IMPACT OF INTERACTIVE MULTIMEDIA-BASED NUTRITION EDUCATION PROGRAMME (IMNEP) ON NUTRITION KAP AND ANTHROPOMETRIC PARAMETERS AMONG OVERWEIGHT AND OBESE PRIMARY SCHOOL CHILDREN IN KOTA BHARU

WAN PUTRI ELENA BINTI WAN DALI

UNIVERSITI SAINS MALAYSIA

2018

IMPACT OF INTERACTIVE MULTIMEDIA-BASED NUTRITION EDUCATION PROGRAMME (IMNEP) ON NUTRITION KAP AND ANTHROPOMETRIC PARAMETERS AMONG OVERWEIGHT AND OBESE PRIMARY SCHOOL CHILDREN IN KOTA BHARU

by

WAN PUTRI ELENA BINTI WAN DALI

Thesis submitted in fulfillment of the requirements

for the degree of

Doctor of Philosophy

November 2018

ACKNOWLEDGEMENT

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

Firstly, I humbly praise the Almighty Allah S.W.T. for giving me the strength and patience to complete this research within the given time frame. I would like to express my endless thank you to my supervisor Dr. Hafzan Yusoff and co-supervisors Assoc. Prof. Dr. Hamid Jan Jan Mohamed and Dr. Nik Siti Hanifah Nik Ahmad for being incredibly supportive supervisors, providing me with the precious knowledge, for the continuous guidance, encouragement and facilitate me with every needs to finish my project.

I am very thankful to the USM Human Research Ethics Committee, Ministry of Education (MoE) via Educational Research Application System and Kelantan Education Department for ethical approval and for allowing me to conduct this project. Also to those who made this project possible especially staffs of Nutrition & Dietetics Programme for the help and assistance whenever I need.

I am also indebted to the cooperation of all school principals, teachers, students and parents from primary schools in Kota Bharu for allowing me to work so closely with them during pilot and intervention studies.

Thanks to Ministry of Higher Education, Malaysia for the scholarship. Most important, to my beloved and wonderful husband Mohd Shahriza Abdul Manas, my respected parents Wan Dali Wan Ishak and Ramlah Hasan, father and mother-in law, and also my siblings, my everlasting thank you for the love, care, support, sacrifice, patient and advice throughout my PhD journey.

Lastly, I offer my regards and blessings and blessings to all of those who supported me in any respect during the completion of the project. Without them, the completion of my research and this dissertation would not have been possible.

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

BIA	Bioimpedence analyses
BMI	Body Mass Index
BMR	Basal metabolic rate
BP	Blood pressure
CDC	Center for Disease Control and Prevention
CG	Control Group
CI	Confidence Interval
COC	Children only control
COI	Child only intervention
CPI	Children parents intervention
CRPBI	Child's report of parental behavior inventory
DISABKIDS	Disease-generic measure for children with chronic diseases
EE	Energy expenditure
EAT	Eating attitude test
EI	Energy intake
EQ-IMNEP	evaluation questionnaire of the interactive multimedia-based nutrition education package
FBG	Fasting Blood Glucose
FBI	Fasting Blood Insulin
FFQ	Food Frequency Questionnaire
HDL	High-Density Lipoprotein

HRQoL	Health-related quality of life
IDEA	Identifying Determinants of Eating and Activity
IG	Intervention Group
IMNEP	interactive multimedia-based nutrition education package
KAB	Knowledge, attitude, behavior
LDL	Low-Density Lipoprotein
MASCOT	Malaysian Childhood Obesity Treatment
MD	Mean difference
MDG	Malaysian Dietary Guidelines
MetS	Metabolic Syndrome
MoE	Ministry of Education
MoH	Ministry of Health
NCCFN	National Coordinating Committee on Food and Nutrition
NE	Nutrition Education
NKAP	nutrition knowledge, attitude and practices
NKAPQ	nutrition knowledge, attitude and practices questionnaire
OW	Overweight
PA	Physical activity
PAQ-C	Physical Activity Questionnaire for Older Children
PE	Physical education
PedsQoL	Pediatric Quality of Life
POI	parents only intervention

PSDQ	Parenting styles and dimensions questionnaire
PUBMED	Public or publisher of MEDLINE database
RCT	Randomised Controlled Trial
RMANCOVA	repeated measure analysis of covariance
RNI	Recommended Nutrient Intakes
SCT	Social Cognitive Theory
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TG	Triglyceride
TSF	Triceps Skinfold Thickness
UK	*UNITED KINGDOM*
US	*UNITED of STATES*
USM	Universiti Sains Malaysia
WHO	World Health Organization

IMPAK PROGRAM PENDIDIKAN PEMAKANAN BERASASKAN MULTIMEDIA INTERAKTIF (IMNEP) KE ATAS KAP PEMAKANAN DAN PARAMETER ANTROPOMETRI DI KALANGAN KANAK-KANAK SEKOLAH RENDAH YANG BERLEBIHAN BERAT BADAN DAN OBES DI KOTA BHARU

ABSTRAK

Obesiti di kalangan kanak-kanak telah menjadi masalah kesihatan yng utama dan telah wujud bertahun-tahun di Malaysia dan di negara-negara membangun. Fokus kajian ini adalah untuk menilai keberkesanan intervensi yang telah dibangunkan yang dikenali sebagai Program Pendidikan Pemakanan Berasaskan Multimedia Interaktif (*IMNEP*) yang mensasarkan kanak-kanak berlebihan berat badan dan obes di Kota Bharu, Kelantan. Kajian ini mempunyai dua fasa kajian; pembangunan *IMNEP*, dan impak pakej *IMNEP*. Fasa I menerangkan bagaimana *IMNEP* dibangunkan dan menerangkan tentang kandungannya. Kemudiannya, *IMNEP* ini dinilai semasa Fasa II dalam kalangan kanak-kanak sekolah (n = 50), penilai (n = 10) dan ibu bapa (n = 8). Dalam Fasa II, satu percubaan 4-lengan rawak berasaskan sekolah telah dijalankan dalam kalangan sekolah rendah di Kota Bharu. Empat belas buah sekolah telah mengambil bahagian dan dibahagikan ke dalam salah satu daripada empat kumpulan: tiga kumpulan intervensi (CPI: pelajar, ibu bapa intervensi; COI: pelajar sahaja intervensi dan POI: ibu bapa sahaja intervensi) atau kumpulan kawalan (COC: pelajar sahaja kawalan). Kumpulan intervensi didedahkan dengan video pendidikan animasi, permainan video pendidikan bertajuk

Makan Sihat Saya dan permainan aktif dengan menggunakan XBOX 360 dalam tempoh 12 minggu diikuti oleh 12 minggu tanpa intervensi.Kebanyakan peserta telah memberikan respon yang positif dan mereka merasakan bahawa *IMNEP* ini adalah menarik dari segi kepelbagaian pilihan topik yang dimasukkan, grafik, kandungan, animasi dan tujuan sebagai medium baru dalam pengajaran pemakanan untuk kanak-kanak dan ibu bapa. Beberapa pengubahsuaian telah dibuat dan versi akhir *IMNEP* telah dikeluarkan. Daripada 139 peserta yang mengambil bahagian pada permulaan semasa Fasa II, seramai 121 (87.1%) peserta telah menyempurnakan kajian intervensi *IMNEP* selama 12 minggu dan 112 (80.6%) telah melengkapkan keseluruhan tempoh kajian intervensi selama 24 minggu. Pada awalnya peratusan pelajar yang berstatus obes (83.5%) adalah lebih tinggi daripada pelajar yang berlebihan berat badan (16.5%). Akan tetapi, selepas 12 minggu, keputusan telah menunjukkan penurunan peratusan pelajar berlebihan berat badan dan obes, penurunan yng signifan bagi berat badan (CPI), indeks jisim tubuh (IJT) (CPI, POI), jisim lemak badan (POI), lilitan pinggang (POI) dan pinggul (COI, POI) dalam kumpulan intervensi. Peningkatan yang signifikan didapati dalam pengetahuan (CPI, POI) dan amalan dalam pemakanan (CPI), pengambilan vitamin A (CPI, COI), dan juga peningkatan dalam fizikal aktiviti terutamanya berdasarkan pernyataan aktiviti terbaik (described best activity) (COI) dan jumlah skor PAQ-C (POI) ditunjukkan dalam kalangan kumpulan intervensi. Dengan menggunakan test RMANOVA, peserta dalam kumpulan intervensi juga terus menunjukkan peningkatan pengetahuan pemakanan yang signifikan (COI, POI), pengambilan vitamin A (CPI, COI) dan kekal aktif (COI, POI) dari mula kajian hingga minggu ke 24. Tabiat makanan untuk kumpulan makanan bagi kumpulan

susu, buah-buahan dan sayur-sayuran adalah kekal dan tiada perubahan yang signifikan didapati. Bacaan antropometri juga terus menunjukkan hasil yang positif dalam kumpulan intervensi. Dalam kohort ini, *IMNEP* telah didapati bermanfaat dalam meningkatkan pengetahuan dalam pemakanan secara berkesan dan meningkatkan aktiviti fizikal tetapi tidak ke atas pengambilan kumpulan makanan terpilih dan pengambilan nutrien. Penetapan sasaran kajian terhadap kedua-dua ibu bapa dan kanak-kanak di dalam intervensi obesiti kanak-kanak adalah penting kerana penglibatan ibu-bapa dapat memberi kesan kepada persepsi kanak-kanak dan kelakuan mereka terhadap makanan dan aktiviti fizikal.

IMPACT OF INTERACTIVE MULTIMEDIA-BASED NUTRITION EDUCATION PROGRAMME (IMNEP) ON NUTRITION KAP AND ANTHROPOMETRIC PARAMETERS AMONG OVERWEIGHT AND OBESE PRIMARY SCHOOL CHILDREN IN KOTA BHARU

ABSTRACT

Childhood obesity has been a major public health concern in Malaysia and other developed countries for years**.** Focus of the present study was to evaluate the effectiveness of developed intervention known as Interactive Multimedia-based Nutrition Education Package (IMNEP) targeting on overweight and obese children in Kota Bharu, Kelantan. This study had two phases; development of the IMNEP and impact of the IMNEP. Phase I describes how the IMNEP developed and its contents. The IMNEP were then evaluated among school children (n=50), review panels (n=10) and parents (n=8). In Phase II, 4-arm cluster randomized school-based trial was conducted among primary schools in Kota Bharu. Fourteen participated schools were randomly assigned into one of four groups: three intervention groups (CPI: children, parents intervention; COI: children only intervention and POI: parents only intervention) or a control group (COC: children only control). Intervention groups were exposed to animated explanatory videos, an education video game entitled My Healthy Eating and active gaming exercises by using XBOX 360 over a 12-week and another 12-week without intervention. In Phase I, majority of the respondents gave positive responses and they felt that this IMNEP was interesting and engaging in terms of variety topics included, graphics, contents, animations and purposes

as new medium in teaching nutrition for children and parents. Some modifications has been made and come out with the final version of the IMNEP. Of the 139 respondents recruited at baseline during Phase II, 121 (87.1%) of respondents completed the 12-week of IMNEP and 112 (80.6%) completed overall 24-week of intervention study. Initially, the percentage of obesity (83.5%) was higher than those overweight (16.5%). However, after 12 weeks, the results showed reduction in the percentage of overweight and obese, significant reduction in body weight (CPI), body mass index (BMI) (CPI, POI), fat mass (POI), waist (POI) and hip (COI, POI) circumferences among those in the intervention groups. Significant increments of nutrition knowledge (CPI, POI) and practice (CPI), vitamin A intake (CPI, COI) as well as higher number of those physically active especially based on described best activities (COI) and Total PAQ-C score (POI) were also shown among intervention groups. By using RMANOVA test, the respondents in intervention groups keep experiencing significant increments of nutrition knowledge (COI, POI), vitamin A intake (CPI, COI) and continued to be physically active (COI, POI) seen in Total PAQ-C from baseline to week 24. Eating habits for milks, fruits and vegetables groups remain unchanged. In this cohort, the IMNEP was found to be beneficial in effectively increased nutrition knowledge and physical activity outcomes but not in selected food groups and nutrient intakes outcomes. Positive results in anthropometric measurements were also achieved in intervention groups. Targeting both parents and children in childhood obesity prevention interventions are crucial because parents' involvement has powerful effects on a child's perception and behaviours towards food and physical activity.

CHAPTER 1

INTRODUCTION

1.1 Study background

Overweight and obesity are defined as “abnormal or excessive fat accumulation in the body that harms health” which was above the ideal of normal weight (WHO, 2003). Body mass index (BMI) is a primary outcome measurement used to evaluate weight management effectiveness and defined as a function of weight in relation to height. This measure is used by health care providers to assess health disease risk associated with overweight or obesity. The WHO Global Database on Child Growth and Malnutrition (2007) uses a Z-score cut-off point of >+1SD (equivalent to BMI 25 kg/m2 at 19 years) as overweight and >+2SD (equivalent to BMI 30 kg/m2 at 19 years) as obesity.

Most of the children around the world are facing the risk of being overweight or obese. It is very rare to open any health journal and not seeing article discussing this public health problem. This obesity problem had been listed in 10 most important public health problems and concerns (CDC, 2015). Among U.S. youth, the prevalence of obesity among school-aged children (6-11 years) (17.5%) was higher than preschool-aged children (2-5 years) (8.9%) but lower than adolescents (12-19 years) (20.5%) (Ogden *et al.*, 2015). In fact, this alarming trend is also happening in Malaysia as more children are becoming

obese and overweight despite reduction in the prevalence of underweight (Tee *et al.*, 2017).

It is noted that childhood obesity is often associated with coronary heart disease, stroke, diabetes, hypertension and a number of other chronic diseases (Freedman *et al.*, 2001). Furthermore, obesity also increases the risk of cancers of the esophagus, breast, endometrium, colon and rectum, kidney, pancreas, thyroid, gallbladder and possibly other cancer types (NCI, 2014).

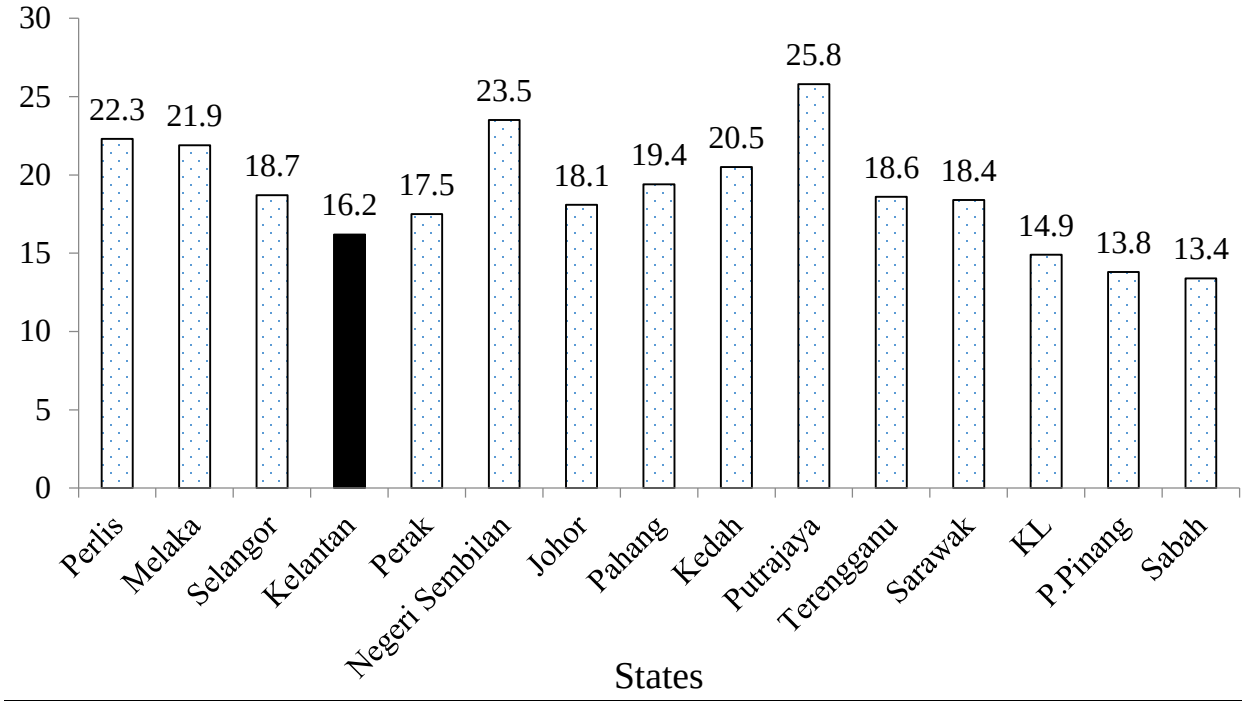

Figure 1.1 Percentages of adults' obesity in Malaysia (Adapted from NHMS, 2015)

Figure 1.1 showed the percentages of obesity cases among adults in Malaysia in 2015. Based on this figure, Kelantan is ranked the 12th highest in obesity cases nationwide, which totaling up to 16.2% for adults aged ≥18 years old while, in the Southeast Asia, Malaysia was the highest (Cheong, 2014). Recent evidence pointed out the growing prevalence of overweight and obesity among Malaysian children. For instance, a study done in year 2013 reported higher prevalence of overweight children among those residing in urban (8.8%) than rural areas (5.9%) (Zainuddin *et al.*, 2013). Another study conducted in Peninsular Malaysia between 2001 and 2002 found that 10.5% and 5.9% of school children aged 6 to 12 years old were overweight and obese respectively (Mohd Ismail *et*

al., 2009). As regards to related studies done in Kelantan, Manan *et al.*, (2012) assessed 175 Malay children from schools in Kota Bharu, Kelantan discovered that 13.1% of the children were categorized as overweight and obese. Another study carried out in the same location (Kota Bharu, Kelantan) but among Chinese school children, found that the prevalence of overweight and obesity was way higher (24.8%) (Soo *et al.*, 2011). Based on latest findings from National Health Morbidity Survey (2015), revealed that 11.9% or 1.0 million children below 18 years were obese. This situation is worrisome because obese children tend to become obese adults. Besides, instillation of preventive actions and treatment of obesity is best to be done at this age period because children are still growing healthily (Cordova *et al.*, 2012).

1.2 Conceptual framework

Through the Identifying Determinants of Eating and Activity (IDEA) Lytle (2009) developed a conceptual model that has been used as determinants of obesity by examining the peer-reviewed literature for factors suggested as related to the development of childhood obesity – Figure 1.2. BMI percentile and anthropometric measurements are directly affected by diet, biological and activity-related factors. In turn, biological factors are affected by youth weight status. In other words, an individual's weight status is determined by metabolic interactions related to energy balance and development of adiposity. Less is known about how weight status may affect blood chemistry in youth. Biological factors are impacted by behavioral factors related to diet, activity and sedentary patterns and other behaviors such as sleep, substance use and weight control. Unusual sleep patterns, substance use including tobacco and alcohol use as well as weight control

may actually predict the development of obesity in youth (Klein *et al.,* 2008; Pasch *et al.*, 2007).

The contextual factors exist at individual/psychosocial level (eg., one's beliefs, attitudes, values and expectations), socio-environmental level (eg., interpersonal dynamics, role modeling, norms and support that occur with families, peers, schools and community) as well as physical environment (eg., access to and support for healthy eating, recreational physical activity and active transportation) that operates at the home, school and neighborhood environments. While, demographic, socioeconomic factors, family history and structure are immutable factors that influence the context wherein young peoples' eating and activity behaviors occur, the behavioral opportunities presented to youth and many of their biological factors.

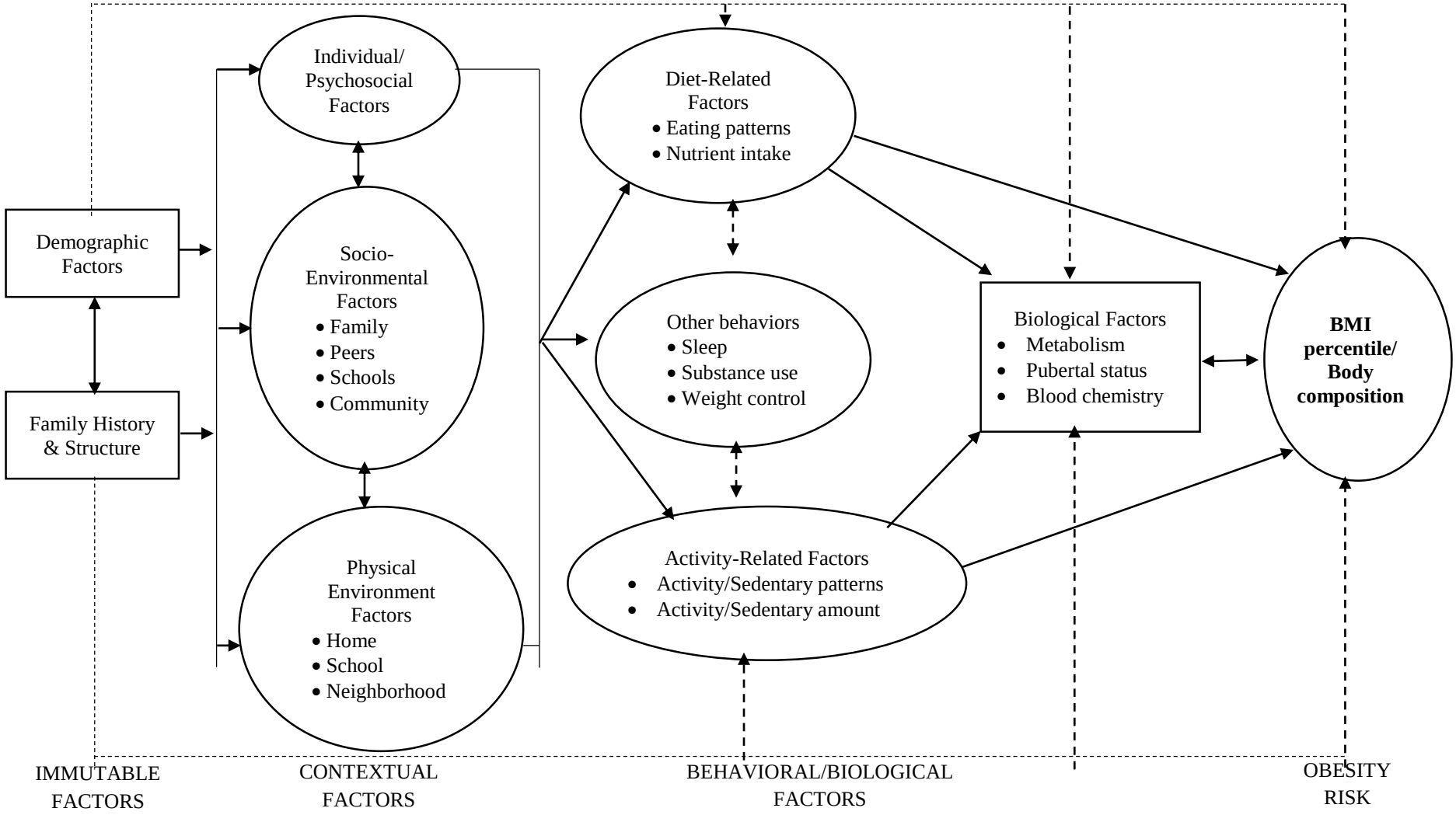

Figure 1.2 Conceptual model: etiology of childhood obesity (Adapted from Lytle, 2009)

1.3 Feasibility, acceptability and applicability definition

In short, feasibility is used to determine whether an intervention is appropriate for further testing or in other words, they enable researchers to assess whether or not the ideas and findings can be shaped to be relevant and sustainable (Eldriege et al., 2016). Evaluations of any interventions are often undermined by problems of acceptability, applicability, delivery of the intervention, recruitment and retention (Andrews *et al.,* 2010).

Usually, the feasibility, acceptabilily and applicability are conducted on a smaller scale in order to provide clear confirmation that their study is in preparation for a future randomized controlled trial designed to assess the effect of an intervention (Eldriege *et al.,* 2016).

1.4 Problem statement

The problem of overweight and obesity among school children have been reported in many Asian countries, including Malaysia. Despite the importance of nutrition for school children was delivered through various health promotion whether on mass media and the internet as well as in school syllabus (Appendix A), many studies revealed the inadequate nutrition and poor eating habits of primary school children (Matvienko, 2007). Various programmes such as School Health Education Programme, School Supplementary Feeding Programme and School Milk Programme as well as Physical and Health Education Syllabus have been implemented among school

children. The purpose of these programmes is to help them to improve their knowledge, promote positive attitudes towards good health and nutrition and also to practice a healthy lifestyle (Ministry of Education Malaysia, 1998; Sahari, 1992).

However, the effectiveness of implementation of these programmes is still doubtful as the prevalence of obesity continues to increase rapidly. Based on the latest findings from the MyBreakfast study (Tee *et al.,* 2017) conducted among 5,332 primary and 3,000 secondary school children throughout Malaysia found that, the prevalence of overweight and obesity were 13.2% and 15.1% respectively. Whereas among the adolescents, the prevalence of overweight and obesity were 15.5% and 13.2% respectively (Tee *et al.,* 2017).

In addition, nowadays less students walk or ride bicycle from their home to the schools. Children also spent a substantial amount of time doing sedentary activities such as watching television, playing video games and surfing the Internet (Leatherdale & Wong, 2009). According to Harrell (2007) study, American children spent 19.3 hours a week watching television, 2.3 hours a week playing video games and 2.5 hours per week sitting in front of the computer.

1.5 Study outcomes

Primary outcomes = anthropometric measurements and nutritional knowledge, attitudes and practices (NKAP)

Secondary outcomes = nutrient intakes, selected food groups (fruits and vegetables, milk and dairy products) and physical activity level

1.6 Objectives

General objective: To evaluate the impact of IMNEP application for overweight and obese primary school children in Kota Bharu, Kelantan.

Phase I: Development of the IMNEP

Objective:

1) To develop the IMNEP for overweight and obese primary school children.

Phase II: Impact evaluation of the IMNEP

Objectives:

1) To evaluate the baseline of anthropometric measurements, NKAP, nutrient intakes, intake of selected food groups and level of physical activity of overweight and obese primary school children in Kota Bharu, Kelantan.

2) To compare the changes in anthropometric measurements, NKAP, nutrient intakes, intake of selected food groups and level of physical activity after 12 weeks of intervention among the four groups.
3) To compare the sustainability of the intervention among the four groups for another 12 weeks without intervention (at week 24).

1.7 Research questions

1. Is there any significant changes in anthropometric measurements, NKAP, nutrient intakes, intakes of selected food groups and level of physical activity between four groups after 12 weeks receiving the IMNEP?
2. Is the effect of intervention on study outcomes between four groups sustain after another 12 weeks without any intervention (Week 24)?

1.8 Hypothesis

- Hypothesis 1, H_A = There is significant changes in anthropometric measurements, NKAP, nutrient intakes, intakes of selected food groups and PA at baseline, week 12 and week 24 after receiving the IMNEP.
- Hypothesis 2, H_A = There is significant effect of intervention on study outcomes between four groups at week 24 (after 12 weeks of withdrawal/ no intervention).

1.9 Significance of study

In this study, the nutrition teaching media has been developed in the form of an animation videos and games as intervention tools. The idea is to provide an alternative

choice of teaching media in nutrition education at schools instead of using the usual textbook particularly targeting on overweight and obese school children. Throughout of this thesis, the intervention was written as Interactive Multimedia-based Nutrition Education Package (IMNEP).

The development of IMNEP could potentially educate the children especially who were overweight and obese and their parents for better understanding of the healthy eating and physical activities which eventually lead to better health outcomes.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Changing health behavior such as diet and physical activity can be a daunting task. Health behaviors are typically influenced by various factors and hence making them resistant to change (Baranowski *et al.,* 2008). However, delivering nutrition education through education games for health is more likely to be effective if targeted at factors that are closely and causally related to the behavior of interest (Baranowski *et al.,* 2008). Very few programs have been shown to be effective in preventing or treating child obesity. Thus, the current collection of the published articles is needed to evaluate the effectiveness of an education program that provided sound nutrition education along for children with the aim of preventing childhood obesity. Surprisingly, there were very limited published evidence on childhood obesity intervention in Malaysia.

For the purpose of this literature review, studies published between January 2000 and December 2015 was searched from PUBMED, Science Direct, Scopus and Google Scholar. I also scanned the reference lists from review articles that included information on interventions that prevent childhood obesity and eligible original articles were also searched manually to identify any additional articles. The keywords used were “nutrition education/ health education and promotion/ obesity prevention/ intervention” AND

"school children/ overweight/ obese/ BMI" AND "school programme/ school intervention".

The search was limited to articles focusing school children population with restricting inclusion criteria to interventions with longitudinal, exploratory and randomized controlled trial (RCT) design. Included articles must have taken an anthropometric measurement of body weight or adiposity such as BMI or skinfolds at baseline and follow-up as primary outcomes and should aim at decreasing BMI or weight. The literature search process is summarized in Figure 2.1.

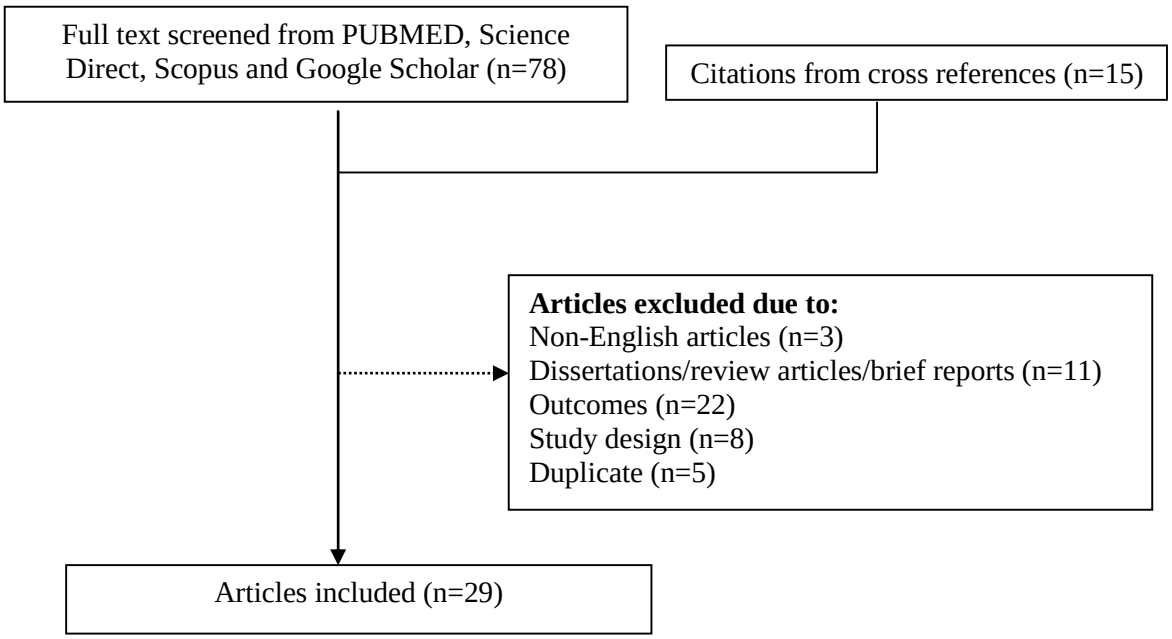

Figure 2.1 Flowchart of literature search

2.2 Studies on Nutrition Education

2.2.1 Respondents

A total of 78 articles was identified from electronic databases, other publications as well as from cross references. Of these, 49 were excluded due to the study design, measure another effect rather than BMI as the primary outcome, studies published in other languages and the outcomes presented in the dissertations, review articles and brief reports. Finally, only 29 studies met all the inclusion criteria and were included in this review. The 29 studies were published between 2001 and 2014 and included a total of 18,785 respondents. Seven studies were conducted in the United States of America, five in the United Kingdom, three in Germany, two in Brazil, China, Israel and Netherlands respectively and one study in Malaysia, Chile, France, New Zealand, Australia and Switzerland respectively. The majority of the included studies took place in the USA or northern Europe which limits its generalisability to other countries since the obesogenic environment is supported by increasingly complex social, political and cultural environments which may be unique to a particular country. In addition, the studies that were not indexed in PUBMED, Science Direct or Scopus and unpublished studies were not identified so that it is less-biased to provide a more comprehensive review.

2.2.2 Study design and sample size

Most of the eligible studies (29 studies) were long-term intervention (9 months – 7 years) and the rest were short-term which lasted about 6 weeks to 6 months. The sample sizes

varied greatly among the studies ranging from 60 to 3086 respondents – Table 2.1. Duration of the study can be a limiting factor for high dropout rate which can be seen in some intervention studies that lasted over one year. Other than that, the instruments used in several studies were self-reported measures (except for the anthropometric measurements) which were highly dependent on the respondents' memory, honesty and truthfulness in answering the questions. Thus, the results may not reveal the actual dietary intake and eating behaviors of the respondent. Besides, self-report bias may have occurred as the diet was not observed.

In terms of methodology, there is a clear need for continuation of research, involving greater number of respondents with a longer duration of follow-up and improved research study design. The findings from few studies included in this review did not described whether the environmental changes made during the interventions are maintained subsequently. Baranowski *et al.,* (2008) has suggested that the intensity and durations of intervention over set periods of intervention should be analyzed and evaluated to ensure the effectiveness of the interventions. In addition, the reliability and validity of the interventions instrument/tools were not comprehensively reported, despite its importance as elements which are essential for determining the effectiveness of the interventions.

2.3 Modes of NE intervention

All of the interventions were conducted on school premises except for seven studies which were conducted at pediatric obesity clinics, student physical fitness centre, pediatric primary care and at home. Nine studies used a single intervention; two implemented physical educations only and seven studies implemented merely on nutrition education. Remaining studies used a combination approach with implementation of two or more interventions, whereas ten studies have involved parents in their intervention. In total, 20 interventions included a physical component such as conducting moderate exercise including brisk walking, jogging and swimming, 22 interventions included education on nutrition or classroom lessons which receiving the nutritional information, information regarding increasing physical activity and decreasing sedentary time and establishment eating habits. Other than that, two studies included a counseling component and three studies involved video game components.

Many health educators and behavioral scientist have creatively used Social Cognitive Theory (SCT) to develop interventions, procedures, or techniques for promoting health behavioral change (Baranowski *et al.*, 2002). Within SCT, human behavior is explained in terms of triadic, dynamic, and reciprocal model in which behavior, persomal factors (including cognitions), and environmental influences all interact. From this literature search, very few studies provide SCT, Health Belief Model (HBM) or cognitive behavioral therapy (CBT) which only two studies found in this literature search provided CBT.

2.4 Outcome measures

Although the primary outcome measure of included studies was BMI, BMI z-scores or changes in weight, they also reported the other outcomes such as measuring dietary changes, PA, nutrition knowledge, self-esteem, self-efficacy, psychological and health-related QoL. In measuring the dietary changes, most studies employed 24-hour food recall, food frequency questionnaires and three days dietary record. The effectiveness of the intervention is based on either intervention producing statistical differences between the intervention and comparison groups or between pre and post-intervention in intervention group according to height/ weight measures or BMI or skinfolds. The Youth/Adolescent Activity Questionnaire, accelerometer and physical activity questionnaires were used in measuring their fitness.

Table 2.1 Details of the included intervention studies

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
DIET ONLY STUDIES							
Cunha *et al.*, Brazil (2013)	Cluster RCT trial, 9 months	559 (IG=277 and CG=282)	9 NE sessions including playing games, staging of theater sketches, watching movies and puppet shows, and writing and drawing contests	- To promote eating habits - To reduce the increase in BMI	Anthropometry, 2 24hours, FFQ, multiple pass method, stages of motivation (changing food behavior), short questionnaire (food consumption and intention to change food habits	- Decreased sugar-sweetened beverages consumption - Increased fruits consumption - Motivation to change eating habits increased over time. - Did not lead to a reduction in BMI gain	- Respondent satisfaction was not measured - Dependent on memory (24hours and FFQ)
Muckelbauer *et al.*, Germany (2009)	Cluster RCT, 1 year	2950 (IG=1641 and CG=1309)	Combined environmental and educational intervention promoting water consumption	To test the effect of a simple, combined, educational and environmental intervention	- BMI - 24-hour recall questionnaire - Water flow - Process evaluation	The risk of OW was significantly reduced by 31% in the IG	Did not evaluate dietary behaviors
James *et al.*, UK (2007)	Cluster RCT, 2 years	434 (IG=219 and CG=215)	Focused education promoting a healthy diet and discouraging the consumption of carbonated drinks	To assess the long-term effects of an obesity prevention programme in schools	- Anthropometry - Waist circumference	- BMI had decreased in IG - The prevalence of OW increased in both IG and CG	- High dropout rate - Consumption of carbonated drinks was not measured

FFQ=Food Frequency Questionnaire; BMI=Body Mass Index; RCT=Randomized Controlled Trial; NE=Nutrition Education; IG=Intervention Group; CG=Control Group; OW=Overweight

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
James *et al.*, UK (2004)	Cluster RCT, 1 year	644 (IG=325 and CG=319)	Focused educational program, including focusing on the balance of good health and promotion of drinking water, tasted the fruit to learn about the sweetness of natural products, music competition, presentations of art and quiz	To determine if a school-based educational programme aimed at reducing consumption of carbonated drinks can prevent excessive weight gain in children	- Anthropometry - 3 days diet record	The percentage of overweight and obese as well as consumption of carbonated drinks decreased	Contamination of RCT due to the randomization was according to classes not schools
Sichieri *et al.*, Brazil (2008)	Cluster RCT, 1-year school (10 months)	1140 (IG=435 and CG=608)	Healthy lifestyle education using simple messages encouraging water consumption instead of sugar-sweetened carbonated beverages	To determine whether an educational programme aimed at discouraging students from drinking sugar-sweetened beverages could prevent excessive weight gain	- Anthropometry - 24-hour recall - Consumption of beverages via short questionnaire	- Non-significant reduction overall BMI among children in IG - But significantly reduced BMI among girls who were OW in IG - Significantly decreased the consumption of carbonated drinks in IG	- Use of one 24 hour recall - Slight family involvement - Intervention may not have been sufficiently intense or long enough to change behavior

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
Golan & Crow, Israel (2004)	Randomized and longitudinal, 7 years	60 (IG=30 and CG=30)	14 1-hour support and educational group sessions; limits of responsibilities, NE, eating and activity behavior modification, decreasing stimulus exposure, parental modeling, problem solving, cognitive restructuring and coping with resistance	To report the long-term outcome in OW children following a family-based health-centered approach	- Anthropometry - Eat-26	Significantly greater reduction of OW children in IG compared to CG	Small sample size
Baranowski *et al.*, USA (2011)	RCT, 2 months	133 (IG=93; CG=40)	"Escape from Diab" and " Nanoswarm: Invasion from Inner Space" video games	To evaluate the outcomes on children's diet, physical activity and adiposity	- Anthropometry - 24 dietary recall - Physical activity	Fruit, vegetable and physical activity increased,	Short duration

EAT=Eating attitude test

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
			PA ONLY STUDIES				
Kriemler *et al.*, Switzerland (2010)	Cluster RCT, 1 year	502 (IG=297; CG=205)	Multi-component PA programme; three existing PE lessons a week, daily short activity breaks and PA homework	To assess the effectiveness of the intervention on physical and psychological health	- Body fat - Aerobic fitness - PA - QoL - BMI - Cardiovascular risk score	- Significantly improved PA and fitness in IG - Small increments of BMI and waist circumference	No nutritional assessment
Thivel *et al.*, France (2011)	Randomized and longitudinal, 6 months	457 (IG=229 and CG=228)	Consisted of; 120 minutes of supervised physical exercise and 2 hours of PE classes per week	To assess the effect of intervention on body composition and physical fitness	- Anthropometric - Cardiorespiratory fitness - Cycling peak power test	- Appears significantly improved in terms of aerobic and anaerobic physical fitness	No nutritional assessments

PA=Physical activity; PE=Physical education, QoL=Quality of Life

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
COMBINED DIET AND PA STUDIES							
Sahota *et al.*, UK (2001)	Cluster RCT, 1 year	636 (IG=314 and CG=322)	Teacher training, modification of school meals, and the development of school action plans targeting the curriculum, PE, tuck shops and playground activities	To reduce risk factors for obesity	- Weight and height measurements - 24-hour recall and 3-day food diaries - PA - Psychological measures	- Vegetable consumption was increased among IG. - No significant difference for other measures between both groups. - Unsuccessful in reducing risk factors for obesity	- Difficult to measure the accurate dietary assessment - Difficult to quantify the PA level
Kain *et al.*, Chile (2004)	Longitudinal controlled evaluation study, 6 months	3086 (IG=2141 and CG=945)	NE for children and parents, 'healthier' kiosks, 90 min of additional PA weekly, behavioral PA program and active recess.	To assess the impact of intervention through changes in adiposity and physical fitness	- Anthropometric - TSF - Waist circumference and - Physical fitness (20m shuttle run test and lower back flexibility)	Positive effect on adiposity indices in boys while physical fitness parameters increased in both boys and girls (<0.001)	- Non-randomized trial

TSF= Triceps Skinfold Thickness; BP=Blood pressure

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
Foster *et al.*, USA (2008)	RCT, 2 years	844 (IG=479 and CG=365)	School Nutrition Policy Initiative included the following components: school self-assessment, NE, nutrition policy, social marketing and parent outreach	To examine the effect of intervention on the prevention of OW	- Anthropometric - FFQ - Eating Disorder Inventory-2 (EDI-2) - Youth/ Adolescent Activity Questionnaire	The prevalence of OW was lower in the IG schools	The use of self-report measures of diet and exercise is less ideal than direct measures
Jiang *et al.*, China (2007)	RCT, 3 years	2425 (IG=1029, CG=1396)	NE and PA through classes, educational materials and text with 10 themes. Including parents in IG	To measure the prevalence of obesity	Anthropometric measures	- Prevalence of OW and obesity were significantly reduced in IG. - BMI did not decrease significantly among severely obese children	Dietary intake, PA and obesity-related behaviours were not measured
Sacher *et al.*, UK (2010)	RCT, 12 months	116 (IG=60; CG=56)	MEND is a multicomponent community-based childhood obesity intervention	To evaluate the effectiveness of the MEND for childhood obesity	- Anthropometry - Body composition - Cardiovascular health - PA and inactivity - Self-esteem - Socioeconomic classification	- Significant reduction in waist circumference and BMI in IG - Significant improvements for BP, PA level, self-esteem and heart rate	- High drop out at 6 months due to logical factors - Lack of blinding for measurement of outcomes

Table 2-1 Continued

Study, country (year)	Study design and duration	No. of respondents	Intervention programme	Aim	Instruments used	Results	Limitation of the study
Boutelle *et al.*, USA (2012)	RCT, 11 months	80 (IG=40 and CG=40)	5-month family-based behavioral weight loss program includes dietary modification, increases in PA, behavioral change skills and parenting skills.	To examine parenting skills and parent weight change as predictors of child weight change	- Anthropometry - Home food environment - PSDQ - Limiting the child's behavior - Encouraging the child - Participating in program activities with the child - CRPBI	- A reduction of 1 BMI unit in the parent was associated with a 0.255 reduction in child BMI.	Unmeasured variables may act as confounders that bias the observed effects.
Caballero *et al.*, USA (2003)	RCT, 3 years	1704 (IG=879 and CG=825)	The intervention had four components: i) classroom curriculum, ii) food service, iii) physical activity and iv) family involvement	To evaluate the effectiveness of a school-based, multicomponent intervention for reducing percentage body fat	- Anthropometry and body fat - PA questionnaire - KAB questionnaire - 24-hour dietary recall - Process evaluation	- No significant reduction in body weight and BMI - Knowledge, attitudes and behavior were positively and significantly changed.	High dropout rates
Vos *et al.*, Netherlands (2011)	RCT, 1 year	81 (IG=41 and CG=40)	Multidisciplinary lifestyle treatment including medical, nutritional, physical and psychological counseling	To evaluate the effect of intervention on obesity and HRQoL	- Anthropometry - DISABKIDS questionnaire	- Significant reduction of BMI in IG - Significant improvements of HRQoL	Intervention used was expensive

PSDQ= Parenting styles and dimensions questionnaire; CRPBI= Child's report of parental behavior inventory; HRQoL=Health-related Quality of Life; DISABKIDS=Disease-generic measure for children with chronic diseases