randomised trials with regards to efficacy of exercise for treating childhood and adolescence overweight. They found that most studies had limitations in design, but based on small number of short-term trials, moderate-to-high intensity aerobic exercise for 155-180 min/weeks is effective in body fat reduction; however, changes on body weight and central obesity has remained challenging [81].

1.4 Prevention of obesity

A range of interventions have been applied to help children maintain a healthy weight and to control childhood overweight and obesity worldwide. To summarise evidence from previous studies and to learn lessons for future intervention development, a search for relevant systematic reviews was conducted. The detailed search strategy and databases used are reported in appendix 1. A total of 191 reports were identified, of which 152 were discarded after review of title/abstract. After reviewing the abstracts, 21 papers fulfilled the search strategy and were reviewed further. Together, these reviews summarised the findings of 93 Randomised Controlled Trials and 115 other study types including 25 Controlled Trials and 16 Randomised Trials. Although all systematic reviews were from the last 10 years, the included studies within them were published from 1981 to 2009. The reviews each had a different focus, and the types of studies included, intervention types and outcome measures of interest varied. The reviews were classified broadly into three main categories including those focusing on food and diet (n=1), on PA (n=3), or on both (n=17). Table 1.1 shows the general characteristics of the systematic reviews included. A total of 13 reviews included only school based interventions. One study was not school based and the remainders included school and other settings.

1.4.1 Quality, validity, and generalisability of the studies

Quality of systematic reviews and included trials

All included studies were systematic including integrative reviews and meta-analysis, in that they addressed a focused clinical question, and had appropriate search strategies using relevant databases. Not all reviews reported on the quality of included studies. One of the reviews concluded that low quality primary studies are underpowered to detect changes in measures of overweight during intervention periods of less than one year [82]. However, a comprehensive review of prevention programmes [83] and a review of PA interventions suggested that positive effects on weight status were not associated with the quality of studies [59;83]. It is likely that selecting appropriate outcome measures, rather than the quality of the study contributes to the level of effectiveness.

Validity

To assess validity of findings, some details regarding methods of assessment, duration of intervention, intervention components, and time of completing measures needs to be considered. Quality assessment methods varied between studies. In general, the quality of included trials does not seem to be associated with intervention outcomes. Most of the included studies were RCTs. However, application of RCTs for assessing the effectiveness of lifestyle and behavioural interventions and efficacy of RCTs over non-randomised trials remains controversial [59;84]. One review has not recognised the type of included studies and it suffered from other flaws including a lack of quality assessment of included trials [85]. The methodological quality of included studies has not been adequately addressed in some reviews and quality assessment of included studies was inconsistent. Some reviews suggest that most studies have had methodological weaknesses regarding a range of characteristics including allocation concealment, blinding, loss to follow-up, study power, attrition, validity of measures, intention to treat protocol, treatment effect, generalisability, and statistical issues [82;86;87]. However, reviews which have not assigned a quality score to each study tend to assess the quality of included studies as good [59].

Generalisability

Almost all intervention studies which have met systematic review inclusion criteria have come from the US and Europe [59;82-86;88-91] and four systematic reviews included intervention studies from other countries including Chile, Israel, Greece, Australia, Singapore, and Thailand [92-95]; however, no comparison was performed to identify possible similarities. One review specifically targeted interventions from China [96]. In this review, the authors acknowledged that none of the included studies were of good quality. Out of 22 studies, nine, seven and six studies were rated as moderate, average, and poor quality. Moreover, ethical issues have not been considered in most of the studies such that none of the included trials reported that informed consent had been obtained [96]. One review included non-US school-based prevention programmes, but most of the original studies were completed in Europe, mainly the UK [91].

A range of interventions/activities tested in previous trials, including summer camps, dancing, and school lunch modifications could not be implemented in communities including Iran where schools do not serve lunch, dancing is forbidden, and summer camp activities are limited in comparison with what has been introduced in other trials. Moreover, the feasibility of completing long lasting interventions is lower in less developed countries that suffer from limited resources. Thus whilst the rationale for prevention activities may be the same in different communities, transferability between settings needs to consider the methods of conveying messages, delivery of activities, and the culture, infrastructure and facilities available when developing an intervention package.

Targeting specific segment of the population in favour of including motivated participants in CTs could also limit generalisability [87] as the level of acceptance and adherence could be different at population based interventions. Doak has suggested that effective interventions have a lower participation rate than non-effective interventions which might indicate that highly motivated participants respond better to interventions [94].

1.4.2 Global Findings

Almost all authors have agreed that there is insufficient evidence for any particular type of intervention being effective in childhood obesity prevention. Some types of intervention show promise, with evidence of short-term changes, or positive direction of effect for intermediary outcomes. Most of the reviews have commented on heterogeneity of existing studies, methodological shortcomings, inclusion of inappropriate outcome measures according to study aim, limited use of theoretical frameworks in intervention development, inadequate description about details of intervention, and little evidence in minority ethnic groups and in developing countries. A summary of outcomes of intervention programmes including physical, psychological, dietary, and PA changes have been presented in the following section. In general, the developmental stage of interventions has not been well described and whether and to what extent stakeholders were involved in designing interventions is unclear. Moreover, the reliability and validity of outcome measures with regards to interventional aims has not been perfectly captured, the main focus being on design and methodology of trials. Cost-effectiveness of prevention programmes has not been addressed which should be included in future studies to estimate genuine consequences of childhood obesity.

1.4.2.1 BMI and prevalence of overweight and obesity

Thirteen systematic reviews have reported weight related outcome measures including BMI changes and alterations in prevalence of overweight and obesity. Most of the included reviews have suggested that BMI could be improved through implementing prevention programmes [82-84;89;91-95;97]; however, the level of improvement varies between studies (effect sizes of 0.06 to 0.50 for effective interventions) [97] and some of the included trials have not shown statistically significant changes between intervention and control groups. Nevertheless, it has been suggested that average effect size of r= 0.04 for intervention studies including non-effective trials is comparable to effect size for other public health interventions including smoking, substance abuse, and eating disorders [97].

Three of the included reviews [59;86;90] have reported no changes [59;90] or trivial effect [86] on BMI. One of the reviews focused on school-based PA interventions during regular PE sessions [59]. It is likely that PA intervention during regular PE sessions would not be sufficient to make detectable changes. The dose of PA, level of adherence, and applying non-objective measures has been suggested as possible contributors to the low level of intervention success. Moreover, PA might increase lean muscle mass and decrease fat mass with no change in BMI [59]. The second review [90] included trials which have targeted specific dietary activities like reducing carbonated drinks or providing children with overall knowledge about health and disease which would not necessarily affect body weight. The authors undertook meta-analysis and omission of studies one-by-one but found no effect on weight outcomes. It should be noted that quality control assessment of included trials was not reported. A systematic review of studies related to active commuting to school showed no association between active commuting and BMI/prevalence of overweight. However, most of the included studies were cross-sectional which could not provide valid estimation of a causal relation [98]. Moreover, findings of two included trials which used accelerometers to record PA, showed that commuting to school does not contribute to more than 2% of total activity of young children [98] which might indicate that active commuting to school as an intervention would not be an effective approach to increase PA level in children. In general, findings suggest that interventions could help children keep a healthy weight given that even slight weight loss during periods of growth would be beneficial. It is likely that combined dietary and PA interventions could yield higher level of desirable changes in comparison with single dietary or PA approaches.

1.4.2.2 Other outcome measures

Some reviews have included studies which addressed a range of adiposity measures including percentage of body fat, skinfold thickness, waist circumference, and waist to hip ratio [59;82-84;87;92-94;96]. Since the measures were collected in only a subset of trials, few studies have drawn firm conclusion about alteration in adiposity measures. However, the changes are promising. Improvement in adiposity measures [99], triceps skinfold thickness, waist circumference, and waist to hip ratio in either short-term PA intervention [84] or interventions targeting at reducing screen viewing [92;93] have been reported. Nevertheless, heterogeneity in skinfold thickness changes [83] has not allowed reviewers to reach definite conclusions. BMI change and skinfold thickness improvement tend to be consistent in some studies, but skinfold thickness and waist circumference reduction could occur in the absence of changes in BMI [94] indicating that a range of measures of body fat need to be included as outcomes for trials.

Three reviews included trials which assessed blood pressure [87;95;97]; however, the effect of intervention on blood pressure was not provided.

Very few studies include psychological outcome measures [87] and the intervention effect on these measures has not been addressed. However, some of the included trials have shown desirable effect of intervention on self-efficacy of children regarding PA and healthy food choices [95;100].

1.4.2.3 Intermediate outcome measures (diet and PA)

Improvements in intermediate outcomes including improvements in dietary pattern, and PA level could be considered as measures of success in management of childhood obesity which would result in obesity control in the longer term [89;90]. Most of the included interventions have shown some level of improvement in dietary and PA status of children. Improvements in dietary intake including lower daily increment in total energy intake, higher level of healthy food consumption and decrease in unhealthy foods [84;88;91;93;95] has been documented. Improvement in duration and level of PA/fitness has been also reported [82;84;85;91;93;95;96;99]. However, weight status has not been necessarily changed in favour of intervention [59;89]. A range of potential sources of bias should be considered in assessing effectiveness of interventions. Heterogeneity of interventions and excluding details of activities like type, intensity, and duration of PA [89], inclusion of limited outcome measures which might underestimate the success of the intervention, measurement error including application of subjective methods to assess PA and challenges with valid estimation of food intake, and limited study power [97] should be considered. Moreover, it has been suggested that children might compensate for dietary and PA changes out of school which results in no improvement in body weight in spite of progress in diet/PA [84;97]. Summerbell et al. proposed that allocation error needs to be considered with regards to the level of effectiveness since many trials allocate intervention at school/institution level and assessment is conducted at the individual level [87]. No other review has addressed the issue, but it seems that unit of allocation error could affect researcher's interpretation of findings.

1.4.2.4 Potential for unhealthy outcomes

Most of the interventional studies have not reported possible effect of prevention programmes on child growth and development, anorexia, impaired body perception, and low self-confidence [83]. However, one of the systematic reviews has included trials which have been reported undesirable weight related outcomes of interventions [94]. Findings indicate that underweight should be monitored since increase in underweight has been shown in some studies. Increase in BMI in intervention groups has also been documented, but concomitant decrease in skinfold thickness might indicate the effect of PA component on lean body mass [94]. It has been also suggested that obesity related interventions could be of help in managing eating disorders in adolescents [94].

1.4.2.5 Associated factors to successful intervention

The reviews have addressed a range of factors which might influence effectiveness of interventions including the characteristics of the intervention programme and the target group. Details of findings are presented in the following section.

Factors related to study design

Intervention components

In general, it is likely that multi-component rather than single interventions, targeting a range of factors in the obesity causal pathway and combining nutrition education, promoting PA, and behaviour modification could be more effective in helping children maintain their healthy weight [59;93;99;101]. However, introducing a simple approach like reducing screen viewing has also been identified as effective [94]. Moreover, general health promotion programmes including weight management activities seem to be promising [97].

Theoretical framework

Findings suggest that programmes which are theory or research based do not necessarily show higher level of success [99]. It seems that identifying which components or constructs of a theory is working rather than applying a theoretical framework by itself would be helpful in designing prevention programmes. In one of the reviews, interventional components classified according to a predefined framework to identify which informational, cognitive, behavioural, environmental, or social support components were included [86]. Findings suggested that interventions including multiple cognitive components had better effect with regards to increasing PA and to decrease sedentary behaviour and interventions including reinforcement showed more desirable effects on increasing PA and healthy dietary behaviour [86].

Study duration

The outcomes of interventions do not seem to be affected by intervention duration [59;97;101]. Summerbell et al. reviewed studies with 3 months to 3 years intervention duration to identify whether behavioural change is sustained over long periods. They concluded that targeting the causal pathways, selecting suitable interventions, and adopting appropriate research methods were more likely contributors to success rather than intervention duration [87]. It has been suggested that interventions which are applied for 6 months to 1 year are likely to be more effective on BMI changes than shorter- and longer-term interventions [93]. For example Doak tested a diet and activity based intervention for 12-15 yr boys which was effective in terms of BMI change after one year, but not two years [94]. However, the authors acknowledged the possibility of introducing publication bias in favour of publishing non-effective longer-follow up period interventions. Stice et al. proposed that longer duration interventions might provide greater opportunity for delivery of components and changing behaviour, but the finding of their meta-analysis suggested that interventions below the median of 16 weeks duration showed significantly greater effect size than longer interventions, though this did not remain significant in the multivariate model [97]. They discussed that interventions targeting multiple health behaviours correlate with intervention duration which could attenuate the unique effects of duration and multi-component interventions [97]. It has also been noted that interventions that apply behavioural theories are usually of longer duration [91]. Therefore the true effect of intervention duration versus theoretical framework based interventions needs to be further investigated. Longer duration of intervention (more than 6 months) was more successful in decreasing sedentary behaviour whereas interventions of shorter duration were more effective in decreasing unhealthy dietary behaviour [86]. This may indicate that active PA pattern would become routine over a long period, but food intake behaviours tend to return to the initial pattern and need reinforcement.

Adherence

Level of intervention adherence has been addressed in very few included trials and it was not measured objectively in any of the studies [59]. It is likely that the level of acceptance of and adherence to interventions would be higher in controlled trials. Therefore, this is a challenging issue in developing and implementing large scale epidemiologic studies. Documentation of non-participants and characteristics of those who have not completed the trial should be also taken into account as the information would be helpful in designing interventions to target all populations including minorities.

Family involvement

It is likely that family involvement in a range of levels and aspects could help children in benefiting from interventions. Due to the lack of autonomy in childhood, collaboration of family, and even school setting is essential in preventing and treating childhood obesity [93;94]. McLean et al. aimed to identify trials which have assessed family involvement in weight management and to explain the nature of the interventions [101]. Involving parents generally resulted in more weight loss in children, which is in accordance with other studies exploring family therapy in the prevention and treatment of obesity [102], specially in girls [92] and supports the role of parents' participation in weight management programmes [93]. Thus the mechanisms through which family support might influence weight management related habits and which family member plays the principal role need to be identified to help in devising effective intervention programmes.

<u>Factors related to target group</u>

Age

Lower levels of intervention success with younger children has been attributed to their cognitive and physiological development stage and children's limited influence on food purchase [82;91;94;97]. However, it seems that the type of intervention rather than the child’s developmental status might explain the higher levels of effectiveness observed in older children [97]. For instance, high intensity dietary education in the long-term has resulted in greater decrease in obesity prevalence among young children [84].

Gender

Gender differences have been documented for diet and PA related interventions in favour of greater impact for girls. This may suggest a need for developing segregated activities for boys and girls. Female-only trials could produce significantly larger effect on BMI status than mixed-sex and male-only trials. Socio-cultural pressure on girls to be slim might explain part of the observed difference [97]. It has been shown that gender has no effect on school-based PA intervention outcomes (regular PA at school) [59]. However, it seems that girls might respond better to educational components regarding increased PA and improved dietary intake, while boys might favourably react to structural and environmental changes [82;92].

Ethnic background

Contribution of ethnicity to success of intervention has been poorly evaluated, but available evidence indicates that special interventions for ethnic minorities could be effective [83]. Some studies have looked at the level of effectiveness of interventions in ethnic minorities, but the association between weight related measures and ethnic background has not been assessed [92]. However, findings of a meta-analysis have shown that it is unlikely that ethnicity contributes to the level of intervention success [97]. It seems that further studies need to be implemented to identify effective interventions for a range of ethnic backgrounds.

1.4.3 Conclusion

In 2001, Campbell et al. suggested that insufficient quality data did not allow drawing of generalisable conclusions with regards to effectiveness of intervention programmes to prevent childhood obesity in children [84]. Katz DL. in 2009, Kamath CC. in 2008, and Kropski JA. in 2008 have referred to the urgent need for designing high quality interventions and evaluation protocols [82;86;89]. An optimistic view might defend the progress in the field of childhood obesity prevention. Nevertheless, developing target group-oriented, multi-disciplinary, and evidence based interventional programmes to help children maintain their healthy weight need to be included in childhood priorities at international and local levels. It is likely that improving PA and food environment along with increasing child and family involvement could improve effectiveness of interventions in future. Contribution of related organisations and bodies in implementing sustainable intervention programmes is crucial [83;89]. Most of the intervention trials have targeted short-term impact and downstream/midstream factors including individual PA and dietary related factors and school meal services, rather than related environmental influences such as better provision of healthy foods and safer play spaces to sustainability of interventions including cultural norms and organisational system changes [87]. It is likely that shifting individual target plans towards environmental changes would be beneficial in the longer term. Targeting overweight and non-overweight children together might decrease the level of success [86]; however, working with high overweight prevalence populations might shift the design of intervention programmes to treatment [82]. Targeting all children and completing sub-sample analysis could address these concerns. Future studies should be built upon successful interventions and to conduct follow-up trials of enhanced versions of the programmes that produced significant effect.

Table 1.1 Characteristics of systematic reviews of childhood obesity prevention interventions

Author (number of included studies)	**Type of studies**	**Quality assessment**	**Age (yr)**	**Setting**	**Intervention/Examples**	**Outcomes**	**Main findings**	**Comment**
Food/diet								
Jaime PC., 2008 (18) [88]	RCT, CT, NCT, cross-sectional	Not reported	Preschool, primary and secondary school	School	Nutrition guidelines, regulation of food and beverage availability, price intervention	Menu composition, availability or sales of food and beverages at school, dietary intake, BMI	Nutrition guidelines and price interventions are effective for improving school food environment and students' dietary intake. BMI, overweight and obesity did not change	Wide variation in follow up duration (6 weeks to 3 years); inclusion of non RCTs
Physical activity								
Jago R., 2004 (9) [85]	Not reported	Not reported	5-18	School, camp	PA at breaks, active travel to school, Extracurricular activities, summer schools/camps	PA assessment (self-report, heart-rate, minutes of PA, DLW, DEXA)	Non-curricular inexpensive activities could increase level of physical activity	Unknown duration of interventions; applying self-report PA assessment in young children; unknown type of studies
Lee MC., 2008 (32) [98]	Cross-sectional	Not reported	5-18	School	Active commuting to school	PA level, percentage of active commuters, BMI, %BF, OW and OB	Positive association between active commuting and overall PA level; no association	Cross-sectional design is not appropriate for exploring relation; application of non-direct methods of recording PA and self-

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
							between active commuting and reduced weight or BMI	or parent-report weight;
Harris KC., 2009 (18) [59]	RCT, CT	Completed	5-18	School	School-based exercise or PA during regular class time	BMI, body composition (%body fat, triceps/subscapular skinfold, total/lean/fat mass, waist circumference, waist/hip)	BMI did not improve with school based PA interventions which lasted for at least 6 months; no consistent changes in other measures were found	PA at PE sessions does not seem to be sufficient to make any significant change; type, duration, and frequency of PA varied; Applying subjective measures to assess PA; most of studies included both nutrition and PA education
Food/diet and physical activity								
Campbell K., 2001 (7) [84]	RCT, CT	Completed	3-12	School	School-based interdisciplinary curriculum based programmes utilising school staff; community based tutoring programme	BMI, skinfold thickness, PA, diet, parental support	Reduction in prevalence of obesity in PA interventions (long and short-term) and diet (long-term), no effect in 2 of 3 diet+ PA interventions	Small number of available studies; heterogeneity; most of the trials depend on existing staff and resources (sustainability)
McLean N., 2003 (16) [101]	RT	Completed	5-60 yr (5-13 was included)	Family /Home	Face to face and distant education/discussion for child and/or parents	Change in target behaviour, overweight	Children benefited from multi-behaviour change	All papers were published prior to 1994; 12 had no

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
							techniques targeting both parents and child; 1.4-11.7% decrease in overweight	control arm; flaws in study design and implementation; food intake and PA level not reported; physical/psychological measures not included
Bautista_ Castano I., 2004 (14) [93]	RCT, NRCT	Not reported	0-18	School (12 out of 14), commu nity	Nutrition education; behaviour modifications; PA promotion; school meal modification	BMI, skinfold thickness, body fat mass%, waist circumference, WHR, prevalence of OW and OB	Combination of nutritional education and PA promotion/ sedentary activity limitation along with behaviour modification could be effective in preventing childhood obesity	Quality of included studies not reported; conclusion on anthropometric measures not drawn; inclusion of interventions in high-risk populations
Summerbe ll CD., 2005 (22) [87]	RCT, CT	Completed	< 18	School, commu nity, clinic	School education via school curriculum; educational sessions by teacher, nutritionist, PE teacher; lunch time club (nutrition and PA curriculum) Community Summer camps activities and weekly	BMI, anthropometry, body composition, KAP (knowledge, attitude, practice), psychological measures, diet and PA	Improvement in diet and PA; small positive change in BMI (diet or PA alone); no difference in combined interventions	Impact of interventions on other outcome measures has not been summarised; role of intervention setting not presented; inclusion of kids as young as 9 months

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
					website visit; after school dance in community centres Clinic Providing obese parents with comprehensive behavioural weight control programme			
Flodmark CE., 2006 (24) [83]	CT	Completed	7mo-14	School	Education, counselling, health promotion; improving school diet; provision of PA	BMI, skinfold thickness, overweight/obesity (%)	Regardless of quality, interventions showed positive weight trend in 41% of studies	Compiling systematic reviews
Doak CM., 2006 (25) [94]	RCT, CT, SSCT (small scale semi-randomised controlled trials)	Not reported	6-19	School	Education for children and parents; counselling and lectures; improving school lunch; providing PA opportunities; improving PE; teacher training; reducing screen viewing	BMI, skinfold thickness, OW and OB%, waist circumference, WHR	About half of the included trials were found to be effective in reducing overweight, obesity, or adiposity measure for at least one subgroup	Inclusion of both health promotion and obesity prevention studies; applying pre-defined criteria for intervention evaluation; comparing BMI to skinfold thickness measures; no report on other included measures; assessing intervention effect as dichotomous
Stice E., 2006 (64)	RCT, CT, quasi-	Not reported	Children and	School (85%	PA including fitness and skill group;	BMI	21% of included studies showed	Effect size and level of contribution of a range

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
[97]	experimental		adolescents (mean age up to 22 yr)	of included trials)	mandated dietary changes; promoting healthy diet; psycho-educational component to promote healthy diet, exercise, and decreasing media use; counselling children and parents; summer camp (diet and PA);		significant prevention effect; larger effects attributed to programmes targeting children and adolescents and females, relative brief programmes, those which solely target weight control, pilot trials, and programmes wherein participants must self-select into the intervention	of factors to OW/OB were assessed; other measures of overweight/obesity not included; setting of intervention not mentioned; quality of studies not considered in analysis
Sharma M., 2006 (11) [91]	Not stated	Not reported	5-17	School	Increased PE; teacher training; after school activities; school meal modification; reducing screen viewing	Dietary and PA changes; BMI	Interventions resulted in modest changes in diet and/or PA related behaviours; related findings to obesity indicators are mixed	Measures of obesity not assessed by all studies and no conclusion were made
Sharma M., 2007 (21) [95]	Experimental, pilot data,	Not reported	3-18	School	Medical and dietary advice; increase activity level; healthy	BMI	Positive change in behavioural indices including	Most of the included studies were from developed countries;

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
	process evaluation data				nutrition; health curriculum; face-to-face counselling; teacher training		leisure time PA, healthy food consumption, switching off TV	inclusion of non-controlled trials; limitation with regards to language and unpublished data
Connelly JB., 2007 (28) [99]	RCT, CT	Completed	0-18	Home, school, community	Nutrition education and skills; physical education and advice; voluntary/compulsory activity; active parenting	Measures of adiposity	Relative compulsory-weekly-aerobic physical activity was effective; nutrition education and skill training and PE did not seem to be effective in reducing adiposity	Measures of adiposity not reported; level of changes as effective not reported; other physical measures have not been reported
Kamath CC., 2008 (29) [86]	RCT	Completed	2-18	Home, school, clinic, community	Home Equipment to limit sedentary behaviour and increased availability of healthy foods School Nutrition education; setting goals towards healthy behaviour; preparation for coping with challenging	BMI, PA and dietary assessment	Dietary, physical activity and combined prevention programmes showed small effects on target behaviour and BMI improvement is modest	Pooled estimate overcomes random variation; methods of dietary and PA assessments has not been reported

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
					situations and barriers; recording healthy activities, contests, guided play at school; recipe modification at school shops			
Kropski JA., 2008 (14) [82]	RCT, CCT	Completed	4-14	School	Nutrition education; provision of PA	BMI, body fat, TSF, cholesterol, diet recall, food diary, FFQ, exercise tests, activity questionnaire, health behaviour questionnaire	School-based prevention programmes seem to be effective in reducing BMI and overweight measures; low quality studies show improvement in diet and PA, but not BMI	Main focus was on quality of included studies
Li M., 2008 (22) [96]	Interventio n studies	Completed	3-19	School	Health education; PA components; dietary interventions; environment modification, acupuncture	Prevalence of OW and OB, weight, skinfold thickness, BMI z-score, biochemical markers, changes in knowledge and behaviour	Body adiposity measured by a range of measures was improved in intervention groups; improvement in blood lipids and glucose, and level of knowledge	Type of included studies not clear; included studies are of poor quality; studies applied a range of references to define overweight and obesity; no conclusion on impact of different interventions (PA, diet) on non- adiposity related outcome

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
								measures; effect of age/gender/SES/duration of intervention was not considered
Katz DL., 2009 (19) [89]	Studies with control measurement or control groups	Completed	3-18	School	Combined interventions (nutrition and PA) with a family component	BMI, weight	Nutrition education, TV reduction, and combination of nutrition education, PA, and TV reduction reduced weight significantly.	Duration of interventions not included; exclusion of poor quality studies; lack of body fat measures
Brown T., 2009 (38) [92]	RCT, CT	Not reported	5-18	School	Lifestyle intervention including healthy eating, increase in PA, reduction in sedentary behaviour, behaviour therapy, social support, education for diet and activity behaviours	BMI, BMI z-score, body fat%, skinfold thickness, overweight%	Combined diet and PA school-based interventions could help prevent overweight in children in long term	Related outcome measures not included; quality assessment of studies not reported
Kanekar A., 2009 (5) [90]	RCT, CT	Not completed	8-11	School	PA interventions including after school clubs and reducing screen viewing; increasing health knowledge; dietary modifications	BMI	No significant changes for BMI were documented	Completing random and fixed effects model (heterogeneity of findings); quality of studies assumed as good, without completing formal quality control

Author (number of included studies)	Type of studies	Quality assessment	Age (yr)	Setting	Intervention/Examples	Outcomes	Main findings	Comment
Zenzen W., 2009 (16) [100]	Experimental and non-experimental studies	Not reported	4-18	School	Dietary, physical activity, healthy lifestyle education, and parental involvement which were based on school curriculum programmes	BMI, weight loss	A range of methodological approaches and theoretical frameworks were applied for intervention delivery; only one study showed improvement in BMI	Quality of included studies not known; findings of included studies were described and no specific conclusion were made

As it has been shown in previous section, a range of heterogeneous outcome measures has been applied to assess effectiveness of interventions which has complicated the assessment of interventions. However, it seems that introducing definite set of measures would not be feasible and they should be selected according to study aim and intervention components. In this section, the most common outcome measures and methods to assess weight status and body fat, PA, and dietary intake are presented. Application, advantages, and limitations of each method have been addressed.

1.5 Assessment of obesity and related factors in children

1.5.1 Assessment of body fat

In order to identify the prevalence of weight problems, its trend, and its variability between populations, standardised methods of assessing body fat in individuals is needed. There are a range of methods available, each with certain strengths and limitations. Ideally any measure of body fat should fulfil a range of requirements including precision, ability to predict the risk of health consequences at different cut-off points, accessibility with regards to simplicity, cost and ease of use in being administered, and acceptability to those being measured [103;104].

1.5.1.1 Laboratory assessment of body composition

A range of direct measures including scanning laboratory techniques have been used to assess body composition [105] (Table 1.2). The gold standard for measuring body fat in children is multi-component measurement of either total body water and body density or total body water plus body density plus body mineral content [105;106]. However, whilst laboratory techniques have higher precision than indirect measures such as BMI, they are less appropriate with regards to validity in obese children and are not feasible measures for large scale epidemiologic studies. Almost all methods are expensive, trained technicians-dependent, time consuming, less acceptable for those being measured, or need bulky equipment. Nevertheless, the validity of indirect methods of body fat assessment has been often evaluated against the direct laboratory methods.

Table 1.2 Laboratory techniques for measuring body composition [105]

Method	**Rational**	**Application in obese adult/children population**	**General comments**
Non-scanning techniques			
Total body potassium	Potassium, as exclusive intracellular cation, is measured as marker of body cell mass	Overestimation of total body fat in individuals with lower level of potassium including obese subjects	Expense
Total body water	Body fat contains no water and all water is present in fat-free mass	Underestimation of body fat due to increased water content of fat-free tissue in obesity	Risk of radiation, timing of measurement
Neutron activation analysis	The amount of a range of chemical elements is measured in vivo	-	Expense, radioactivity exposure, sensitivity variation, used as reference method for all other laboratory techniques
Densitometry:			
Hydrostatic weighing	Body density is calculated from apparent weight loss in water divided by weight in air	Not suitable for young children	Expense, well-trained examiners
Water-displacement plethysmography	Measuring change in pressure in chamber filled with water versus water+ individual when individual weight in air subtracts from initial water	Successful in obese adults	Expense, no need for total immersing
Air-displacement plethysmography	Calculating gas volume in two chambers with and without the individual	-	Expense
Total body electrical conductivity (TOBEC)	Based on the differences in electrical conductivity of fat-free mass and fat. TOBEC is measured by observing the changes induced by placing an	-	Expense, sensitivity (insensitive to shifts of fluids and electrolytes between intra- and extra-cellular compartments and variation in bone

Method	Rational	Application in obese adult/children population	General comments
	individual in electromagnetic field		mineralisation)
Ultrasound	High frequency sound waves from an ultrasound source penetrates the skin and pass through adipose tissue to adipose-muscle tissue interface where a proportion of sounds which are reflected as echoes would be translated into depth readings by a transducer	The method may be superior to skinfold calliper techniques for measuring subcutaneous fat in obese individuals	Validity for range of body fatness not known, lower resolution than scanning techniques but providing a reasonable estimate of adipose tissue thickness in compare with TOBEC and skinfold calliper techniques
Bioelectrical impedance (BIA)	BIA measures the impedance of an electrical current passed between two electrodes located on the right ankle and the right wrist of an individual	-	Changes in body fluid compartment volume could be traced in interventional studies, single measure is invalid due to some conditions including oedema and dehydration which alters the resistance measurements
Scanning techniques			
Computerised tomography (CT)	CT constructs a two-dimensional radiographic image of the underlying anatomy of specific area of the body based on the relationship between the degree of attenuation of an X-ray beam and the density of the target tissue	Not suggested for children due to exposure to ionising radiation	Expense, no information on chemical composition of the structures
Magnetic resonance imaging	Hydrogen protons behaviour is slightly different in fat and lean tissue such that the time that nuclei need to release the radio-frequency-induced energy and return to random configuration varies	-	Expense, size of equipment, no ionising radiation, whole body scan and multiple scan can be completed

Method	Rational	Application in obese adult/children population	General comments
Dual energy X-ray absorptiometry	Impedance to a weak electrical current passed between the right ankle and right wrist is measures. It relates to body volume (conductor volume) and height (length of the conductor)	-	High precision, difference between equipments, calibration dependence

1.5.1.2 *Body mass index*

Although none of the existing measures fulfil all of the above mentioned criteria, BMI is often recommended and used for assessment of body fat for children, adolescents, and adults [106-109]. It is inexpensive, relatively simple to administer, repeatable and in adults, can be linked to health consequences at different cut-offs [97].

In children, BMI has limitations because their height and weight are constantly changing. Therefore, a standard measure of BMI for each age and sex (BMI Z-scores) is more meaningful for comparisons and percentiles at different levels can be applied to classify children to a range of weight categories. Z-scores reflect the reference distribution, are comparable across ages, sexes, and indicators, and allow summary statistics to be calculated [107]. Limitation of applying BMI percentiles is that the same interval of percentile values corresponds to different changes in absolute values in different anthropometric indicators. Moreover, it would not be possible to quantify changes in percentile values near the extremes of the reference distribution [103;110].

<u>Reference levels and cut-offs for defining obesity</u>

In order to derive BMI Z-scores, a normal reference population is needed, to provide age- and sex-specific BMI ranges. A variety of reference population data are available which are used for this purpose in different definitions. Furthermore, a range of cut-off points have been applied by investigators to classify children into different weight categories [111-113]. Selecting the most appropriate indicator, reference data, and establishing cut-off points to distinguish those at risk of malnutrition and morbidity have been considered in this field since Gomez et al. tried to describe cause of death in malnourished children in 1956 [114]. In 1977 Waterlow JC, et al [115] described criteria which should be fulfilled in developing reference population. They suggested two approaches to be applied in case of children's growth in industrialised countries are not the same as another country [115]. The first is to construct a local standard and the second is to make an arbitrary adjustment in the cut-off points derived from reference population. The WHO Expert Committee in 1995 outlined features which should be considered in developing new international growth standard [103] including: 1) the sample should include healthy children undergoing unrestricted, but not excessive growth from several developing and developed countries; 2) secular trend in growth should be minimal or absent; 3) the sample size should be large enough to reflect normal variance, and to estimate extremes percentiles of weight and height distribution; and 4) in defining cut-offs, sensitivity, specificity, and positive predictive values of functional and health-related outcomes should be considered.

Standardised percentile curves of BMI for Iranian children

Iranian growth charts were developed in 1999 based on measures in a sample of 3301 children (1599 boys) from aged 2 to 18 yr in urban Tehran [111] used Health and Disease Survey data bank to produce growth charts. The charts were constructed using Healy's method which produces smooth centiles that are close to the data. A grid test confirmed the goodness of fit of the smooth centiles to the data. It has been shown that weight and height of children living in urban Tehran are representative of urban children in Iran [116] but the growth charts do not meet the internationally recognised criteria for a reference population, as the children included were not necessarily well nourished [103]. Therefore, lower cut-offs than US reference might indicate this limitation rather than lower potential of growth or nutrient deficiency in Iranian children. These reference data has been rarely used in epidemiologic studies in Iran [117;118]. Applying a range of growth references has shown that the prevalence of obesity in 6-12 yr children in Ahvaz (a city in south of Iran) which was estimated by Iranian growth charts (10.9%) was two- and three-folds higher of that estimated by CDC (5.2%) and IOTF (3.6%) [118].

CDC (Centres for Disease Control and Prevention) growth charts

CDC releases anthropometric reference data which are based on health examination survey results from NHANES for all ages of the US population [119]. Adjusted BMI percentiles for age and sex are among the indices which have been tabulated and used to classify children to weight categories. The reference meets the proposed standards for establishing growth charts [103], but it is based on US data which might not be appropriate to apply in non-US populations who possibly have followed different growth patterns.

IOTF (International Obesity Task Force) standard

To develop an international standard definition of childhood overweight and obesity, data on BMI were obtained for children from six large nationally representative cross sectional surveys from Brazil, the UK, Hong Kong, the Netherlands, Singapore, and the US with over 10000 subjects [113]. For each survey, after controlling for measurement errors, centile curves were drawn that at age 18 years passed through the cut-off points of 25 and 30 kg/m^2. The curves were averaged further to provide age- and sex-specific cut-off points for 2-18 yr. IOTF standard has been widely used in epidemiologic studies, but evidence suggests that it could not provide acceptable level of sensitivity in a range of populations including Iranian children [109;120].

Multicentre Growth Reference Study (MGRS)

The MGRS was launched by the WHO to develop an international reference for assessing growth and development of infants and children based on collected data from a range of developed and developing countries [121]. The rational was to describe how children should grow rather than how a population of children grow. In other words, MGRS introduced a standard for growth. A standard defines a recommended pattern of growth that has been associated with specified health outcomes and the minimisation of long-term risks of disease. In comparison, other growth reference standards, including CDC and IOTF describe how a defined population grow [122]. On the other hand, CDC and IOTF references show positive skewness in body weight which result in underestimating obesity in children [120;123-125].

The challenging issue in developing and using an international standard is the legitimacy of combining populations from a range of genetic backgrounds and growth potential [122]. As noted before, differences between height and weight of well nourished children from different ethnic backgrounds are relatively small in comparison with the difference between poor and privileged children from the same background, supporting the use of international growth standard [42;126;127].

Thus where standardised national growth reference charts are not available, the WHO charts are the most appropriate for classifying children to a range of weight categories in epidemiological studies. However, direct measures of body fat including circumferences and skinfold thickness have some advantages [107] which might enable the measures to provide additional useful information to BMI.

1.5.1.3 Waist and hip circumference

Waist circumference has been proposed as the preferred anthropometric measure of abdominal fat [8] and its ability to identify children with adverse cardio-metabolic risk profiles has been reported [106]. Waist circumference has been shown to correlate with intra-abdominal fat [128] as measured by DXA, and is a better measure of total body fat than waist to hip ratio in adult populations [129]. It is also suggested as a good index of central obesity in children and adolescents [129] where a relationship between increasing waist circumference and adverse atherogenic lipoprotein profile, cholesterol, and insulin has been found [129-131]. Comparing two data sets in 1987 and 1998 showed that among British children, the proportional increase in waist circumference exceeded the proportional increase in BMI [132] which suggests that the former is a more sensitive measure for detecting obesity in children [133]. Waist circumference provides a measure of visceral adipose tissue in children [134]. Application of universal cut-off values for defining obesity in children has not been recommended mainly because of ethnic differences in intra-abdominal fat mass [129]. Nevertheless, waist circumference is a useful measure for monitoring changes in trends and evaluating interventions related to childhood obesity prevention.

1.5.1.4 Skinfold thickness

Skinfold thickness is a proxy measure of the size of subcutaneous fat which reflects total body fat [129]. The common sites of measuring skinfold thickness include the triceps, biceps, subscapular, suprailiac, and midaxillary regions, which could be applied as single or multiple measures in estimating body fat [129].

<u>Precision</u>

It should be noted that the relation between subcutaneous and internal fat is not linear and distribution of subcutaneous fat varies with age, sex, and race or ethnicity [129] which could be source of bias in estimating body fat. Both within- and between-examiner measurement errors are common for skinfold measures, making it essential to have adequate staff training with standard protocols [129].

<u>Single and multiple skinfold</u>

Subcutaneous fat is distributed unequally and it varies with age, sex, and ethnicity. Changes in energy balance might alter the rate of fat deposition in a range of skinfold sites. Triceps skinfold thickness is most commonly used for the assessment of percentage of body fat in children [129]. However, in order to estimate total body fat, multiple skinfold is preferable especially among those undergoing rapid weight gain.

1.5.2 Blood pressure measurement in children

Blood pressure is accepted as a measure of cardio-metabolic risk which is independent of BMI in children [106]. An upward trend in the national average blood pressure in children in the US has been attributed to the rising prevalence of overweight over the past decade [135]. It has been suggested that obese children are at greater risk of developing hypertension and the risk exists within the entire range of BMI [136;137]. There is also some evidence that certain ethnic groups, including South Asians, are at higher risk of increasing systolic blood pressure when they become overweight or obese, compared to Caucasian populations [138].

A reduction of endothelial-dependent dilatation and arterial compliance in obese adolescents follows the same pattern as of obese adults suggesting that exposure to excessive adiposity at early age leads to accelerating atherogenic process [66] which indicates that childhood blood pressure tracks to adulthood.

Findings of a cross-sectional study among children and adolescents showed that obesity is a determinant of high ambulatory blood pressure. In particular, predominantly abdominal fat identified by skinfold thickness relates to higher blood pressure [139]. A relationship between PA and blood pressure has also been documented. Aerobic-based PA (a minimum of 40 minutes of moderate intensity at least five days a week) can reduce systolic blood pressure in children and adolescents [66].

1.5.3 Assessment of physical activity in children

Assessment of PA is important to quantify levels of PA, to monitor trends, to determine the effectiveness of interventional programmes, and to help understand the relationship between PA and health consequences [140;141]. Moreover, it has been shown that the level of PA in childhood may determine adulthood PA level [142].

A range of methods including subjective questionnaires reports and objective motion sensors have been applied to measure PA in children (Table 1.3). The lack of sustainability and the transitory nature of PA in children [142] has introduced further considerations in validating PA assessment methods. Direct observation of individuals' movement is the gold standard for recording PA [140]. However, DLW and indirect calorimetry techniques which measure energy expenditure are also widely applied as criterion measures [140;143]. These methods are impractical and not applicable in epidemiological settings. Motion sensor devices are increasingly used for assessing children's PA. Several types are available, but there is no evidence that any one is superior [141;143;144]. The time frame for measurement is also variable [145]; however, a reliable estimate of children's habitual PA, requires a 4-9 day record [144].

Self-report methods have been used as a principal source of information in many studies [146]. Comparing findings from self-report questionnaires and direct methods of PA assessment in children and adolescents might suggest that subjective methods are of acceptable validity [140;147]; however, some evidence has shown poor to moderate correlation between questionnaires and objective methods including accelerometry [148]. Diaries which are the most valid subjective methods are not appropriate for children. Difficulty in recalling information and limited ability of younger children in completing the questionnaires have been noted [146] which could be improved by using parents' proxy report or interviewer-administered questionnaires. A range of questionnaires including Physical Activity Questionnaire for Older Children (PAQ-C) which is a guided self-administered 7-day recall measure have been used as a cost-efficient method for assessing general PA levels during the school year for children as young as 9 yr [147].

No single accurate and feasible subjective method of recording children's activity in epidemiological studies is available. However, using combined measures and targeting specific activities including focus on key times or places, and using proxy measures like involvement in community sports have been suggested [146].

Limitations of the present study did not allow the investigators to objectively measure PA. Therefore, parents were asked to report habitual levels of children's PA by estimating the average time the child spends doing sedentary, moderate, and vigorous activities out of school in both weekday and weekend-days.

Table 1.3 Methods for assessing physical activity in children [140-143;148-151]

Method	Pros	Cons	Validity and reproducibility
Criterion standards			
Direct observation	Appropriate measure of PA and PA pattern, but short-term pattern and sudden changes of PA in children might not be captured	High experiment burden; potential reactivity of the individuals, but limited reaction from young children is probable	Satisfactory inter-observer agreement; good correlation with heart rate and oxygen consumption methods
DLW is water in which both the **hydrogen** and the **oxygen** has been partly or completely replaced for tracing purposes with an uncommon **isotope** of these **elements**	Easy application in free-living participants; low reactivity	Obtaining isotopes; expense; ability in measuring TEE (pattern of EE cannot be identified). To calculate EE, accurate dietary record should be collected	Accurate (in adults)
Indirect calorimetry measures EE from O2 consumption and CO2 production	Appropriate for validating objective techniques in laboratory settings	Non-portable equipment (the new portable lightweight gas analysis devices are still bulky)	Accurate and valid for short term EE
Objective techniques		**Adherence to wearing the device**	
Heart rate monitoring relies on the linear relationship between heart rate and O2 consumption	Ability to assess TEE and pattern of PA; minimum participant and observer burden; cost-effectiveness; unobtrusive	High cost; extensive time to download; limited specificity to estimate PA in individuals; potential influence of factors that change HR including emotional stress and body position; lag behind changes in physical movement	Valid to estimate EE and PA in groups of non-obese children
Motion sensors	Step is good unit of ambulatory activity which in turn can be achieved by an individual's natural lifestyle	Reliable measure in field settings, but in field setting, stability of activities should be considered to acknowledge uncontrolled and various real changes in activity including torso/ non-vertical movements	Most motion sensors are likely to be valid and reproducible in estimating PA in children. Feasibility of motion sensors with regards to missing or lost data and refusal rate is acceptable
Pedometers measure the total number of steps over a specific period	Re-usable; lightweight; unobtrusive; inexpensive; easy to use; non-	Most pedometers cannot store data; not able to provide information on	Moderate to good reproducibility in children (the most reported is Digi-

Method	Pros	Cons	Validity and reproducibility
	reactive	frequency, intensity, duration, and type of activity. It could be addressed by regular record of activity counts which in turn could decrease level of objectivity	walker)
Accelerometers measure accelerations produced by a body segment. Accelerations are converted to digital signal by electric transducers and microprocessors	Re-usable; non-reactive;	Lack of standard method to clean, analyse, and report data; Converting counts to units of EE may increase measurement error	Moderate to good reproducibility in children (the most reported is ActiGraph); In Combination with heart rate monitoring could yield valid estimation of EE in children
Subjective techniques		**Not able to capture short-burst sporadic nature of PA in children**	
Self-report questionnaires	Easily administered; inexpensive; low burden on investigator and respondent	Limited ability of children in recalling intensity and duration of PA; probable effect of social desirability; deliberate misrepresentation; overestimation of time spent in vigorous PA; Underestimation of time spent in unstructured PA	Wide range of correlation coefficient with direct observation, heart rate, and motion detection (-0.10 to 0.88); lower level of correlation in younger children
Interviewer-administered questionnaires	Improvement in child's cognition and accuracy; interview format may improve results	Difficulty in remembering more than the previous day's activity leading to lower correlation with a 7-day recall; limited ability of younger respondents in completing the questionnaires (young as 3rd grade); increases cost and burden to the investigator in compare with self-report methods; risk of response bias	Good agreement with direct observation (about 80%)
Proxy reports	Keeping away from recall errors caused by children's cognitive	Respondent bias (characteristics and perception of proxy respondent)	Correlation with direct observation varied; need for developing valid and

Method	Pros	Cons	Validity and reproducibility
	limitation		reliable instrument for applying in epidemiologic studies
Diaries		Not suitable for children under 10 yr; high burden on participant	Most accurate subjective method in adults
TV viewing includes self-reported surveys and diaries, direct observation	Diaries: collection of detailed information; not affected by memory; could be used as level of compliance Direct observation: gold standard	Diaries: Intrusive and might encourage behavioural reactivity Direct observation: infeasible; expensive; might influence behaviour	Parents seem to underestimate TV viewing time; validity and reproducibility varies enormously

1.5.4 Assessment of dietary intake in children

Dietary intake has been assessed in the majority of health and nutrition studies to identify the relationship between intake and occurrence of disorders, to evaluate dietary changes over time, and to assess the effect of food related interventions. The role of food intake has been discussed in the context of energy balance [152] and some argue that as intake is totally behavioural, while only half of expenditure is behavioural, energy imbalance is primarily caused by excess intake.

A range of methods, mainly subjective, have been used for assessment of dietary intake (Table 1.4). Current or past food intake for a specific period is usually recorded, obtained by either self-report from the participant/caregiver or by an interviewer. The most valid method which is often seen as the gold standard is weighed food records. Multiple 24-h recall method also has high validity. However, dietary history and FFQ which could capture dietary intake over a longer period might be more appropriate in epidemiological studies aimed at identifying possible correlation between food intake and / or dietary habit with occurrence of disease.

Table 1.4 Individual dietary intake assessment methods [153;154]

Method	Implication	Pros	Limitation	Reproducibility
24-h recall: Exact food intake over the previous 24-h is asked by nutritionist	Assessing actual intake applying multiple 24-h recall over several days. To estimate intake over longer periods, 24-h recall could be completed in different seasons	Multiple single-day recall on different individuals produces a valid measure of intake of a population; inexpensive; easy; quick; low respondent burden; applicable in illiterate groups	It can be conducted in children aged≥8 yr and younger children should be accompanied by caregivers; it should be preferably completed at individuals' home environment to facilitate recall; high possibility of omitting infrequent consumed foods	Applying non-consecutive days, it can provide a relatively reproducible estimate of usual intake at group level
Estimated food records: The respondent records all foods and beverages eaten in household measures and to record ingredients of mixed dishes and consumed proportion from prepared dish	Assessing actual or usual intake depending on number of measurement days	Applicability in large scale studies; inexpensive	Respondent's dependent (literacy, motivation, estimation of quantities, problems with converting volumes to weights in case of asking respondent to do conversion)	Level of reproducibility is lower than weighed food records
Weighed food records: The individual weighs all consumed foods and beverages during a specified time. Preparation methods and brand names are recorded	The most precise available method to estimate usual food and nutrient intakes	Accuracy	Heavy burden on respondents and low compliance; need for literate, motivated, and numerate respondents; time consuming; risk of changing usual intake to simplify records in favour of under-reporting; expense	7-day record is used to minimise memory lapses and inadequate estimation of portion size; appropriate for estimating average usual nutrient intake
Dietary history: Trained nutritionist asks about usual food intake and meal pattern of an individual over a	Describing usual food or nutrient intakes over a relatively long period to estimate prevalence of	Appropriate for estimating habitual intake	Time consuming; labour intensive; overestimation of nutrients intake in compare with weighed records	At group level, dietary history shows good reproducibility especially over relatively short time frame (1 month). The

Method	Implication	Pros	Limitation	Reproducibility
relatively long time (a month). It consists of usual eating pattern, frequency of consumption of specific foods, and recorded dietary intake for three days	inadequate intake. Findings could be applied in developing national food policy and fortification planning.			agreement between two dietary histories at individual level is good
FFQ: Applying comprehensive or specific food items, intake is recorded over short- or long-term by self-administered or interview methods. In semi-quantitative FFQs, usual portion sizes are recorded	Identifying association between dietary habits and disease (semi-quantitative); Healthy Eating Index could be calculated	Rapid; high response rate; less burden on respondent than other methods; ease of collecting and processing data; portion sizes could be quantified in FFQ (semi-quantitative data); suitable for estimating specific food item	Lower level of accuracy than other methods; limited success with children who may have difficulty in averaging portion sizes and frequency of consumption and in conceptualising time frame	Lower level of variability in consumption frequency and portion sizes; quality of FFQ and appropriate training would improve reproducibility

Care giver administered FFQs are most commonly used for the assessment of dietary intake in interventional programmes for young children. Changes in consumption of food groups could be monitored and these could be applied to estimate nutrient intakes [153].

Recently, alternative techniques including observer-recorded food records and recall methods, and computer-based methods of validation and dietary assessment have been introduced to assess dietary intake with higher precision in modern society [155].

<u>Validity of dietary assessment methods</u>

The practicality of resources and complexity of recording food intake and eating behaviour has encouraged investigators to make efforts to introduce accurate, feasible, and inexpensive methods to measure food intake at the population level [156;157]. There are controversies on the validity of dietary intake assessment methods [158]. Assessing actual food intake is impractical, difficult and time consuming therefore relative validity is usually measured [159]. Related errors to validity are mostly systematic and a range of approaches have been proposed to deal with these [159]. The main concerns related to validating dietary assessment methods are presented in table 1.5.

Table 1.5 Influential factors in validation studies [159]

Factor	**Description**
Selection of subjects	The individuals should be representative of the target group preferably selected from the population under study.
Time frame	Methods should measure similar parameters in similar time frame.
Sequence	Test method should be administered before the reference and completion of test should not affect reference method because of poor time spacing. Seasonal variation in food intake especially in communities which are dependent to local products needs to be considered.
Independent error	Methods should be independent with regards to type of errors in reporting dietary intake.
Sex and age	Response of men and women seems to be different. Young children and older individuals might have difficulty with conceptualising size of foods and remembering portions.
SES	It affects dietary intake through dietary diversity.

Comparator standard for validation studies

There is debate on many aspects related to dietary intake assessment including accuracy of the assessment method in capturing actual food intake [158] and the methods for conversion of data on food consumed to estimate macro- and micro-nutrient intake. The latter are related to the complex composition of foods, and individual variations in nutrient bioavailability [160]. The first issue is the most important [161] and therefore data collected by any method needs to be evaluated against a reference or comparator method. Applying DLW as a non-dietary reference method has suggested that all reported dietary methods suffer from some degree of under-reporting [159]. Seven-day food records have been established as the "gold standard" for dietary assessment methods [158]; however, because of the technical limitations which leads to the lack of a true gold standard, it should be acknowledged that good agreement between the test and the reference method does not necessarily ensure accuracy of estimation [159;162]. The reference method should be independent of the test method with regards to type of errors [159]. Alternatively, assessment of dietary biomarkers of energy intake might be applied as comparator in assessing specific nutrient intake [163]. Cade et al in a review showed that in less than 20% of validation studies, FFQ has been validated against a biomarker [164] which might indicate that complicated methodology and significant expense hamper investigators to apply biomarkers as a reference method in validation studies. Food diaries have been used as the comparator method in some studies [165-168] including the study carried out by Cade et al. [156] as the original model for designing the present study.

CADET (Child and Diet Evaluation Tool)

CADET is a 24-h food ticklist, that has been identified as a user friendly valid tool for epidemiological studies assessing children's food intake [156]. The ticklist data is used to estimate energy intake and also to assess micro-nutrient intake, based on an algorithm that estimates the dietary content of each food type according to portion size. The algorithm and the content of the food ticklist are population specific, and whilst the original was developed for Caucasian children in the UK, a UK South Asian version has been developed recently [169].

FFQs should be designed based on the target population's food and dietary patterns [168]. In previous studies in Iran, nutritionists have used 24-h food recall to estimate food and energy intake of school aged children [41;117;170;171]; but no valid local tool such as CADET was available for use by literate mothers/caregivers of young children which could be used in large epidemiological studies (percentage of literacy in men and women is 88.7% and 80.3% at national level) [2].

1.6 Aim

The aim of the study presented in this thesis is to determine the prevalence and factors associated with childhood obesity in Tehran, and to explore stakeholders' views on perceived causes and solutions, as a basis for intervention planning. Specific objectives have been included in the following chapters.

1.7 Key points

- Childhood obesity is a growing global public health problem. Evidence suggests that Iranian children especially those who live in big cities including Tehran are at significant risk of developing overweight and obesity.
- Childhood obesity is a strong predictor of later coronary heart disease and it might track into adulthood. It is also associated with increased blood pressure, hyperlipidemia, type 2 diabetes, and psychological consequences in childhood.
- A range of interventions have been tested for the control of childhood obesity. Whilst most of them have suggested some level of success in improving intermediate outcomes including dietary intake and habit, PA, and nutritional knowledge, their success in helping children maintain a healthy weight has been more limited. Reviews suggest that future interventions need to be devised in liaison with stakeholders including parents and school staff to identify the most feasible components and potential barriers. Moreover, tailored interventions should be developed for different communities and settings and outcome measures should be selected according to the study aim, characteristics of the study

population, and feasibility of measures. The increasing trend in childhood obesity highlights the role of prevention programmes.

- A number of studies have been undertaken in Iran to determine the prevalence of childhood obesity and to identify associated factors [13]. However, to date, no studies have focused on the prevention of obesity in children.

2 Development and validation of a dietary assessment tool for children

2.1 Introduction

Dietary intake is measured in almost all of obesity prevention programmes, mainly as an intermediate outcome measure. As discussed in chapter 1, there is much discussion and debate about the validity and feasibility of dietary assessment methods, and no single method stands out as a gold standard for population studies. Each approach has certain strengths and drawbacks, and the choice of method depends partly on the study aim, population characteristics, and available resources. There are currently no appropriate instruments for the assessment of dietary intake among children in Iran that can be used for large scale population studies, such as for the evaluation obesity prevention programmes. In the present study, I contributed to the development and validation of a dietary intake assessment tool to capture average daily energy intake of free living primary school aged children in Iran.

2.2 Aim and study questions

1. To develop and validate a semi-quantitative food ticklist to estimate energy intake among primary school aged children.

- How does the estimated energy intake from the new food ticklist compare with estimates obtained from a 24-h semi-weighed food diary in this population?
- How does the estimated fruit intake from the new food ticklist compare with estimates obtained from a 24-h semi-weighed food diary in this population?

2.3 Methods

2.3.1 Food ticklist development

The new food ticklist was modelled on the Child and Diet Evaluation Tool (CADET) developed by Cade et al [156] in the UK (chapter 1), and adapted to the local population in Iran.

Food/drink groups

A range of approaches were used to identify common foods and drinks consumed by Tehrani school aged children. Two main sources of data were used. First, a research study conducted in 2004 among 761 Tehrani school aged children [170] aimed at describing their energy patterns using one 24-h food recall and FFQ especially designed for quantifying snack consumption. Secondly, the National Household Food Consumption and Nutritional Status Survey (2001-2003) (chapter 1) [172], which records food intake from a representative sample of households in Iran based on a 24-h recall for three consecutive days. Bread, fats and oils, and sugar containers, as major contributors to energy intake were weighed and recorded for two days. In addition, 28 mothers with primary school aged children in Tehran were asked to record all foods and drinks consumed by their children for three days including one weekend day. In order to classify food/drink items into relevant groups which are easily recognised by mothers, a range of approaches were implemented. First, food items were grouped based on those used in a reference Iranian cookery book [173], in consultation with experts involved in the National Food Consumption Survey. These groupings were then presented to two focus groups comprising mothers who were nutritionists, or mothers with no background in food and nutrition, and revised based on the findings. The first version of the questionnaire was sent to 15 nutrition experts around the country to be reviewed. To assess the feasibility of the questionnaire, it was also sent to 15 mothers to be completed for one day. There was also an open question to collect any comments on the questionnaire. The experts' comments and the mothers' suggestions were applied and the final version was developed.

Food ticklist

The final questionnaire pack consisted of two sections including the food ticklist and a semi-weighed food diary which were completed for one day. The ticklist consisted of 12 foods/drink groups including breads, dairy and egg, fruits and vegetables, nuts and seeds, sweet and savoury snacks, cookies, desserts, and ice cream, drinks, main meals including soups, cooked rice, sauces and other mixed dishes, Kebabs, pasta, and ready to eat foods, and one group for other food items such as butter, dressing, honey and jam, and sugar. The average portion size of food/drink items has not been quantified for Iranian children. Therefore, a range of multiple-choice questions was included in the food ticklist to estimate the amount of food/drink. The included amounts was mainly based on the average portion sizes which has been introduced by Amini et al. in 2006 [170] which has been subsequently reviewed by nutrition experts.

2.3.2 Semi-weighed food diary

The 24-h food diary was completed on the same day, and parents/guardians were asked to report prospectively all food items consumed by their child that day, including any food consumed by the child whilst at school. The diary consisted of 6 boxes to record food/drink consumed before breakfast and breakfast, morning snack, lunch, afternoon snack, dinner, and after dinner. Items were either weighed (home scale) or measured by household portions (estimated). Parents were asked to provide recipes for any food items that they cooked at home, and to quantify amounts using household measures (e.g. number of cups, tablespoons etc.). For ready made food items or snacks, they were asked to provide the brand names. Participants were provided with instructions for completing each part and examples were provided where needed (Appendix 2).

2.3.3 Data collection

2.3.3.1 Sampling frame

District 6 was selected as a typical middle class area of Tehran city and participants were drawn from a random sample of all state primary schools in this district.

2.3.3.2 Sample size calculation

The difference of estimated energy intake between ticklist and diary in previous study in the UK was 242 Kcal [156] and the mean of energy intake in the mentioned study was close to the reported energy intake in Tehrani children [170]. In order to detect 240 Kcal difference in mean energy intake between the two dietary assessment methods, with 80% power (α=0.05), 75 children would be sufficient. However, in order to analyse results for boys and girls separately, the sample size needs to be doubled (i.e. 150 children). In order to allow for an expected low response, the sample approached was boosted to 250 children.

2.3.3.3 Sampling schools and classes

The children were selected from pupils in year 1 and 2 in 12 schools (6 Boys' and 6 girls' schools). A computer generated random number table was used to select the 12 schools from all 34 state schools (15 boys' schools) in district 6, and for schools with more than one eligible class in each year group, to select one of the classes at random. The response rate was low; therefore we sent 388 questionnaires (instead of 250) to parents from 5 schools (3 boys' school) and collected 228 questionnaires of which 91 were acceptable. Then, 7 new schools (3 boys' school) were selected according to the aforementioned sampling frame and 565 questionnaires were sent of which 170 were accepted. We were planning to analyse data for 150 children, but 261 questionnaires were finally assessed. Since 29.5% of the questionnaires were correctly completed initially, we had to increase invited parents to about 1000 to make sure that we collected sufficient questionnaires before summer holiday.

All children in selected classes had an invitation letter including a consent form. Participating children were incentivised by being given simple stationery on returning completed questionnaire packs. To collect the packs, 2 to 5 visits were made to each school.

2.3.4 Estimation of energy intake

2.3.4.1 Food diary

To calculate energy intake, five trained nutritionists converted the reported amounts of foods from household measures to weight in gram using an agreed protocol. To check for errors, 10% of samples from each nutritionist were recalculated by another colleague. The error rate was not calculated, but the list of errors was used to develop a complementary guideline. The supervisor of nutritionists coded all food items to reduce the error rate.

For food items that are frequently consumed more than once a day, such as bread, the total amount was calculated, taking account of frequency as well as portion consumed on each occasion. In some cases (especially for mixed dishes) the total amount of food for the family, rather than the child's portion was recorded. In these cases, the reported portion sizes for Tehrani school aged children based on a previous research study [170] were applied where available.

2.3.4.2 Food Composition Tables

Iranian Food Composition Tables are not complete. Therefore the energy content of foods was estimated from the Dorosty Food Processor (DFP) [174] which is a food composition database adapted from the McCance and Widdowson's Food Composition Tables [175]. The database includes all foods/drinks on the aforementioned food composition tables and a number of some local food stuff. The energy content of included items is available, but nutrient contents are not provided for all items. The database accepts new codes and the developer gave us permission to add recipes of mixed dishes to the database to calculate energy content. New codes were included for mixed dishes and some Iranian food items which are absent from the database. The energy content of 112 additional items was provided by the principal investigators of the ongoing study on Compiling Iranian Food Composition Tables. The outputs could be exported to Microsoft Excel for further analysis.

2.3.4.3 Food ticklist

To estimate the energy content of each mixed dish, the energy content of individual ingredients based on recipes proposed by Amini [170] and the Iranian reference cookery book [173] were used. The new codes and energy content of new items were added to the DFP database. Food items or mixed dishes with comparable energy content were put together on the food tick list. The mean of energy contents for all similar dishes was calculated and a new code was created. The new code and the energy content in Kcal were added to the DFP data base.

Specific foods

Consumption of fruits in gram was calculated based on ticklist and diary. Vegetables which are commonly consumed in mixed dishes were not assessed.

2.3.4.4 Repeatability

In order to identify whether a single day food diary was an appropriate reference method for validation, twenty one parents were asked to complete food diaries for two separate days (with 3 days interval). The energy intake derived from food diary showed no significant difference between the first (1875.3± 623.1 Kcal/day) and the second day (1840.6± 492.9 Kcal/day).

2.3.5 Analysis

The data were entered in MS Access 2000 (chapter 3). A data checking protocol was developed (Appendix 3) and data entry was completed by a colleague. The energy intake estimate from the two methods was compared using paired t-test and linear regression was used to examine the extent of correlation between methods. Bland-Altman plots were used to assess limits of agreement between the two methods. This plots the mean value of energy intake from the two methods (x-axis) against the absolute differences between the two methods (y-axis). The 95% limits of agreement for the plot were set at +/- 2SD.

Data cleaning

The energy content of all food items and mixed dishes was calculated based on the values provided in the DFP. For the ticklist and diaries, total energy intake over 24 hours was calculated and added to the database. All data were exported to SPSS 14.0. A new variable was created to show the difference in energy intake between the two methods. Questionnaires from those consuming less than 1000 or higher than 4000 Kcal/day, or those where there was a greater than 1000 Kcal/day difference between two methods were checked and 11 records were excluded as the data was incomplete or the values provided were implausible.

2.4 Results

Complete and acceptable ticklist and diaries were returned for 261 children (149 boys and 112 girls) from year 1 and 2, and these data were used for analysis.

A range of potential biases and sources of error were considered in relation to data collection and analysis in this study. These include respondent bias, incorrect estimation of portion sizes, and errors in handling with mixed dishes [176].

2.4.1 Response rate

A total of 953 parents from 12 schools were approached, with a response rate of 65% (621 questionnaires). The returned questionnaires were checked for completeness, and those where the diary and ticklist were not completed on the same day, where usual consumption rather than actual consumption were reported or where the questionnaires were incompletely filled in, were discarded. In the end, less than half of the returned questionnaires (42%; n=261) were suitable for analysis.

2.4.2 Characteristics of study population

Children were from middle socio-economic area and attended state schools. A total of 261 children (149 boys; 57.1% and 148 grade one; 56.7%) participated in the study.

2.4.3 Energy intake

The energy intake estimate obtained from the ticklist (P=0.1) and food diary (P=0.5) were both normally distributed (Kolmogorov-Smirnov test). The mean energy intake estimated from the former was 2086.1± 656.4 and for the latter 1969.6± 609.1 Kcal/day.

2.4.4 Comparison of test and reference method

The energy intake estimate was slightly higher from the food ticklist compared with food diary, but the differences were not statistically significant using the paired t-test. Stratification by sex showed that the methods were comparable in boys and girls (Table 2.1). However, boys had significantly higher energy intake than girls (P=0.007 for ticklist and P=0.001 for diary).

Table 2.1 Energy intake estimated from ticklist and diary

Method	**Mean± SD (total)**	**Mean± SD (boys)**	**Mean± SD (girls)**
Food ticklist	2086.1±656.4	2180.8±684.2	1960.1±597.5
Food diary	1969.6±609.1	2080.9±625.0	1821.5±555.9

Correlation between methods

There was a relatively strong correlation between the two methods in estimating energy intake (r=0.40, b=0.7, p<0.001) (Figure 2.1).

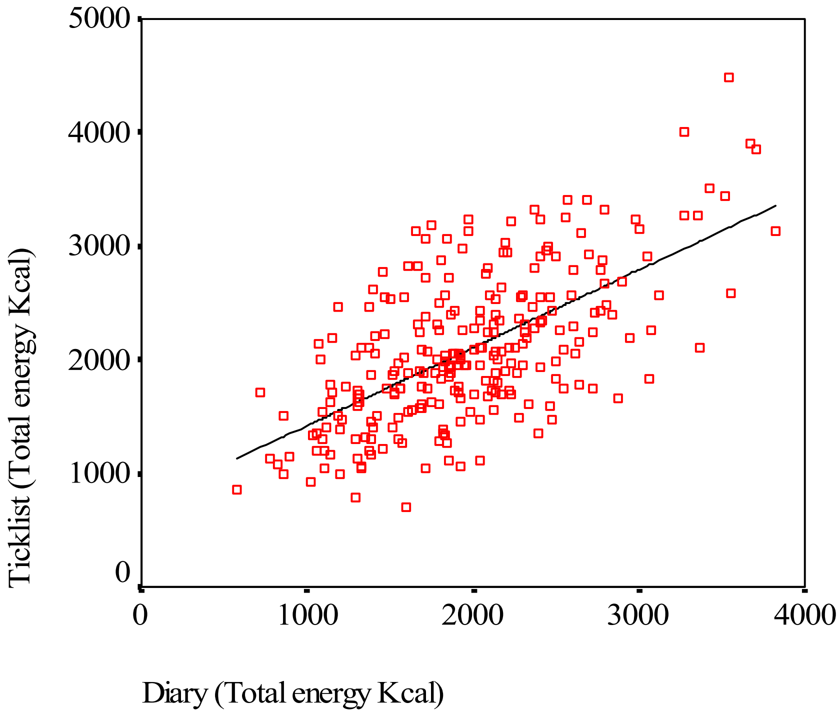

Figure 2.1 Correlation between energy intakes estimated by diary compared to the ticklist

From the ticklist, 7.5% of boys and 10.7% of girls and from the diary, 21.9% of boys and 18.0% of girls did not eat any fruit on the day of recording. Recorded mean daily fruit consumption by ticklist (249.1± 212.2 gr) was higher than diary (176.0± 156.0 gr) (P<0.0001). There was also a significant difference between boys and girls in the total amount of fruit consumed by food diary (P=0.03), but not the ticklist (Table 2.2).

Table 2.2 Comparison of total fruit intake between ticklist and diary

Total fruit	**Sex**	**Mean± SD (gr)**
Ticklist	Boy	255.1± 228.9
	Girl	241.2± 188.7
Diary	Boy	158.5± 146.1
	Girl	199.0± 165.8

Amount of specific fruits consumed is shown in table 2.3. Except for banana, a strong correlation is observed between ticklist and diary in estimating fruits eaten.

Table 2.3 Comparison of amounts of specific fruits consumed between the ticklist and diary

Fruit		**Mean± SD (gr)**	**Correlation coefficient (P value)**		
			Total	**Boys**	**Girls**
Apples/pears	Ticklist	108.6± 47.5	0.60	0.72	0.60
	Diary	115.2± 51.3	(<0.001)	(<0.001)	(<0.001)
Orange/lemon	Ticklist	258.7± 124.3	0.80	0.82	0.81
	Diary	260.9± 108.8	(<0.001)	(0.006)	(0.009)
Melon	Ticklist	110.8± 58.0	0.90	0.92	0.88
	Diary	142.7± 68.5	(<0.001)	(<0.001)	(0.002)
Banana	Ticklist	90.5± 38.2	0.40	0.30	0.60
	Diary	67.0± 26.0	(<0.001)	(0.048)	(0.002)
Satsuma	Ticklist	99.2± 44.3	0.70	0.64	0.77
	Diary	100.6± 56.6	(<0.001)	(<0.001)	(<0.001)

Bland-Altman plots to compare methods

The Bland-Altman plot is used to determine the level of agreement between two methods which assess one outcome. The plot for energy intake (Figure 2.2) shows that the difference between the methods is quite close to zero (116.47 Kcal). The distribution of values is reasonable and very few values are out of ±2SD of the mean of differences (SD=541.15). The plots for boys and girls were similar (not shown). The plot for fruit intake (Figure 2.3) shows that the difference between the methods is 73.08 gram and again, very few values are out of ±2SD of the mean of differences (SD=182.0). However, the degree of scatter increases with increasing fruit intake, suggesting that agreement is better for low fruit intake, but agreement is poorer for fruit intake of 600 gram per day or more. The degree of scatter of about 1000 Kcal for energy and about 182.0 gram for fruit intake suggests that the food ticklist is appropriate for energy and fruit intake assessment at group-level. However this degree of scatter makes it unreliable for use at the individual level.

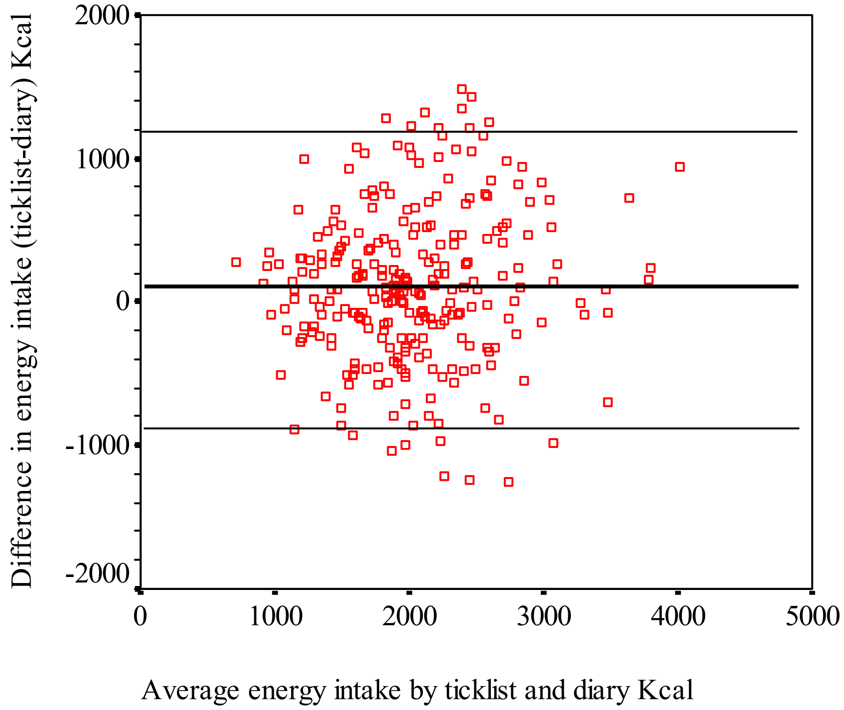

Figure 2.2 Agreement between diary and ticklist (Bland-Altman plots) for energy intakes

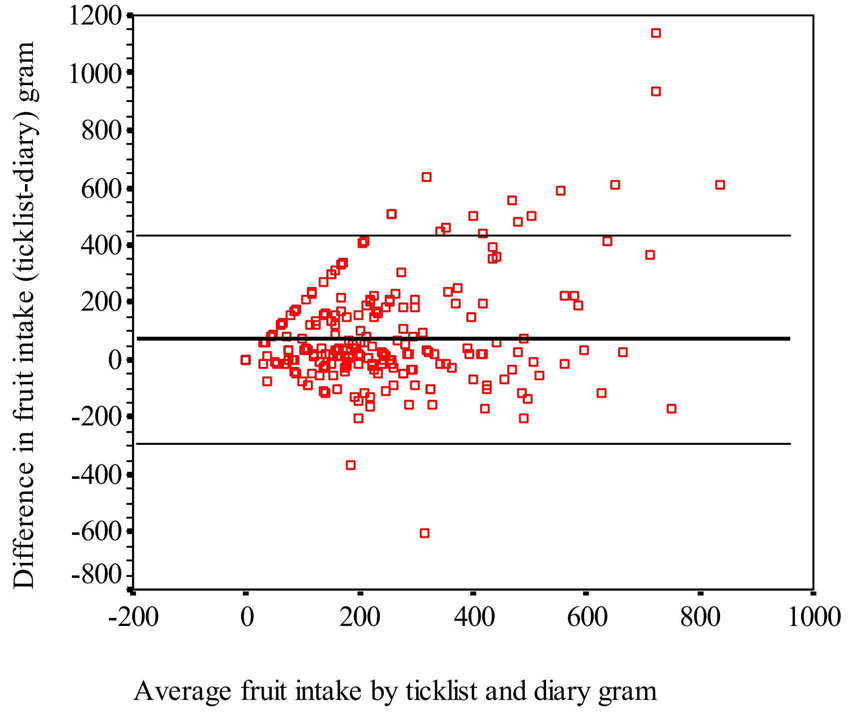

Figure 2.3 Agreement between diary and ticklist (Bland-Altman plots) for fruits intake

2.5 Discussion

This study demonstrate relative validity of a simple food ticklist tool compared to a more detailed semi-weighed food diary for estimating daily total energy intake of children in Iran. Statistical analysis showed relatively high correlation, good agreement and no statistically significant difference in energy intake between the two methods. Moreover, the ticklist could be used to estimate fruit intake in children. The ticklist is a simple tool that can be completed by parents with minimal input from nutritionists, and is suitable for use in epidemiological studies.

We found no significant difference between food ticklist and the food diary in assessing energy intake in children and the reliability of the food ticklist was acceptable. However, the level of energy intake by food ticklist was slightly higher (116.5 Kcal/day) than that recorded intake by food diary in boys and girls. This is similar to the findings of the validation study for the original CADET, which compared the food ticklist to a semi-weighed food diary [156]. On the other hand, energy intake of year 1 children estimated by the ticklist (2112.2± 638.5 Kcal) is comparable to the reported intake for year 1 Tehrani school children recorded by 24-h food recall (1910.0± 551 Kcal) [170].

The findings suggest that the children, as a group, consumed more fruits than their peers from other populations including the UK [156;177] and they meet the current daily recommendation of fruit consumption as of 2.5 servings of fruits [178].

Higher levels of energy intake and fruit consumption estimated from food ticklists might be explained by the usual overestimation of energy intake by FFQs [162;179;180]. There is however, no true gold standard for assessing dietary intake. The food ticklist is not a pure FFQ, but going through the list of food items is a similar process and may help respondents remember some items which might have been missed on the food diary. In other words, it is possible that a food diary is biased towards underestimating energy intake. Statistical analysis to explore any significant difference in energy intake showed no significant difference. Furthermore the magnitude of difference between methods is relatively small (<6% of total energy intake), which is much smaller than that observed in similar study in the UK [156].

The correlation in estimated energy intake between methods observed in this study (r=0.4) is at high end of that reported for FFQs/food ticklist and dietary recall/dietary record in young children in other studies [156;181;182]. However, the ticklist and diary was completed on the same day and person and therefore the method could not be entirely independent. The suitability of the FFQ for assessing dietary intake was shown to be as responsive as one- or multiple-day diet records and biomarkers [156;183;184].

The standard deviation of total energy intake obtained from the food ticklist was higher than that observed in a similar study in the UK [156] which used average portion sizes to calculate energy intake. However, findings of a study among school aged Tehrani children [170] which used 24-h dietary recall also showed a wide standard deviation in energy intake, which might suggest that the dietary patterns of children in Tehran, with a broader range of food items consumed and greater variation in preparation of mixed dishes could affect all dietary assessment methods. Moreover, energy and nutrient contents of commonly consumed new foods including fast foods is difficult to record as fast food restaurants in Iran are run independently using a range of recipes. Difficulties with assessing new mixed diets in Asian countries including western foods than pure western dietary intake has been already suggested [168].

2.5.1 Strengths and limitations

This is the first study in Iran to develop and validate a simple tool to assess dietary intake in children. The main limitation of the present study was the lack of availability of standard values for energy and nutrient content of different foods, since the compilation of the Iranian Food Composition Tables is not complete. However; a systematic approach was used to obtain the best estimates for energy content and use of the DFP software will allow further validation for nutrient content when the Iranian Food Composition Tables are released.

The two assessment methods were administered only for a 24-h period, whereas some researchers suggest that comparisons should be made on several days [158] and some investigators have collected dietary intake data for longer period in validation studies [185;186]. However, we did undertake a small sub-study to compare three day food intake, assessed by ticklist, among a sample of participants (chapter 3). The three day period included a weekend day. Although the actual food items differed each day, there was no significant day-to-day variation in total energy intake.

A range of approaches was applied to deal with measurement errors. To minimise respondent bias, complete guide was provided and foods are not categorised as healthy/unhealthy. Quantifying questions were included to decrease incorrect estimate of portion sizes.

2.6 Key points

- The validation study showed that the food ticklist is a valid tool to assess energy intake in groups of children.
- Compare with a more resource intensive 24-h diary, the ticklist is a valid tool to estimate fruit intake in children.
- The food ticklist is a feasible tool that can be used in epidemiologic studies.

3 Prevalence and correlates of childhood obesity in Tehran

3.1 Introduction

The prevalence, pattern and factors associated with obesity were examined among children in Tehran using a range of measures. In addition to describing the distribution and risk factors for obesity, this allowed the testing of the feasibility and acceptability of potential outcome measures in a population setting, for a future trial of childhood obesity prevention.

A range of outcome measures including anthropometry, dietary, biomedical examinations, physical activity, psychological characteristics, and level of health and nutritional knowledge has been applied to assess the effectiveness of intervention programmes aiming at preventing childhood obesity. Findings of the previous studies have revealed that intervention programmes might affect certain aspects of children's health suggesting the importance of including a series of outcome measures, however; validity, cost, and feasibility of applying outcome measures in epidemiological studies should be considered. In obesity prevention programmes, decreasing and or maintaining body weight is the main goal which could be assessed through prevalence of weight problems and BMI changes over the time. However, complementary approaches including reducing total body fat and fat deposition at some sites has been also addressed [87;187].

In the present study, BMI Z-scores and/or weight categories have been selected as measures of weight status in children and a range of body fat measures including skinfold thickness and waist and hip circumference was included. Blood pressure, as measure of early cardiovascular risk factor, and psychological measures were also assessed. Correlation of included measures with weight status and in some cases with each other was assessed.

3.2 Aim, objectives and study questions

The aim of this chapter is to examine the pattern and distribution of obesity in young school children in Tehran, and how BMI Z-score compares with other measures of body fat including waist and hip circumference and skinfold thickness, and their level of PA, energy intake, psychological measures, and blood pressure. In order to achieve the study aim, a series of study objectives and questions were applied:

1. To estimate dietary intake, PA levels and rate of overweight and obesity among 6 to 8 yr pupils.
   - What is the prevalence of overweight and obesity among this population of children?
   - To what extent does the prevalence of overweight/obesity differ according to different definitions and reference criteria?
   - What is the average daily energy intake among this population of children and does it differ by sex?
   - What is the range of parent reported PA levels in these children?
2. To examine the relationship between diet, PA and weight status.
   - What is the relation between weight status and energy intake?

- Is there a relationship between reported PA levels and weight status among these children?
- Is there a relationship between reported PA levels and measures of adiposity including waist circumference and skinfold thickness, and with blood pressure?

3. To explore the relationships between body image dissatisfaction, health related quality of life, and weight status among children.
    - What is the level of body dissatisfaction among this population?
    - Is there a relationship between body dissatisfaction and weight status in this population?
    - What factors are associated with quality of life scores, and is there a relationship between quality of life score and weight status in this population?
4. To examine the relationship between anthropometric measures, blood pressure, and socio-demographic factors and the risk of overweight and obesity, as determined by BMI.
    - What is the range of skinfold thickness measures, waist, and hip circumference, among boys and girls taking part in the study?
    - What are the relations between BMI and other anthropometric indices?
    - What is the relationship between BMI and blood pressure?
    - What is the relationship between socio-demographic factors (including gender, district of residence, parents' educational level, and family size) and the risk of overweight and obesity in children?
    - Combining the above findings, which socio-demographic and lifestyle factors remain as predictors of weight status in a multivariate model?

3.3 Methods

3.3.1 Sampling

Sampling frame (districts and schools)

Specific locations from various regions in Tehran were selected to provide a balance between cost and sampling requirements. Tehran city is geographically divided into 22 districts, numbered sequentially according to SES of residents excluding district 22 which is classified in high socio-economic category. The northern areas (lower number districts) are considered to have the highest socio-economic groups. Tehran municipality has partitioned the city to three main regions including high (districts 1-5 and 22), medium (districts 6-13), and low (districts 14-21) socio-economic areas. In the present study, definitions for geographical locations and SES were based on the mentioned classification. Studied districts and schools were purposively selected. District 1 includes some marginal underprivileged groups and the Education Office of district 3 does not tend to support research in their district. Therefore, district 2 was selected as a higher socio-economic district for this study. District 6 has been identified as a typical middle class district and in research studies with limited resources this district tends to be used by researchers from a range of disciplines as a representative area of Tehran city. District 15 was selected to represent a lower socio-economic area. The district has preserved its traditional and has a very co-operative local Education Office. Since schools in Iran are segregated, in each district one boys' and one girls' school was selected. In district 2, schools with most affluent families, and in district 15 schools with the most indigenous families were selected.

Sample size

A pragmatic approach to the sample size was taken, considering the available time and resources I had for my fieldwork. A sample size of 300 children (50% boys) was feasible, given the measures planned. This sample size is sufficient to estimate the overall prevalence of obesity in the sample to within +/- 5%, with 95% confidence, assuming a conservative estimate for prevalence of around 20% (based on previous studies in Iran). This sample size also allows for detecting a difference in prevalence between groups (e.g. between districts) of at least 15%.

Sampling individual students

To obtain measures from 300 children across the 6 schools, 50 were selected using simple random sampling, stratified by school year (1 and 2). Each eligible pupil was assigned a unique number, and randomly selected. Selected children had an information sheet including a consent form (Appendix 4) sent to their parents. If the selected children's parents did not consent to their child being included in the study, another child was selected until the required number was obtained. After 4-6 visits, if insufficient numbers of children had been recruited, new schools were invited.

3.3.2 Data collection

Measures

A range of measures were undertaken by trained research staff using standardised protocols and validated instruments, on all children who had valid consent to take part in the study (Table 3.1). In addition, questionnaires were sent out to the parents of all consented children for self-completion. Child measures included anthropometric measures (weight, height, skinfold thickness at five sites including biceps, triceps, subscapular, suprailiac, and thigh, and waist, thigh, and hip circumferences), and blood pressure has been included. All measures except for weight and height were repeated two times and both measures recorded. In addition psychological measures were undertaken on all pupils through interviewer led questionnaires using validated instruments. The validated questionnaire instruments included a measure of health-related quality of life and self image body size perception. These included the Paediatric Quality of Life Inventory (PedsQL) [188] (Appendix 5), the Farsi language version of which was validated by myself. The original instrument in English has been extensively used and validated. For the Farsi linguistic validation a three step algorithm was followed, including forward translation with the production of a "reconciliation version", backward translation, and patient testing [189]. The final version is kept with Mapi Research Institute as the Farsi version of PedsQL, Young Child Report.

A nine silhouette rating scale developed by Collins [190] and adapted by Rand and Resnick [191] was used to assess body size perception and body image dissatisfaction. The scale includes silhouette figures of the same height, with weight ranging from very thin to very obese for boys and girls (Appendix 6). Children were asked to select the figure which they thought most looked like them (perceived own body size), the figure that resembles the way they want to look (preferred self body size), and the figure that they thought was best for a boy or girl to look like (preferred ideal body size for children). The analysis confined to the first two questions.

Dietary assessment was undertaken using the 24-h food ticklist described and validated in (chapter 2). Parents/caregivers were asked to complete the ticklist for three days during a single week, including one weekend day.

Parent questionnaires (Appendix 7) included questions on residential area, family size, and parents' educational level and occupation. Parents were also asked to report the duration of sleep and out of school sedentary, light, moderate, and strenuous activities for their children for a typical week- and weekend day. They were provided with examples of types of activities that would be considered for each category to assist them.

Table 3.1 List of measures obtained

Variable	No. measures	Instrument used
Socio-demographics		
Age, sex, family composition, educational level of parents, parents' occupation		Parent questionnaire
Physical measures		
Height	1	Leicester Portable Height Measure
Weight	1	Soehnle digital scale
Waist, hip, and thigh circumference	2	Tape measure
Skinfold thickness: Biceps, Triceps, Subscapular, Suprailiac	2 (to 4)	Holtain skinfold calliper
Blood pressure	2 (to 3)	Mercury sphygmomanometer
Psychological measures		
Quality of life	1	PedsQL (validated for Farsi)
Body image perception	1	Collin's Pictorial Image Scale (adapted)
Dietary assessment	3 days (including one weekend day)	Food Ticklist
Physical activity	Report of typical activity	Parent questionnaire

Procedures

Standard Operating Procedures were developed (Appendix 8) for all measurements [103;192]. The research team was trained by myself (for measurements on girls) and a male colleague (to go through measurements on boys). The team included three paediatric nurses who undertook all blood pressure, weight and height measurements and 8 nutritionists who undertook all other measures and questionnaires. All the skinfold thickness and circumference measures were undertaken by the same 3 people for consistency.

School visits

The field work was completed between December 2007 and April 2008 with 5 researchers going to a school on each assessment day. Four of these completed measures and questionnaires and the fifth (coordinator) was in charge of checking consent forms and collecting new signed forms, supervising the measurement process and handing over and explaining to children about the parents' questionnaires and food ticklist. Participating children were incentivised by being given simple stationery on the measurement days and educational clocks on returning completed questionnaire packs.

Schools provided the research team with details of parents' educational level and occupation for children who did not return the questionnaires.

3.3.3 Analysis

3.3.3.1 Data management

A data base was created in MS Access 2000 and sample data entry was done in several stages to explore any faults. Data entry was completed by two persons and a data checking protocol was followed (Appendix 3) which showed very few errors (Table 3.2).

Table 3.2 Summary of data entry check results

Data	Total fields (N)	Acceptable range (5%)	Errors (N (%))
Physical and psychological measures	24396	1220	18 (0.07)
Food intake	506370	2531	44 (0.009)
Parents' questionnaire	23484	1174	11 (0.05)

3.3.3.2 Physical measures

Anthropometry

Children were classified to weight categories using BMI Z-score cut-offs recommended by the WHO [121] (Table 3.3). To investigate any relationship between weight status and other measures, either BMI Z-score, as a continuous index, or weight status categories (as below) were used.

Table 3.3 Criteria for weight classification based on cut-off values for BMI z-scores using WHO standard data

Weight category	Z-Scores	Percentile Equivalent
Underweight	BMI < -2SD	-2SD= 2^{nd}
Healthy weight	-2SD ≥ BMI ≤ +1SD	+1SD= 84^{th}
Overweight	+1SD > BMI ≤ +2SD	+2SD= 98^{th}
Obesity	BMI > +2SD	

Other reference standards and definitions for weight status classification in children (WHO 2007, CDC 2000, IOTF, and Iranian references) were also applied to the data and agreement between these for those classified as overweight or obese were compared (Table 3.4). The cut-offs used for categorisation were the 5^{th} (to differentiate between underweight and healthy weight), 85^{th} (healthy weight and overweight) and 95^{th} (overweight and obese) percentiles.

Table 3.4 Suggested cut-offs to classify children to four weight categories

Weight category	**BMI Percentile**	**BMI Equivalent (IOTF)**
Underweight	BMI $<5^{th}$	BMI <17
Healthy weight	$5^{th} \geq$ BMI $< 85^{th}$	$17 \geq$ BMI < 25
Overweight	$85^{th} \geq$ BMI $\leq 95^{th}$	$25 \geq$ BMI ≤ 30
Obesity	BMI $> 95^{th}$	BMI > 30

The mean of two readings were recorded for waist, hip, and thigh circumferences and these were used as continuous variables for analyses.

Skinfold thickness measures from five sites were used to derive total and upper body skinfold thickness measures using the following equations:

Total skinfold thickness= biceps+ triceps+ subscapular+ suprailiac+ thigh

Upper body skinfold thickness= biceps+ triceps+ subscapular

Blood pressure

Systolic and diastolic blood pressure was measured twice and the mean of two readings used for analysis.

3.3.3.3 *Dietary intake*

The mean of three days energy intake including one weekend day was calculated and presented as Kcal/day. Total fruit intake was calculated and presented in grams.

3.3.3.4 *Physical activity level*

The average duration of daily activity in each level category (x) was calculated using the formulae [(minutes of x activity on week days * 6) + (minutes of x activity on weekend days)]/7.

3.3.3.5 *Psychological measures*

<u>Body size perception</u>

Body dissatisfaction was calculated by subtracting ideal self (which picture would you like to look like) from perceived body size (which picture looks most like you). Therefore body dissatisfaction range was from -8 to +8. A negative score indicated that the child perceived him/herself as thinner than ideal and they wish to be fatter, and a positive score means that he/she perceived themselves as more overweight than ideal and they wish to be thinner. Zero indicates children who are satisfied with their size. Body size misperception (misperception of healthy weight) was also calculated based on objectively measured weight categories to differentiate whether satisfaction and dissatisfaction were related to weight status and being a healthy weight. The following definitions were used:

Weight category based on objective measures	**Misperception**	**No misperception**
Underweight	Desire to be thinner+ Satisfied	Desire to be fatter
Healthy weight	Desire to be fatter+ Desire to be thinner	Satisfied
Overweight	Desire to be fatter+ Satisfied	Desire to be thinner
Obese	Desire to be fatter+ Satisfied	Desire to be thinner

Health related quality of life

The PedsQL consists of four domains including physical, emotional, social, and school functioning. Number of items in physical functioning area is 8 and other dimensions have 5 questions each. Applying 3-point scale including 0 (not at all), 2 (sometimes), and 4 (a lot) and transforming the scores to 100, 50, and 0, total scores have been calculated. Psychosocial score was calculated by summing up the items over the number of items answered in the emotional, social, and school functioning scales. Physical health summary score is equal to physical functioning scale score, and total score equals sum of all the items over the number of items answered on all the scales. Maximum score for each domain and total functioning is 100.

3.3.3.6 Socio-demographic status

Parental education level was classified into four categories including "illiterate and primary education", "secondary and incomplete high school", "high school diploma", and " graduates".

3.4 Results

3.4.1 Feasibility and acceptability

A total of 862 invitation packs were distributed to 9 schools. The overall response rate was 37.6%, ranging from around 25% (22.1 to 32.8%) in the higher, 35% in the middle class (23.4 to 52.4), and 65% in the lowest socio-economic districts.

In total 324 signed consent forms were returned and 319 children underwent assessment. Consented children that were not assessed were either absent from school on measurement days (n=4) or were excluded (n=1 because was not able to hear and communicate). Among those parents who consented, 227 returned their questionnaire packs (71.2%), although some of the returned questionnaires were incomplete. The characteristics of those with and without a parent questionnaire were compared, based on available data. The information was obtained from the school for non-responders. There were no differences between children's weight status, school year, nor parents' educational level or working status between responders and non-responders. Questionnaire response rate was higher in girls' compared to boys' schools (74.7% and 67.3% respectively), and in the more deprived (88.9%) compared to the higher (68.1%) and middle class (57.6%) districts.

All children had their height and weight measured, although the protocol was not followed in a handful of cases (e.g. taking off heavy clothes in winter, or ensuring the child had an empty bladder before being weighed). No specific problems were recorded in measuring upper body skinfold (biceps, triceps, and subscapular) and suprailiac skinfold, and less than 0.6% of children refused measurement (because of cold or lack of privacy).

Measurement of thigh skinfold was more difficult and not undertaken for 58 children, mainly because they had no underwear, they refused to takes clothes off, or occasionally inability of the researcher to do the measures (n= 8 where children were overweight). Thigh and hip circumference measures were also not completed for some children (n=43 and 14 respectively) for similar reasons.

Administration of the questionnaires including PedsQL and self image body size perception were uneventful, and all children completed these.

3.4.2 Response rate

Response rate was lower than expected in districts 2 and 6. Therefore, additional boys' school in district 2 and 6 and another girl's schools in district 6 were recruited. A total of 319 children (153 boys and 166 girls) were included in the final sample of those who were measured. Among these, 227 parents returned the parent questionnaire.

Table 3.5 shows the sampling frame and response rates in participating schools. Some students were absent on all measurement dates resulting in the difference between the numbers consented and those measured.

Table 3.5 Sampling frame and response rate in studied schools

Schools	**Total eligible (Year 1 and 2)**	**Number invited**	**Number consented**	**Response rate (% consent among invited)**	**Number assessed**
District 2					
Boys (1)	253	104	28	26.9	23
Boys (2)	297	100	29	29.0	29
Girls (1)	340	134	49	36.6	44
District 6					
Boys (1)	215	54	22	40.7	22
Boys (2)	178	141	33	23.4	33
Girls (1)	89	65	25	38.5	25
Girls (2)	96	84	44	52.4	44
District15					
Boys (1)	253	78	52	66.7	52
Girls (1)	131	82	60	73.2	52
Total	1852	862	342	39.7	324

A total of 957 dietary questionnaires (food ticklist) were sent to parents of 319 children who completed measures, of which 634 questionnaires were returned (66.2%) and 462 sufficiently complete for analysis (72%). The completed questionnaires were checked by a nutritionist (Appendix 3). Data entry was complete for 174 children of whom 131, 26 and 17 had for 3, 2 and 1 days respectively.

3.4.3 Sample characteristics

The socio-demographic characteristics of the study population are presented in table 3.6. In the more deprived district, family size was slightly larger than in the other two districts, though this difference was not statistically significant (P=0.09). There were however, statistically significant differences (P<0.001) between the three districts in relation to parental education and mothers' work status. Most of the mothers in district 15 were housewives and almost one third of mothers in districts 2 and 6 were classified as working mothers.

Table 3.6 Socio-demographic characteristics of the study population by residential district

	Residential district	**2 (affluent)**	**6 (middle)**	**15 (deprived)**	**Total**
Family size (mean± SD)		3.84±0.8	3.90±0.8	4.14±1.1	3.98± 0.9
Fathers' education N (%)	Illiterate, primary education	0(0)	0(0)	16(15.5)	16(5.2)
	Secondary school, incomplete high school	4(4.3)	7(6.3)	45(59.2)	56(18.2)
	High school diploma	24(26.1)	38(33.9)	36(94.2)	98(31.9)
	Graduates	64(69.6)	67(59.8)	6(5.8)	137(44.6)
Mothers' education N (%)	Illiterate, primary education	0(0)	1(0.9)	23(21.7)	24(7.7)
	Secondary school, incomplete high school	3(3.2)	6(5.3)	31(29.2)	40(12.8)
	High school diploma	30(32.3)	51(44.7)	48(45.3)	129(41.2)
	Graduates	60(64.5)	56(49.1)	4(3.8)	120(38.3)
Mothers' working status N (%)	Housewife	59(62.8)	75(63.6)	98(91.6)	232(72.7)
	Clerk	21(22.3)	25(21.2)	1 (0.9)	47 (14.7)
	Teacher	11(11.7)	6 (5.1)	6 (5.6)	23 (7.2)
	Other	3 (3.2)	12 (10)	3 (2.7)	17 (5.4)

3.4.4 Anthropometry

3.4.4.1 Descriptive findings

Table 3.7 shows a summary of all physical measures in boys and girls by district. For most anthropometric measures, girls had slightly lower measures, except for triceps and thigh skinfold which were non-significantly greater in girls compared with boys. Both diastolic ($P<0.001$) and systolic BP ($P=0.07$) were lower in girls compared to boys. In general, all anthropometric measures (but not BP) were lower in children from the more deprived district (district 15) compared to those from other districts. These differences for weight, height, and BMI were statistically significant in girls ($P= 0.003$, 0.003, and 0.005, respectively). In boys, the mean weight and BMI were lower in the deprived area.

Table 3.7 Anthropometric and blood pressure measures in boys and girls by district (all measures are means±SD)

	Boys			Girls			Total	
District (sample size)	**2 (53)**	**6 (51)**	**15 (49)**	**2 (41)**	**6 (67)**	**15 (58)**	**Boys (153)**	**Girls (166)**
Age (month)	88.3±7.7	89.4±7.8	88.2±7.6	91.4±6.8	90.9±7.1	88.9±8.2	88.6±7.7	90.3±7.5
Weight (Kg)	27.3±7.6	27.2±5.8	25.5±5.5	27.2±5.7	27.1±6.8	23.3±4.7	26.7±6.4	25.8±6.1
Height (Cm)	125.4±5.2	126.8±6.8	125.4±6.4	125.8±5.4	126.0±6.8	122.5±7.0	125.8±6.1	124.8±6.7
BMI (Kg/M^2)	17.2±3.6	16.9±2.9	16.0±2.3	17.1±2.8	16.9±3.2	15.4±2.3	16.7±3.0	16.4±2.9
BMI Z-scores	0.44±1.05	0.26±1.3	-0.06±1.1	0.34±1.2	0.19±1.4	-0.38±1.16	0.22±1.2	0.03±1.3
Waist circumference (Cm)	58.7±9.7	58.9±8.2	56.0±6.6	58.4±10.6	57.6±8.5	53.8±6.8	57.9±8.4	56.5±8.7
Hip circumference (Cm)	67.1±8.7	66.9±7.0	64.8±6.4	67.1±6.7	67.3±7.8	62.7±5.9	66.3±7.5	65.6±7.2
Thigh circumference (Cm)	36.6±6.3	36.3±4.4	35.1±4.6	36.7±4.9	37.0±5.2	34.8±4.3	36.0±5.2	36.2±4.9
Biceps skinfold (mm)	5.8±2.1	6.3±3.3	5.5±2.5	6.6±2.6	6.2±2.5	5.1±1.5	5.9±2.7	5.9±2.3
Triceps skinfold (mm)	7.5±2.5	7.7±4.7	6.5±2.7	10.9±3.8	9.5±3.8	7.7±2.3	7.3±3.4	9.3±3.5
Suprailiac skinfold (mm)	7.2±4.8	8.4±5.8	6.0±3.6	7.8±3.9	7.5±4.6	5.4±2.5	7.2±4.9	6.8±3.9
Subscapular skinfold(mm)	8.3±6.1	8.7±5.3	6.8±3.4	9.3±5.7	8.2±4.4	6.3±2.1	7.9±5.1	7.8±4.3
Thigh skinfold (mm)	14.7±5.3	14.1±6.6	12.1±5.0	16.7±4.6	17.9±6.1	14.1±4.7	13.6±5.8	16.2±5.5
Systolic BP (mm Hg)	94.3±11.8	102.7±9.0	98.3±10.3	94.6±13.3	92.1±11.7	93.0±7.1	98.4±10.9	93.0±10.7
Diastolic BP (mm Hg)	62.1±8.3	71.7±9.5	64.0±6.9	60.3±8.0	60.7±7.5	60.0±5.4	66.0±9.2	60.4±6.9

3.4.4.2 *Overweight and obesity*

The weight status of the study children by socio-demographic characteristics is summarised in table 3.8.

Table 3.8 Children in each weight status category* by gender, grade, and residential area

	Underweight	**Healthy weight**	**Overweight**	**Obese**
	Number (%)			
Boys	3 (2.0)	105 (68.6)	25 (16.3)	20 (13.1)
Girls	5 (3.0)	116 (69.9)	26 (15.7)	19 (11.4)
Grade 1 (5-7 yr)	2 (1.3)	111 (72.5)	21 (13.7)	19 (12.4)
Grade 2 (6-8 yr)	6 (3.6)	110 (66.3)	30 (18.1)	20 (12.0)
District 2 (affluent)	0 (0)	58 (61.7)	23 (24.5)	13 (13.8)
District 6 (middle)	5 (4.2)	74 (62.7)	19 (16.1)	20 (16.9)
District 15 (deprived)	3 (2.8)	89 (83.2)	9 (8.4)	6 (5.6)
Total	8 (2.5)	221 (69.3)	51 (16.0)	39 (12.2)

* Categories according to WHO reference charts

Overall 28.2% (95% CI 23.3-33.1) of children were classified as overweight or obese. Prevalence of overweight or obesity was slightly higher among boys compared to girls, and in the older compared to the younger age group, though these differences were not statistically significant. The prevalence of overweight and obesity showed an increasing trend from deprived to affluent districts (P=0.001).

Table 3.9 Children in four weight categories by age- and sex specific BMI percentiles according to WHO, CDC, IOTF, and Iranian references

	Number (%) children in each weight status category by reference standard definitions			
Weight category	**WHO**	**CDC**	**IOTF**	**Iran**
Underweight	16 (5.0)	27 (8.5)	8 (2.5)	0(0)
Healthy weight	214 (67.1)	214 (67.1)	238 (74.6)	195 (61.1)
Overweight	34 (10.7)	40 (12.5)	44 (13.8)	59 (18.5)
Obese	55 (17.2)	38 (11.9)	29 (9.1)	65 (20.4)

Using the various reference data for defining weight status resulted in different proportions being classified as overweight or obese, ranging from 38.9% using the Iran charts to 22.9% for the IOTF definitions (Table 3.9). The IOTF and CDC definitions were most similar in the proportions classified to each category. Compared to the WHO reference standard, the Iran charts classified 11% more and the CDC and IOTF 12.2% and 13.2% fewer respectively as overweight or obese.

There was high agreement for weight status classification between definitions. Agreement between the WHO and CDC (Kappa coefficient 0.76), IOTF (Kappa coefficient 0.67), and Iran (Kappa coefficient 0.75) references were all statistically significant ($P<0.001$). The level of agreement between definitions was similar between boys and girls and between year 1 and 2 children.

For the remainder of the analyses, the WHO definition was used when weight status was analysed as a categorical variable.

3.4.5 Dietary intake

Table 3.10 shows the total energy intake on up to each of 3 measurement days and the mean for all days, in boys and girls, as derived from the food ticklist. Although total energy intake was slightly higher among boys compared with girls for most days, the overall mean intake was not significantly different between genders. Energy intake on week days (1817.3± 740.9 Kcal) however, was significantly lower than on the weekend day (1996.7± 715.7 Kcal) ($P=0.03$).

Table 3.10 Mean energy intake according to number of measurement days in boys and girls

Number of measurement days	Energy (Kcal) Boys		Girls		Total	
	N	**Mean± SD**	**N**	**Mean± SD**	**N**	**Mean± SD**
One day *	71	2143.6±908.3	84	1868.8±712.1	155	1994.7±816.8
Two days	74	1877.3±677.0	82	1960.0±923.0	156	1920.7±814.1
Three days	69	1930.1±757.4	82	1867.8±610.8	151	1896.2±680.1
Mean	79	1984.6±724.0	95	1918.0±615.3	174	1948.3±665.5

* P=0.04

Mean energy intake was slightly higher in the deprived area (2018.4±751.06 Kcal) compared to the other districts (1883.0±575.1 and 1945.2±754.4 Kcal), however; the difference was not statistically significant.

There was a trend for increasing energy intake with increasing weight status, although this was not statistically significant (Table 3.11) and remained non-significant after adjustment for age, gender, and residential area

Table 3.11 Energy intake by weight status categories

Weight category	**Underweight**	**Healthy weight**	**Overweight**	**Obese**
Energy (Kcal)	4 (1767.4±301.3)	117 (1929.4± 597.0)	28 (1958.4 ± 879.8)	25 (2054.2 ± 754.4)

The correlation between mean of energy intake and BMI Z-score was not statistically significant.

Mean of fruit intake was 339.4± 228.5 g. The average fruit intake in the three residential areas was roughly similar. It was similar between boys and girls, but slightly higher in overweight (351.97± 217.8 g) compared to non-overweight (332.90± 235.0 g) children.

3.4.6 Physical activity and sleeping

A summary of the parent reported duration of sleeping and time spent outside of school hours doing other levels of PA are presented in table 3.12.

A minimum of 60 minutes of MVPA has been recommended for children to have healthful living [193;194]. About 60% of children for whom PA was reported, achieved the recommended level; however, the mean of vigorous PA duration was 24 minutes/day. On the other hand, parents did not report on PA at school thus underestimating total PA level in the studied population.

Table 3.12 Reported sleep duration and time spent in different levels of physical activity (hours/day)

Activity	Boys		Girls		Total	
	N	Mean± SD	N	Mean± SD	N	Mean± SD
Sleeping	83	9.4±1.0	105	9.6±1.0	188	9.5±1.0
Sedentary	78	5.4±2.5	101	5.3±2.5	179	5.4±2.5
Light	78	1.2±0.8	101	1.6±1.5	179	1.4±1.3
Moderate	77	1.2±1.0	105	1.1±1.1	182	1.1±1.09
Vigorous	81	0.4±0.8	107	0.4±0.9	188	0.4±0.9
Moderate/Vigorous	74	1.6±1.4	104	1.5±1.6	178	1.6±1.5
Total	66	17.5±3.1	94	18.1±3.5	160	17.8±3.3

There was little difference in reported levels of sleep and activity between boys and girls, except that girls spent significantly longer time undertaking light activities (P=0.02). There was also no real difference in reported sleep or activity levels by weight status except that hours of MVPA were much lower in the underweight compared to the other weight status groups (Table 3.13).

Table 3.13 Reported sleep duration and time spent in different levels of physical activity in each weight status category (hours/day)

Activity	Underweight	Healthy weight	Overweight	Obese
Sleeping	10.1±0.99	9.44±1.03	9.43±0.85	9.76±0.83
Sedentary	4.05±1.11	5.29±2.41	5.89±2.89	5.46±2.66
Light	1.61±0.94	1.45±1.44	1.15±0.70	1.43±0.75
Moderate	0.78±0.34	1.09±1.02	1.35±1.00	1.28±1.62
Vigorous	0.09±0.23	0.39±0.76	0.51±1.26	0.37±0.82
Moderate/Vigorous	0.78±0.34	1.50±1.40	1.87±1.55	1.68±2.08
Total	17.03±1.90	17.67±3.33	18.54±3.70	18.10±3.17

The reported sleep or activity levels were adjusted for age, sex, residential area, dietary intake, and total numbers of activity hours. No significant relationship between weight status and PA level was observed (Table 3.14).

Table 3.14 Odds ratio (95% CI) for being overweight compared to non-overweight according to sleep duration and time spent in different levels of physical activity

Activity (hours)	OR for overweight (95% CI) Unadjusted	OR for overweight (95% CI) Adjusted
Sleeping	1.10 (0.80-1.53)	1.35 (0.83-2.20)
Sedentary/ light	1.02 (0.91-1.14)	0.83 (0.64-1.09)
Moderate/vigorous	1.14 (0.92-1.41)	1.13 (0.86-1.51)

Correlation between sedentary/light or MVPA and waist circumference, blood pressure, and skinfold thickness was assessed. There was an indirect correlation between diastolic blood pressure and average hours of sedentary/light activities (P=0.049) which did not remain after adjustment for age, sex, residential district, and BMI Z-score. The significant positive correlation between average hours of MVPA and thigh circumference (β=0.3, P=0.005) remained after adjustment for age, sex, residential district, and BMI Z-score (β= 0.08, P=0.05).

3.4.7 Body size perception and body image dissatisfaction

Perception of body size

The mean of self image score for the total sample was 4.31± 1.4 which was similar across ages, sexes, and residential districts. The score was higher in overweight children than their peers (4.62± 1.6 vs 4.04± 1.6, P=0.003) which remained significant after adjustment for age, sex, and district.

Perception of ideal self

As shown in table 3.15 regardless of weight status, more girls perceived themselves as more overweight than ideal compared to boys and more boys compared to girls were satisfied with their current size. However, the differences were not statistically significant (P=0.09).

Table 3.15 Satisfaction with body size in boys and girls

	Boys	**Girls**	**Total**
	N (%)		
Perceived more overweight than ideal (positive scores)	43 (28.1)	65 (39.6)	108 (34.1)
Perceived thinner than ideal (negative scores)	50 (32.7)	47 (28.7)	97 (30.6)
Satisfied (score=0)	60 (39.2)	52 (31.7)	112 (35.3)

Significant difference was observed in body dissatisfaction among weight categories (P<0.001) (Table 3.16). Obese and overweight children compared to the others, perceived themselves as more overweight than ideal. None of the underweight children perceived themselves as more overweight than ideal, rather two thirds perceived themselves as thinner than ideal. Among healthy weight children around a quarter perceived themselves as more overweight and around a third as thinner than ideal whilst the highest proportion (39.3%) were satisfied with their weight status. More than half of overweight children (54.9%) and about one third of obese children (28.2%) were either satisfied with their current weight status or perceived themselves as thinner than ideal.

Table 3.16 Satisfaction with body size in four weight categories

	Weight status				
	Underweight	**Healthy weight**	**Overweight**	**Obese**	**Total**
	N (%)				
Perceived more overweight than ideal (+)	0 (0)	57 (26.0)	23 (45.1)	28 (71.8)	108 (34.1)
Perceived thinner than ideal (-)	6 (75.0)	76 (34.7)	11 (21.6)	4 (10.3)	97 (30.6)
Satisfied	2 (25.0)	86 (39.3)	17 (33.3)	7 (17.9)	112 (35.3)

Table 3.17 Satisfaction with body size by weight status and gender

	Boys		**Girls**		**Total**	
	Non-overweight	**Overweight**	**Non-overweight**	**Overweight**	**Non-overweight**	**Overweight**
	N (%)					
Perceived more overweight than ideal (+)	22 (20.4)	21 (46.7)	35 (28.9)	30 (66.7)	57 (25.1)	51 (56.7)
Perceived thinner than ideal (-)	40 (37.0)	10 (22.2)	42 (35.3)	5 (11.1)	82 (36.1)	15 (16.7)
Satisfied	46 (42.6)	14 (31.1)	42 (35.3)	10 (22.2)	88 (38.8)	24 (26.7)

Whilst all overweight children were more likely to correctly perceive their body size (Table 3.17), girls were more likely to do so compared with boys (66.7% and 46.7% respectively). After adjustment for age, residential area, and sex, there remained a statistically significant relationship between being overweight based on BMI, compared to being non-overweight, and perception of being more overweight than ideal (adjusted OR 2.9; 95% CI: 2.08-7.2; P<0.001).

3.4.8 Health related quality of life

Perceived physical, emotional, social, and educational functioning, as well as psychological and total score, was recorded using the Iranian translation of the PedsQL, with higher scores indicating higher quality of life (Table 3.18). Boys' scores in all dimensions were higher than for girls. After adjustment for age, residential district, and weight status, the difference between boys and girls was statistically significant for physical (P=0.007) and emotional function (P=0.006) and of borderline significance for school (P=0.06) and psychological (P=0.08) functions.

Table 3.18 Perceived physical, emotional, social, and school functioning scores in boys and girls based on responses to PedsQL

Dimension	**Score (Mean± SD)**			**P-value for difference in mean scores**
	Boys	**Girls**	**Total**	
Physical	81.5± 11.5	77.5± 12.7	79.4± 12.3	P=0.004
Emotional	77.7± 18.7	71.0± 21.4	74.2± 20.4	P=0.003
Social	76.8± 18.6	76.3± 19.3	76.5± 18.9	NS
School	82.3± 15.2	79.0± 15.6	76.5±18.9	NS (P=0.06)
Psychosocial	78.7± 14.6	75.5± 15.6	77.0± 15.2	NS (P=0.06)
Total	79.8± 11.9	76.5± 13.4	78.0± 12.8	P=0.02

The total score was similar between non-overweight and overweight children, but non-overweight children had slightly (non-significant) higher scores in all domains except for physical functioning (Table 3.19). The difference in physical functioning by weight status was statistically significant (P=0.03), and remained so after adjustment for age, sex, and residential district (adjusted OR 1.03; 95% CI: 1.01-1.06; P=0.006).

Table 3.19 Perceived physical, emotional, social, and school functioning score by weight status

Dimension	**Score (Mean± SD)**	
	Non-overweight	**Overweight**
Physical	78.49± 12.6	81.8± 11.2
Emotional	74.6± 20.7	73.1± 19.7
Social	76.8± 19.6	75.8± 17.2
School	81.0± 16.0	79.7± 14.1
Psychosocial	77.3± 15.7	76.2± 13.8
Total	78.0± 13.2	78.0± 11.7

Emotional (P=0.006), social (P=0.01), educational (P=0.001), psychological (P=0.001), and total (P=0.001) score were all significantly higher in the deprived district compared to the middle and affluent areas. After adjustment for age, sex, mothers' working status, parents' educational level, and weight status, a statistically significant relationship between residential district and emotional (P=0.005, β=0.2), educational (P=0.004, β=0.2), psychological (P=0.004, β=0.2), and total (P=0.004, β=0.2) scores were observed.

3.4.9 The relationship between BMI and other physical measures

3.4.9.1 Skinfold thickness, waist, hip, and thigh circumference

Skinfold thickness was measured at five sites including 3 upper body sites (biceps, triceps, subscapular) and two lower body sites (suprailiac and thigh). The sum of all skinfolds was higher in girls compared to boys, and particularly triceps skinfold in the upper body and thigh skinfold in the lower body were significantly greater (P<0.001). On the other hand, waist and hip circumferences were slightly higher in boys compared to girls, although the differences were not statistically significant (Table 3.20).

Table 3.20 Correlation between BMI Z-scores and skinfold thickness and other measures of body fat in boys and girls

Measure	Boys		Girls		Total	
	N (mean± SD)	**r**	**N (mean± SD)**	**r**	**N (mean± SD)**	**r**
Biceps (mm)	151 (5.9± 2.7)	0.62	164 (5.9± 2.3)	0.67	315 (5.9± 2.5)	0.64
Triceps (mm)	151 (7.3± 3.4)	0.64	162 (9.3± 3.5)	0.72	313 (8.3± 3.6)	0.63
Subscapular (mm)	153 (7.9± 5.1)	0.69	163 (7.8± 4.3)	0.69	316 (7.9± 4.7)	0.68
Sum of upper body skinfold (mm)	151 (21.1± 10.2)	0.73	162 (22.9± 9.4)	0.75	313 (22.07± 9.8)	0.72
Supra iliac (mm)	151 (7.2± 4.9)	0.69	163 (6.8± 3.9)	0.79	314 (7.0± 4.4)	0.73
Thigh (mm)	122 (13.6± 5.8)	0.75	139 (16.2± 5.5)	0.78	261 (14.9± 5.8)	0.70
Sum of lower body skinfold (mm)	130 (20.7± 9.8)	0.76	131 (22.6± 8.7)	0.79	261 (21.7± 9.3)	0.74
Sum of all skinfold (mm)	130 (41.6± 19.2)	0.74	131 (44.1± 16.1)	0.78	261 (42.9± 17.7)	0.73
Waist circumference (cm)	153 (57.9±8.4)	0.80	165 (56.5±8.7)	0.79	318 (57.2±8.6)	0.80
Hip circumference (cm)	142 (66.3±7.5)	0.80	163 (65.6±7.2)	0.84	305 (66.1±7.3)	0.82
Thigh circumference (cm)	131 (36.0±5.2)	0.82	145 (36.2±4.9)	0.86	276 (36.1±5.0)	0.83

The relationship between BMI Z-score and the various skinfold and other measures is presented in Table 3.20. All correlations were highly statistically significant (P<0.001) with partial correlation coefficients ranging from 0.63 for triceps skinfold to 0.73 for suprailiac skinfold. The correlation coefficient was greatest for the sum of skinfolds (r=0.73), particularly for the lower body measures, and was higher in girls (r=0.79) compared to boys (r=0.74).

Correlation was higher for the circumference measures than for skinfold measures, with the highest correlation being with thigh circumference for both boys (r=0.82) and girls (r=0.86).

The correlation between skinfold thickness and circumferences and BMI in non-overweight and overweight children was also assessed (Table 3.21). The mean of all measures were higher in the overweight compared to non-overweight groups, and for both groups the skinfold and waist measures were significantly correlated with BMI Z-score ($P<0.01$). However, the correlation coefficients for all skinfold measures and waist circumference were higher for overweight compared to non-overweight children, whereas correlations for hip and thigh circumference differed little by weight status.

Table 3.21 Relationship between mean skinfold thicknesses and circumferences and BMI Z-score by weight status

Measure	**Correlation**			
	Overweight		**Non-overweight**	
	mean± SD	**r**	**mean± SD**	**r**
Skinfold thickness				
Biceps	8.4± 2.9	0.5	4.9± 1.4	0.3
Triceps	12.0± 4.0	0.4	6.9± 2.2	0.3
Suprailiac	12.2± 5.2	0.7	5.1± 1.7	0.5
Subscapular	13.0± 6.1	0.7	5.8± 1.3	0.5
Thigh	21.7± 5.3	0.5	12.8± 4.0	0.4
Circumference				
Waist	67.5± 7.7	0.7	53.1± 4.4	0.5
Hip	74.5± 6.6	0.7	62.6± 4.2	0.7
Thigh	41.9± 4.9	0.6	34.0± 3.0	0.7

3.4.9.2 Blood pressure

The mean systolic and diastolic BP was 95.1 mmHg (range 69.0 to 125.0) and 63.1 mmHg (range 45.0 to 90.0) respectively, being significantly higher in boys compared to girls (mean±SD of 98.4±10.9 vs 93.0±10.7 for systolic and 66.1±9.2 vs 60.4±6.9 for diastolic respectively).

Blood pressure measures by weight status category are presented in table 3.22. There was a statistically significant increasing trend in systolic and diastolic blood pressure by increasing weight status (ANOVA, $P<0.001$).

Table 3.22 Mean of systolic and diastolic blood pressure in weight categories

Blood Pressure	**Mean ± SD**			
	Underweight	**Healthy weight**	**Overweight**	**Obese**
Systolic	90.9± 7.4	94.1± 9.9	96.8± 13.3	104.1± 11.6
Diastolic	64.6± 11.9	61.9± 7.8	63.3± 8.7	69.1± 9.6

After adjustment for age, sex, height, and residential district, a statistically significant relationship was observed between overweight and increasing systolic and diastolic blood pressure. For every unit increase in Z-score, the systolic and diastolic blood pressure increases by 2.0 mmHg ($P<0.001$, 95% CI 1.05-2.95) and 1.05 mm Hg ($P<0.004$, 95% CI 0.33-1.76), respectively.

Blood pressure correlation with body fat measures

There was a significant positive correlation between systolic and diastolic blood pressure and BMI Z-scores, waist circumference, and skinfold measures. For all measures, the correlation coefficients were greater for boys. The highest correlation was seen for waist circumference. The correlation between skinfold and blood pressure is approximately the same as BMI Z-score and blood pressure (Table 3.23).

Table 3.23 Correlation between blood pressure and measures of body fat by gender

	Pearson correlation					
	Boys		Girls		Total	
	Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic
BMI Z-score	0.34***	0.24**	0.21*	0.16**	0.28***	0.21***
Waist	0.45***	0.35**	0.21**	0.14	0.32***	0.25***
Upper skinfold	0.33***	0.29**	0.20**	0.14	0.23***	0.22**
Lower skinfold	0.35***	0.34***	0.17*	0.22**	0.22***	0.22***

***P<0.001 **P<0.01 *P<0.05

Socio-demographic factors associated with weight status

Weight status differed significantly between children from different districts (Table 3.24). Whilst 83.2% of children in district 15 (deprived area) were classified as healthy weight, only around 60% of children from the high and middle class were in this range. The prevalence of overweight and obesity combined in the less deprived areas was double that observed in the deprived district, whilst obesity rates were between 2.5 to 3 times greater.

Table 3.24 Variation in weight status category by district, as a proxy for deprivation

	District			
Weight category	**2 (affluent)**	**6 (middle)**	**15 (deprived)**	**Total**
Underweight	0 (0)	5 (4.2)	3 (2.8)	8 (2.5)
Healthy weight	58 (61.7)	74 (62.7)	89 (83.2)	221 (69.3)
Overweight	23 (24.5)	19 (16.1)	9 (8.4)	51 (16.0)
Obese	13 (13.8)	20 (16.9)	6 (5.6)	39 (12.2)

No difference was found between weight status categories and family size, and mother's working status. However, prevalence of overweight was higher among children whose mothers (P=0.003) were more educated and similar non-significant was seen in relation to father's educational level (Table 3.25).

Table 3.25 Parents' educational level in non-overweight and overweight children

Level	Father		Mother	
	Non-overweight	**Overweight**	**Non-overweight**	**Overweight**
Illiterate, primary education	14 (87.5)	2 (12.5)	19 (79.2)	5 (20.8)
Secondary school, incomplete high school	42 (75.0)	14 (25.0)	32 (80.0)	8 (20.0)
High school diploma	73 (74.5)	25 (25.5)	101 (77.7)	29 (22.3)
Under- and postgraduate	91 (66.4)	46 (33.6)	71 (59.7)	48 (40.3)

Table 3.26 shows the relationship between socio-economic factors, energy intake, and duration of MVPA and weight status in a multivariate model. Model 1 includes age, sex, and residential area. Educational level of parents was added in model 2. In model 3 and 4 average energy intake and level of MVPA were sequentially included.

The number of people included in the analyses reduced in each model because of limited data availability. The increased risk of overweight in more affluent areas was observed in all models and the OR remained relatively stable. The relationship between parental education and weight status was less stable, but no statistically significant trends were observed. Neither energy intake nor duration of MVPA was related to weight status in fully adjusted model.

Table 3.26 Odds ratio (95% CI) for being overweight compared to non-overweight in a multivariate model

		Model 1 (n=319)	**Model 2 (n=303)**	**Model 3 (n=167)**	**Model 4 (n=163)**
Age		1.03 (0.69-1.54)	1.23 (0.80-1.90)	1.68 (0.90-3.13)	1.55 (0.77-3.12)
Sex	Girl	1.00	1.00	1.00	1.00
	Boy	1.07 (0.64-1.78)	1.15 (0.67-1.97)	1.29 (0.63-2.66)	1.58 (0.70-3.53)
Residential area	Deprived	1.00	1.00	1.00	1.00
	Middle	3.02 (1.56-5.90)	4.26 (1.60-11.35)	3.40 (0.91-12.72)	4.44 (0.74-26.52)
	Affluent	3.77 (1.90-7.51)	5.13 (1.85-14.20)	3.42 (0.87-13.40)	5.41 (0.91-32.19)
Mother's educational level	Under- and post graduate	-	1.00	1.00	1.00
	High school diploma	-	0.49 (0.25-0.96)	0.36 (0.15-0.89)	0.45 (0.17-1.24)
	Secondary school, incomplete high school	-	0.33 (0.09-1.20)	0.24 (0.05-1.24)	0.29 (0.03-2.75)
	Illiterate and Primary	-	0.82 (0.18-3.72)	0.13 (0.01-1.98)	0.15 (0.01-4.16)
Father's educational level	Under- and post graduate	-	1.00	1.00	1.00
	High school diploma	-	1.29 (0.65-2.57)	1.43 (0.56-3.61)	1.34 (0.47-3.82)
	Secondary school, incomplete high school	-	3.53 (1.14-10.95)	6.80 (1.36-33.93)	4.47 (0.50-39.77)
	Illiterate and Primary	-	1.51 (0.21-10.86)	4.97 (0.27-91.51)	9.25 (0.26-331.01)
Energy intake		-	-	1.00	1.00
MVPA		-	-	-	1.21 (0.94-1.56)

3.5 Discussion

The study showed that overweight and obesity is common among young school age children in Tehran, with an overall prevalence of 28% at the age of 7, and up to 38.3% in more affluent areas. Even in this relatively young age group, overweight is associated with higher blood pressure, an important marker of cardiovascular health. Although most children correctly perceived their weight status, misperception was common, particularly among healthy and overweight children. Of note, there was no relationship between weight status and parent reported sleep duration or PA level, and no evidence of lower quality of life scores among overweight children in this sample.

3.5.1 Prevalence of weight problem

The absolute value for prevalence of obesity varied according to the definition used and cut-offs applied. Nevertheless, even the most conservative estimate based on the CDC cut-offs, show that over 22% of children were either overweight or obese. Whichever definition was used, the prevalence of underweight was negligible, even in the most deprived district. In the absence of prognostic data, there is no consensus on which cut-offs are most appropriate for defining overweight/obesity in child populations. In terms of surveillance and monitoring of trends, it is important to apply the same single standard reference criteria to allow comparability. Similarly, the IOTF cut-offs are probably most useful to allow international comparisons. However, there are merits and disadvantages to any of the cut-offs, and it is difficult to choose a single definition over another for a given population.

The sampling procedure used for this study allows us to obtain a relatively precise estimate of the prevalence of overweight and obesity among young school age children in Tehran. Using the WHO criteria [121], we found that over a quarter of 7 yr in Tehran were overweight or obese, and that the prevalence was slightly higher among boys compared to girls, and considerably greater in the more affluent compared to the more deprived districts.

Global statistics on childhood overweight shows that in the US and some European countries including England, Northern Ireland, Germany, and Denmark, the prevalence is almost similar in boys and girls younger than 17 yr. However, in Mexican American children and a range of Asian countries including Iran, India, Korea, China, and Japan the prevalence is higher among boys [7;13;23;26;35].

The contribution of low PA levels to the development of childhood obesity is very likely [195] and limited PA opportunity for girls in Tehran, as discussed in chapter 4, might partly explain the higher level of sedentary activities in girls and higher level of vigorous PA in boys reported in this study. Moreover, cultural norms which expect girls not to participate in out-door activities and traditional sex-role divisions [196] could affect total energy expenditure in young children.

The prevalence estimate observed in this study is consistent with findings from previous prevalence studies in Iran [7;37;38;197]. The prevalence of obesity among young children in Tehran is also similar to the global-western pattern [51-55;198]. However, the lower prevalence of obesity in deprived areas observed in this study is not universal. For example, the relationship between the SES and risk of obesity is reverse among children from the US and UK [25;26;199] with obesity being related to deprivation, whereas other studies in developing countries have had findings similar to this study, obesity being more common in children come from more affluent backgrounds [199;200].

In this study we also found that higher level of mother's education was associated with increased risk of obesity, although this effect was not significant in the multivariate analysis. Whilst parental education may be a proxy for SES and affluence, this relationship may also be mediated through other means. Individuals with higher levels of education might have busier jobs which limit their time to provide healthy food options and activities for their children [201]. Previous studies among adolescent boys in Tehran and children from other developing countries showed that children of more educated and affluent parents are more likely to be overweight [202;203] than offspring of less educated parents. However, studies from developed countries show the reverse [26;204]. It is likely that a higher level of education results in a higher level of concern about child nutrition, which is translated to different behaviours depending on the environment where they live. For example, fear from underweight still exists in developing communities (as discussed in findings from focus groups), leading to a higher risk of overnutrition among educated well-off families. However, in the multivariate model, the only factor that was clearly related to weight status was residential district.

Underweight is reported as a persistent issue alongside the emerging problem of obesity in some developing countries [205;206]. However; in this study, underweight was not prevalent and rates were negligible, even in the more deprived areas.

3.5.2 Dietary intake

Mean energy intake was slightly higher in boys compared with girls, in overweight compared to non-overweight children, and in more deprived compared to more affluent districts, though none of these differences were statistically significant. Furthermore, no significant relationship exists between energy intake and BMI Z-scores.

The mean total daily energy intake of children (1948.3± 665.5 Kcal) was lower than the recommended levels by the FAO (Food Agriculture Organization)/WHO (2040.8± 483.7 Kcal), but was higher than the values recommended by the Institute of Nutrition of Central America and Panama and the Committee on the Scientific Evaluation of Dietary Reference Intake for US and Canadian children [207;208]. The 1985 FAO/WHO recommendations have been questioned because of the increasing trend in prevalence of childhood obesity and since the introduction of valid methods for energy needs assessment methods which were unavailable in early 1980s [207]. The observed difference in energy intake between boys and girls in this study was lower than that expected and recommended by available guidelines [207-209].

The lack of significant energy intake differences by weight status in this study is similar to findings from another study among year 1 Tehrani children [170]. It is likely that obese children consume more energy than lean children as a group [210] possibly because of their higher requirement [211]. As a cross-sectional measure, the present study can not explain whether overweight children have a higher energy intake because of higher requirements or whether high energy consumption was the cause of their obesity. Moreover, the contribution of food intake and dietary pattern to childhood obesity is not clear [212-214].

The validation of the ticklist for estimating total energy intake in children was demonstrated. However, the limitation of using a 24-h food diary as the reference standard for the validation study should be acknowledged. Using DLW as the reference method, misreporting of energy intake, mainly overestimation, has been documented in population of children whose mothers completed semi-quantitative FFQ regardless of weight status [162]. Such misreporting might dilute any true association between energy intake and weight children.

The difference in energy intake between working- and weekend-days was about 180 Kcal. Traditionally in Tehran, young families visit their parents on weekends to have Friday lunch which tends to be a larger meal with a variety of dishes and desserts. This could explain the higher energy intake observed on weekend days.

Higher levels of energy intake in the deprived area might reflect higher consumption of high calorie low nutrient dense foods which is more common in households from lower socio-economic backgrounds [6]. However, the lower prevalence of overweight and obesity in this area again highlights the lack of consistent relationship between energy intake and obesity. As discussed above, it may also reflect limitations of the dietary intake assessment method, or the cross-sectional design of the study. Despite its limitations, the dietary assessment method was feasible to apply, and would be a useful tool for longitudinal studies and trials.

3.5.3 Physical activity

In this study only 60% of children achieved the recommended minimum of one hour of MVPA per day, which is lower than that reported in many international studies of children of this age [215;216] where PA has been measured objectively. The lower reported activity observed here may be because any activity during school hours was not reported and so the total duration of MVPA may be underestimated. However, children spend a relatively short time in school in Iran (about 5 hours), and there is limited opportunity for active play during the school day. We also used parental proxy report rather than objective measures, which may have affected the results. However in general parents tend to over-report their children's PA levels. On the other hand this may reflect reality as cultural norms also influence PA in children, and several studies have reported higher levels of PA among Caucasian compared to Asian, African-American, and Hispanic children [195;217].

There was no apparent relationship between PA levels and weight status and with measures of body fat in this study. Other studies which used parent questionnaires to assess leisure PA in children also did not identify significant differences between obese and non-obese children [218]. PA interventions are promising in improving body composition; however, findings on the role of PA in preventing childhood obesity are not consistent [195;217;219]. PA needs to be investigated in longitudinal studies to evaluate body fat changes during the growth process [195]. Moreover, habitual PA might better identify differences between obese and healthy weight children than PA records [219]. The cross-sectional design of the study along with applying subjective measure of out of school PA for a typical day could mask the relationship between PA and weight status and a range of direct measures of fatness including waist circumference and skinfold thickness which have been considered as more appropriate measures for this purpose [219].

Sleep duration has been shown to correlate with BMI in other populations of children and adult which is likely to be hormone mediated [220-224]. We found no relationship between sleep duration and BMI. About a third of children (35.4%) were classified as short sleepers (sleep less than 10 hours/day) [221]. Overall, sleep duration in this child population is lower than that observed in many western populations, where most previous studies have been undertaken (mean 9, rather than 10 hours) [225;226]; however, sleep duration among Asian children has been reported as lower by about 1 hour compared to their US counterparts [227]. Sleep duration including napping in the day time was subjectively measured, which may explain the lack of association observed in this study.

3.5.4 Body size perception and body image dissatisfaction

We found that in general about one third of children were satisfied with their perceived body size while 70% classified as healthy weight based on their BMI. Girls were more likely to be dissatisfied with their body size and to perceive themselves as more overweight than ideal. Despite this, body size misperception was relatively low, and most overweight children did perceive their body size as large.

Previous studies which were mainly in older children, showed associations between weight status and body dissatisfaction [228-231]. The finding that girls generally selected smaller figures than boys for their ideal size has been reported by other investigators

[198;231] and a difference in body dissatisfaction between boys and girls has been shown in older children which might refer to boys' concern for being strong and muscular [45;230;232]. The present study suggests that the association between weight status and body image is established at a young age in both sexes and sex differences could be already apparent in young children.

Moreover, about half of overweight children perceived themselves as either healthy weight or thinner than ideal. The influence of media as well as family and peers on body image has been reported for older children [233-235] . Findings of our focus groups with parents showed a cultural preference for heavier children in Iranian society, which may explain this finding and be one of the contributors to childhood obesity.

There is evidence that both exposure to obesity in the family and high levels of obesity among school peers are independently associated with higher rate of obesity underestimation by young children [45]. The considerable high prevalence rate of overweight and obesity among Tehrani adult population (31.3% in men and 41.9% in women) [14] as well as alarming prevalence of overweight and obesity in school aged children in Tehran [14;37] could also be a contributor to the noticeable range of body size underestimation in the present study.

3.5.5 Health related quality of life

The overall quality of life score among children in this study is similar to the scores of healthy weight children in other studies [236;237]. In almost all domains, quality of life scores did not significantly differ by weight status. This finding differs from those reported in most other studies, which show that generally overweight children have lower scores for a range of health related functioning [60;236-240]. However, the effect of obesity on quality of life score seems to be greater in clinically obese children [237;241]. These might partly explain why we did not identify significant difference between overweight and non-overweight in this sample of young children. Furthermore, social norms might contribute to these findings. Parent-proxy reported scores was not included in the study, but social preference for heavier children may influence perceived quality of life. The other possibility is that overweight children have adapted to their current health status and have not experienced a healthier state [237].

In this study we found that quality of life scores were generally higher among children from the more deprived district compared to the other areas. This suggests that living in traditional context is likely to provide children with higher level of emotional, educational, and psychological confidence which needs further investigation.

In this study we found that quality of life scores were higher in all domains among boys compared with girls. This sex difference has not been reported in previous studies. Only one study among children and adolescents found a slightly higher score among boys, but this was limited to physical functioning domain [238].

3.5.6 Physical measures

Systolic and diastolic blood pressure were significantly positively correlated with BMI Z-score and were higher in boys compared to girls and in overweight compared to healthy weight children even after adjustment for potential confounding variables. Systolic and diastolic blood pressure were also positively correlated to waist circumference and skinfold measures.

Earlier studies in Tehran showed that at similar height, level of systolic and diastolic blood pressure is higher in boys than in girls as young as 6 yr [242]. Higher level of blood pressure, in obese children has been also documented [243;244].

Other measures of body fat, including skinfold thickness, waist, hip, and thigh circumference were all highly correlated with BMI Z-score, and the correlation coefficients were higher among overweight compared to non-overweight children, and slightly higher for girls, compared to boys. Whilst obesity, as assessed by BMI, is more prevalent among boys compared to girls, and boys had higher waist and hip circumference, skinfold measures and thigh circumference was generally greater in girls than boys. This suggests that each of these may be measuring slightly different things despite the high correlation among measures. In the absence of a direct link between BMI and health outcomes in children, these findings suggest that a range of body fat measures should be obtained for outcome assessment in obesity prevention trials.

The strong correlation between BMI and other measures of body fat, including skinfold measures, in obese and non-obese children, has been previously reported [245;246]. In this study, upper body skinfold measures were generally lower than similar aged children from developed countries, though lower body skinfold and waist, hip and thigh circumference was similar or higher [247]. This may indicate genetic differences in fat distribution and storage. The difference in distribution of body fat again suggests that a range of measures, rather than a single measure should be used for assessment of body fat in children for epidemiological studies.

3.5.7 Strengths and limitations

Although there have been several previous studies to examine the prevalence and distribution of childhood obesity in Iran, this is the first study which targeted young school children and included a wide range of measures including physical and psychological outcomes. The sample was selected to include children from different socioeconomic districts, making it more representative and allowing for some comparisons between districts. On the other hand, the sample included children from urban Tehran city and the findings, particularly the prevalence estimates, are not likely to be the same for all of Iran. A major limitation was the relatively low consent rate (40%). This has implications for selection bias and may affect the prevalence estimates, particularly in the more affluent district where response rate was 25%. Nevertheless, the prevalence estimates are similar to those from other studies of representative samples in Tehran [14] suggesting that there was no response bias in terms of weight status. The lower uptake rate in this study is partly related to the use of informed consent for obtaining measures. The concept of signing consent forms is relatively new in Iran, and most previous prevalence studies had not sought consent before undertaking measures. Those in affluent areas in particular, are more likely to question why their signature is needed, and this contributed to the lower response in that sub-population. Whilst the low consent rate has implications for prevalence estimation, it is not likely to affect most of the other analyses undertaken which examine the association between variables.

Another limitation is the incomplete response rate of parents to the parent and the dietary assessment questionnaires (71% and 55% respectively). However, there were no differences in the child's weight status or other available socio-demographic factors between responders and non-responders, suggesting that non-responders were not likely to comprise a biased sample. The response rate to the dietary assessment questionnaire was disappointing, but similar to the response rate to other similar dietary assessment instruments [156].

In this study, PA assessment was subjective, based on parent report. There is evidence that subjective measures tend to overestimate PA levels, and they are less accurate than objective measures. Nevertheless, the mean total duration for all activities outside of school time was reasonable (17.8±3.3 hours/day), suggesting some face validity. Parents also reported higher amounts of time spent in sedentary and light activities, compared to MVPA, which again strengthens the face validity of the instrument.

3.6 Key points

- Findings of this cross-sectional study confirmed that the prevalence of overweight and obesity is considerable in boys and girls and in lower and higher socio-economic residential areas of Tehran.
- The instrument used for PA level assessment was of poor quality, but no important differences were observed between overweight and non-overweight children. Up to 40% of children in this study did not reach the recommended levels of daily MVPA of at least 60 minutes per day.

- Boys compared to girls and overweight children compared to non-overweight had higher daily energy intake, though the differences were not statistically significant.
- The relatively high prevalence of overweight and obesity even in the deprived area implies that interventions should target all groups. High energy intake in this group suggests that they may be at risk of increasing obesity, and even though have a lower prevalence of overweight, prevention is important to prevent increasing trend.
- Inclusion of psychological measures adds useful information to assess children's health status and to monitor the wider effects of any intervention. Assessment of body image and size perception and health related quality of life was feasible and acceptable in this study.
- Perception of body size was generally accurate, but body dissatisfaction rates were high, particularly among girls who tended to prefer a thinner ideal size. Monitoring of body image is important for obesity prevention trials to ensure that the intervention does not adversely affect dissatisfaction, which could be a marker for unhealthy eating behaviours.
- Significant relation was observed between BMI Z-scores and other physical measures including skinfold thickness and waist, hip, and thigh circumference which is stronger among overweight children than their non-overweight peers.
- Significant correlation between weight status and systolic and diastolic blood pressure was observed. Blood pressure was also correlated with waist circumference and other measures of body fat.

- Measuring weight, height, blood pressure, waist circumference, and multiple skinfolds is feasible and including more than just BMI as a measure of adiposity will allow a wider range of outcomes to be monitored in epidemiologic studies.

4 Use of qualitative approaches to inform the development of a childhood obesity prevention intervention

4.1 Introduction

As discussed in chapter 1, the Iranian community, similar to populations in many other low-middle income countries, has been experiencing a nutrition transition [4] and overweight and obesity have been identified as a serious growing problem in recent years [16;172], particularly among children and adolescents [37-39;248-250]. Some research has sought to identify possible contributors to overweight and obesity in Iran [251-253]; but interventional studies, and those aimed at informing successful intervention have not been carried out so far. This is the first qualitative study undertaken in this community to explore the perceptions of important stakeholders on approaches to childhood obesity prevention in Iran.

A broad range of environmental factors [254] and genetic susceptibility to the obesogenic environment [255] are associated with the onset of obesity in children worldwide. This has resulted in a variety of strategies having been developed internationally, including implementation of prevention programmes, pharmacological treatments [72;256], and surgical interventions [72;257] for the prevention and treatment of obesity.

4.1.1 Developing complex interventions

Complex interventions which are mainly non-pharmacological include a number of interconnecting components and are applied in a range of settings including the health service, the community, workplaces or school [258;259]. Childhood obesity prevention interventions are a good example, with components tackling diet and PA behaviours and delivered through a variety of settings. Identifying the most appropriate set of activities to prevent obesity in a specific population is a challenge and using frameworks to guide decision-making has been suggested [260]. A framework provides standardised identifiable processes, principles and values for decision-making which can be applied across a range of populations and situations [260]. A number of conceptual frameworks including the Medical Research Council framework for the development and evaluation of complex interventions and the ANGELO (Analysis Grid for Environments Linked to Obesity) framework are relevant to the development of obesity prevention interventions [258;261].

4.1.1.1 The MRC Framework

The Medical Research Council (MRC) proposed a stepwise approach to guide researchers in designing and evaluating complex interventions [258]. The framework consists of five phases including a) Preclinical or theoretical step which tries to understand the problem and to address reasons why the intervention would be of desirable effects; b) Modelling (phase 1) which focuses on how the intervention would work; c) Exploratory trial (phase 2) through which the effect size would be estimated and trial measures could be piloted and optimised; d) Definitive randomised controlled trials (phase 3) to formally assess the effectiveness and cost-effectiveness of the intervention; and e) Implementation (phase 4) which examines the implementation of the intervention into practice providing information on intervention success with regards to stability of intervention, possibility of existing adverse effects, and response rates [258;259]. The framework was renewed in 2008 in response to identified limitations of the framework [262]. The new framework paid greater attention to early phase piloting and development work and emphasises that the proposed phases may not necessarily follow a linear sequence. Advantage of tailored interventions to local circumstances over completely standardised interventions was also underpinned. Application of the new framework would not have changed the methodology of the present study which includes the first two phases of the framework.

4.1.1.2 ANGELO Framework

The ANGELO framework was proposed by Swinburn in response to the lack of environmental approaches to obesity prevention [261]. Whilst much research has focused on educational, behavioural and pharmacological interventions, the importance of interventions to create a supportive environment are relatively lacking. Identifying and modifying the environmental contributors to obesity are likely to have a major impact on obesity prevention and this is a key element in successful community interventions [261]. Moreover, environmental changes could be incorporated into structures and systems resulting in higher level of sustainability and cost-effectiveness. The environmental approaches would also minimise the possible negative effect of direct weight reducing related messages including risk of developing eating disorders [261].

The framework has been developed to identify obesogenic factors in the environment and it aims to translate the concept of the environment into measurable elements. It is based on the ecological model for understanding obesity which has been proposed as appropriate for developing obesity prevention interventions [261]. The ANGELO framework provides a conceptual construct for dissecting obesogenic environment and to engage stakeholders in identifying associated factors to obesity and prioritising elements of environmental interventions. It consists of five phases, with heavy emphasis on stakeholder involvement throughout: i) identification of obesogenic/leptogenic potential elements by stakeholders groups, ii) level of importance given to these elements related to dietary intake and PA, iii) determining the perceived size of the problem (relevance), iv) addressing changeability of contributing elements, and finally v) ranking by combining scores allocated to each element for each of importance, relevance and changeability. This process would be the basis for setting priority areas for further development of the intervention [261].

4.1.2 Community consultation for intervention development

One of the basic principles of successful community health programmes is involvement of the target community in every phase of the project [260;263] including intervention development which also provides "external validity and contextual relevance" [264]. In both of the above mentioned frameworks researchers are encouraged to engage the community in the process of developing complex interventions and for identifying potential barriers and facilitators to successful intervention.

Qualitative studies are a useful vehicle for engaging the local community, both for identifying potential components of the complex intervention, and to explore potential barriers, whether the intervention corresponds with the anticipated practice conditions, and whether the anticipated effects are likely be generated in real settings [258;261;265]. Very few studies have applied qualitative research in the development or refining of intervention components in community-based interventions. Instead qualitative studies have mainly been used to provide information about contextual circumstances of the implementation, delivery, and evaluation of the interventions. They have also been used for pilot-testing of outcome measures in order to alter contextual circumstances for implementation [265]. This may partly explain why previous studies having failed to engage stakeholders when developing the programmes.

FG is one of the qualitative study techniques which provide researchers with the opportunity to engage the community in the process of intervention development. FG involves several participants discussing an issue with a facilitator present and provides an opportunity to explore the views and opinions of stakeholders through conversation with others. Furthermore, participants have the opportunity to hear other members' opinions which helps to refine and deepen their ideas and to discuss differences and disagreements [266].

The concept of running a FG is that the group process allows people to express and clarify their opinions better than what is conveyed in an interview [267]. FGs explore people's knowledge and experiences and provide explanation for why they think in that particular manner [267]. Such knowledge provide researchers with a perspective of other people with similar experience and is helpful in later engagement of the community [267]. FGs are particularly appropriate for studying sensitive issues and provide an opportunity for contribution for a wide range of community members, including those who are illiterate, from disadvantaged backgrounds, those who are reluctant to be interviewed or feel they have anything to say. Furthermore, they tend to be more productive than interviews with regards to generating critical comments. Conversely participants may not express their opinions if they feel the majority of the group agree on a specific view that is contrary to theirs. The presence of researchers and other participants may also raise concerns about confidentiality and reluctance to share certain issues. Nonetheless, participants tend to support each other in sharing common feelings and experiences and confident group members often break the ice and help other participants expressing their views [267].

Several researchers have undertaken qualitative work in relation to childhood obesity; previous studies have rarely linked the findings from the qualitative work to inform intervention development for obesity prevention. Furthermore, most such previous studies have been undertaken in western societies, and the findings may not be applicable to the context in Iran. In the present study, a pragmatic approach was taken to allow contextual information to be gained from relevant stakeholders in Iran that will help in intervention development. It is likely that multi-component and multi-setting interventions are more likely to succeed [264] and a set of interventions that individually produces small effect on energy balance, could make significant contribution to obesity prevention programme as part of a broader programme [260]; therefore, a range of stakeholders were invited to participate in FGs.

4.2 Aim and study questions

The aim of the FGs was to gain important contextual information to explain why behaviours that promote obesity occur in the local population, and to gain insights on barriers and facilitators that would help tailor an intervention programme to the community. The following study questions were applied to achieve the aim.

- What are the main perceived contributors to childhood obesity among stakeholders?
- What is the range of activities and interventions that stakeholders felt could contribute to obesity prevention?
- Which types of intervention components do stakeholders believe are most important and which are most amenable to change and how do they trade these concepts against each other?
- What are the perceived facilitators and barriers towards maintaining healthy weight in children?
- Which settings are considered as most appropriate for targeting in order to maintain healthy weight?

4.3 Methods

Initial FGs

Two FGs including one session with six mothers and one session with three mothers and two couples were held in summer 2007 to test all procedures and the topic guides. As a pragmatic approach, parents were invited through informal means. Following these sessions, the two facilitators met and based on the experience, the topic guide was updated in a way that more time was allocated to brain storming and prioritisation of the suggested activities where limited time was given to introducing the project and the aim of holding FG.

4.3.1 FG participants

The main FGs were held with parents (mainly mothers) of young children and school staff (mainly teachers) working in primary schools in Tehran city. Parents were selected from a range of socio-economic backgrounds to include two groups from each of high, medium, and low socio-economic districts of Tehran. Families were approached through primary schools in district 2 (north of Tehran, high socio-economic level), 6 (centre of Tehran, nominated as typical middle class district), and 15 (south east of Tehran, a less privileged district with few immigrants). The schools used were the same as those where physical measures were done (Chapter 3). Participants were selected in consultation with school staff, to represent parents of children from years 1 and 2, with children having a range of weight status.

Both parents were initially targeted as participants, but none of the fathers was available to attend a morning session and few parents would attend afternoon meetings. Therefore, in order to hold a mixed parent group, an additional session comprising parents of young children from high and average social class was held, with parents invited through personal network.

Inviting school staff to participate in FGs was more challenging, as very few were willing to attend after school meetings. The head teachers co-ordinated meetings in various ways, sometimes using one of their usual monthly "teachers' meeting" for this purpose. In one school the head teacher announced that the monthly meeting would be held by a research team (S2). All teachers and the school nurse attended. In the second school, the head teacher did not give participants priori notice but announced the meeting 10 minutes before the planned time (S3). A mix of teachers and school staff attended. In one school, a mixed FG with school staff and mothers was performed, with the head teacher having selected participants personally (SM1). The last FG with school staff was held at the Nutrition Institute (S1), comprising participants who had cooperated with the research team in completing physical measures at schools.

4.3.2 Interviewees

PE teachers and school nurses were also invited to FGs with school staff, but only two school nurses managed to attend. Other attempts to gather these participants in separate FGs was not successful, therefore two PE teachers and one school nurse who agreed, were invited for personal interviews.

The school nurse had worked for about 30 years and she was well known by many school staff in the district. One of the PE teachers was a 20 yr old who was completing her degree in sports science, and the other, a retired PE teacher with a degree in sports science who worked on a temporary contract.

4.3.3 Data collection planning

Topic guides were developed according to the study question (Appendix 9). Table 4.1 shows a range of qualitative study approaches to collect and to analyse data. The present study was a pragmatic study to address a specific question rather than pure qualitative research and none of the mentioned approaches has been applied directly, but the procedure is more in line with the grounded theory approach.

4.3.3.1 Perceptions on obesity, importance, and causal influences

First, participants were asked what they understood by the words overweight and obesity. Their perceptions of obesity as a health problem, the causes and what activities they believed could help children maintain healthy weight, were then explored.

Table 4.1 Common qualitative research approaches [268]

Research approach	Analytic strategy	Method	Application
Grounded theory	Constant comparative analysis	Taking one piece of data (e.g. an interview) to compare with other data to identify similarities and differences between them to develop conceptualisations of the possible relations between various pieces of data	To study those individual's behaviours which could be attributed to fundamental social processes to understand human phenomena within the context in which they are experienced. Naturalistic inquiry, thematic analysis, and interpretive description are methods which depend on constant comparative analysis process.
Phenomenology	Epistemology (modes of awareness), Ontology (modes of being)	Exhaustive, systematic, and reflective study of experiences to identify depth and details without making comparisons or considering available conceptions.	To discover underlying structure or essence of target experience through study of individual cases.
Ethnography	Iterative process of transforming, translating, and representing cultural ideas arising through active involvement in the field as written document.	Immersion and engagement in fieldwork or participant observation to know a culture or group and to describe that issue through text.	To interpret the process and products of cultural behaviour. In healthcare context, effect of social and cultural elements on understanding and enacting health issues is trying to be explored.
Narrative analysis	Generating, interpreting, and representing individual's story in narrative form	Recognising the extent to which the individual's story provides insights about the lived experience.	To learn about the experiences of studied population who is facing a specific situation.
Discourse analysis	To analyse the language that is used and the way that it is used.	Trying to understand what is presented by communication ways that people use to exchange ideas to uncover the social influences underlying thoughts and behaviours.	

4.3.3.2 Prioritisation of intervention components and barriers

Then they were asked to prioritise the activities that would have the greatest impact on children to maintain their healthy weight and to identify facilitators and barriers towards suggested activities. In the final part of the prioritisation exercise, participants were asked to consider both importance and feasibility combined, and decide on a maximum of eight components or activities that would best be included in a childhood obesity prevention programme. The FGs were scheduled to last about 90 minutes, including about 25 minutes devoted to brainstorming and generating ideas on potential activities, and 65 minutes for the prioritisation exercise.

Topic guides were also developed (Appendix 10) for the interviews, based on the findings from the FGs, to explore participants' ideas about the importance and feasibility of activities suggested by FG participants.

Invitation letters, information sheets and consent forms (Appendix 11) were sent to invitees through the school office. A head teacher from the deprived area believed that mothers respond better to standard invitations from the school (M5). She therefore sent a different simple invitation letter and information, indicating that there would be a meeting on health and nutrition related issues.

Interviewees were contacted personally and handed an invitation, as this is more socially acceptable in Iranian society.

Travel costs and simple refreshments were offered to all participants and they were given presents for their time and cooperation.

4.3.4 Data collection

All FGs had two facilitators, including myself and one of two other colleagues. I conducted all interviews. Most FGs were held in schools in venues from the prayer room to the head teacher's office. Therefore, FG equipments had to be portable and suitable for a range of situations. To organise the prioritisation exercise, four coloured laminated boards were provided to display a) all suggested activities to help maintain healthy weight in children, b) activities perceived by the group as important, c) activities perceived by the group as feasible, and d) final prioritised list of activities. Furthermore, for each board, three columns were included to separate home, school, and community settings, to help participants organise their thoughts. I moderated all sessions while the co-facilitator wrote any ideas emerging from the group on post-it notes and attached and moved them to the relevant boards during the process of prioritisation.

Participants were then led through a process of prioritisation, reflecting on the ideas generated by the groups as potential activities for obesity prevention. The purpose of prioritisation was partly to get to the end product which would be the prioritised list of ideas, but also to explore the perceived barriers and facilitators through prioritisation process. They were asked to prioritise, first considering the importance of each idea. It was emphasised at this stage that groups should not be constrained by resources or what they think might be a barrier towards implementing activities. The major directing role of facilitators in this step was to repeatedly remind participants to focus on what they think would have most impact on preventing obesity in childhood. Next, participants were asked to select activities that they believed would be feasible to implement, and were most amenable to change.

Data saturation was reached by the 9th FG, as no new information emerged in the last two FG.

4.3.4.1 Data trustworthiness

Credibility: To ensure the facilitators understand participants' responses, ideas generated were checked during and at the end of each session. After the prioritisation exercise, the final list was read out and participants were offered as chance to check and confirm.

Transferability: The research process and analysis has been documented completely enabling interested investigators to determine transferability of the results to other settings.

Dependability: Following each session, minutes were recorded to summarise the session environment, notes on participants, and any potential source of bias which was not detectable by audio record.

Confirmability: The analysis process was checked by P.A. to explore possible inter observer differences.

4.3.4.2 Transcription of audio records

All FGs and interviews were recorded using a digital recorder. Following each session, a backup copy was made and stored in a safe place and a copy was sent for transcription. The audio files were transcribed verbatim and transcripts stored electronically. All transcripts were reviewed by myself and the audio files were used either to complete or to correct the texts where necessary.

4.3.5 Data analysis

4.3.5.1 Coding

An iterative approach was used for data analysis. Discussions were analysed thematically, using an open coding method. The responses and discussions were collated under related study questions, using Microsoft Excel to organise them. Each row contained data from one FG or interview. Each transcript was read and examined for key concepts and themes related to each of the research questions. Other emerging themes were also coded and recorded. Perceived contributors to childhood overweight and obesity were classified into three main categories (assigned to one column each) including causes related to food and nutrition, PA, and all other causes. Concepts related to the description of overweight and obesity and perceptions of its importance as a public health problem were recorded in another column. Themes related to under-nutrition and underweight were frequently mentioned as a problem, and a column relating to this was therefore also recorded.

Data from the prioritisation exercise was the main source of analysis for the other study questions. Themes related to interventions were first coded according to the main setting, including the home, school or community. Within each setting, ideas for intervention were coded at three levels:

“Theme code” which refers to the general theme of the activity like "activities for family", " PA at school", and "rewards and competitions".

"Theme description" which included more detail of the activity such as “nutrition education for children by parents”.

“Example” which presents a specific example or activity that was mentioned such as “asking children to make a salad” as an example for “nutrition education”.

For each of the above, a “FG code” was also added to indicate from which group the idea had been generated.

Another column was added to the worksheet to indicate any “Comment on setting”, which included comments on the level of importance, perceived effectiveness, and feasibility of suggested activities within settings.

“Importance”, “Feasibility”, and whether the activity was included on the “Final” list were also recorded in three separate columns.

Two further columns were used to note any themes related to “Barriers” and "Facilitators" to successful intervention.

A column coded as “Discussion” was used to record details of any disagreement between participants, and any relevant observations from the facilitators were recorded in “Comments” column.

Related “Quotes” were also recorded.

In addition to the transcripts, the contents of the post-it notes that recorded intervention ideas for the prioritisation exercise were organised after each FG onto four A4 sheets, comprising “suggested activities to help maintain healthy weight”, “important activities”, “feasible activities”, and “final activities”. For each sheet, the included activities were colour coded to represent the setting for intervention. After completion of all FGs, the data were organised in four tables and translated to English (Example table: Appendix 12). The final tables including Persian and English versions were reviewed and checked by P.A.

Transcripts of interviews were also summarised in the same way as that described for the FG. Data were added to the relevant cells on the Excel sheets created for FGs. However, there were topics which were not captured in FGs like question about school facilities to do anthropometric measures in children by school nurses. Responses to those questions were kept in separate sheets and were added to findings where appropriate.

4.3.5.2 Comparative analysis

To collate discussions in a sensible way, related information to each theme was exported from summary sheets in Microsoft excel file to Microsoft Word file. For instance, to present relevant data to “PA” all activities suggested to increase PA or to decrease sedentary behaviours at home, school, and local community settings were recorded. Participants discussed some activities in prioritisation process. Those ideas were recorded with more details including related barriers, potential facilitators, and relevant quotes. Code of FGs was also kept by each activity to show the frequency of suggestions. Using page number which had been already recorded for each sentence in the Excel summary sheet, transcripts were checked to review discussion within the relevant context.

Summary sheets were updated during analysis and transcripts were read frequently to find related discussion and quotes.

4.4 Results

4.4.1 Participants and general description

In total there were 11 FGs (7 with parents, 3 with school staff, and 1 mixed) with a total of 85 participants and 3 interviews of about 50 minutes duration each (Table 4.2).

All participants were Iranian and residents of capital city Tehran. The mean age of participant parents was 30.3 yr (23-47 yr). Most of the mothers (89.1%) were housewives. The mean age of school staff was 39.9 yr (35-53 yr) and 26% of attendees were male (5 out of 19). Most of the school staff participants had a university degree (75%) compared to a 44% of parents.

Table 4.2 Total number of invitees and participants in FGs

FG code[2]	**Invited (N)**	**Participants (N)**		**Apologies (N)**
		On time	**Delayed**	
M1	9	2	3	0
M2	12	5	2	2
M3	10	10	0	0
M4	10	4	1	0
M5	9	9	0	0
M6	8	3	0	0
P1	8	5	2	1
S1	9	4	0	0
S2	9	9	0	0
S3	Not known	10	0	Not applicable
SM1	Not known	8	0	Not applicable
Total	-	69	8	-

[2] M: mothers, P: parents, S: school staff

4.4.2 Definitions for overweight and obesity

Participants described overweight and obesity from a range of perspectives, which could be grouped into four main themes. These broadly related to appearance, excess body fat, behavioural (diet and PA related) and technical/medical definitions. Related definitions to appearance and excess body fat were predominant, but other common descriptions related to technical definitions, and to behavioural factors were also mentioned. Almost all groups addressed a range of definitions and no specific difference was observed between mothers/parents and school staff.

Related definitions to appearance included "big frame", "flaccid Muscles", "plum cheeked", "having big belly", "having more muscle than other people", "bad body shape", "deformation of body", and "imbalanced figure". However, some groups mentioned "extra fat storage or deposition of fat", and "fat accumulation especially in the abdomen and hip" which also referred to undesirable appearance to some extent. Some participants including mothers and school staff mentioned technical definitions including "abnormal weight for specific age and height", "high weight and height", "abnormal weight to height and age ratio", "higher than normal or imbalanced weight to height ratio", and "higher percentage of weight than what it should be according to BMI and percentiles".

Some groups provided particular definitions for obesity and overweight. Obesity was defined as "overweight", "a kind of disease", "not desirable", and "deficiency in metabolism". Definitions for overweight included "extra fat", "overeating", and "limited/lack of activity".

Some groups of parents and school staff differentiated between overweight and obesity, whilst a few attendees perceived that overweight and obesity are the same, with obesity being a continuation of overweight (extreme overweight leads to obesity). For those that differentiated, these related to consequences (though one group of mothers believed that both overweight and obesity has consequences), appearance (obesity is easily identified, but overweight may not be recognisable and it could be covered up by clothes), and causes (overeating results in overweight; whereas obesity like thinness, relates to genetics). However, these differences were not agreed by all participants in the same group. In particular, some participants expressed that both overweight and obesity have consequences.

4.4.3 Overweight and obesity as a public health problem

Almost all groups perceived overweight and obesity as a growing problem which threatens children's health. However, the risk of underweight, as a marker of malnutrition, was also highlighted as a problem, especially among groups in the deprived area. Overweight was perceived as more common than obesity among children. Some participants quantified the size of the problem in Tehran, suggesting that it was a major problem:

"2 to 3 children out of 10 are obese" (Mother in high income area). *"School is full of fat children"* (Parent in middle socio-economic area). *"About 60% of children are obese"* (Mother in middle socio-economic area).

The difficulty in identifying obesity in children was discussed by parents group, particularly for non-professionals. Whilst most groups remarked that obesity has been increasing during recent years and is more prevalent among older children, one group of mothers in the low socio-economic area commented that obesity was on the decrease, because ladies try to lose weight nowadays and girls would follow their mothers. Most participants also observed that the age of onset of obesity has decreased over time.

My daughter last year and the year before, I mean mothers don't notice overweight in year 1 and 2 (children)*, it increases from year 3 onward, especially year 4 and 5 who are very obese. It means prevention should start earlier, from year 1 and 2* (Mother from middle class area).

4.4.4 Perceived contributors to childhood overweight and obesity

A number of themes emerged as perceived contributors to obesity in Tehran, which could broadly be grouped as factors related to the child, the family, the school, the local environment, and cultural beliefs acting either independently or in combination. Within each of these groups, factors related to diet and PA were predominantly discussed. A number of contextual factors also emerged which were thought to contribute to childhood obesity. These are discussed in more details below (Figures 4.1a and 4.1b).

Most of the perceived contributing factors to childhood obesity are indirectly influenced by socio-economic conditions and Government regulations (Figures 4.2).

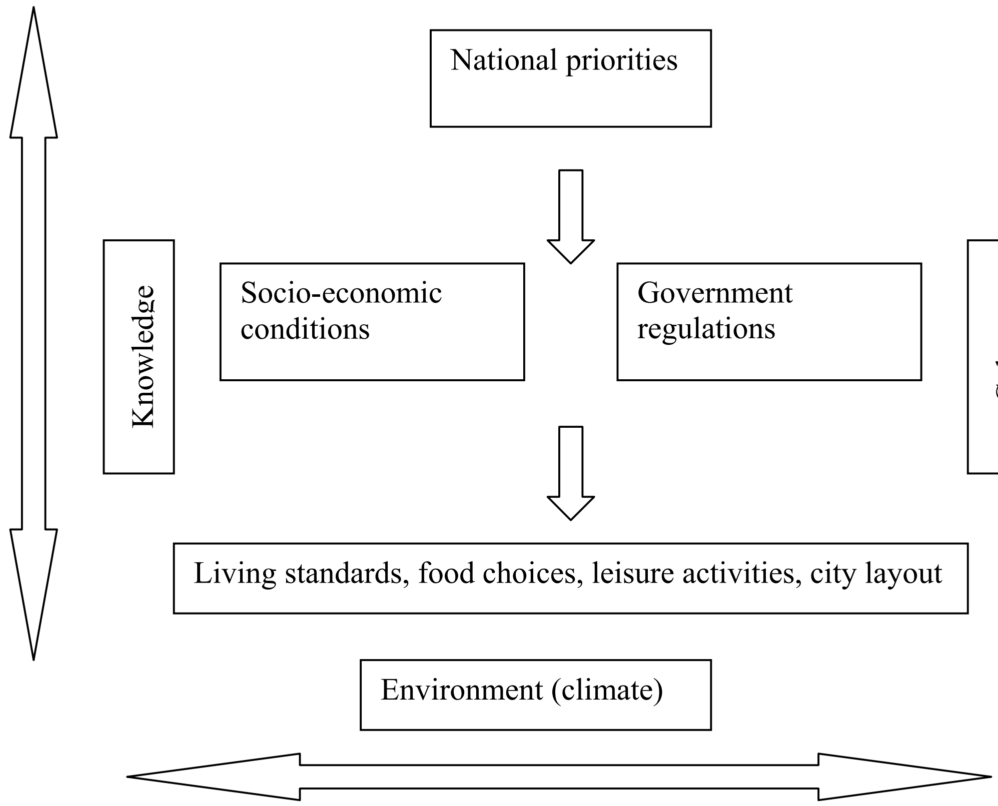

Figure 4.2 Underlying contributing factors to childhood obesity

Factors related to the child

A prominent theme emerging from most of the groups including mothers and school staff was the perception that biological factors including genetics, stress, constipation, and hypothyroidism are important contributors to childhood obesity.

I think overeating or… genetics. My daughter is very slim, she is not gluttonous … she might eat whatever I offer, but she doesn't get fat (Mother from affluent area).

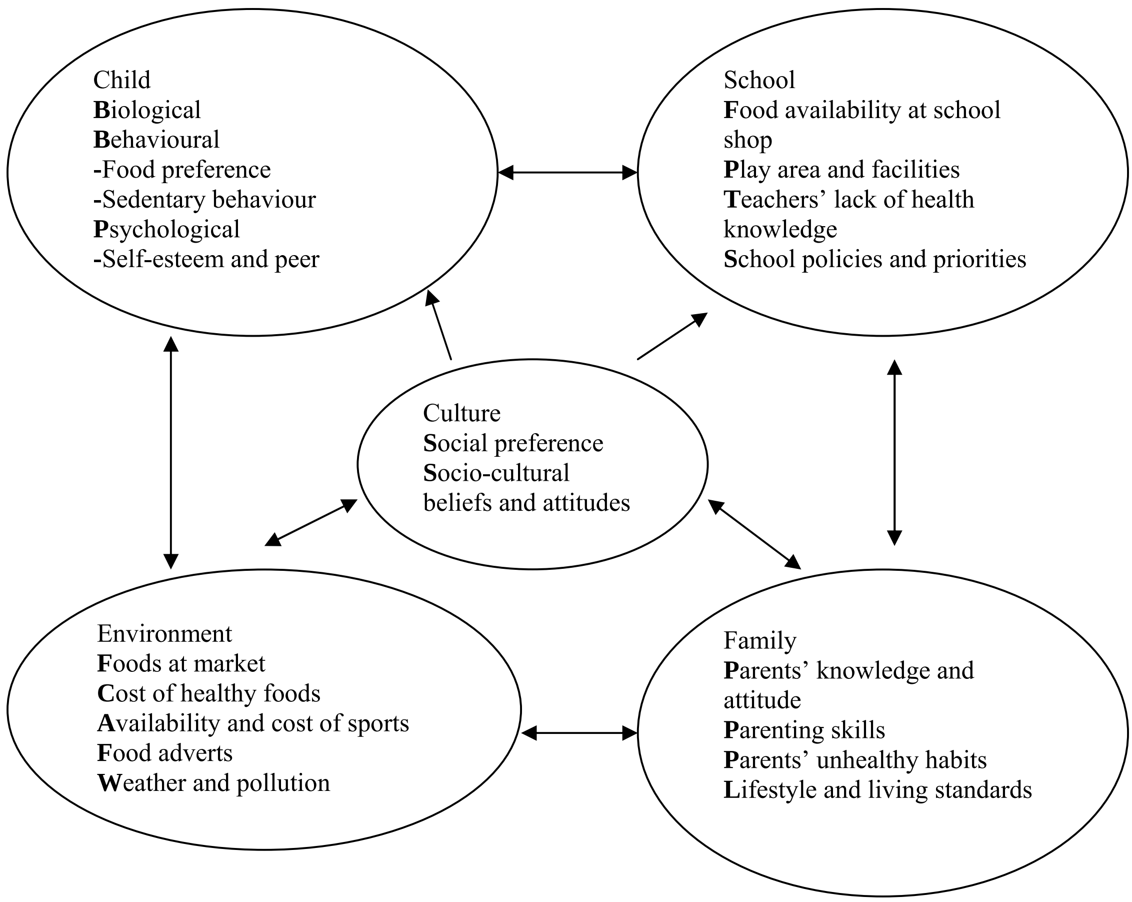

Figure 4.1a Contributing factors to childhood obesity

Behavioural factors, including children's preference for certain foods and tendency towards sedentary activities were discussed by almost all groups. However, these factors were seen to be influenced by the wider community, family and school rather than being intrinsic to children as independent individuals. Children's preference for unhealthy and non-home made foods including fast foods, processed meats, crisps, other savoury snacks, and chocolate and sweets as well as avoidance of healthy foods, such as vegetables and fish, was frequently mentioned.

Crisps and stuff tempt children, we ourselves can't control ourselves… I like it so much and child likes it as well. She likes ice cream…. (Mother from low income area).

Some children don't accept this food… because they wouldn't eat those food that… for example we say vegetables are good, most of children don't like it in food… they like pasta and starchy food (Mother from middle socio-economic area).

Participants also implicated the replacement of main meals with junk foods and skipping breakfast as important prevalent behaviours among children that contribute to obesity.

Limited PA and increase in sedentary activities, such as prolonged periods in front of the television and computer were also acknowledged as important contributors to childhood obesity in recent years.

These behavioural factors were often seen to be manifestation of modernisation, which are promoted by environmental influences. For example, expansion and increased availability of fast food outlets and development of computerised technology for children's entertainment over recent decades were seen to have facilitated these behaviours.

A PE teacher in interview noted: *Now it has changed… because of entertainment at home. In the past, in central and southern areas of Tehran* (referring to middle and low socio-economic level areas), *roads and alleys were full of kids… they played football, volleyball… but it has changed even football which is the most popular sports… we don't see kids playing football like they used to do in the past.*

Psychological factors, including low self-esteem and peer pressure especially among girls were also seen as contributors to childhood obesity. For example, peer pressure was perceived as a barrier to children's acceptance of home made traditional sandwiches in favour of more unhealthy options.

I made cheese sandwich with baguette because my child feels embarrassed if she has traditional bread (Mother from middle socio-economic area).

When I put cheese and bread for my daughter, she says I feel embarrassed, my friends take crisps and things, she limits me to make her cheese and bread two times a week… she takes cakes and juice at least four times (Mother from middle socio-economic area).

Unfortunately it (peer pressure) *is more common in girls, boys listened to us, but girls…* (Teacher in middle socio-economic area).

Factors related to the family

Factors related to the family usually referred to parents and children, but occasionally reference to the influence of grandparents was also made. There was a general perception that social preference in Iran, and predominantly among fathers and grandparents, was for heavier children, and being overweight was equated with being healthy.

A teacher commented: *We, we prefer fat children, … we like him, we hug him, we kiss him and this attitude leads to encouraging children who are not like that fatter…*

School staff and parents identified inadequate parental knowledge about health and nutrition as a problem contributing to childhood obesity. Limited and inaccurate health information was implicated as a contributor to mistaken beliefs and attitudes and poor parenting skills, resulting in promotion of unhealthy dietary and PA behaviours among children.

One teacher commented: *Most parents give* (kids) *junk foods like crisps and flavoured corn puffs to get rid of children…*

Another teacher (high socio-economic area) noted: *When I say she* (the child) *hasn't done her homework, she* (the mother) *says she is too weak to write a full page, you expect too much. They consider thinness as an excuse for not having energy, but I don't think so, the fatter one might not be able to move...*

However, the role of external factors in influencing parental attitudes and behaviours, in the same way as discussed for the children, was acknowledged by most participants. Poor living conditions, such as overcrowding (people predominantly live in small flats), and lack of time because of long working hours and bad traffic were proposed as contributors to sedentary behaviour and other unhealthy habits by almost all groups.

My daughter is so active. She is moving around when I ask her questions (doing her homework)*… because we live in a flat, there are people in the lower floor. I keep saying don't run…I don't let her exercise. The school gave her an exercise CD, but I don't let her watch it, because she jumps up and down* (to do exercises) (Mother from high socio-economic area).

One teacher commented: *Parents spent time to take children to parks and kids used to play outside. Nowadays, either parents don't have time or children don't feel like going...*

A father said: *One problem is that in big cities, fathers and mothers are all working which means that they don't put in the amount of effort required for children. They come home in the evening, tired, what is for dinner, let's go out to get a sandwich…*

Parents and school staff highlighted parents' unhealthy dietary and PA habit and parents acknowledged that they should not preach what they do not practice.

A father commented: *It's not practical* (including exercise in the daily activities of the family)*, it's just words. I tell my kid it's good to exercise, but when I myself don't exercise…so, my kid won't exercise either…*

Lifestyle change as a result of modernisation, combined with low awareness of the implications for health were also discussed and implicated. Topics considered included increased availability of foods leading to overeating by parents, mothers' preference for serving ready meals rather than home-cooked food for convenience, increase in car use as the main mode of transportation, and smaller social networks, limiting opportunities for group activities for children.

A PE teacher in interview said: *They can't get rid of computers; they should limit its use, so they need to find something to replace it* (computer). And also: *Now socialising has decreased. In the past, auntie came to your home, the cousins played together, but coming and going* (to relative's homes) has *decreased.*

Although most of the discussion related to diet was around food type, a few groups also discussed the importance of portion size.

A mother from the middle class area said: *As my older son is fat, my husband believes that I should cook less food. When you cook less...because my son takes some food from the sauce pan frequently till the evening... My husband says cook less, so he will eat once, and if he gets hungry, he will eat fruit whereas he goes for the food as long as it is there. How much can I tell him not to eat? Some of my friends did this, it has been very effective on their children's weight, they* (children) *lost weight, they cook less food.*

Another aspect perceived to be contributing to childhood obesity was the change to smaller family size. This was discussed from two angles. Firstly, because there are fewer children, parents pay more attention to them, one manifestation of which is to focus on feeding them.

A teacher from the deprived area said: *As there are few kids in the families, like one or two kids, parents pay too much attention ... mother keeps saying eat, eat in this way... they don't let the child be. At eating time he is full and doesn't want to eat, but the mother is there and he has to eat.*

Secondly, as children are less likely to have siblings, opportunities for physical play and activities in groups are reduced.

Factors related to the school

Almost all groups commented that the school environment is a major influence on primary school children and their behaviour. State schools in Iran do not serve lunch and all children eat lunch at home. Nevertheless availability of unhealthy food items at school shops was believed to be an important contributor to obesity. Regarding PA, poor quality PE sessions as well as small playgrounds and lack of indoor space were discussed.

PE teachers and school nurses often commented on the inadequacy of school teachers' knowledge on health and nutrition issues and how to use available resources and facilities. This was believed to contribute to the unhealthy school environment. Some mothers and PE teachers also mentioned that school management and the Education Department prioritise academic and other issues within schools over health and nutrition.

A PE teacher said: *… Most of the time, they* (the head and teachers) *take PE session to do their activities or they give exams in PE session or makeup classes* (they hold makeup sessions in PE time) *… while PE should be the principal…*

Factors related to the wider environment

There was much discussion on the role of the local and national community and environment in childhood obesity. These included concerns about road safety, neighbourhood security, the climate, and air pollution in Tehran in relation to limiting PA.

Most of the groups commented on the high cost and poor availability of PA facilities. Participants also noted that although Tehran has parks and other areas for walking, it is a big and crowded city and the layout does not encourage walking. Moreover, in most areas either road safety or neighbourhood security was seen to limit children's activities outdoor (see below). Finally, the climate with long and hot summers and very cold winters as well as serious air pollution was seen as a barrier for outdoor activities including in school. A few groups referred to mandatory dress codes and compulsory segregated leisure centres as factors which reduce levels of family activity especially for girls who might not be allowed to do some activities.

A mother from the underprivileged area said: *My daughter is scared to play outside in Tehran. But my husband is from Kashan* (city in centre Iran)*, when we go to Kashan in the summer, we hardly see her, she wears skates all day, she is in the alleys. Because she is not scared of being lost or kidnapped. In Tehran, she is scared of going out… she always says I'm bored I'm exhausted. Then she ends up sitting in front of the computer.*

Increasing availability and popularity of less healthy foods, fast foods, and snacks such as crisps and use of artificial hormones in foods, in contrast to the high cost of fresh foods was perceived as a contributor to unhealthy dietary habits and hence obesity. Most groups also addressed the undesirable effect of advertisements for junk foods and unhealthy snacks on demand and intake of such food in children.

Factors related to culture

Cultural beliefs and some aspects of modern lifestyle were also seen as contributors through their influence on dietary and PA behaviours by all groups. Cultural attitudes towards expected social behaviour were also discussed as a barrier towards PA especially in girls.

> A mother from the low socio-economic district mentioned: *There is a football pitch in front of our house. My daughter is dying to play there, but there is limitation for girls to go and her father believes that she is not a child now and it is not nice to do such things. I mean this is our attitude that when girls grow up it would not be nice to be active. She is supposed to be like a lady, polite, and calm...*

There was also discussion of social expectation to serve high fat foods, especially for guests, and unacceptability of simple more healthy dishes, especially among men.

Summary

A range of inter-related factors related to the child, her family, her school, her wider environment and culture were discussed and implicated for the rise in childhood obesity. Underlying this was the perception that modernisation over the last decade had contributed to changes in behaviour. The themes emerging from FGs are summarised in figure 4.1b.

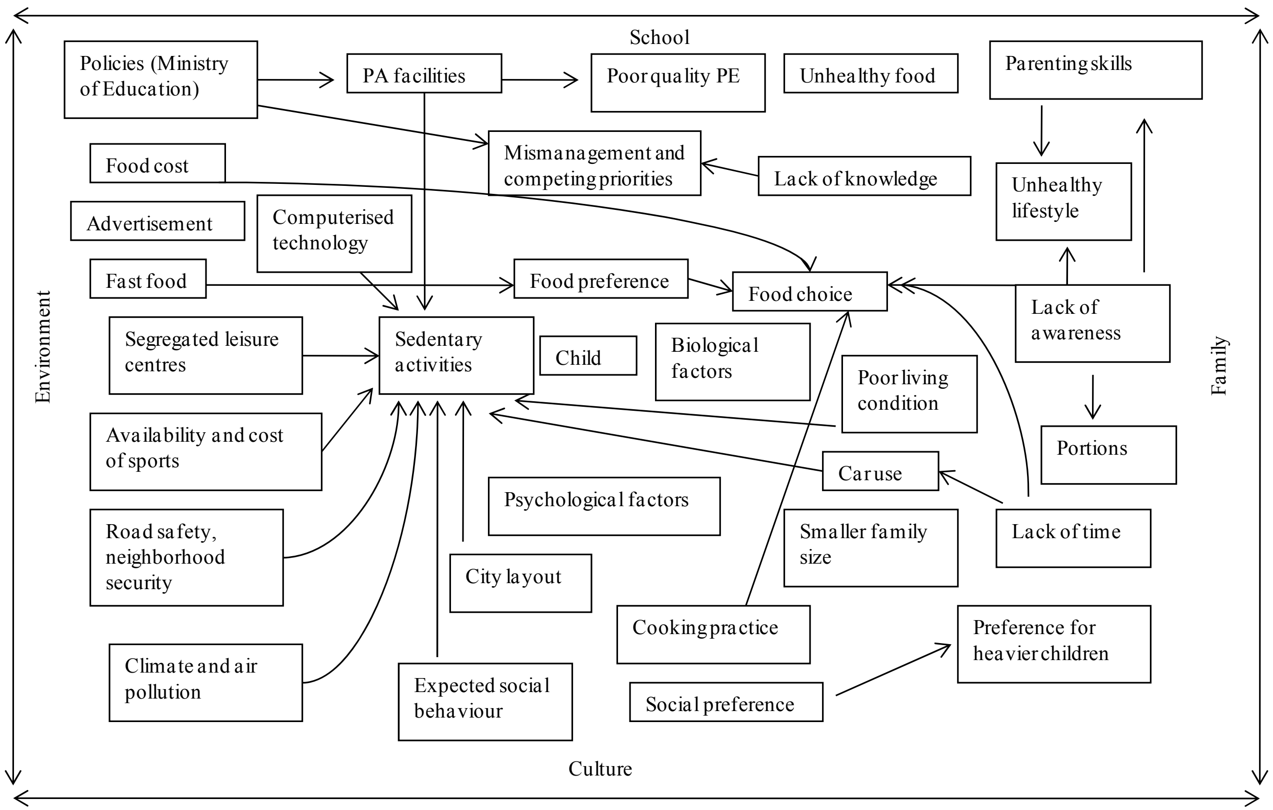

Figure 4.1b Contributing factors to childhood obesity

4.4.5 Interventions for obesity prevention

Participants suggested a range of intervention components that would target families (home), schools, and communities for obesity prevention. The activities were mainly related to modifying two general behaviours including “food and nutrition” and “PA”. The main processes for achieving behaviour change discussed, related to “education" and "skill building”. Two distinct platforms were also identified for delivery of intervention, including the school and related community, and national governmental level strategies.

4.4.5.1 Governmental level strategies and policies

Interventions suggested at state level included development of new policies such as "establishing a nutrition counselling system", reforming of existing policies, such as "modifying PE related policies" and better regulation of existing policies, such as "monitoring adverts and health related programmes". Participants also outlined the organisations they felt should be involved in these processes, including the Ministry of Health (and affiliated Nutrition Department, School Health Department, and National Nutrition and Food Technology Research Institute); Committee of Health Policy at Islamic Republic of Iran Broadcasting; Ministry of Education; Ministry of Commerce; and Tehran Municipality.

Government level interventions were broadly related to three themes: i) increasing and improving the level of health information for the community, ii) improving accessibility and availability of healthy food and iii) promotion of PA (Figure 4.3). Each of these are discussed in more detail below.

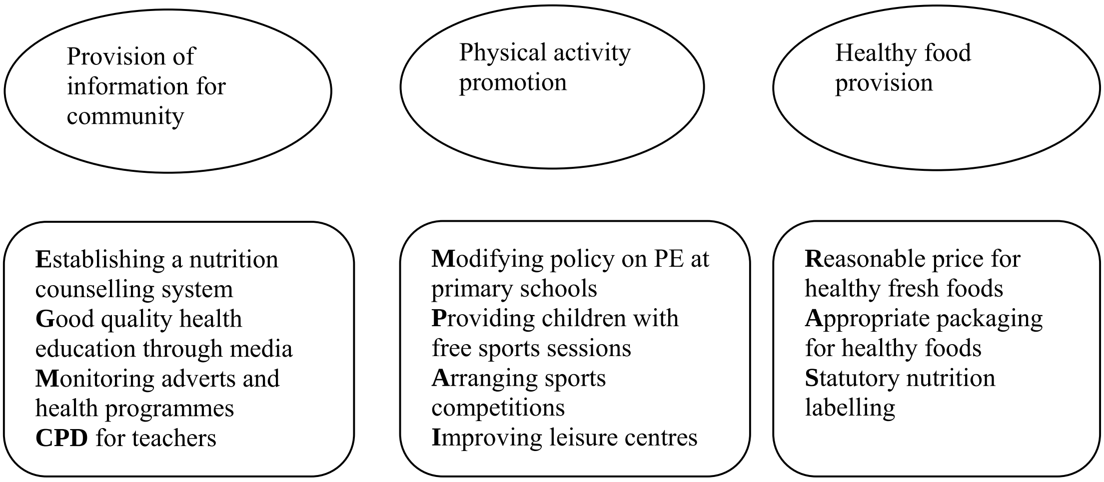

Figure 4.3 Themes related to governmental level interventions

Provision of accurate and cutting-edge information on health

Helping families with making healthy food choices and providing health and nutrition information through counselling units at worksites was suggested by one group of school staff.

One deputy commented: *I think all bodies should have a nutrition counsellor, all organisations like Education Office, IRIB* (Islamic Republic Iran Broadcasting), *the military, … it'd be very useful.*

A number of ideas suggested by participants in all groups related to education of the public through accurate and innovative ways of providing health information. There was widespread belief that conflicting and even misleading messages in relation to nutrition and health are distributed through the media. Therefore, there was great emphasis on the importance of conveying correct information.

A father in the mixed FG commented: *I believe in accurate information. Because there are many articles being distributed, then the incorrect messages result in giving unnecessary foods to children.*

Educating families through published media and public broadcasting was suggested several times by most of the groups. Participants discussed existing health and nutrition programmes that have been broadcast over recent times, and concluded that these were not appealing to children. Using animation to convey health messages to children was favoured. Participants felt that children are interested in news, and especially medical news, and this could be an opportunity for targeting and informing all family members including children. There was also suggestion that food adverts, which are mainly developed by the food industry, should be monitored and required to confirm key messages from educational programmes, in order to prevent confusion.

Another approach for conveying information was felt to be through Continuing Professional Development (CPD) education to update teachers' health and nutrition knowledge and skills, which in turn help them inform children and parents. However, to achieve this and append relevant modules for teachers' education requires state intervention, and needs approval by the Education Department.

Adopting supportive strategies to promote PA

Increasing PA was considered a key theme for maintaining healthy weight in children by all groups. In terms of interventions, the main theme was related to increasing opportunities to expose children to active environments.

One PE teacher in interview commented: *What you can't see you won't miss. When a child sees a range of games and play equipment in the neighbourhood, at school, then he would feel like playing, but when he just sits in front of a TV and new computer games where he thinks he is driving in the middle of a road, then he would not leave that and go somewhere else.*

A common theme was intervention to improve current PE policy. Currently in Iran, PE sessions for children in primary years one to three are run by regular class teachers, rather than trained PE teachers, and many participants including parents, teachers, and PE teachers commented that this needs to change. The central Education Office, as the only decision making body regarding educational organisations in Iran, was seen as a key player. It was also felt that the Education Office should review curriculum content and revise this to allow children more free time to play. Another suggestion by a few groups of mothers and school staff was that the Office should consider increasing the school day (currently 5 hours), in order for the academic curriculum to remain, but allow time for exercise and other activities for children in the school as well. An alternative suggestion, was that extending the school day would allow children to do their homework at school and have time to do activities at home instead.

The role of the state in improving PA opportunities outside of school was also discussed commonly. Suggestions included the provision of free sports classes and competitions, and improving leisure centres and facilities, especially for children. One group of mothers from low socio-economic group emphasised the importance of providing an appropriate environment for girls where they could do exercise without head scarves and bulky clothes. However, there was some discussion and disagreement as to whether this would be acceptable to the general population.

A mother from the low socio-economic area noted: *In north Tehran* (referring to high socio-economic area), *girls cycle, but it's impossible in the south or here. My sister is 18, she has got roller-skates and everything, when she skates, the neighbours say_" oh look at her she is skating, she is out for the evening.*

Improving accessibility and availability of healthy foods

Availability of healthy foods at a reasonable price and decreasing the production of unhealthy foods were recommended several times by some groups. Related activities including limiting accessibility and visibility of unhealthy foods for children in local shops, were also suggested.

Two mothers from the middle class area discussed: *I was in Sepah* (a chain store) *yesterday. I looked for crisps for a while… I didn't find it there* (where it used to be stored), *it might have been downstairs, but I don't think so. I mean crisps and flavour corn puffs were not there. …I wondered why it was not there, then I thought maybe they had been instructed not to store them where the kids select snacks.* The second participants replied: (It is in) *the beans section… where oil, dressings, and peas and beans are. Somewhere that is not interesting for children.*

Packaging and labelling of foods were also discussed, and the importance of making healthy food packaging more appealing to children.

One deputy head recalled: *Last year, I'm not sure if you remember, milk used to be packaged in a cup* (in almost all primary schools in Iran milk is distributed for free) *and there is a picture of a child with red eyes on the cup, like blood in his eyes. The children said that we are afraid of holding it in our hands.*

Food labelling has been mandatory in Iran for many years, but nutritional labelling has been only introduced recently. Energy and nutrient content of food products are written on the packaging, but the precision of the information is a matter of debate. Iranian Food Composition Tables are still being compiled and most of food manufacturers do not have the technical ability to assess the energy and nutrients content of their products.

4.4.5.2 School level interventions

Discussion around school level interventions could be divided into six areas (Figure 4.4):

<u>Disseminating relevant and accurate health and nutrition information</u>

School staff

The main activity discussed by all groups was the provision of CPD on health and nutrition related topics for school staff who would then disseminate this to pupils and parents. While all participants agreed that habits are built up in the family, almost all groups (including teachers and school staff) referred to the powerful effect of teachers on children's' behaviour. A similar comment was that children listen to school staff and they in turn convey messages to their families. On the other hand, ignorance of school staff, especially teachers, could act as a barrier towards effective intervention through school.

Education (child, parent, school staff)	Working with school shops	Rewards and competitions	Working on self-esteem (peer pressure)	Improving PE	Provision for doing PA
Group education by school nurse **S**chool magazine and booklets **C**omputer based educational programmes **L**ectures **P**arents' meeting **F**amily education (lectures) **R**eading materials **CPD** for teachers	**T**o monitor school shop opening hours **R**unning school shops by young and educated vendors **S**elling healthy snacks at school shops **P**arents to run school shops	**R**ewards for bringing healthy snacks **T**o praise children for healthy behaviour at school assembly and classroom **T**o give points for healthy behaviour	**W**eekly snack schedule provided by school **P**rohibition from bringing unhealthy snacks **P**rovision of healthy snacks for all	**R**aise the importance of PE as a subject **G**iving certificates and points for regular attendance	**P**roviding sports facilities and equipments **C**ompulsory morning exercise **D**aily PA in the classroom **N**on-competitive activities for children and teachers **P**ainting playground games **P**A as homework

Figure 4.4 Themes related to school level interventions

Children

Education of children on health and nutrition was frequently suggested by all groups. Not only would this help the children to learn, but they could also convey messages to families.

A mother commented: *It would be better to work on children rather than parents. Last year there were many lectures given by a nutritionist in my son's school, nobody turned up, even parents of obese children…means they don't believe in this. But if we tell kids about that* (it would work). *Like the police assistant project* (children monitor their parents' driving), *he says, daddy don't drive fast, police will give you points.*

Other approaches discussed for conveying health and nutrition information to children through school were by school nurses, and providing information through print media, such as the school magazine. Education by school nurse was prioritised as important and feasible by some groups and one school nurse emphasised the feasibility and efficiency of their role in educating children. She explained that school nurses have a relevant degree, regularly attend refresher courses and are very aware of nutritional issues. Furthermore, they use a range of approaches for distributing educational messages to children.

A school nurse commented: *This year I developed a ten page booklet about the benefits of fruits and vegetables and I asked parents to read that for their kids so they would know as well, and it was very well received.*

However, education by school nurses is not part of the formal education at school and school nursing is a dying breed.

Providing and distributing nutritional fact sheets were also prioritised. However, some groups doubted if children would benefit from printed materials as they often ignore these. Almost all groups believed that direct and traditional methods of education would not appeal to the new generation and method of education should be developed according to the young generation's taste, who prefer active ways of learning such as computer-based educational programmes. Furthermore how knowledge is transferred to practice was also discussed.

Inviting nutritionists to give talks was perceived as useful, but too costly an activity for schools. There was a suggestion that final year nutrition students have considerable knowledge about healthy eating and obesity subjects and could undertake an apprenticeship at schools as part of their training. However, some barriers were also identified which challenge the feasibility of such an intervention. Some students simply want to pass their training and would not do the task properly, it would not possible to run such a scheme in remote areas, and such a scheme would add workload to university staff, who would need to evaluate and supervise students during this activity.

Parents

Parents referred to their need for receiving accurate information regarding unhealthy food culture and dietary habits. School staff also prioritised modifying parents' views about healthy nutrition and emphasised undesirable outcomes of parents' unawareness about health and nutrition. School was perceived as one of the appropriate settings to provide health and nutrition knowledge and skills for parents. Furthermore, school was suggested as one of the channels for distributing health and nutrition materials developed at governmental level. Parents' meetings were identified as the opportunity to educate parents, but infrequency of such meetings was seen as a barrier to continuity. Holding regular talks at school was also identified as an opportunity for both parents and staff to receive accurate information.

Family education talks are something held in all schools in Iran often covering the psychological and educational affairs of children. Some groups prioritised health and nutrition education to be included as a permanent part of those meetings. However, attendees discussed some barriers also, including that poor quality presentations has resulted in low attendance for these in the past. The large number of schools and low number of experts and also the need to deal with a wide range of problems in big cities were also highlighted as barriers to feasibility.

A mother from the middle class area said: *Many families aren't even bothered to go to school to collect the children's marks. They would never attend* (lectures) …

Some groups prioritised sending reading materials to parents as they could be very informative and would not need their attendance at school. However, participants also commented that sending materials would not guarantee that the target audience would read and receive the messages. In particular, the activity would not benefit illiterate parents and their families, which comprise 15.4% of the population in Iran. A number of approaches for increasing the level of acceptance including feedback and evaluation forms and free prize draws were suggested.

Bearing in mind the expected low participation of parents at school talks, some groups suggested that educational programmes and lectures on TV would be more effective. It was also mentioned that parents emulate each other and they convey information among themselves rapidly.

A deputy from high income area noted: *Just like the session you had for mothers in our school* (FG with mothers at her school). *I called mothers to remind them to come and I even asked mothers who were in school at the time, but they refused... then the mothers who attended told others about the session and then mothers kept saying why didn't you tell us?*

Less educated mothers from the deprived area, who tend to follow a more traditional lifestyle, suggested that by training some mothers through meetings at school, messages would be conveyed to other mothers and parents in the community. However, they referred to the necessity of cooperation between community members as a key factor in any community based activity. They also emphasised the power of continuity since not all individuals would respond to education immediately.

<u>Working with school shops</u>

Almost all groups, including school staff, discussed approaches to improve school shops. Most suggestions were prioritised in the final list, except for ambitious suggestions such as closing down the school shops. Suggested activities generally included sets of examples like controlling opening hours, hiring younger and knowledgeable personnel to serve at school shops, and providing more fresh and healthy food options. As school shops are usually run by the school janitors, participants suggested that shops should instead be run by young and nutritionally aware people, such as parents (particularly housewives) with supervision by experts.

Participants suggested both providing more healthy foods and decreasing availability of unhealthy options. However; most groups ultimately perceived that a balance between selling healthy foods and drinks and other options would be most effective in the long term. Participants noted that children could buy unhealthy foods from nearby shops before and after school time, even though most come to school either by school bus or with their parents. Availability of healthy food options in the school shop was believed to help develop a taste for such items from childhood. It was commented that children like to eat similar food together and they like shopping. Availability of healthy foods at the school shop would build up healthy shopping ability in children and an excellent opportunity for them to do something they enjoy.

Parental contribution to provide healthy foods at school shops was also suggested.

A school nurse explained: *There is a successful scheme in two schools. Families run the school shops and it is a nice system. Families get involved, they provide hot food, then five are there with gloves, under control, providing sandwiches for all children... it is not against the law and they just need to get health certificates...*

It was also suggested that school shops opening hours need to be controlled carefully.

A mother from the affluent area said: *I just popped out to pick up my son* (at noon)*… the school shop was open and it was crowded. Kids having some junk just before lunch; they will either eat too much or lose their appetite…*

Rewards and competitions

Encouraging children to follow healthy food habits and holding competitions for naming those who eat healthy snacks at school was prioritised as an intervention component by almost all groups. A range of approaches were suggested for encouragement, but all recognised the powerful effect of such encouragement on young children's behaviour which would then form a habit. School was identified as the best setting for such activity. However, encouragement of healthy food habits by parents was also prioritised and perceived as a complementary activity.

A teacher in school staff meeting noted: *He* (child) *might do it as he is encouraged, but when he gets home he may not eat healthy things… encouragement would work if it would be continuous both at home and school, not just as a temporary programme at school.*

Using competitions as an approach to encourage children at school was mentioned several times by most of the groups. Prizes were perceived as very important motivators for children; though certificates, points, and verbally praising children either at morning assembly or in the classroom were all suggested as potential approaches. Participants also discussed that educating children is preferable to competition. They referred to the risk of spoiling children by offering prizes and mentioned that children may eventually expect a reward for anything they do. Despite these reservations, all groups agreed on the desirable effect of encouragement on children’s healthy eating behaviour.

A mother from the middle class area said: *My daughter didn't use to take cheese and bread to school..., but now she herself tells me 'put bread and cheese and herbs for me, I like to take it', or 'cheese and bread and walnut, let me take it so my teacher will see what I have, she will give me points'...well it was a kind of encouragement and now she eats, sometimes she makes it at home and eats it.*

Working on self-esteem

Low self-esteem was discussed in the context of children being influenced by peer pressure. For example children sometimes refuse to eat healthy home-made or traditional snacks because they feel embarrassed, preferring unhealthy alternatives that their peers eat. Participants recommended a range of approaches for tackling peer pressure and improving self-esteem.

A weekly snack schedule for schools (i.e. a list of snacks allowed for each day) was prioritised by almost all groups and some groups confirmed the feasibility of such activity as it has implemented in some schools, and the practicality and ease with which it is followed. Such a programme was believed to prevent peer pressure to buy junk food. One comment was that some families might not be able to afford "special snacks". Therefore, planning a weekly snack programme had to be in line with common items in the family food basket according to each area, and the necessity of parental cooperation was also underlined.

A teacher from the low socio-economic area believed that low income families could take part in such a programme: *If a family can not buy... if I know I have to put banana in my kid's bag on Thursdays, I'd plan to buy bananas on Wednesdays...*

In addition, adopting school policies, including prohibiting children from bringing unhealthy snacks to school was prioritised several times by many groups including school staff. They emphasised the words policy and rules, as it would not be feasible to enlist parents' cooperation.

A school staff explained his experience: *In our school, one of the teachers tried to do that* (to ban bringing of unhealthy snacks)*, but unfortunately as parents were not aware, despite being from a high socio-cultural level, some of them opposed the plan and said why does this lady give this schedule to our kids. My child likes to eat sausages. There is no rule to force my kid to eat certain things...*

Participants discussed that such policies had been adopted in some schools, but children do not adhere to them. It was mentioned that some children take unhealthy snacks, but change the original pack to disguise it. Participants identified supervision, for example by school nurses, to ensure adherence to policies as essential. However, not all schools have a school nurse and in big schools, the school nurse could not provide adequate supervision. Another suggestion was that some children could be trained to work as health assistants in schools. Children like to take responsibility which would be valuable in implementing the activity.

A school nurse noted: *Regarding controlling snacks, we selected some pupils as health assistants. I trained them. Then, child with child, face to face, it's got positive effect, they were taught on what to eat to be good for their health. They were taught about nutrients. Then he tells his schoolmates, face to face. I always tell them, I say educate the children, but not to take his snack and throw it way. Teach him what to eat to be good for him and it is absolutely effective.*

Providing specific snacks for children during breaks at school either with financial support from parents or for children to buy with their pocket money was also suggested. Participants discussed that such a scheme would need to be well organised and there would need to be additional staff to help teachers (in Iran, class teachers do not have assistants). In one school where such a scheme had run, a fixed budget was provided for giving free snacks (from the school shop) to children from poor families. One suggestion was that schools could provide food tokens for children from deprived families to be only exchangeable for healthy foods at school. Participants suggested that such schemes should have financial support from the Ministry of Education and also need parents' cooperation. Parents may hesitate and be suspicious if money is collected from them to be spent on what the school wants to provide.

Most groups discussed children eating together at school and in the classroom. However, to avoid them eating unhealthy snacks together supervision was needed. There was also a suggestion of restricting snack time to the first 5 minutes of breaks, which may put some children off having any snack at all (e.g. prefer to go to play, or to go to the toilet) and make them more likely to eat snacks from home instead of buying unhealthy snacks from the school shop. It was generally perceived that eating in a group would encourage children to eat healthy foods and compete with peers.

A mother from the middle class area noted: *I was in a class couple of days ago on behalf of the teacher. One of the children asked me to let him have his snack. I let him and all others took their snacks from their bags. They looked at each other and ate bread and cheese. If they had gone out, they would not be interested in their snacks as soon as they see the school shop.*

Improving PE

The Ministry of Education was identified as the main responsible body with regards to improving PE sessions. However, participants also suggested some activities to improve PE sessions within available resources. Most groups agreed that the most effective approach was to raise the importance of PE as a subject. Need for better communication between parents and PE teachers about children's PA level was highlighted. Teachers, it was felt, should educate parents about the role of PA in their child in relation to health, and parents should clearly talk about their expectations from school.

A range of suggestions were made and almost all were prioritised as important and practical activities. Giving certificates and points for active participation in PE sessions, and taking seriously the assessment and mark obtained in PE were recurrent themes from many groups. The perceived barrier to incentives, was that children would only do the minimum 5 to 10 minutes play in the school playground to get the points. Parents and school staff commented that PE is not taken seriously and many children are absent on PE day as parents do not bother to take them to school if they would have more important work.

A PE teacher said: *School should take children's' presence seriously. Children normally find it hard to wake up. Mothers would say ok you've got PE, Quran, and arts, no need to go to school.*

Children like to get good marks and they would do everything to achieve the top mark. Regarding PE, getting ready for exams would mean doing daily PA, which could be a useful intervention.

A mother suggested: *Marks are important. She* (her daughter) *can't do skipping, so she won't get a good mark. She will try to learn, she does exercise, she has to practise at home.*

Participants concluded that current policy regarding PE teacher recruitment is unlikely to change; therefore alternative approaches were suggested. One suggestion was to enlist sports science students to cover PE sessions as part of their apprenticeship. Some participants recalled successful stories about trained mothers running PE sessions. However, this was against Education Office laws, and they had to stop. In some schools, the class teacher takes a day off once a week, and the school invites a PE teacher instead from the school budget. These suggestions were rarely prioritised at the end of the discussion mainly because of barriers towards changing current policies.

Provision of PA at school

School was considered as the most important setting for increasing the opportunity for doing sports and PA. Mothers suggested that children should learn how to play sports at school and schools should provide sports equipment. However, there was recognition that liaison between family and school is needed. The importance of family was noted since parents also need to encourage play rather than allowing the child to sit all day. In all sessions participants referred to the observation that children like and listen to school staff. They commented on the influence that school staff would have if they took part in exercise alongside pupils during breaks. Some mothers discussed how deputies used to participate in their games when they were at school and that it changed their level of activity.

Participants considered approaches needing limited alterations to current school structures and their limited facilities, in relation to increasing children's PA levels. Need for providing appropriate indoor and outdoor space for activity, possibly by developing unused areas in schools, was often suggested. Identifying such space was considered a priority for implementing several other activities during school time. Suggestions included using prayer rooms and corridors. Doing exercise in indoor spaces was thought to allow girls to dress more appropriately, without having to wear head wear and uniform. However, one PE teacher disagreed, and felt children should play and do exercise outdoors in the playground, as _"shortage of oxygen could lead to exhaustion"_.

Providing sports facilities and equipment was mentioned commonly by most of the groups and was also addressed in the interviews with PE teachers. Although a broad range of equipment was discussed, most agreed that provision of basic sports equipment such as balls and skipping ropes would be a good start.

Compulsory morning exercise was repeatedly brought up by participants. The word "compulsory" was added because parents believed that doing morning exercise is part of the school plan but is rarely implemented, and certainly not regularly. On the other hand, school staff perceived that many parents are not happy with the activity, citing "cold weather" as their reasoning. Mothers and teachers believed that parents who are against the plan, bring their children to school later to prevent them from having to take part. School staff also emphasised the need for trained PE teachers as well as appropriate venues for holding morning exercise sessions in all weathers. Some schools in Tehran have very small playgrounds (the size of one of the schools in the present study was 80 m^2). One PE teacher commented that schools with small playgrounds could not run morning exercise sessions because of the lack of space. The idea of doing morning exercise in either classrooms or school corridors was proposed by some groups. There is more space in the corridors compared to the playground and if all children exercise at the same time, disturbing classes because of noise would not be an issue. All groups also agreed that morning exercise sessions could involve all children, and require no extra resources. It was also noted by parents that some children do not take part in exercise and many undertake exercise routines incorrectly, putting them at risk of muscle cramps and injury. Therefore, parent group stressed the importance of having a qualified teacher to monitor exercise sessions and a PE teacher suggested use of big monitors to display and demonstrate the actions. While compulsory morning exercise was frequently suggested as an important intervention by many groups, one PE teacher disagreed, and disputed the effectiveness of morning exercise, essentially 10 minutes compared to the required minimum of 30 minutes per day on children's weight status.

In addition to morning exercise, the introduction of 5 minutes of daily PA in the classroom was also prioritised as an important activity. Participants felt that children could do such activity within the small classroom space, and without making much noise.

Participation of children in a range of sports competitions, including within school breaks, intra-school and at the community level, were recommended by a few groups. Particularly mothers emphasised including year 1 and 2 children in sports events, since usually only older children are involved. PE teachers did not agree, and argued that limited space and facilities would mean that the few children selected to take part in important competitions could not practise sufficiently if more children were included.

A PE teacher noted: *There is no facility. There was a swimming competition, I went with some children, and we selected from those who had already won* (in the past)*... because there is no opportunity to take them to a swimming pool to practise and see who can swim well...*

Non-competitive activities, such as running were also suggested as important, recognising that children are interested irrespective of there being a prize.

Planning PA programmes for teachers was also prioritised by a group of school staff. Acknowledging the effect of school staff as role models for children, it was noted that teachers should be of healthy weight before recommending that children should follow a healthy lifestyle. There were suggestions that planning sport events for school staff and children together would be well received by both groups and would be effective in the long term.

An intervention that was often prioritised for its feasibility was painting simple games on the school playground or using play mats for games such as hopscotch. Participants believed that increasing numbers of people living in small flats has meant that children are no longer familiar with such games, this would provide them with a fun learning opportunity to become more active.

Setting daily PA as a homework subject was also prioritised as a perceived important activity. However, as primary school children are only at school for 8 months in a year, this was believed to limit the feasibility, effectiveness and maintenance. Furthermore teachers were not sure whether parents would cooperate with the school sufficiently.

A teacher in a mixed FG including mothers commented: *I asked them* (parents) *to report the children's bed time. Some parents recorded that their children slept at 9 p.m. just for the sake of saying it, when in fact they had slept at 11 or 12. I realised that telling lies was spreading in my class, so I put it away.*

Other school activities

Most groups discussed activities which could be carried out in school to improve the children's general health. Playing games, celebrating _"health day"_ seasonally, art competitions, and cooking demonstration were suggested by school staff as successful strategies. It was commented that children like extra curricular activities and if done regularly, these could be effective in improving children’s attitudes towards healthy living.

Many schools do not have suitable space and facilities for exercise. There was therefore a suggestion to train all children on a special day at school to learn how to do exercise for help maintaining a healthy weight which they could practise at home daily.

A PE teacher commented: *Most obesity* (in children) *is abdominal obesity. Because of eating junk foods, their tummy gets obese… sit ups I think, are very good for children… in school we need to have a foam mattress, but they can do it at home. It would be better if we take time for a day and explain* (the activity) *in the school playground, it would be better if we train them rather than describing it schematically. They might not understand and to do it wrong.*

4.4.5.3 The *family*

A wide range of activities at the family level were proposed all related to increasing levels of PA and limiting sedentary habits (Figure 4.5). Stakeholders seemed to view the government (health authorities) as responsible for developing and delivering most such "family activities" and "parenting skills" programmes. However, there was recognition that awareness raising and availability of health information was a pre-requisite for such programmes.

Family activities

Encouragement of exercise among parents through initiating home-based exercise, and action planning were seen as important by a number of FG participants including parents and school staff. Types of activities that were suggested as feasible for families included family morning exercise and walking. In one group of school staff this was challenged however, and the view was that such activities would have no effect on weight status.

A deputy head commented: *Imagine that we walk for 15 minutes. Does it work in the long term? Or would it just increase our appetite and we would eat a lot more… we will definitely put on weight.*

Important and feasible components of the family "action plan" and children's timetables were suggested to include limiting family time spent in sedentary activities and agreeing a time table for watching TV.

Activities for family

Developing family PA action plan
Activity schedule for kids
Setting up family and friends group activities
Taking children to parks regularly
Climbing once a week
Walking as mean of transportation
Sports class

Parenting skills

Improving family food and PA habits
Informing children on the consequences of obesity
Arranging healthy meals at right time
Healthy food basket
Healthy cooking

Figure 4.5 Specific examples of family interventions

All groups agreed that it is feasible for children to be kept more active in the home, and mothers suggested a range of approaches to achieve this. Suggestions included that mothers could do more active play with their children. However, perceived barriers were that parents do not know what games are suitable and most active games are noisy and would disturb neighbours. Further suggestions were therefore that suitable less noisy games could be taught to parents as part of an educational programme.

Other approaches for keeping children physically active whilst at home included involving them to help with daily chores, making arrangement for children to play together among friends and neighbours and allowing children to play in residential underground car-parks (multi-story buildings in Tehran usually have a big common area under the building where residents park) and surrounding green spaces.

A teacher who lived in the lower socio-economic area explained her own experience: *Our neighbours in the flat below us have a daughter, she comes to our place. When she is with us I know her mother knows that she is with other children. Then I tell them to do something active…*

Another mother from the affluent district noted: *My daughter always invites her friends round. As we've got garden, I tell them to go and play together. But many* (parents) *would not do that because* (they think) *it is a hassle. I mean parents just care about themselves...*

Taking children to the parks and hiking (Tehran is surrounded by mountains) were commonly suggested and often prioritised as important activities for weight maintenance. Within this, suggestions included joining team sport activities in the parks on Fridays (weekend day in Iran), joining people who do regular morning exercise in the parks, weekly hikes with the family, or hiking as part of a school activity. Participants noted that children like outdoor play and taking them to the park would mean they are active.

A PE teacher commented: *Kids hardly sit in parks. Children at age 8-9 very rarely sit in park. They go everywhere, so it* (going to park) *would be much better than staying at home.*

A potential barrier to Friday activities in the park, was that there would be competing priorities, as it is the only weekend day in Iran.

Walking and developing a walking habit from early childhood were also emphasised as important. particular, walking to and from school was frequently mentioned as a way of developing a daily habit. Cycling to school was also suggested and discussed, but not prioritised because girls are not expected to cycle in the streets and many children do not have a bicycle. Attending sports classes was mentioned as an important activity for children but the high cost and limited availability of such classes for children was noted as barriers, and therefore this was also not prioritise.

Parenting skills

The family and home environment was perceived as the most important setting for influencing children's dietary habits. On the other hand, nearly all groups agreed that children look up to and obey their teachers and other school staff and listen to them even against their own preference. Thus the role of the school was seen as complementary. The family has a pivotal role in building and initiating healthy attitudes and behaviours while the school could enforce these in a broader setting.

A teacher commented: *You know the school is more effective than the family, sometimes when the teacher says _"eat all your snack"_, they* (the child) *will have it, but the mom could not force him to have it even in 20 hours.*

Improving the family food and PA habits were frequently discussed. Two strands to this theme referred to the child "building up healthy habits in children" and to the parents "modifying unhealthy behaviour among parents". A range of approaches for achieving these goals were suggested, mainly related to the provision of relevant information to parents. Below are some of the ideas related to this theme.

One approach suggested and frequently prioritised was to inform children of the consequences of eating unhealthy foods and obesity.

A mother from the middle class area commented: *I think we should give kids insight that some foods, some snacks are unhealthy. I mean by eating those* (foods) *some complications would occur. My daughter… I mean she hardly ever eats flavour corn puffs… she came to me a couple of days ago and said that flavour corn puffs are carcinogenic and I won't eat it again. I mean I had instilled in her attitude, awareness, and I had told her… and I bought it* (flavour corn puffs) *very rarely.*

Regular times for serving and eating the main meals and set times for eating snacks were believed to be important for encouraging healthy eating by most groups. The importance of eating breakfast was often cited, and many participants recognised that skipping breakfast often leads to eating unhealthy alternatives later in school.

A teacher from low socio-economic area said: Children often don't eat breakfast… skipping breakfast apparently leads to obesity because then they eat unhealthy foods like corn puffs, crisp or cakes at school.

A mother from middle SES area noted: *One who skips breakfast I mean he is hungry and wants to eat a lot for lunch to compensate for the energy he spent since the morning and this brings about obesity…*

Although traditionally lunch is the main meal in the Iranian diet, over recent years things have been changing due to work patterns, and for many fathers dinner has become the main meal. Therefore, children often have two main meals. Customarily in Iran, dinner for the whole family is served around 8-9 p.m. in winter and around 9-10 p.m. in the summer. Serving dinner at an earlier time, eating more simply for dinner, and increasing the time between eating dinner and going to bed were therefore also frequently suggested and prioritised by most of the groups.

A mother from low socio-economic area said: … *We should eat dinner at 7 and do some activity till 10, if they want to have something at 10; they can have some fruits and go to sleep…*

Another mother from middle income area said: *I personally… my husband comes home late, I used to wait for him to have dinner together, I ate late and I became obese. Then I decided I mean I talked to him. Family health depends on my child and I have dinner earlier. We have our dinner at 7:30…*

An important barrier to this however, was perceived to be fathers' working hours, as men often work till the late evening and eating dinner together is seen as the only opportunity for family time.

Reflecting this dilemma, a mother in parents' FG noted: *It doesn't necessarily mean that the child should have his meal with his father and mother, it means that the child needs to have a healthy family… he either has dinner with his father or not. I think he needs to feel his father presence. A father who loves him…*

Potential solutions were also discussed, including bringing children's dinner time earlier and for mothers to eat with the children; eating together but providing a simple dish for the children and mothers; and encouraging fathers to alter their work patterns so they come home earlier.

Parenting skill training was also discussed in relation to nurturing a healthy attitude among children from the early years. Suggested approaches were persistence whilst avoiding extreme strictness, and application of "non-compulsory" and "non-judgmental methods".

A mother from middle income area commented: *Education is not to say do this and don't do that. I think preaching is not effective for anybody, we should believe in something …*

Training parents to teach healthy food shopping and healthy cooking to their children was also mentioned. A few groups of mothers suggested that children could be involved in drafting a weekly healthy meal plan, particularly for breakfast.

Healthy cooking, which was characterised by using fresh and healthy ingredients as well as healthy cooking methods (e.g. baking instead of frying) was often prioritised as an important and feasible activity. Related to this, was the importance of cooking light and simple foods for dinner, in contrast to traditional customs. The importance of healthy food shopping for the family and limiting the purchase of unhealthy snacks was addressed as a prerequisite to healthy cooking.

Many participants commented on the importance of reducing unhealthy food intake in the diet, but noted that such food should be clearly labelled so that everyone is aware of what is healthy and what is less healthy.

4.4.6 Barriers towards successful intervention

In the process of intervention prioritisation, a range of barriers were identified by the participants. The perceived barriers were related to either initiating or sustaining of programmes or both. These barriers could be classified into five categories, mostly influenced by living conditions, cultural beliefs and habits, and related to the family, schools, and the community or environment (Figure 4.6). Many of these were similar to the perceived causal influences, and are discussed in more detail below.

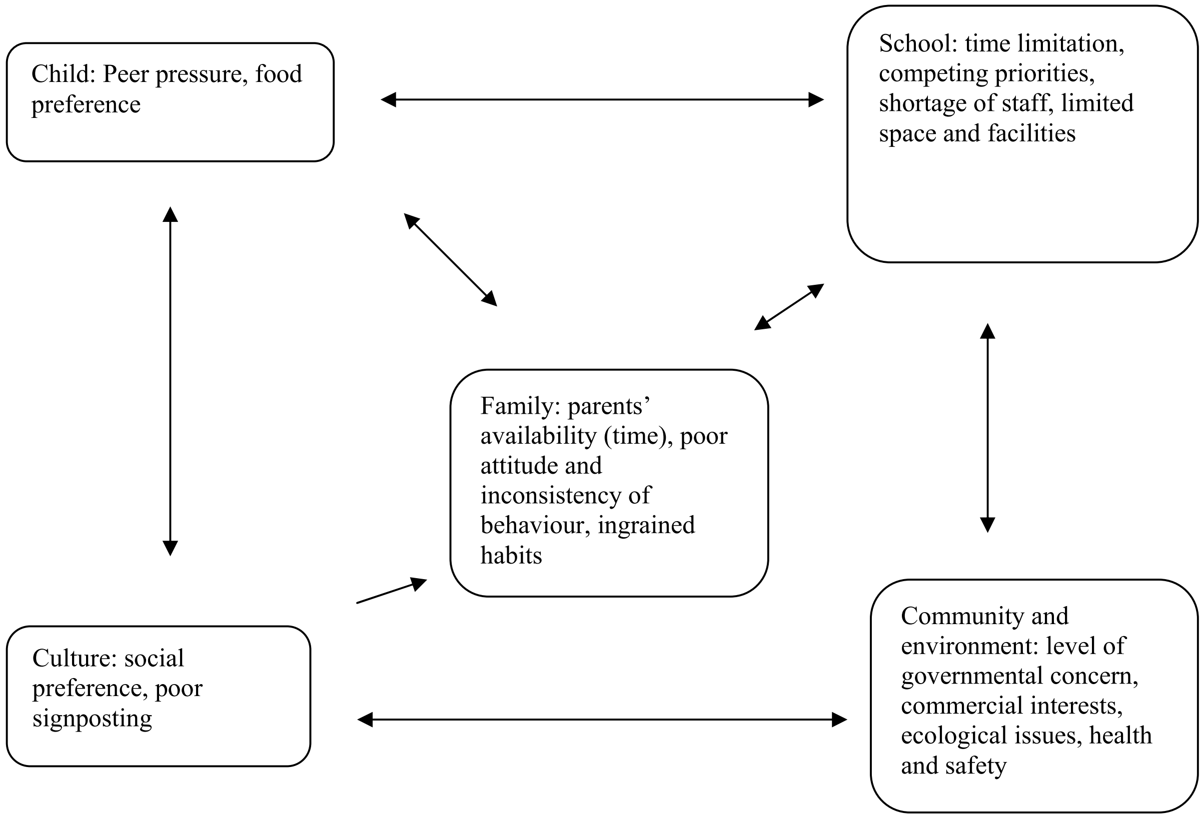

Figure 4.6 Themes identified as barriers towards successful intervention

4.4.6.1 Culture

Social preference for heavier children, which was discussed as a contributor to childhood obesity and it was also identified as a barrier towards healthy weight programmes.

A mother noted: *At school we tell the children not to eat junk food as they will become obese. When they talk about this matter at home, parents like chubby kids and they will say_" it's good to be chubby"_. Most of people think like this.*

Lack of awareness and poor signposting of facilities and opportunities was also identified as an important barrier to intervention coverage. Most of the groups complained of lack of community activities and facilities provided by the governmental sectors. However, some participants discussed the availability of such facilities. Participants also discussed the need for opportunities to exercise in parks. However, a PE teacher mentioned that the council puts up banners about free exercise sessions in parks, and there are also trained educators to guide people how to exercise and to use the sports equipments available in parks.

A PE teacher commented: *The council have built sports called "Al Zahra". The halls are in all areas, especially built for ladies. Moreover, they arrange hiking trips for children for free and hold competitions… physical fitness classes are also available for all ages. I go to one of the halls on Fridays, I am the supervisor there. But unfortunately just older ladies come along. No children...*

4.4.6.2 Child

Peer pressure was identified as a serious barrier towards improving food habits among children, but a few mothers suggested solutions that they had tried.

A mother from the affluent area noted: *When my son's friends come to our house I don't give them crisps and corn puffs. I just offer traditional foods … like dried apricots, hazelnuts. Kids love these foods. They get used to eating crisps and flavour corn puffs, but they are very happy with eating those* (traditional snacks).

Another mother from the middle class area said: *I put cheese in baguettes as my kid would feel embarrassed if she eats kind of common* (traditional) *breads.*

Children's preference for unhealthy foods was seen as a barrier to intervention, as well as a cause of obesity. Although there were suggestions of persisting in providing children with healthy food options, many did not believe that this would necessarily result in children consuming these foods.

A mother explained: *I did not like yogurt when I was a child and I still don't like it- I mean my taste has not changed despite all efforts- they kept saying eat this, it is nourishing, it is this, it is that… but my taste is still the same.*

4.4.6.3 Family

Although the active involvement of parents was recognised as crucial in the establishment and sustainability of intervention programmes in all settings, lack of time was constantly cited as a barrier. A considerable percentage of mothers in Tehran are working and fathers have multiple jobs. Therefore, competing priorities at the family level, social pressures, and poor liaison between families and school were perceived as basic barriers resulting from lack of time.

A mother from the high socio-economic level area said: *I personally can't put that much time to think about his education, food, and taking him out to play. I can take him on a trip or for entertainment to improve his mood, but I can't take him somewhere to sap his energy...*

Another mother said: *It* (arranging home based physical activities) *is not practical. My husband tried so hard but it did not work. There is lack of time, it never goes beyond rhetoric, people are exhausted…*

In most groups poor attitude, inconsistency of behaviour, and lack of cooperation between those who influence children, including parents and school staff, was discussed as a key potential barrier to successful intervention.

A school staff commented: *In our school, one of the teachers tried to do that* (to ban bringing of unhealthy snacks)*, but unfortunately because parents were not aware, despite being from a high socio-cultural level, some of them opposed the plan and said "_ why does this lady gave this rule to our kids? My child likes to eat sausages, or to eat this and that. There is no rule to force my kid to eat certain things..._"*

Another school staff said: *I see the mother puts a small healthy sandwich for the child, then the father comes in at the school break. He brings a large pack of Cheetoz* (flavour corn puffs). *He then says I bought it, because otherwise you will need to wait in the school shop queue…*

Modification of behaviour among parents, and even among children of this age was seen to be difficult after habits have formed and become ingrained. This was seen as a barrier to the many suggested activities for improving dietary habits and PA levels.

4.4.6.4 School

School start time and length of time in school were identified as barriers for a number of interventions. Primary school children attend school from 7.30 in the morning for 4 hours, on six days per week for 8 months of each year (see below). Teachers believed that any intervention provided through school, would not be sustained during the long summer holiday away from school. Moreover, the early school start time was regarded as a barrier limiting the potential for pre-school activities such as morning exercise at home and walking to school.

> A teacher commented: *School plays an important role, children listen to teachers. It is very effective, but unfortunately they come to school for 7-8 months, then holidays start. Next year there's a new teacher, this is an issue. But children do listen to school staff.*

Competing priorities in the school setting was identified as a barrier towards running school activities. An already saturated curriculum and prioritisation by schools of other subjects over PE were frequently mentioned.

> In contrast to this theme in the context of finding out a time to implement "eating breakfast together", a school nurse said: *They can take the first 20 minutes of PE sessions to do it* (to eat breakfast at class together)…

A few groups thought that schools need to deal with other basic needs which take priority and would limit the contribution of school staff and facilities for health interventions.

Regarding limiting unhealthy school snack, one mother from the affluent area said: *We kept saying in the last three, four months but no one took action. I mean, we asked the head teacher* (to ask teachers to tell children what to bring to school). *She did not pay attention. She said this is not a priority. We've got more important things… providing doors and benches…*

Some groups noted that classroom and school based would be extra work for teachers. In Iran there are no teachers' assistants to help with class work. Participants also assumed that any extra curricular activity would not be part of the teachers' responsibilities which would limit the sustainability of the programme. However, a few teachers counterbalanced this view by stating that intervention in schools is feasible.

One teacher from the deprived area said: *It is doable. Children are coming at 7:30. We can ask mothers not to serve breakfast at home and bring the children to school at 7... They can eat in classes as we don't have a big place* (to serve breakfast for all children in a same place). *It would be a good way of putting emphasis on eating breakfast.*

Several groups commented on the need for replacing older PE staff with younger new teachers. Reasons for this included the perception that, young PE teachers play better with children and children are more motivated by them. However, there were also obstacles identified to employing and promoting such staff.

A deputy head teacher noted: *We have got PE teachers. Young ones really work well, but the older teachers just give a ball to children and let them play…*

On the other hand, a retired PE teacher expressed the opposite view. In the context of suitable physical activity for younger children, he said: *Some of our colleagues, either they are young or do not care, ask children to do warm up exercises, which would make children lose interest.*

Limited space and facilities for indoor PE sessions and lack of basic sport equipment were mentioned as contributors to childhood obesity, but they were also identified as barriers to implementing interventions. Some successful experiences for convincing such limitations were described.

A young PE teacher said: (On cold days) *I took table tennis rackets to the class, depending on the size of the class, 2 or 4 children played and it was like a competition for them... they also did hopscotch... when it is cold all of those could be done.* She also noted: *The school playground was too small…. Then I tried to make groups, there were 20 children, I made 4 groups, then when they competed, each turn one child came forward...The head teacher was very cooperative, but as the school playground was too small, as soon as the children clapped or made a noise, someone complained that other classes have got lessons.*

Finally, with regards to inviting speakers or planning other school activities, the limited school budget and lack of resources were often mentioned as barriers.

4.4.6.5 Community and environment

A broad range of suggested interventions were related to decisions and action at governmental level. However, this was also discussed as a barrier by some groups and interviewees. There were suggestions for parent volunteers to help with school shop and to help run PE sessions (because the Education Office does not provide PE teachers for the first three years of primary school). However, strict regulations prohibit voluntary work at school and it was believed that government would not change this rule.

Competing priorities for the Government was also considered a barrier.

A mother from the deprived area commented that the Government should provide high quality PE sessions: *In my opinion children make a large segment of our population. If the community cares, it should invest in these children, because no country has got Iran's young population, children under 15. If they want, they could do...*

A PE teacher in an interview said: *Our country has encountered modernisation suddenly. Other countries build a sports centre beside apartments blocks when they plan to build the block, but they* (the Government) *think about religious issues first…, they build mosques, but they do not think about sports centres.*

Commercial interests which were frequently mentioned as serious barriers were also related to Governmental policies. Examples included the power of the food industry in directing advertising, strategies of granting food subsidy for high density foods including sugar and oil, and the small budget allocation for the promotion and provision of health for the community. Commercial interests at a smaller scale such as in running school shops, were also discussed. However, central policies were believed to affect local problems indirectly.

Climate and air pollution were identified as barriers to PA, but limited space and facilities for indoor PA were not believed to be amenable to change. Therefore, environmental conditions were seen as barrier to intervention.

Health and safety issues were also identified as barriers by some groups with regards to school activities and children playing in groups.

A mother from the deprived area noted: *Here… they do not take children on excursions. If they did take the kids on excursions, other places, they would learn about sports competitions. There is a cinema which belongs to the Education Office. They only take children over there. Mrs. M* (head teacher) *always says I'm afraid if we take them, in case there is an accident.*

Many participants suggested that residents of big cities like Tehran do not trust each other any more, which results in limited opportunity for children in a neighbourhood from gathering and playing together. Some mothers did describe successful stories based on their experiences, but most believed that lack of trust is a major barrier.

4.5 Discussion

In the present study, findings from FGs have provided important contextual data on the perceived contributors to childhood obesity in Tehran, and where the emphasis should be placed for prevention interventions. Moreover the data provide a better understanding of the barriers that need to be targeted to reverse the obesity trend. The findings should facilitate the development of tailored intervention programmes for Tehrani school children. Moreover, the process could be widely applied to develop similar interventions in other sub-populations in Iran. The level of discussion and range of ideas generated were basically similar in each identity group; however, the presence of fathers and mothers at the mixed session generated more discussions and disagreements.

4.5.1 Overweight and obesity

All groups of participants believed that primary school aged children's behaviours are developed and controlled by parents and teachers; therefore, it is crucial to consider their views in programming efficacious plans. Although participants were aware of the importance of childhood overweight and obesity which is similar to findings from other studies [269-272], they were not clear about the difference between the terms.

4.5.2 Contributing factors to childhood obesity

The findings suggest that parents and school staff have sophisticated views of the possible causes of childhood overweight and obesity which addressed biological, behavioural, structural, and social causes. They acknowledged that a range of factors are responsible for childhood obesity and they referred to both dietary intake and PA as main drivers of obesity in children, although there was also an emphasis on biological and medical causes. The role of modernisation and cultural norms on eating habits and PA behaviours were apparent and these themes pervaded many of the other perceived causal influences; however, the role of the government and national policies which influence living standard through SES and official regulations was frequently addressed. The emerging themes were similar between parents and school staff and the groups acknowledged that a range of contributing factors relate to their area of responsibility.

The main focus was on the role of parents and family; however, a range of macro- and micro-environmental factors which influence parental knowledge and skills were identified. For example, living conditions including long working hours, food costs, and availability of sports facilities are all contributed to poor parental behaviours.

School factors were mainly related to poor PE sessions because of regulations on recruitment of PE teachers and limited PA facilities because of restricted school budget which were mainly seen as outcome of the governmental policy and regulations.

There is similarity between beliefs around the causes of childhood obesity in the present study and findings from other qualitative and quantitative studies which were predominantly carried out in western countries [272-277]. The identified themes include lack of knowledge, family eating habits, availability and cost of leisure activities and sedentary lifestyle, food marketing and mass media, living conditions, and government policy. However, in the process of developing intervention approaches based on perceived contributing factors, the context of the target community and the relationship between causes should be considered. For example, in our study similar to a study from Australia, smaller living quarters over recent years was identified as a contributing factor to limited PA in children. However, in Iran this has meant living in very small flats whereas in Australia, participants mainly referred to decreasing size of backyards [278].

Furthermore, the participants frequently referred to the expansion of fast food outlets as a cause of unhealthy dietary intake in children. In our study population, less than 20% of families ate ready meals and only about 10% ordered fast foods more than once a month (almost similar for normal and overweight children). This is likely to be less frequent than that in most developed countries [274]. Thus different interventions are likely to be needed.

A range of perceived immediate causes including overeating of obesogenic foods and long screen viewing hours which directly influence energy balance have been suggested in several studies [278;279]. However, some perceived contributors such as expansion of fast food restaurants and limited availability of playing areas are not necessarily associated with the obesity epidemic [280]. These factors need further investigation before being targeted for intervention.

4.5.3 Intervention programme

There is consistency between beliefs about causes and proposed solutions. The participants suggested at least one activity for each of the perceived contributors, except for the biological causes. There was a few suggestions for tackling structural and government-related causes, but in the prioritisation process, these activities were not prioritised as practical solutions. The opinions of physicians and other stakeholders for potential interventions were gathered in other studies [273;281;282] which showed that GP's and lay people's perception of causes and solutions to obesity are similar, but for lay people the proposed solutions are less likely to relate to the perceived causes, compared to GPs.

There was a general belief that successful interventions should include a range of activities in all settings. The type of proposed activities was similar between identifying groups. However, mothers tended to endorse practical and simple activities like setting up group activities for children in their neighbourhood and they paid more attention to details of activities like the ingredients of healthy dishes.

All groups were interested in more and better quality information being made available to parents, school staff, children, and all other community members. Inconsistency in food related messages [278] and strategies for addressing the problem of obesity [283] make parents feel confused. Furthermore, studies from Iran and other countries revealed that children know about healthy and unhealthy foods, but they need to understand details and mechanisms through which food affects health status [278;284].

In general, participants showed greater interest in healthy diet approaches than PA solutions which is similar to findings from other studies [277] and may refer to their perceived ability to follow food related activities at the family level.

Identified intervention components by a range of populations are very similar to those in this study [269;272;277;279] and the themes for interventions aim at obesity prevention related to child factors, family dynamics, parenting, knowledge and beliefs, extra-familial influences, and resources and environment [277] are identical to those in this study. Whilst proposed activities are relatively similar in different communities, the structure, living standards, level of resources, and the culture of the people are different. Thus for the same intervention component, the implementation and level of activities may need to be tailored for specific population.

In Tehran, suggested better provision of PE at school, referring to sessions being run by qualified PE teachers rather than class teachers. However, better provision of PE sessions in other studies has referred to staff with expertise in certain sports, with an assumption that all PE staff are qualified [269;278]. On the other hand, some community activities such as campaigns for healthy behaviour using celebrities and humour and school activities which need extra resources, such as after school clubs, were not suggested by any participants in the present study. This may reflect an appreciation of what would be culturally acceptable, and awareness of limitations in available resources.

In general, greater concerns were expressed about physical inactivity in girls and limited opportunity for them, mainly because of cultural and environmental issues, especially in middle income areas. However, the same concern in western countries was attributed to suitability of strenuous exercise for girls [277]. It suggests that targeted PA interventions for boys and girls should be developed according to their needs.

It was felt that activities at the community level will have a powerful impact. However, the Government's commitment was frequently questioned by all groups which led the participants to prioritise activities within the local context. Agencies other than the government could provide services relevant to obesity prevention [272]. However, it is not clear whether the participants were less aware of non-governmental bodies or they purposively wanted to blame the Government. A mother from middle socio-economic area referred to NGO run activities for children and a PE teacher referred to availability of leisure activities for women in all districts which is organised by the Tehran municipality, but none of the other participants seemed aware of related activities.

The participants believed that unhealthy lifestyles develop at an early stage of life and it would be late to start programmes at school age. Nevertheless, School was recognised as an influential setting for establishing healthy habits [269;278;285].

The role of family members and the home environment on shaping behaviours was emphasised. It was also believed that the family influences school and community activities as all programmes need parental support and involvement. Other family members including grandparents were seen as influential individuals who cause inconsistency in handling children's dietary habits [277]. Other studies from western countries showed that health promotion strategies may be more effective when targeting the wider family [277]. Therefore, the role of grandparents is not necessarily related to cultural beliefs and they should be targeted in intervention programmes to improve level of success.

4.5.4 Barriers

The participants identified a range of barriers in the process of prioritisation which were similar to the proposed barriers mentioned in other studies [269;274;277-279]. These included children's preference, manipulating children's behaviour by family members, lack of parental recognition of the problem, poor environmental conditions, and related issues to SES such as living conditions and cost of leisure activities. Barriers towards PA in girls which was mainly attributed to state policies in our study were recognised as cultural issues in other studies [286].

Participants identified the Government as a main driver of many barriers, but this concept did not lead the groups to undermine their own roles.

Poor communication was identified as a cultural barrier towards successful intervention as some participants were unaware of activities and facilities available in the community. This finding is not unique to Iran, and was also identified in a study in Canada [279], suggesting that better signposting and advertising of facilities may be worthwhile.

There was general consensus that fathers' attitudes and behaviours may be a barrier to healthy lifestyle among children. This is similar to findings from other investigators [274].

Participants identified a few but important facilitators which were also identified in other studies [277;286]. Parents and school staff see themselves as having responsibility which tells that they are ready to be involved in programmes. They also mentioned children's preference for PA and their inherent nature for being active.

4.5.5 Strengths and limitations

Representativeness of focus group participants is a common concern [274;279] and the level of availability of stakeholders should be acknowledged as a potential source of bias. Parents who attended focus groups were not completely representatives of Tehrani parents. Most of the mothers were housewives and fathers attended only one FG. The greater participation by mothers is similar to other studies and indicates the pivotal role of mothers as primary child carers in most communities [277]. The discussion at the mixed FG was more extensive and disagreement in the prioritisation process including identification of barriers was voiced, indicating that fathers may have a slightly different perspective. Although most of the themes around causal influences and important levers for intervention were similar in all groups, many of the identified barriers to obesity prevention by mothers were perceived to be influenced by fathers' attitude. This may need further discussion in mixed groups.

Focus group participants were from a range of educational level and socio-economic backgrounds, drawn from three (high, medium, and low) socio-economic areas in Tehran, and including parents and school staff. Engaging parents from lower socio-economic groups is a concern for some investigators [278], but the attendance of people from the underprivileged area in the present study was considerably higher than from other districts. Nevertheless, in the FG with less educated mothers, more prompting was needed to facilitate the discussion.

4.5.6 Implication of findings for intervention development

The suggested activities and identified barriers in the present study help to inform the development of an intervention programme that takes account of contextual factors and has a greater likelihood of success. The rich discussions and ideas generated were not always consistent with the final prioritised intervention components perceived to be important and feasible within groups. Nevertheless, some consistent themes emerged that can inform priorities for intervention.

At the state level, provision of good quality information for the public, and improving PE were identified as the most important activities which should be implemented. Provision of healthy foods and leisure activities were often prioritised, but not included in the final list of important and feasible activities.

Many activities at school level were prioritised. Providing information and education for children, families, and school staff were usually included in the final lists by most groups. Innovative methods including computer-based education for children, reading materials, meetings, and lectures for parents, and CPD for school staff were proposed as possible means of conveying such information. Provision of PA at schools was identified as a more important activity than PE which is limited to low quality and short duration PE sessions. Moreover, it is practical to develop tailored PA programmes for different populations and situations. Provision of healthy snacks in carefully supervised school shops was also prioritised. Working on self-esteem and using rewards and competitions to encourage children to follow healthy habits were also perceived as important and feasible activities which could be applied at school and home.

Home level activities were mainly dependent on educating parents in the first place. Encouraging families to eat healthy foods and lead an active lifestyle seems challenging and strategies at governmental level including SES recovery were seen as a way of improving the current situation.

From the FG findings, some important principals could be derived to enhance the success of any intervention programme. Strategies to inform all community members including children of the risk of obesity and its associated consequences emerged as an important principal. Liaison between school and home is crucial to implement effective and long-term programmes which are not limited to a certain place and school year. A range of appropriate activities for the target community should be adopted in different settings to increase the level of success. Briefing and engaging authorities is needed to implement sustainable and effective programmes and to tackle potential barriers.

4.6 Key Points

- Use of qualitative approaches was feasible and useful for exploring the perceptions of a wide range of people in Tehran.
- There was high awareness that childhood obesity is a problem and a range of risk factors including related causes to diet and PA at the micro and macro levels were identified.
- There was consistency between identified causes and suggested interventions. Potential interventions were mainly focused on healthy eating and PA. Provision of accurate information and development of skills for all community members was emphasised.
- The important contribution of the state in providing a supporting environment was highlighted, but most of the feasible activities were perceived to be school-based and liaison with families was emphasised as essential.
- Findings from this study suggest that there is likely to be strong public support for obesity prevention programmes, but all groups believed that close liaison should be established between the school, the family, and the broader community.
- Since Iran is ruled by a central government and all policies have to be adopted at the ministerial level before being sent to all educational institutions to ensure

uniform implementation, substantial government support would be needed for the adoption of any school level intervention.

- The identified barriers were related to the child, family, school, culture, and wider environment, but the most challenging barriers were those related to the macro-environment including living conditions and state regulations.

5 Conclusion

5.1 Targeting childhood obesity prevention interventions and deciding on outcome measures for a trial

Findings of the cross-sectional study showed that childhood overweight and obesity is prevalent among boys and girls in Tehran (29.4% and 27.1%), particularly in the more affluent residential areas. However, even in the deprived area a sizeable proportion of children were obese, and mean energy intake was higher than in other areas. Considering global trends, it is likely that obesity rates will increase more steeply in deprived areas and so this population also needs to be targeted for prevention interventions. The confirmation that weight status is closely linked with blood pressure, a marker of cardiovascular disease, even in this age group, lends weight to the importance of prevention interventions starting in younger children.

A range of international and national reference standards have been applied to define obesity in children, but there is no agreement whether international or local reference values are most appropriate. A few studies aimed at producing growth related cut-offs for Iranian children [111;116;287] but they either suffer from technical flaws or do not provide sufficient information. Therefore, using international references, especially those standards which include databases from developing countries, such as WHO growth charts, is recommended.

Whilst BMI is commonly used and relatively simple to measure, it has limitations as a measure of body fat. The cross-sectional study showed high correlation between BMI and other adiposity measures, but the strength of correlations varied, and the correlations with blood pressure measures also differed. In the absence of evidence linking a particular BMI cut-off in children to health outcomes, it is important to monitor intervention effects using a range of adiposity measures and also blood pressure.

Intermediate outcomes are also important and should be monitored as potential explanatory pathways for any intervention effects. The validated food ticklist used in this study provides an estimate of total energy and fruit intake. The current tool did not allow the assessment of specific nutrients or food groups which may need to be considered in an intervention trial. Pragmatic considerations necessitated the use of a parent reported measure for PA assessment. This was a major limitation of this study, and non-objective measures have been shown to have poor validity. Ideally, an objective measure of PA should be included in any intervention trial, and in the absence of direct measures, assessing specific period of PA provides useful information.

Intervention trials should monitor a range of health outcomes, and include adverse outcomes as well as weight status related ones. Given that childhood obesity is particularly linked to psychological outcomes, it is important to monitor the effects of any intervention on their psychological health as well. This study showed that assessment of quality of life and body image perception are feasible in this age group, and that these measures do differ in subgroups of the population. They are therefore useful additional outcome measures for any prevention intervention.

5.2 What this thesis adds

This thesis has laid the foundation for the development of a childhood obesity prevention intervention in Iran. The review of systematic reviews highlighted the absence of effective interventions and that future intervention trials should consider local context and involve local stakeholders in intervention planning. The use of qualitative methods enabled exploration and understanding of local context and the perceptions of the community in relation to the most feasible and acceptable interventions. Unlike many other countries, a prominent emerging theme was the need for state level intervention and support for obesity prevention. Any local initiatives in Iran are unlikely to be successful without such support. Furthermore, an overwhelming view was that skill based educational interventions were needed to be delivered at all levels. The issue of resources also needs to be considered, and any intervention needs to be sustainable within limited available resources. These findings provide principles on which to build a prevention intervention, and highlight the importance of involving a wide range of stakeholders, and including multiple components to maximise the chances of success.

The cross-sectional study confirmed known patterns of obesity distribution in Tehran, lending validity to the study. In the context of intervention development, it confirmed the feasibility of undertaking a range of detailed measures in young children, validating their use in interventional trials.

Using the MRC framework for Complex Interventions, this study has started the process of intervention development and leads the way for an exploratory trial to test an obesity prevention intervention among children in Iran.

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Appendices

Appendix 1 Search strategy and data bases

Interventions to prevent childhood obesity

1. Cochrane Library
"child* OR adolesc* and obes* OR overweight in Title, Abstract or Keywords and prevent* in Title, Abstract or Keywords and intervent* in Title, Abstract or Keywords in Cochrane Database of Systematic Reviews"

- ✓ Cochrane reviews: 12 (1 relevant from title)
- ✓ Technology assessment: 2 (2 relevant from title)
- ✓ Other reviews: 20 (19 relevant from title)

2. PubMed

- ✓ MeSH database: 5 (3 relevant from title)

((("Obesity"[Mesh] AND "Child"[Mesh]) AND "prevention and control "[Subheading]) AND "Intervention Studies"[Mesh]) AND systematic[sb]

- ✓ PubMed: 143 (39 relevant from title)

((child* OR adolesc*) AND (obes* OR overweight) AND (prevent* AND intervent*)) AND systematic[sb]

3. ARIF database
9 (3 relevant from title)
child [Abstract] AND obesity [Abstract]

Total: 191
124 excluded from title
28 excluded from abstract
17 repeated articles
Total reviewed: 21

Appendix 2 Food intake questionnaire

Children's Food Intake Questionnaire

ID:

This questionnaire belongs to: Name: Grade: School: Date: Tel:

National Nutrition and Food Technology Research Institute

The epidemiology and prevention of childhood obesity in Tehran

Questionnaire guide

Dear parent/ caregiver,
The booklet includes Food Ticklist and diary. Please complete both sections for a same day (example: 10^{th} of December).

Section 1: Food Ticklist
Please record all foods and drinks your child eats at home, school, and all other places during one day.
Please start with breakfast column and tick the items he/she eats.
Complete snack, lunch and dinner columns, respectively.

Example

Breads						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Lavash			√			
Taftoon	√					√

Record total amount of consumed food or drink in the following tables. To record the items which has been consumed more than once on each day (example: bread), write the amount for each meal and record the total amount. For example, when your child eats a

$10*10$ cm^2 slice of Taftoon for breakfast, a 10*10 slice for dinner, and 4 slices of Lavash for lunch, you should complete the table as follows:

How many slices of Lavash in total did your child have today?
☐None ☐1-3 ☑ 4-6 ☐7-9 ☐10-12

How many slices of Taftoon in total did your child have today?
☐None ☐1 ☑ 2 ☐3 ☐4 ☐5 ☐6

1 slice for breakfast
and 1 slice for dinner

If your child has something at school or when you did not accompany him/her, please ask him/her about the type and amount of food/ drink to record on the questionnaire.

Note: Please try not to miss any consumed food/ drink.

If the child has something which is not on the list, please select the most similar item. For example, you could record "Baghla Polo" instead of "Dami-e-Baghla", "Hot dog" instead of "Sausage", and "Italian ice cream" instead of "Salaar ice cream".

Breads						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Lavash						
Taftoon						
Barbari						
Sangak						
Fantezi						
Shirmal, Sokhari, Ghandi						

How many slices of Lavash in total did your child have today? (1 slice= $10*10$ cm^2)
☐None ☐1-3 ☐4-6 ☐7-9 ☐10-12

How many slices of Taftoon in total did your child have today? (1 slice= $10*10$ cm^2)
☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6

How many slices of Barbari in total did your child have today? (1 slice= $10*10$ cm^2)
☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6

How many slices of Sangak in total did your child have today? (1 slice= $10*10$ cm^2)
☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6

How many servings of Fantezi in total did your child have today? (1 serving= 1 medium size)
□None □1/4 □1/2 □3/4 □1 □1.5 □2

How many servings of Shirmal, Sokhari, and Ghandi in total did your child have today? (1 serving= 1 Sokhari)
□None □1/2 □1 □1.5 □2 □3

Eggs and Dairy						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Egg (fried, poached, boiled)						
Milk						
Milk beverages						
Yogurt						
Cheese						
Cream						

How many eggs in total did your child have today?
□None □1/2 □1 □1.5 □2 □2.5 □3

How much milk in total did your child have today? (1 serving= 1 normal glass)
□None □1/4 □1/2 □1 □1.5 □2 □3

How much milk beverages in total did your child have today? (1 serving= 1 medium glass)
□None □1/4 □1/2 □1 □1.5 □2 □3

How much yogurt in total did your child have today? (1 serving= 1 medium bowl)
□None □1/4 □1/2 □1 □1.5 □2 □3

What type of milk and yogurt did your child have today?
Milk □low fat □2.5% fat □whole
Yogurt □low fat □2.5% fat □whole

How much cheese in total did your child have today? (1 serving= 1 match box)
□None □1/4 □1/2 □1 □1.5 □2 □3

What type of cheese did your child have today?
□Tabriz, Lighvaan □medium fat □cream cheese □Mosalassi

How much cream in total did your child have today? (1 serving= 1 table spoon)
□None □1/2 □1 □1.5 □2 □2.5 □3

Main Dishes						
Aash, Soups, Abgoosht, Haleem						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Haleem (wheat, aubergine)						
Abgoosht						
Aash						
Soups						

How much Aash, soups, Abgoosht, and Haleem in total did your child have today? (1 serving= 1 medium bowl)

□None □1/4 □1/2 □1 □1.5 □2 □3

Cooked Rice (Polo)						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Plain, sabzi or zireh polo						
Stanbuli, Loobiapolo						
Tahchin, Zereshkpolo						
Baghla, Adas, nokhoodpolo						
Other mixed polo						

How much cooked rice in total did your child have today? (1 serving= 1 Kafgeer or 10 tablespoons)

□None □1/2 □1 □1.5 □2 □3 □4

Sauces and mixed dishes						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Ghormehsabzi, Karafs						
Gheimeh						
Badenjan/Kadoo						
Fesenjan						
Nargesi, Omelette						
Taskabab, Loobia, Rago						
Fried/ canned fish						

Prawn						
Schnitzel						
Kashkeh badenjan, Mirzaghassemi						
Vavishka						
Minced meat and potato						
Cooked legumes						
Dolmeh, Kalehgonjeshki						
Koofteh						
Khorak-e-zaban						
Del-o-jegar, Maghz, Sirabi, Shirdan						
Kookoo sabzi						
Kookoo sibzamini						
Kotlet						
Morgh						
Goosht/ Mahicheh						

How much sauces and khoraak in total did your child have today? (1 serving= 1 tablespoon)

☐None ☐1-2 ☐3-5 ☐6-10 ☐11-15

How many Kookoo in total did your child have today? (1 serving= 1 medium slice)

☐None ☐1 ☐2 ☐3 ☐4

How many Kotlet in total did your child have today? (1 serving= 1 medium slice)

☐None ☐1 ☐2 ☐3 ☐4

How much Morgh in total did your child have today? (1 serving= 1 small leg or 1/2 small breast)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3

How much Goosht/ Mahicheh in total did your child have today? (1 serving= 1 match box)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3

What was cooking method to make meat/ chicken ready for today?

☐Fried/ fried and boiled ☐Boiled ☐Grilled/ oven cooked

Kebab						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Minced kebab, Tabeie						
Barg, Fish Kebab						
Chicken Kebab						

How much Minced kebab/ Tabeie in total did your child have today? (1 serving= 1 piece Tabeie or 20 cm of Minced Kebab)

☐None ☐1/4 ☐1/2 ☐3/4 ☐1 ☐1.5 ☐2

How much from all other kebabs in total did your child have today? (1 serving= 20 cm of kebab)

☐None ☐1/4 ☐1/2 ☐3/4 ☐1 ☐1.5 ☐2

Pasta						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Pasta and meat, Pasta salad						
Plane pasta						
Lasagne						

How much Pasta in total did your child have today? (1 serving= 10 tablespoon)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3 ☐4

Ready to eat foods						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Fried chicken, fish, and prawn						
Chips						
Burger						
Olivieh Salad						
Sausage sandwich						

and Donar Kebab						
Pirashki						
Sanbouseh, Falafel						
Zorrat-e-Mexici						

How much fried chicken, fish, and prawn in total did your child have today? (1 serving= 1 small leg or 1/2 small breast)
□None □1/2 □1 □1.5 □2 □3 □4

How much chips in total did your child have today? (1 serving= 1 medium bowl)
□None □1/2 □1 □1.5 □2 □3

How many burgers in total did your child have today? (1 serving= 1 medium hamburger)
□None □1/2 □1 □1.5 □2 □3 □4

How much pizza in total did your child have today? (1 serving= 1 medium slice)
□None □1/2 □1 □2 □3 □4 □5 □6

How much Olivieh Salad in total did your child have today? (1 serving= 1 tablespoon)
□None □1/2 □1 □2 □3 □4 □5 □6

How much sausage sandwich and Donar kebab in total did your child have today? (1 serving= 1 sandwich)
□None □1/4 □1/2 □3/4 □1 □1.5 □2

How many pirashki, Sanbouseh, and Falafel in total did your child have today? (1 serving= 1 medium)
□None □1/2 □1 □1.5 □2 □3 □4

How much Zorrat-e-Mexici in total did your child have today? (1 serving= 1 small cup)
□None □1/4 □1/2 □1 □1.5 □2

Snacks						
Nuts and dried fruits						
	Breakfast	Snack	Lunch	Snack	Dinner	After Tea
Nuts						
Walnut						
Peas and raisin						
Berenjak, Gandomak						
Sesame						

and hemp seed						
Bargeh, dried apricot						

How much nuts and dried fruits in total did your child have today? (1 serving= 1 small cup)

☐None ☐1/4 ☐1/2 ☐1 ☐1.5 ☐2

Sweet and savoury snacks						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Crisp, Chiplet, Khalalinamaki, etc.						
flavour corn puff, Keranchi, pop corn, Pofila, Tortilla, etc.						
Chocolate, toffee, Negrokis, Smarties, Morvarid, etc.						
Candy, Noghl						
Biscuits, wafer						
Savoury biscuits						
Chocolate biscuits						
Cakes, Kolouchech						
Breakfast cereals						

How much crisps and flavour corn puff in total did your child have today? (1 serving= 1 small pack)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐2.5 ☐3

How many chocolate in total did your child have today? (1 serving= 1 piece)

☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7

What was the brand name?

How many candies in total did your child have today? (1 serving= 1 piece)
□None □1 □2 □3 □4 □5 □6 □7
What was the brand name?

How many savoury biscuits in total did your child have today? (1 serving= 1 biscuit)
□None □1/2 □1 □1.5 □2 □2.5 □3 □4

How many biscuits/ wafer in total did your child have today? (1 serving= 1 biscuit)
□None □1/2 □1 □1.5 □2 □2.5 □3 □4

How many cakes, Koloucheh in total did your child have today? (1 serving= 1 cake or Koloucheh)
□None □1/2 □1 □1.5 □2 □2.5 □3 □4
What was the brand name?

How much breakfast cereals in total did your child have today? (1 serving= 1 medium bowl)
□None □1/4 □1/2 □1 □1.5 □2 □3

Pastry, dessert, and ice cream						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Plain cake, Yazdi, Keshmeshi						
Sheerini-e-tar, Nan-e-khameie, ice cream cake, Polombier						
Cookies						
Danish pastries/ Butter cookies						
Pirashki						
Iranian ice cream						
Plain/ Italian ice cream						
Chocolate ice cream (Magnum)						
Ice lolly						

Faloodeh						
Baghlava, Sohan, Gaz, Zoolbia, Bamiyeh						
Crème Caramel, chocolate pudding, mousse						
Sholeh-zard, Masghati, Fereni						
Rice pudding						
Halva, Kaachi, Ranginak, Samanou, Vitamineh, Maajoun						

How many cakes, cookies, and Pirashki in total did your child have today? (1 serving= 1 piece)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3 ☐4 ☐5

How much ice cream and Faloodeh in total did your child have today? (1 serving= 1 medium ice cream or 1 medium bowl of Faloodeh)

☐None ☐1/2 ☐1 ☐2 ☐3 ☐4

How many Baghlava, Sohan, Gaz, Zoolbia, and Bamiyeh in total did your child have today? (1 serving= 1 piece 3*3 cm^2)

☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6

How much crème caramel, Sholeh-zard, and rice pudding in total did your child have today? (1 serving= 1 medium bowl)

☐None ☐1/4 ☐1/2 ☐1 ☐1.5 ☐2 ☐3

How much Halva, Kaachi, Ranginak, Samanou, Vitamineh, and Maajoun in total did your child have today? (1 serving= 1 tablespoon)

☐None ☐1-2 ☐3-6 ☐7-10 ☐11-15

Fruits and vegetables						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Sweet fruits and fruits Faloodeh (grapes, dates, etc.)						
Watermelon, melon						
Date						
Banana						
Apple, pear						
Orange, sweet lemon						
Satsuma						
Potato, Balaal, carrot, beetroot, turnip						
Broad been, corn, green pea						

How many sweet fruits and fruits Faloodeh in total did your child have today? (1 serving= 1 medium fruit or bunch)
□None □1/4 □1/2 □1 □2 □3 □4

How much watermelon and melon in total did your child have today? (1 serving= 1 medium slice)
□None □1/2 □1 □2 □3 □4 □5

How many dates in total did your child have today? (1 serving= 1 date)
□None □1 □2 □3 □4 □5

How many bananas in total did your child have today? (1 serving= 1 medium fruit)
□None □1/4 □1/2 □1 □2 □3 □4

How many apples and pearls in total did your child have today? (1 serving= 1 medium fruit)
□None □1/4 □1/2 □1 □2 □3 □4

How many oranges and sweet lemons in total did your child have today? (1 serving= 1 medium fruit)
□None □1/2 □1 □2 □3 □4 □5

How many Satsumas in total did your child have today? (1 serving= 1 medium fruit)
□None □1/2 □1 □2 □3 □4 □5

How many potatoes, Balaals, carrots, beetroots, and turnips in total did your child have today? (1 serving= 1 medium vegetable)
□None □1/4 □1/2 □1 □2 □3 □4

How much baked broad been, corn, and green pea in total did your child have today? (1 serving= 1 medium bowl)
□None □1/4 □1/2 □1 □1.5 □2 □3

Drinks						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Fizzy drinks						
Sherbet, Juice						

How much drink in total did your child have today? (1 serving= 1 medium glass)
□None □1/2 □1 □1.5 □2 □2.5 □3

Other foods						
	Breakfast	Snack	Lunch	Snack	Dinner	After dinner
Butter						
Dressing						
Olive oil						
Olive						
Sugar, cube sugar						
Jam, honey						
Halva shekari						
Chocolate spread, peanut butter						

How much butter, dressing, and olive oil in total did your child have today? (1 serving= 1 tablespoon)
□None □1/2 □1 □1.5 □2 □3

How many olives in total did your child have today? (1 serving= 1 medium olive)
□None □1 □2 □3 □4 □5 □6

How many cube sugar and how much sugar in total did your child have today? (1 serving= 1 large cube or 1 teaspoon sugar)

☐None ☐1 ☐2 ☐3 ☐4 ☐5 ☐6

How much jam and honey in total did your child have today? (1 serving= 1 teaspoon)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3

How much Halva shekari, chocolate spread, and peanut butter in total did your child have today? (1 serving= 1 tablespoon)

☐None ☐1/2 ☐1 ☐1.5 ☐2 ☐3

Section 2: Food diary
Please record all food and drinks that your child has consumed during the day and write the amount either in gram or household measures like spoon, cup, and bowl.

To report fruits, please record numbers and the size as small, medium, and large.

Please record trade name and weight of packed foods and drinks. The example below will help you complete the food diary easier and accurate.

Breakfast

Food/ Drink	Amount	
	Household measure	Weight
Lavash	1/4	-
Cheese (Lighvaan)	1 match box	-
Jam (Carrot), Packed	-	25 gram
Tea	1 cup	-
Sugar	3 teaspoons	-

Please record all consumed foods and drinks during the day. Lunch and dinner tables are in the next section.

Please record all eaten items for breakfast and before breakfast.

Before breakfast and breakfast

Food/ Drink	Amount	
	Household measure	Weight

Please record all consumed foods and drinks between breakfast and lunch including snacks at school breaks, snacks eaten on the way to home, and anything eaten prior to lunch.

Morning snack

Food/ Drink	Amount	
	Household measure	Weight

Please write down all foods and drinks that your child has between lunch and dinner.

Afternoon snack

Food/ Drink	Amount	
	Household measure	Weight

Please record all foods and drinks that your child has after dinner before going to bed.

After dinner

Food/ Drink	Amount	
	Household measure	Weight

Lunch and dinner recipes

Please record type and amount of all ingredients that you use to prepare today lunch and dinner. Remember to write weather the items are raw or cooked, and gross or net. To record meats, please write if it is lamb or beef, breast or leg, and with or without bone. Then, record child's portion from the total amount.

Example: Mrs. Ahmadi mixed 1 Kg of Sabzi-e-Kookoo, 4 eggs, 150 gram vegetable oil, 2 tablespoon flour, and 1 tablespoon salt to make 6 pieces of Kookoo for four. Her child ate 1 piece. She also used 4 medium bowls of yogurt and three medium cucumbers to make Mast-o-Khiar and the child had 1/5 of it. He also had half Lavash and one glass of Dough. The following table shows how she recorded in food diary.

If main meal consists of simple foods like cheese and bread with vegetables, please record as of breakfast.

Example

Name: Kookoo sabzi and Mast-o-Khiar Prepared for: 4		
Food/ Drink	Amount	
	Household measure	Weight
Sabzi-e-Kookoo, gross	-	1 Kg
Whole egg	4	-
Vegetable oil	-	150 gram
Wheat flour	2 tablespoon	-
Salt	1 tablespoon	-
Yogurt	4 medium bowl	-
Cucumber, peeled	3 medium	-
Lavash	1/2 bread	-
Dough	1 medium glass	-

What portion of the food did your child eat? 1/6 of Kookoo and 1/5 of Mast-o-Khiar

Lunch

Name: Prepared for:		
Food/ Drink	Amount	
	Household measure	Weight

What portion of the food did your child have?

Dinner

Name: Prepared for:		
Food/ Drink	Amount	
	Household measure	Weight

What portion of the food did your child have?

Appendix 3 Data checking protocol

All data were entered in Microsoft Access by two persons: 1) Measures including weight, height, circumferences (waist, hip, and thigh), blood pressure, and skin fold thicknesses (biceps, triceps, suprailiac, and subscapular), children's questionnaires including self image body size perception, PedsQL, and dietary intakes (CADET), and 2) Parents' questionnaire.

In order to check anthropometric data, the file will be imported to SPSS and all the variables will be sorted into ascending or descending order. The outliers and any obvious mistakes (e.g. weight>100 kg for a 6 yr child) will be identified using normal distribution graphs. To check weight and height, BMI will be calculated to find any inconsistency between the two measures.

To check other anthropometric measures, the outliers (for each variable) will be selected and the other measures of the same child will be checked. If all measures are outliers (e.g. all skinfold measures are high and BMI and WC are also high), the reading will be accepted. If there is an inconsistency between the measures, the questionnaire will be checked, and if the recorded measure is correct, that measure would not be considered in data analysis.

To check all data (measures and questionnaires), 10% of all records will be selected randomly (using random number table) and all the data will be checked by the main investigator. If a specific mistake would be frequent for more than 10% of the checked records, data entry would be repeated for that field. In general, less than 5% error would be accepted.

All the points will be recorded in a note book and data cleaning will be started according to a protocol which would be developed after completion of data checking.

Dietary Intake Data

The dietary intake booklets will be delivered for checking in packs of 20. One of the investigators who have worked with the questionnaire will check the questionnaires for common mistakes which were already classified as well as any possible mistake.

The codes (Children's ID) of the questionnaires (which being identified as problematic) will be recorded and a note about the error will be attached to the booklet. The same checking system (as explained above) will be applied.

Appendix 4 Information sheet and consent form

The epidemiology and prevention of childhood obesity in Tehran

National Nutrition and Food Technology Research Institute

Parents' information sheet

National Nutrition and Food Technology Research Institute has launched a project to prevent childhood obesity in children. Your child's school was selected as one of the collaborating schools. This information sheet provides information about aim and method of the project. Please read the information promptly and contact the researchers would you have any question.

What is the aim of the study?

Our aim is to develop a series of activities to prevent development of obesity in school aged children. The prevention package will be tested in some schools in future.

Is there any obligation to participate in the study?

Participating in the study is completely voluntary. Please read and sign the attached consent form if you would like to take part in the project. You could withdraw from the study at any time. Your child would not be included in the study before you send the signed consent form.

What will happen if my child takes part?

On measuring day at school, height, weight, waist, hip, and thigh circumferences, blood pressure, and skinfold thickness at five sites including biceps, triceps, subscapular, supra iliac, and thigh will be measured. Relevant information to children's health status will be collected by two questionnaires. Questionnaires pack including parents' questionnaire containing general questions and questions about your child physical activity and three days food consumption questionnaires will be sent to you on measuring day.

Are collected data kept confidential?

All collected data will be kept confidentially by the researchers.

What is the application of the findings?

The findings will be presented as PhD thesis of the principal investigators and the results will be presented in national and international scientific meetings and will be published in scientific journals. The proposed intervention package will be applied in designing obesity prevention programme in primary schools further.

We would like to thank you for your cooperation.

For further details please contact principal investigator at:

Behnoush Ahranjani [redacted]

Consent form

Please complete and sign the form below.

□ I confirm that I received and read the information sheet and I provided with enough time to ask questions.

□ I am aware that my child's participation in the study is voluntarily and I have the right to withdraw my child any time without providing any reason.

□ I accept my child to participate in the study named above.

Name (Full):

Child's name (Full):

Date:

Signature:

Researcher (Full name):

Date:

Signature:

Appendix 5 Paediatric Quality of Life

Paediatric Quality of Life
Inventory

Version 4.0 – UK English

YOUNG CHILD REPORT (ages **5-7**)

Instructions for interviewer:

I am going to ask you some questions about things that might be a problem for some children. I want to know how much of a problem any of these things might be for you.

Show the child the template and point to the responses as you read.

If it is <u>not at all</u> a problem for you, point to the smiling face.

If it is <u>sometimes</u> a problem for you, point to the middle face.

If it is a problem for you <u>a lot</u>, point to the frowning face.

I will read each question. Point to the pictures to show me how much of a problem it is for you. Let's try a practice one first.

	Not at all	Sometimes	A lot
Is it hard for you to click your fingers?	☺	😐	☹

Ask the child to demonstrate clicking his or her fingers to determine whether or not the question was answered correctly. Repeat the question if the child demonstrates a response that is different from his or her action.

Think about how you have been doing for the last few weeks. Please listen carefully to each sentence and tell me how much of a problem this is for you.

After reading the item, gesture to the template. If the child hesitates or does not seem to understand how to answer, read the response options while pointing at the faces.

Physical Functioning ***(PROBLEMS WITH…)***	**Not at all**	**Some-times**	**A lot**
1. Is it hard for you to walk?	0	2	4
2. Is it hard for you to run?	0	2	4
3. Is it hard for you to play sports or exercise?	0	2	4
4. Is it hard for you to lift big things?	0	2	4
5. Is it hard for you to have a bath or shower?	0	2	4
6. Is it hard for you to help in the home (like picking up your toys)?	0	2	4
7. Do you have aches and pains? (Where?____________)	0	2	4
8. Do you ever feel too tired to play?	0	2	4

Remember, tell me how much of a problem this has been for you for the last few weeks.

Emotional Functioning ***(PROBLEMS WITH…)***	**Not at all**	**Some-times**	**A lot**
1. Do you feel scared?	0	2	4
2. Do you feel sad?	0	2	4
3. Do you feel angry?	0	2	4
4. Do you have trouble sleeping?	0	2	4
5. Do you worry about what will happen to you?	0	2	4

Social Functioning ***(PROBLEMS WITH…)***	**Not at all**	**Some-times**	**A lot**
1. Do you have trouble getting on with other children?	0	2	4
2. Do other children say they do not want to play with you?	0	2	4
3. Do other children tease you?	0	2	4
4. Can other children do things you cannot do?	0	2	4
5. Is it hard for you to keep up when you play with other children?	0	2	4

School Functioning ***(PROBLEMS WITH…)***	**Not at all**	**Some-times**	**A lot**
1. Is it hard for you to pay attention in school?	0	2	4
2. Do you forget things?	0	2	4
3. Do you have trouble keeping up with schoolwork?	0	2	4
4. Do you miss school because of not feeling well?	0	2	4
5. Do you miss school to go to the doctor or hospital?	0	2	4

How much of a problem is this for you?

☺	😐	☹
Not at all	Sometimes	A lot

Appendix 6 Body Image Assessment

BODY IMAGE ASSESSMENT

Child ID………………………………………………………………………………

Version of drawings used   Male   Female

Instructions to interviewers

- Check the child is comfortable and happy to continue with some more questions.

- You need to decide which version of the body image drawings you are going to use for the child and indicate above (use boy drawings for boys and girl drawings for girls).

- Say "I am going to show you some drawings of some girls/boys, and then ask you some questions about the drawings. The drawings show girls/boys as they would be before they get dressed in the morning"

  Ask the following questions:

  1. **Which picture do you think looks most like you?**

     Record number of picture chosen………………………………………

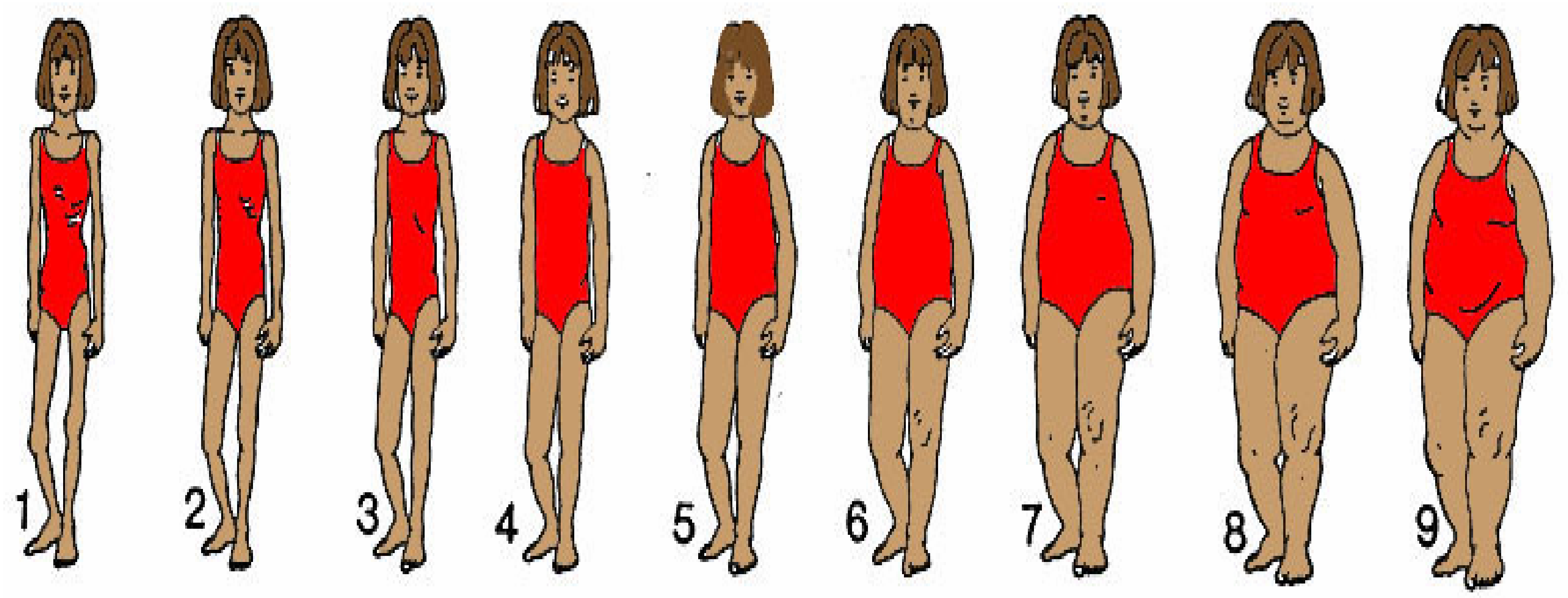
  2. **Which picture shows the way you would like to look?**

     Record number of picture chosen………………………………………

  3. **Which picture shows the way you think is best for girls/boys to look?**

     Record number of picture chosen………………………………………

- Thank the child for answering the questions.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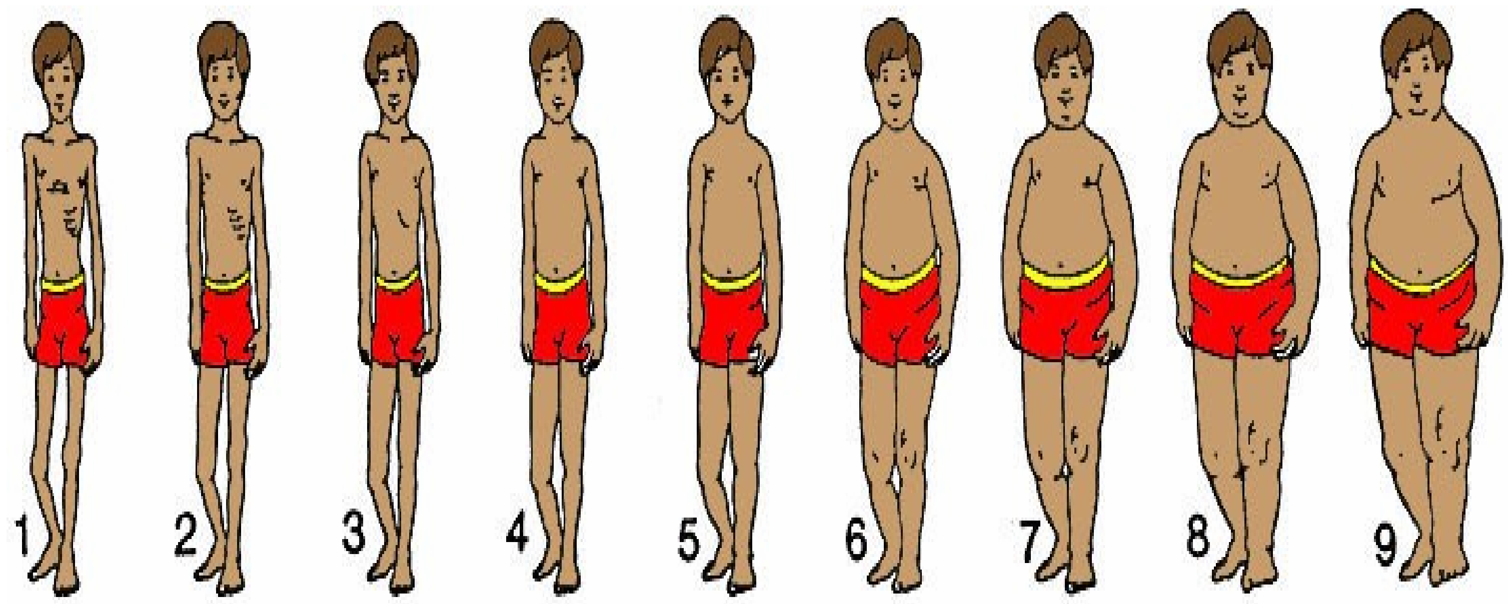
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Appendix 7 Parent questionnaire

The epidemiology and prevention of childhood obesity in Tehran

National Nutrition and Food Technology Research Institute

Questionnaire for parents

Completing the questionnaire

This questionnaire will take about 15 minutes to complete

All information about you and your child will remain confidential

Please answer the questions in relation to the child named below

Please answer all the questions by ticking the boxes or writing in the spaces provided

If you have any queries, please contact the principal investigator on [redacted]

Please remember to complete and return the questionnaire by [insert date]

Thank you in advance for your cooperation

Child's name…………………………………………………………………………..

Your relationship to this child

Mother

Father

Other (please state)……………………………………………………………

In this first section, we would like to know a bit more about your household and where you live.

How many individuals are there in the same household?................................

Please complete the table

Relationship with your child	Number of such individuals in your household
Grandparent	
Sister	
Brother	
Other relative (please state relationship to child) ………………………………………………………... …………………………………………………………	

Please now indicate to what extent you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Don't know
There is heavy traffic in our local streets						
I am concerned about strangers when my child goes to play in the neighbourhood						
Road safety is a concern in our area						
There are no lights/ crossings in the neighbourhood streets						
My child would need to cross several roads to get to play areas						
There are few sporting venues within our local area						
Public transport is limited in our area						

Now please tell us about your family's eating habits. In general, how often does your family:

	Less than once a year	1-4 times a year	5-11 times a year	1-3 times a month	1-2 times a week	More than 2 times a week
Go out for a meal?						
Have take away food from a fast food shop?						
Have ready made meals?						
Cook food from fresh ingredients?						

To what extent does each of the following influence the foods which you buy, prepare and eat as a family?

	Very important	Important	Neither	Not important	Not at all important
Price					
Palatability (taste)					
Satiety (being filling)					
Family preference					
Nutritional value					
Availability					
Food safety					
Advertising					
Health of family members(e.g. diabetes, heart disease)					
Shelf-life/storage					

Now please tell us about your child and his/her usual habits. For an average school day (24 hours) and weekend day (24 hours) please estimate the time (in hours/minutes) that your child spent doing the following activities:

This is an EXAMPLE of how to fill in the boxes in the question below

Activity	Total hours/minutes in school day	Total hours/minutes in weekend day
Sleeping (including night time and day time)	11 hours 30 minutes	10 hours 0 minutes

Activity	Total hours/minutes in school day	Total hours/minutes in weekend day
Sleeping (including night time and day time)		
Sitting activities for example: classroom work, homework, reading, watching TV, playing computer, sewing, eating, sitting in car or bus		
Light activities for example: getting dressed or undressed, tidying a room, imaginary play, playing a musical instrument, cooking		
Mildly energetic activities for example: playing in the garden, playground games, walking, bicycling (slow/moderate speeds), swimming for fun, gymnastics		
Energetic activities for example: running, bicycling (fast speeds), football, tennis, roller-skating		

Now think about a typical weekday and a typical weekend day for your child in the last year.

	Weekday		Weekend day	
	Hours	Minutes	Hours	Minutes
How much time would you say your child spends playing outdoors on a warmer day, such as spring and summer?				
How much time would you say your child spends playing outdoors on a colder day such as in autumn and winter?				

Which of the following places are within walking distance (no more than half hour walk) from your home? How often does your child walk or cycle to each of these places?

	Within walking distance		If yes, how often does your child walk/ cycle there?			
	No	Yes	Never	Less than 1 time a week	1-3 times a week	More than 3 times a week
School						
Playground/ park						
Bakery						
Shops selling fresh fruit and vegetables						
Fast food/ take-away shops						
Other food shops						
Child's friends' home						
Place of worship						

On average, how often does your child choose to eat each of the following types of foods?

	At least once a day	5-6 times a week	2-4 times a week	Once a week or less	Don't know
Piece of fruit					
Vegetables					
Chocolate bar					
Packet of crisps					

What is your child's date of birth? …………………

Finally we would like to know a little bit more about you and your family

How old are you?...... yr old

Are you: □Male □Female

What do you do for living? Please specify…………….

What is your highest level of education?.......................

In a typical week (7 days) how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time? Write the appropriate number in each space below.

Activity	Times per week
a) Strenuous exercise (heart beat rapidly (e.g. jogging, vigorous swimming, netball, aerobics, circuits)	
b) Moderate exercise (not exhausting, but tiring) (e.g. fast walking, tennis, cycling, easy swimming, dancing)	
c) Mild exercise (minimal effort) (e.g. yoga, archery, bowling, golf, easy walking)	

Has anyone in your family (including yourself) been diagnosed with diabetes?

□No

□Yes Please state the relationship of the family member(s) with diabetes to your child ……………………………………

Has anyone in your family (including yourself) been diagnosed with heart disease?

□No

□Yes Please state the relationship of the family member(s) who have heart disease to your child …………………………………

That is the end of the questionnaire.
Thank you very much for taking the time to complete this.

Appendix 8 Children's physical measures standard operating procedures

General Points

If a child is distressed by any of the measures or refuses to have them done, stop immediately and return the child to class. Inform their teacher and note details on the child's record sheet. Research team assistant who brings children from class should take them to the toilet first. Children were taken from classes in group of four.

Height Measurement

- Shoes and socks/tights to be taken off.
- Place heels, buttocks and shoulders to upright of Leicester Height Measure.
- Weight should be evenly distributed on both feet.
- Move indicator touching top of head, but not pressing down.
- Make sure head is on a level looking forward (not tilted up or down).
- Explain actions and breathing and tell child to leave heels on floor.
- Hold head up under child's ears and ask child to breath in – the level should move up.
- Reading is made to the nearest 0.1cm.
- Record reading on form.
- If child has posture problem make note in comments column.

Weight Measurement

- Children should be wearing light indoor clothing.
- Shoes and socks to be taken off.
- If child has not been to the toilet prior to measurement session, also record.

- Pockets should be emptied of heavy items including purse, keys, and fruits/snacks.
- Switch machine on.
- Ask child to step on scale.
- Record reading on form.

Waist Circumference

- Light clothing is worn, with the waistline exposed.
- A flexible non-stretchable tape measure is used.
- Child should be standing erect, arms loosely at sides, feet 25 to 30 cm apart.
- The measurement is at the halfway point between 10^{th} rib and iliac crest, measure and mark.
- The tape should be horizontal all the way round, check clothes are not caught in tape measure.
- Ask child to breathe in, and then out, take measurement now, no compression to be used.
- Repeat for 2 measurements re-applying the tape, results should be within 0.5cm, record both.
- Repeat measure again if two readings would differ for more than 0.5 cm.

Hip circumference

- Measuring must be done over light loose clothing.
- A flexible non-stretchable tape measure is used.
- Child should be standing erect, arms loosely at sides, feet together.

- Stand to the side of the child to identify the maximum circumference of the hip.
- Position the measuring tape around the hip and check the tape position is horizontal all around the body.
- Measure the hip circumference and read the measurement at the level of the tape to nearest 0.1 cm.
- Repeat for 2 measurements re-applying the tape, results should be within 0.5cm, record both.
- Repeat measure again if two readings would differ for more than 0.5 cm.

Skinfold thickness measurements

General points

- Take all measurements on non-dominant side therefore ask child to hold pen and write.
- Position needle at 0 every time a measure is done.
- Stand the child up.
- Do not measure through clothes; get help to hold t-shirt up/take off if sleeves are tight.
- Measurements will be done on biceps, triceps, subscapular, supra iliac, and thigh areas.
- Make sure it is just skin and not muscle being pinched.
- Warn child that there will be a ‘pinch’ (do sample test on hand).
- Measure twice to obtain within 0.4 of the readings otherwise do four readings. Do not leave the pinch to minimise intra observer error.

- Support calliper only whilst taking the reading, but keep the skin pinched whilst waiting for needle to stop moving.
- Record all.

Biceps and Triceps: also see diagram for positioning

- Mark the midpoint of the arm using a tape measure from the elbow (olecranon point) to the shoulder (acromium point) for biceps and triceps.
- Child to put hands by sides and palms facing front for biceps and back for triceps.
- Pinch the skin longitudinally 1cm above the mark, and place the callipers horizontally. Release the callipers but hold the skinfold.
- Take reading when needle has settled.

Sub scapular: also see diagram for positioning.

- Child stands erect, holding arms near to side, shoulders and arms are to be relaxed.
- Request help to hold up T-shirt if needed.
- Check you are measuring on the correct side, looking from the back.
- Locate the lower edge of the scapula on the non-dominant side. Hold a skinfold at 45 degrees to the horizontal, extending down in an imaginary line towards the elbow of the same side.
- Jaws of callipers are placed perpendicular to fold 1 cm lateral to fingers.

Supra iliac: also see diagram for positioning

- Child stands erect, holding arms near to side, arms slightly away from sides.

- The measurement is in the anterior axillary line just above the iliac crest. The skin is aligned 45 degrees to the horizontal parallel to the iliac crest.

Thigh: also see diagram for positioning

- Roll trousers up the leg where possible. If trousers are too tight around upper leg or if tights are worn, check that child has underwear on. If child is not wearing underwear and trousers cannot be pulled up, do not do measurements.

Thigh skinfold

- Child stands erect with feet together and weight shifted to dominant foot.
- The measurement is taken on the non-dominant side on the anterior (front) aspect of the thigh, midway between the proximal border of the patella (knee cap) and inguinal crease (crease at top of thigh).
- Take a vertical pinch 1cm above the mid-point of the thigh (as marked with skin pen), place callipers at mid-point of thigh with jaws perpendicular to the length of the fold.

Thigh circumference

- Child should be in light indoor clothing and exposing relevant parts as needed to undertake measurement.
- Take the measure at the mid-point of the thigh on the non-dominant side (as marked with skin pen for above skinfold), with child standing erect with legs slightly apart.
- Repeat for 2 measurements i.e. reapply tape, results should be within 0.5cm. Record both.

Blood pressure

- Take the first reading after the child has been sitting for 3 minutes. Get them to remove shoes for weight measure, and then take first reading. Leave a minimum of a 5 minute interval before taking second reading. You can do height and weight measure before repeating.
- Give explanation of number of readings and feeling a tight squeeze to child.
- Child should be seated with right arm supported and horizontal at mid-sternum (heart level), use cushion. Ask child to relax arm, not to fidget or talk.
- Tight or restrictive clothing should be removed.
- Confirm by looking at cuff markings for suitable size, choice of normal child size and larger.
- Fit cuff firmly and comfortably, with no wrinkles.
- If unable to do readings in right arm state why not in comments column.
- First Korotkoff sound (K1) is recorded as systolic and fourth Korotkoff sound (K4) is recorded as diastolic blood pressure.
- Record all readings.

Biceps

Triceps

Subscapular

Suprailiac

Thigh

Appendix 9 Focus group topic guide

- Greeting
- Explaining aim of the study
- Reminding about recording and confidentiality
- Main questions
  - What is overweight and obesity? What do you understand by the terms overweight and obesity?
  - To what extent is overweight and obesity important as a health issue in children?
  - How and to what extent do you believe it is as an important health issue among Iranian children?
  - What are the most important contributors to childhood obesity?
  - What are the best approaches for dealing with childhood overweight and obesity?
  - What are the most feasible activities for preventing/controlling overweight and obesity among children in our community?
- Further questions
  - Who should be mainly responsible for preventing overweight and obesity?
  - To what extent should schools play an active role in running preventive health programmes?
  - To what extent could parents (home environment) play an active role in running preventive programmes?
  - Are there others who should be involved in prevention?
  - How could parents and school staff interact in developing and running such a programme?

- What are the community barriers towards prevention of overweight and obesity which could be lessened by school or home based activities? How could we use the community facilities to run the plan?
- What kind of resources, support, or training would make it easier for you to be active in preventing or dealing with the problem?

Appendix 10 Interview topic guides

Physical education teacher

- Greeting
- Explaining aim of the study
- Reminding about recording and confidentiality
- Main questions
    - ▪ How do you perceive the trends in children's weight status over the last few years, from your experience? If perceive change, what do you think are the important contributors to this?
    - ▪ What are the current programmes or activities running in your schools? Which could be considered as activities proposed by the education and training office?
    - ▪ Do all children take part in PE, and how do you encourage universal participation?
    - ▪ Is there any difference between grades? Does the lack of trained PE teachers play any role?
    - ▪ Do you think it would be useful for any additional activities for a school to offer?
    - ▪ Do you anticipate any barriers in undertaking such programmes?
    - ▪ What are the potential opportunities and facilities to improve current programmes?
    - ▪ Do you see any ways that parents could cooperate with the schools in launching PA activities?

- What important activities do you propose as feasible to be done at home to increase children's PA? (Considering working parents, financial limitation, modern life style)
- What are the possible features of home-school cooperation?
- How do you consider the role of the local community?

- Complementary questions
  - Do you think the school has a role in increasing children's PA levels?
  - What in your view is the importance of PE, in school?
  - What is the role of facilities and space in enabling PA?
  - Is there any difference regarding PA opportunities between boys and girls?
  - Considering cold weather during school time, what would be your approaches to keep students active?
  - Is PE perceived as important by other teachers, parents and children?
- Further comments

School nurse

- Greeting
- Explaining aim of the study
- Reminding about recording and confidentiality
- Main questions
    - How do you perceive the trends in children's weight status over the last few years, from your experience? If perceive change, what do you think are the important contributors to this?
    - Is there any difference between the grades?
    - Do you regularly record students' weight, height, and other measures? If yes, how do you use the mentioned measures? What equipments and indices do you use? How often do you undertake measures? If no, why? (Lack of equipment, limited time, not in the duties list)
    - What are the current programmes or activities running in your schools to maintain healthy weight in children? Which could be considered as activities proposed by the education and training office?
    - Do you think any further activities could be offered by schools?
    - Do you foresee any barriers to undertaking such programmes?
    - What are the potential opportunities and facilities to improve current programmes?
    - How do you judge school nurses' responsibilities and authority in this regard?
    - Do you see any opportunities for parents, schools, and the local community to cooperate in designing and running the programmes?
    - What important activities do you think are feasible to be undertaken at home to maintain a healthy weight for children?

- How do you consider the role of the local community?

- Complementary questions
  - Do you think there is any role for school nurses in helping children maintain a healthy weight?
  - What is the effect of permanent presence of school nurses on the programme success?
  - Do you need to receive specific education or to be provided with measuring instruments to do and to interpret routine measures?
- Further comments

Appendix 11 Information sheet and consent form (Focus group)

The epidemiology and prevention of childhood obesity in Tehran

National Nutrition and Food Technology Research Institute

Participants' information sheet

National Nutrition and Food Technology Research Institute has launched a project to prevent childhood obesity in children. Your (child's) school was selected as one of the collaborating schools. This information sheet provides information about aim and method of the project. Please read the information promptly and contact the researchers would you have any question.

What is the aim of the study?

Our aim is to develop a range of activities to prevent development of obesity in school aged children. The prevention package will be tested in some schools in future.

Is there any obligation to participate in the study?

Participating in the study is completely voluntary. Please read and sign the attached consent form if you would like to take part in the project. You could withdraw from the study at any time.

What will happen during the session?

The investigators facilitate the discussion. We will discuss childhood obesity, contributing factors to childhood obesity, potential activities to help children maintain healthy weight, and possible barriers to successful intervention. All participants will be encouraged to express their views, but they will not be obliged to talk about any topic.

Are collected data kept confidential?

All discussions were recorded for further analysis. Collected data will be kept confidentially by the researchers.

What is the application of the findings?

The findings will be presented as PhD thesis of the principal investigator and the results will be presented in national and international scientific meetings and will be published in scientific journals. The proposed intervention package will be applied in designing obesity prevention programme in primary schools further.

We would like to thank you for your cooperation.

For further details please contact principal investigator at:

Behnoush Ahranjani [redacted]

Consent form

Please complete and sign the form below.

 I confirm that I received and read the information sheet and I provided with enough time to ask questions.

 I am aware that my participation in the study is voluntarily and I have the right to withdraw without providing any reason.

 I accept to participate in the study named above.

Name (Full):

Child’s name (Full):

Date:

Signature:

Researcher (Full name):

Date:

Signature:

Appendix 12 Summary tables (FG)

Mothers, Behzadi girls' school, 29/1/2008

Activities Help Maintain Healthy Weight		
HOME	SCHOOL	LOCAL COMMUNITY
Exercise	Cooking demonstration led by children themselves	Educating parents on importance of out-door play with children
Healthy food	Teachers taking part in exercise and activities alongside pupils during breaks	
Reducing fat consumption	Sports competitions for grade 1 and 2 children (in sports halls)	
Prevent children from being afraid of cold weather	Calendars with nutrition information and tips	
Regulate time between eating dinner and going to sleep	Making use of play mats in the school playground (e.g. hopscotch)	
	Non-competitive sports sessions	

Important Activities		
HOME	SCHOOL	LOCAL COMMUNITY
Taking children to parks	PA including Giving importance to PE sessions Providing a warm environment for exercise (a sports hall) Investing in PE in the same way as happens in private schools including: Recruiting PE teachers Replacing the older staff with younger PE teachers	
To enrol on sports courses		
Limiting sedentary games		

Feasible Activities		
HOME	SCHOOL	LOCAL COMMUNITY
Decreasing fizzy drinks and unhealthy snack intake	Providing nutrition guidelines/recipes for parents	
	Limiting availability and consumption of unhealthy snacks at schools	
	Weekly programme of snacks for school breaks, developed by school	
	Educating children	

Final Activities		
HOME	SCHOOL	LOCAL COMMUNITY
Educating children by parents, e.g. cooking skills	Family education in the same way as the KARAMAT Project[3] distributes messages and educates children through art and painting	
PA at home, e.g. skipping (using skipping rope) and dancing	Providing healthy snacks from home and having health assistants at school to monitor snacks	
Encouraging children (through rewards)	Educating children about nutrition and sports/PA	
Following a healthy nutrition plan (for children) through the parents	5 minutes daily physical activity in classroom	
	Encouragement for healthy behaviour by giving certificates/ points	

[3] Schools send information on different topics to parents and it is called “KARAMAT Project”.