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The Effectiveness of School- Based in Reducing and Preventing Childhood Obesity in China

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Abstract:

Research Aim: To describe the components and effectiveness of school-focused interventions to reduce obesity among children in China.

Background: The rise in global childhood obesity is a significant healthcare issue. Obesity and overweight are responsible for more than 3.4 million deaths around the world every year. The health risks associated with childhood obesity include cardiovascular diseases, type 2 diabetes, and many other breathing-related complications. Notably, childhood obesity is a major predictor of adult obesity and if obesity is not addressed during childhood, obese children become obese adults. Thus, there is a need to examine interventions that aim to prevent and reduce childhood obesity.

Methods: The structured literature review (SLR) synthesized and analysed four randomised controlled trials(RCTs) of school-based interventions which took place in China. Besides, the review employed an array of criteria to select suitable studies for research. For instance, only sources, which were focused on school-based intervention and published from 2015 until2019, were eligible for inclusion. Furthermore, the review conducted its search from renowned journal-databases such as CENTRAL, CINAHL, and MEDLINE.

Results: The SLR included four studies with a sample size of 23,029. All four studies concluded that the school-based interventions were effective in reducing the participants' body mass index(BMI), reducing participants' body weight and increasing the participants' knowledge of healthy lifestyle bahaviours and increasing levels of physical activities. The research further recorded a positive impact of the interventions on the children's dietary bahaviours. However, only a few studies looked at sedentary lifestyle as an outcome, but the studies stated that there was no significant effect of the interventions on children's sedentary bahaviour.

Conclusion: The SLR revealed that school-based interventions to reduce obesity in China were often successful in increasing physical activity, reducing BMI and weight, and increasing awareness of healthy lifestyle factors. However, the review was not conclusive in relation to waist circumference and the prevalence of sedentary behaviour as many studies did not report on these variables. In general, because there were few studies focusing on the area of school-based obesity intervention in China, further studies are needed to better understand how to address the problem and prevent it in the future.

Key Words: Effectiveness, School- Based, Reducing, Childhood Obesity, China.

1: Introduction

1.1 Background

Childhood obesity has in recent years been classified as a global health care problem given its rapid rise. WHO reported a 47.1% rise in the global prevalence of overweight and obesity in children between 1980 and 2013 (Williams & Greene, 2018). Childhood obesity has reached epidemic levels, which has prompted renewed efforts to preventing it given the risks associated with it. Particularly, childhood obesity is likely to persist into adulthood. Besides, obese children are at an increased risk of developing noncommunicable diseases such as high blood pressure, hyperglycaemia (high glucose levels in the blood) and hyperlipidaemia (high fat levels in the blood) (Sahoo, et al., 2015; Kumar, et al., 2010).

Childhood obesity poses numerous health risks both such as cardiovascular diseases and type 2 diabetes. An overweight child may also develop breathing-related complications such as asthma and sleeping disorders. Since the child's bones are still developing, the excessive weight may cause joints problems and musculoskeletal

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discomfort. Moreover, obesity in children can be associated with low self-esteem, anxiety, poor quality life and even bullying and stigma (Agha & Agha, 2017). Unfortunately, childhood obesity can spill over to adulthood and be the source of health risks such as heart diseases, diabetes and cancer. Therefore, there is a need to formulate strategies to address the epidemic. However, the vulnerability of children and complexity of the environment in which they operate make it hard to implement strategies to prevent childhood obesity (Danford, et al., 2015).

Although childhood obesity is evidenced in both developed and developing countries, its highest prevalence is recorded in developed countries (Sahoo, et al., 2015). The incidence of childhood obesity has been rising at an alarming rate across the globe, but it is highest in developed nations. Over the last 30 years, developed countries have witnessed the doubling and tripling of childhood obesity (Cathaoir, 2016). Although majority of the children affected by childhood obesity live in developed countries, developing countries also record higher prevalence. In fact, the prevalence of childhood obesity in developed countries is twice that in developing countries (Gupta, et al., 2012).

About 41 million preschool children (<5 years) were estimated to be overweight or obese in 2016 across the globe (WHO, 2018). Asia is the most affected region by these statistics, with nearly half of all overweight and obese children under the age of five being from there. (WHO, 2018). According to Ma (2010), China has experienced a significant increase in the levels and pervasiveness of weight problems and obesity amongst childhood over the last quarter of a century. A Chinese National Survey on Students' Constitution and Health (CNSSCH) has been conducted every five years since 1985. Results from the 2010 survey reveal that 23.2% of boys and 12.7% of girls in urban districts were overweight or obese. This compares poorly with the results from the first such survey wherein comparative figures were 1.3% for boys and 1.5% for girls. In rural areas, the figures rose from 0.5% to 13.7% for boys, and from 1.6% to 8.6% for girls (Ma, 2010).

1.2 Impact of Childhood Obesity: Physically and Economically

Childhood obesity is associated with numerous health complications, explaining the reason for classifying it as a major public health concern. The disease is highly associated with health complications at the paediatric age and is a risk factor of adult morbidity and mortality. In particular, it leads to metabolic and cardiovascular health complications in children (Cali & Caprio, 2008). Childhood obesity also leads to glucose metabolism abnormalities, which increase the risk of type 2 diabetes (Weiss & Kaufman, 2008; Pulgaron & Delamater, 2014; Galuska, et al., 2018). Obese children report increased difficulties with daily physical tasks and physical performance (Valerio, et al., 2014). Obesity in children is also linked with a higher prevalence of psychological disorders associated with stigma and bullying. In particular, obese children are more likely to have depression, low self-esteem, and behavioural disorders than healthy-weight children (Delamater, 2014). Other health impacts of childhood obesity include high blood pressure, diseases of joints, liver problems, and respiratory disorders (Xu & Xue, 2016).

Apart from the health impacts, childhood obesity has significant financial implications. The economic costs are encountered at the household level and at the health system level (Pelone, et al., 2012). Many families in China face huge costs in treating childhood obesity and enrolling their children in weight management interventions. The direct cost of weight management interventions targeted at overweight and obese children ranges from hundreds to thousands of pounds (Moore, 2017). The high cost of obesity management has been cited as one of the major barriers to its effective management (Arai, et al., 2015). Obesity is associated with significant societal costs given the large disease burden it imposes on healthcare systems. Although the cost of obesity is high in both developing and developed countries, the cost per capital is significantly higher in developed countries.

1.3 Social Determinants of Obesity (Dahlgren-Whitehead Model)

According to Moradi et al., (2017), social determinants of health may be defined as those phenomena which effect wellbeing, such as socio-economic factors and cultural influences (Figure 1).

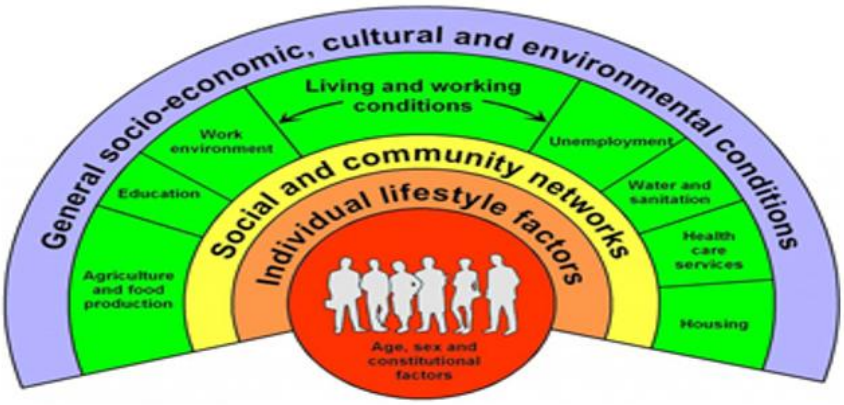


Figure 1: Dahlgren and Whitehead (1991) model of social determinants of health

Social factors play a critical role in determining the risk of childhood obesity. Perhaps the major social determinant of obesity in children is socio-economic status. In developed countries, urban poor households report high incidences of childhood obesity, which are attributed to poor diet and limited physical activity. On the other hand, urban rich households in developing countries are the ones that have the highest rate of childhood obesity. Children from these families have a high affinity of adopting western-like sedentary lifestyles. High socioeconomic status private schools also record high rates of childhood obesity because children attending them have high amounts of pocket money to spend on high-calorie foods, rarely carry out household chores, and travel by car or bus (Raychaudhuri & Sanyal, 2012). Cawley (2010) affirms these findings through the assertion that the relationship between socioeconomic status and obesity is complex. While poor households may lack access to healthy food alternatives and be forced to consume cheap energy-dense foods, affluent households may also lead to weight gain because high socioeconomic status often leads to indulging in sedentary lifestyles (Cawley, 2010).

Family dynamics are also a major determinant of obesity. Maternal employment is associated with an increase in childhood obesity. Increasing a mother's weekly hours has been shown to explain 11.8-34.6% increases in childhood obesity. Children with working mothers have a higher likelihood of engaging in sedentary lifestyle such as watching television for long than those with unemployed mothers, which increases the risk of obesity (Cawley, 2010). Traditions and culture prevalent in the family also influence childhood obesity. Cultural beliefs such as the myth that fat children are healthy contribute to increased cases of childhood obesity. Parenting styles that discourage leftover food are also a major social determinant of childhood obesity (Raychaudhuri & Sanyal, 2012). The level of education among parents and area of residence are also a major cause of health inequalities related to obesity. In particular, mother education and the social facilities availability in a residential area are major contributors to health inequality (Moradi, et al., 2017).

The complex aetiology of childhood obesity explains the many factors that have been associated with the illness. Apart from lifestyle and diet, childhood obesity is caused by other factors. The impact of sedentary lifestyle, dietary intake, and reduced physical exercise in children is mediated by other factors such as age and gender (Ye at al., 2017). Genetic factors are also associated with an increased risk of obesity. Genes that regulate appetite through actions in the central nervous system have been shown to determine dietary preferences, which influence the energy intake of a child. Consequently, genetics are a mediating factor in the aetiology of childhood obesity (Herrera & Lindgren, 2010; Thaker, 2017).

2: Methodology

2.1 Research Question and Aim

2.1.1 Research Question:

What is the effectiveness of school-based interventions against childhood obesity in China?

2.1.2 Research aim:

- To identify components and describe effectiveness of school-based interventions to reduce childhood obesity in China.

2.2 Approach to Methodology

According to Higgins and Green (2008), research on evidence-based healthcare plays a critical role towards adding knowledge to patient values and professional expertise. Their research points out that problems are likely to arise when focus is directed to the results of one or two studies only, which is backed by the

University of York, Centre for Reviews and Dissemination (CRD)(2009) by pointing out that it can lead to methodological bias or error or unreliable and equivocal results. A SLR is suitable for this research study as it answers a defined research question through the collection and summarization of all empirical evidence fitting pre-determined eligibility criterion. However, according to Holy and Salmon (2011), the primary aim of a SLR is to construct a comprehensive evaluation of intervention programs and their effectiveness through the consolidation and consideration of the diversity of outcomes exhibited in multiple studies. This approach adds a concurrent appraisal of the quality of the methodologies employed in these studies. Moreover, Higgins and Green (2008) concur with Holly et al (2011) contention that rigorous and structured literature reviews are a high point in any evidence-based research. A SLR takes a systematic strategic approach in order to create a summary of the best quality evidence relevant to any given research question. The methodology employed therein is not simply organized and unambiguous but is also eminently reproducible (CRD, 2009).

There exist multiple accepted versions of a structured literature review. For instance, in a review the focus is upon efficaciousness and the objective is to ascertain the existence of a causal link between interventions and consequences (Jesson, 2011; Pettigrew & Roberts, 2008). Also, the SLRs of efficacy aim to assess the effectiveness of interventions in relation to planned change which, according to Pettigrew and Roberts (2008), diminishes inconsistencies and uncertainties. Thus, this approach is advantageous in relation to any required choices since it uses robust strategies and techniques. Nevertheless, as Gough et al., (2012) point out, before any approach can be selected, there must be a satisfactory comprehension and appreciation of the basic canons embodied in the principal research methodologies. There is a need to have a thorough awareness of the underlying presumptions regarding various methodological approaches before selecting the appropriate research design (Jesson, 2011).

2.3 Inclusion and Exclusion Criteria

Inclusion criteria denote those requirements, which must be delineated before a review of the existing research is conducted (Gough et al., 2012). These criteria are established in accordance with certain elements in the research, including the topic, the type of participants who will be involved, the nature of the intervention, the research design and the projected outcomes. The PICOT framework, as described by Bettany-Saltikov (2012), is employed in the present study and thus encompasses multiple criteria, to wit: population, intervention, context, outcome and study type.

2.3.1 Population

The study participants were deemed to be the studies in which the students were the main drivers of change. 'Students' were defined as those aged between 5 and 19, in both primary and secondary school in China. Studies that concentrate on parents or teachers only were excluded.

2.3.2Types of Interventions

The only interventions included in this study were those that aimed to reduce obesity in school children. A limitation was placed on where these interventions took place, so only those interventions that were delivered in school were included. Others were excluded such as interventions that took place at home or in clinics, community programs and family-oriented childhood obesity interventions.

2.3.3 Outcomes

The principal outcome which this study aims to identify, is a decrease in the level of childhood obesity. This outcome can be measured in relation to BMI, waist circumferences and weight levels. Secondary outcomes include changes in dietary habits, alterations in levels of physical activity, marked changes in sedentary behavior and changes in health-related knowledge amongst student.

Table 1: PICOT Framework

PICOT	Criteria for Inclusion	Criteria for Exclusion
Population	Status as school student (5-19 years old). Children. Adolescent. Youth.	Any population outside the school environment. Adults working in schools (e.g. Studies that concentrate on parents or teachers).
Intervention	All school-based interventions which target obesity in children.	Clinical-based intervention. Home-based intervention. Interventions which involve parents only. Interventions based within the wider community.
Context	Schools, China	
Outcome	Perceptible reducing in student weight and as measured by the researcher in terms of BMI, weight or waist circumferences, improvement in dietary habits, alterations in levels of physical activity, marked changes in sedentary behavior and improvements in health-related knowledge amongst student.	Irrelevant findings such as results of student academic performance in school.
Types of studies	Randomised Control Trials (RCTs). Journals and publications in the English language. Studies from 2015 until 2019	Qualitative studies, documents for reviews, non-randomised quantitative studies, cohort studies, case studies, case control trials, research published in languages other than English. Studies before 2015

2.4 Data Collection and Analysis

2.4.1 Selection of Studies

The electronic database search was conducted in the manner detailed above. The limiters were the China context, English language, publication years 2015-2019 and the research design type. All findings were imported into REFWORKS, where the duplicates were removed. A subsequent screening was conducted of the titles and abstracts for all studies, including those emanating from the manual searches employing the specified inclusion and exclusion criteria to identify which were valid for this review and Studies which did not meet the selected criteria were excluded and not used in the research. For those that had a degree of ambiguity regarding their eligibility, the full text was screened to determine eligibility. Lastly, the studies that had been determined appropriate for inclusion and synthesis, were recorded and used for the purpose of this review.

2.5Quality Assessment

As stated by Armijo-Olivo,et al., (2011), a quality assessment denotes the traits and standards embodied in the methodological evaluation and the extent to which a piece of research regulates the internal validity and partiality inherent in any given design and evidence assessment. The reasoning behind this is that in any public health context, it is essential to apply the most rigorous standards of evidence to obviate any potential exaggeration or underestimation of an intervention's impact arising from failures in the research design (Bettany-Saltikov, 2012). Quality assessment also considers the risk of bias, the suitability of the study design and other elements related to the study's robustness (CRD, 2009).

For this research study, the Cochrane Collaboration Risk of Bias Tool (CCRBT)(adapted from Higgins & Green, 2011) was selected as it focuses on six core aspects which are the most germane to RCTs. CCRBT evaluates bias in various areas, including;

- Random sequence generation
- Allocation concealment
- Blinding of participants and personnel
- Blinding of outcome assessment
- Incomplete outcome data
- Selective outcome reporting

2.6 Data Extraction

The extraction of data mandates that information which is sourced and documented be acquired from pertinent primary sources for inclusion in the review (Bettany-Saltikov, 2012). The data extraction used in the current review follows the format utilised by the Research Council for Complimentary Medicine (RCCM) (2013).

This choice accords with the criteria included in the Cochrane risk of bias tool. Data extraction and quality evaluation of the chosen studies were conducted concurrently due to the similarity of the processes involved (Bettany-Saltikov, 2012; CRD, 2009). The data extraction phase required specific data to be mined from the included studies and to be captured according to certain variables with each data anticipated to be unique. Data from the included studies were collected in accordance with general information, methods, participants, interventions and outcomes (Armijo-Olivo et al., 2011).

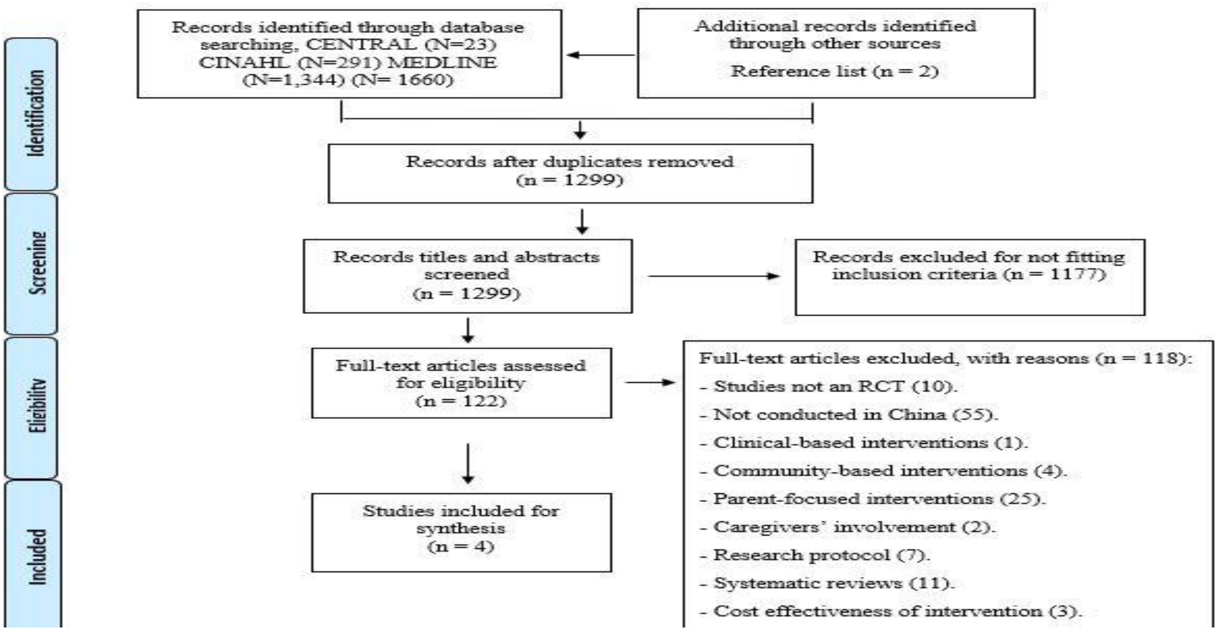
2.7 Data Synthesis

Data synthesis comprises the establishment of correlations between two components (Hart, 2001). Collins and Hages (2010) further state that data synthesis also joins findings from all existing and available evidence acquired from primary research on any given subject. Using the studies which demonstrate methodological robustness, it becomes possible to construct a narrative synthesis and establish novel links via a textual description compared to the findings of the studies, which were included along with the systematic description (Bettany-Saltikov, 2012; Jesson, 2011). According to Collins and Hages (2010), meta-analysis comprises an approach to narrative research analysis, which employs a degree of diligence and precision akin to that used in systematic reviews. However, this was not applied due to the diversity of the studies; for example, the types of interventions and range of outcomes included in this review.

3: Results

3.1 Selection of Studies

The PRISMA flow diagram describes the flow of the study selection process (Figure 2). The initial database search retrieved a total of 1658 records, with an additional two articles identified by reading the reference lists of the studies included in the review. These records were then uploaded to RefWorks in order to identify duplicates, resulting in the removal of 359 articles. The titles and abstracts of the remaining 1299 articles were then screened against their importance to the research question, with 1177 being subsequently excluded. The remaining 122 articles were then read in full to assess their eligibility as per the inclusion and exclusion criteria. As can be seen from the PRISMA diagram (Figure 2), this resulted in a total of 4 articles being included for synthesis in the review as they fulfilled the inclusion criteria. Notably, a total of 118 articles did not meet the selection criteria for reasons highlighted in the flow chart. For example, the research did not include 55 studies because they were not conducted in China. Similarly, two studies involved caregivers, while 11 were systematic reviews.



3.2 Included Studies

All four studies (Liu et al., 2019; Wang et al., 2018; Xu et al., 2015; Xu et al., 2017) were conducted in China and they used a cluster RCT design to evaluate the effectiveness of a school-based intervention in preventing and reducing childhood obesity. Donnar and Klar (2000) defined a cluster RCT as 'a comparative study in which the units randomised are pre-existing (natural or self-selected) groups whose members have an identifiable feature in common, and in which outcomes are measured in all, or a representative sample of the individual members of the group.'

The interventions in all four studies were delivered by qualified trained personnel (teachers, physical health education experts and clinical dieticians). Moreover, of the four studies, three had active controls (i.e. routine care), while one had a control group (i.e. no intervention). Xu et al., (2015) and Xu et al., (2017) investigated the effects of the same multicomponent intervention, but the latter did so on a far wider scale and compared its effects to standard health education lessons. Wang et al., (2018) investigated a multicomponent physical activity intervention and compared the effects of the physical activity intervention to standard health education lessons. Liu et al., (2019) investigated a theory-based comprehensive intervention and compared the results between the intervention schools and no intervention (i.e. control group) schools.

3.3 Assessment of Study Characteristics

3.3.1 Participants

Across all four studies, the sample comprised of a total of 23,029 child participants, with ages ranging from 6 to 13 years of age. These children attended a total of 108 different schools, based in 15 large cities across China. Moreover, all the children who participated in the research lived within urban environments. However, children were excluded from participation if they were suffering from, or had a history of, any cardiovascular or respiratory conditions, or a disability that might have impeded their ability to engage in regular exercise (Liu et al., 2019; Wang et al., 2018; Xu et al., 2015; Xu et al., 2017). Wang et al., (2018) recruited the largest sample size (n=10091), whilst Xu et al., (2015) had the smallest sample (n=1182). The calculations of samples sizes were demonstrated in all of the studies included in this review.

3.3.2 Interventions

All of the included studies provided complete details of their intervention or, as in the case of Xu et al., (2017), referred the reader to the full intervention details, as previously published in other work. Again, all of the educational elements in the studies were delivered by a professionally trained preceptor; however, only Liu et al., (2019) study provided a detailed account of how they had ensured adherence to the intervention.

Both Xu et al.'s (2017) Xu et al.'s (2015) studies implemented the same, multicomponent intervention, which targeted children, their parents and staff working within the school environment. The intervention comprised of nutrition and health classes, which included parental and staff participation; physical exercise for children either two times per day for 10 minutes or once a day for 20 minutes; and the distribution of publicity materials concerning the intervention to parents and teachers. Staff participation included school canteen managers, operators and members of the school's leadership.

Both Wang et al.'s (2018) and Liu et al.'s (2019) multicomponent interventions were markedly similar to those of Xu et al., (2015) and Xu et al., (2017). They comprised educational elements and publicity material that was distributed to students, parents and staff, and parents were also involved in the educational activities. However, unlike Xu et al., (2015) and Xu et al., (2017), Wang et al.'s (2018) intervention did not implement a fixed amount of physical exercise for students and instead, focused more heavily on parental involvement and environmental modification. For instance, Wang et al.'s (2018) intervention gave children access to equipment to ensure that the children could calculate their BMI during break times.

Wang et al.'s (2018) intervention not only required parents to participate in the health education activities – they also attended dedicated lessons without the children. The topics covered in these lessons included childhood obesity, the health consequences of a lack of physical activity, and skills to support their children in engaging in physical activity every day. Additionally, Wang et al.'s (2018) study was distinct in that it delivered two, fun events during the 12-month follow-up period. One of these was a painting competition that included all schools within the intervention clusters, whilst the other entailed a writing activity where students explored obesity and its hazards to health. The former event was delivered during the second half of the study period, culminating with a national contest for students who had won earlier rounds of the competition, at the local and regional level.

Finally, Liu et al.'s (2019) multicomponent intervention required schools to provide at least three 45-minute physical education classes per week, with at least 30 minutes of moderate-to-vigorous physical activity. Liu et al., (2019) implemented this measure as part of a range of other school policies, which also included a ban on unhealthy snacks and sweetened beverages, whilst advocating that children should not play on smartphones or other similar technology during breaktimes. Liu et al., (2019) also required students to keep diaries of their behaviours related to diet and physical activity for one week (from Monday to Sunday), once a month. Liu et al., (2019) highlighted other commendable self-reporting behaviours. For instance, children were encouraged to drink at least 800 ml of water daily and avoid eating huge portions of meat. When the students achieved one of the eight targeted behaviours, they were eligible to receive a sticker from a staff member. Thus, both the interventions of Wang et al., (2018) and Liu et al., (2019) involved giving incentives to students.

3.3.3 Percentage of Participants Included in Analysis

According to the studies of Xu et al., (2015), children were 1182 in total. The researchers documented that 6.3% of children (a total of 74 children/n=74) were lost to follow-up. Accordingly, the analysis included 93.7% of participants, which translates to 1108 children (n=1108). The researchers gave various reasons for the loss of follow-up. For example, some children were ill, and others missed due to important engagements during the day of the post-intervention survey. Conversely, Wang et al., (2018) documented that of the 10091 participants, 97.7% or 9858 children were available for follow-ups (n=9858). Consequently, the researchers lost 2.3% of their total respondents (n=233). Thus, according to Wang et al., (2018), 233 children did not complete the follow-up survey. The study gave similar reasons to Xu et al., (2015) to explain the loss of follow up (sickness and scheduled events).

On the other hand, Liu et al., (2019) used a total of 1889 children (n=1889) from 6 schools. Notably, only six schools were eligible for the study (n=6/50% of the total number of schools). The study assigned930 children (representing 49% of the total participants) to random intervention groups. Moreover, the remaining 959 participants (51%) were assigned to the control group. According to Liu et al., (2019), 48.3% of the participating children were girls, while the rest (51.7%) were boys. Furthermore, between the 6-month and the 12-month follow-ups, the measurements for height and weight were available for 97.2% (1837) and 97.4% (1839) of the children, respectively. Accordingly, 2.8% (52) and 2.6% (50) of the 1889 participants missed the follow-up, respectively. Lastly, Xu et al., (2017) used 9867 participating urban children to conduct their studies (n=9867). However, the researchers did not give the number of respondents who missed the follow-ups.

3.3.4 Outcome Measurement

The included sources measured primary and secondary sources such as BMI, Weight, and self-reported measurements in various ways. For example, studies by Liu et al., (2019) calculated the children's BMI from the ratio of their body weight and height at the intervals of 6 and 12 months, respectively. Moreover, Wang et al., (2018) used validated questionnaires to obtain measurements regarding participants' dietary behaviours and their knowledge of a healthy lifestyle. Besides, the researchers used validated food questionnaires to determine the extent to which children consume diets such as soft-drinks, fast-foods items, and red meat. Xu et al., (2015), on the other hand, used participants' self-reports to determine their eating-behaviour and lifestyle patterns.

Furthermore, all four studies were explicit in describing the statistical testing used during their data analysis, reporting their methods completely. In terms of the statistical power of these analyses, all of the studies adopted the value of 0.05 for alpha values and significance levels – 'the probability of obtaining a result at least as extreme as the one that was actually observed in the study, given that the null hypothesis is true' (Panagiotakos, 2008, p.98). Liu et al., (2019) calculated that their sample size would provide 90% power at 5% significance level (two-sided), enabling the detection of 0.8 kg/m2 in BMI at 12 months follow-up. The studies by Wang et al., (2019), Xu et al., (2017) and Xu et al., (2015) were based on the same power calculations and reported that a statistical power of 80% would be sufficient to detect a clinically significant difference in BMI between the control and intervention clusters, with $\alpha = 0.05$ (one-sided). Thus, Liu et al.'s (2019) findings provided weighty evidence for the effects of their methods.

Xu et al., (2017) chose to measure the lipid and glucose concentrations of the participants at both baseline and 12 months post-intervention in evidencing how the risk of bias can be circumvented through the research design. These represent surrogate measures of dietary intake, as a poor diet is well recognised to result in increases in lipid and glucose blood concentrations. More importantly, such measurements cannot be influenced by the researchers or participants, while self-reported data can (Fritzley et al., 2012). Of course, using such outcome measures is far more costly and time consuming, as well as requiring additional consent and ethical permission to collect blood samples from children. However, in terms of validity, this significantly enhances Xu et al.'s (2017) findings related to dietary intake.

All four studies reported their outcome data as an effect size in the form of odds ratios (OR). In quantitative research, effect size describes 'the magnitude of the difference between groups' (Sullivan &Feinn, 2012, p.98), whereas an OR is defined as 'the strength of association between exposure and an event' (Persoskie& Ferrer, 2017, p.224). The effect size measures the difference in percentage change between study arms that can be directly attributed to the intervention, with percentage points, thereby representing the units of measurement (Persoskie& Ferrer, 2017). Thus, in the case of the studies included in this review, the OR reflected the strength of the association between exposure to the intervention and changes in children's obesity-related outcomes (i.e. reductions in BMI and increases in exercise). Subsequently, effect sizes can be categorised as either small, medium or large and they were calculated as Cohen's (1988) d values. Chen, Cohen, and Chen (2010) calculated that the OR values of 1.68, 3.47, and 6.71 are directly equivalent to Cohen d's small, medium and large, respectively.

These results will now be presented, as measures of the effectiveness of each school-based intervention in terms of body measurements, diet, physical activity and sedentary behaviour.

3.4 Included Studies' Results

3.4.1 Waist Circumference, Weight, and BMI Results

All the studies in the review measured the children's BMI at post-intervention baselines of 12 and six months. Foremost, the research of Xu et al., (2015) concluded that for 12 months post-intervention, there was a marginal increase in the overall BMI value in the control group versus the experimental group (-0.29 ± 1.40 vs. -0.32 ± 1.36, p = 0.09); however, this change was only approaching significance. On the other hand, the likelihood of the intervention group to reduce their BMI was significantly high (OR = 1.44, 95% CI = 1.10, 1.87) by 0.5 kg/m² or higher during the study period, when compared to the control clusters. Therefore, the results suggest that Xu et al.'s (2015) intervention had desirable effects on BMI amongst Chinese school-going children. However, larger sample size and adequate study power would elucidate better outcomes.

Furthermore, Xu et al.'s (2017) study offered similar data, with their much larger sample size and adequately powered study, also providing BMI z scores, in addition to exploring mean BMI. Following the implementation of the same intervention, Xu et al., (2017) reported a BMI intervention significance, BMI z scores for -0.14 (95% CI = -0.18, -0.11; p<0.001), for -0.3 kg/m2 (95% CI = -0.4, -0.2; p<0.001). Thus, this provides a fairly strong evidence base of the positive effect, in terms of the direct impact on body fat composition, of the multi-component intervention used in both studies (Xu et al., 2015; Xu et al., 2017).

Similarly, Wang et al., (2018) also determined that their multi-component intervention had a positive impact on BMI. Children within the intervention groups had a significantly smaller increase, versus those in the control clusters in mean BMI 0.46 (0.02) vs. (0.22 (S.E. 0.02), P = 0.01) and BMI z-score 0.16 (0.01) vs. (0.07 (0.01), P = 0.01). Thus, across these three studies, this data supports the effect of multi-component interventions for promoting reductions in BMI amongst Chinese school-going children. Conversely, Liu et al., (2019) did not report such positive effects. Instead, Liu et al., (2019) did not report any significant differences between the mean BMI (0.07 kg/m2 [95% confidence interval (CI) -0.16 to 0.31, p=0.54]) and the z-score (0.02 [95% CI: -0.08 to 0.11, p=0.73]) at 12 months, when comparing the intervention and control clusters of their study. Of course, this may very well be a result of the marked difference in the intervention used by Liu et al., (2019), as will be discussed in the next chapter of this work.

Three studies recorded and reported the weight of participants at both the baseline and follow-up. The research then used the data to assess the intervention impacts in terms of the prevalence and occurrence of overweight or obesity as per the BMI, height, and the weight measurements at both the one-year follow-up and the baseline. During the time, Wang et al. (2016) reported that new cases of overweight/obesity had significantly reduced and furthermore, a large proportion of previously obese/overweight participants had a normal weight by the end of the study (control vs. intervention = mean (S.E.) 0.13 (0.01) vs. 0.08 (0.01), adj. β=−0.08, 95% CI = −0.15, − 0.01). Despite the lack of significant positive changes in BMI in Liu et al. (2019), the combined prevalence of obesity and overweight increased by only 0.2 percent in the comprehensive intervention cluster (23.8% vs. 23.6%, p=0.954), while it increased by 1.5 percent (24.2% vs. 22.7%, p<0.001) in the control cluster after the intervention (p=0.067).

Finally, in terms of waist circumference, Xu et al.'s (2017) study was the only RCT to measure this outcome. The researchers' findings also showed beneficial effects, with a reduction of -0.5 cm in waist circumference (95% CI: -0.6, -0.3; p<0.001) amongst the intervention clusters, versus the controls.

3.4.2 Knowledge (Attitude) results

Xu et al., (2017) established that participants in the control group improved less significantly, as opposed to those in the comprehensive intervention group with regard to their nutrition knowledge. Students were assessed in terms of their correct response to knowledge in nutrition (Xu et al., 2017). In this regard, Xu et al., (2017) compared the control group to the comprehensive intervention group (0.8% vs. 8.9%, p=0.001). The researchers documented that respondents understood that failing to diversify food items is risky nutrition behaviour. For instance, the results indicated that respondents' knowledge that coarse grains were more nutritious than processed grains significantly improved (-1.6% vs. 2.6%, p=0.028). Moreover, respondents understood that taking more soy products and milk was beneficial to their health (0.8% vs. 3.1%, p=0.013).

The participants also gained new knowledge that moderate exercises would enhance their learning (12.0% vs. 21.0%, p<0.001). Lastly, Xu et al., (2017) also documented increased participants' knowledge that they would be more prone to obesity if they exercised less often (1.9% vs. 5.6%, p=0.003).

Accordingly, the researchers improved the respondents' knowledge of nutrition, and physical activities increased to 855.1 plus/minus 405.6 from 815.9 plus/minus 420.6 minutes every week. Notably, the studies established that changes in the control group were insignificant, and recorded changes in physical activities in the comprehensive intervention group. However, according to Xu et al., (2017), the researchers did not observe significant improvements in practice and attitude.

Xu et al., (2015) used questions to investigate the participants' knowledge and attitudes about the risk factors related to obesity. The researchers inquired about the rate in which respondents consumed soft-drinks, vegetables, fried snacks, and fatty meat. The studies also investigated the participants' frequency of prolonged screen time and physical activities. According to the finding of Xu et al., (2015), respondents showed a significant change in their awareness of the five selected obesity factor risks. Besides, the analysis revealed that the consciousness was more effective in the intervention cluster than in their counterpart cluster. Similarly, Wang et al., (2018) investigated the effectiveness of improved awareness of nutrition and healthy lifestyle behaviours on parents and children. The researchers prepared one health class per semester for parents and covered topics such as healthy living skills for their children, the consequences of physical inactivity, and the knowledge of childhood obesity. Unlike the parents, students were taught by their class teachers. The study assessed the participants' understanding of diet and healthy lifestyle using validated questionnaires, both at the intervention and control schools. Besides, parents provided the researchers with children's background information such as family structure, size, and parental education. Wang et al., (2018) measured students' mean height and body weight at both post-intervention and baseline to ~0.01m and ~0.1kg. Wang et al., (2018) compared the control and the intervention school at baseline (p=0.33), similar to the previous studies of Xu et al., (2017).

According to Wang et al.'s (2018) research findings, the enhanced knowledge in the control and intervention schools achieved varied results. For instance, the prevalence changes of either obesity/overweight (control vs. Intervention=2.9% vs. 0.9%) or for obesity (control vs. Intervention=2.3% vs. 0.6%) increased in both control and intervention students. However, Wang et al., (2018) found that obesity was less likely to affect the intervention school students.

Furthermore, the studies of Liu et al., (2019) concluded that improved knowledge and attitudes were paramount in reducing childhood obesity. Besides, the researchers added that schools are significant in influencing students' knowledge and behaviours of healthy lifestyle and diet. Accordingly, Liu et al., (2019) focused on educational strategies to enhance participants' knowledge of obesity-risk factors. Moreover, the studies lauded health education activities and school-level policies in advocating for practical skills and different health practices which aimed at preventing obesity. Similarly, the findings reported significant effects in favour of behaviour-related outcomes and knowledge outcomes. For example, for knowledge relating to obesity (mean differences: 0.19:95% CI: 0.33 from 0.06; p=0.005).

3.4.3 Physical Activity Results

All studies reported the effect of the intervention in terms of levels of physical activity amongst Chinese school-going children, versus no intervention (Wang et al., 2018; Xu et al., 2015; Xu et al., 2017; Liu et al., 2019). Across all of the four research works, the intervention had a significant and positive impact on levels of physical activity. For example, Xu et al., (2015) cited that students in the intervention clusters significantly increased the frequency with which they went running or jogging (OR = 1.55, 95% CI = 1.18, 2.02), versus their counterparts in the control groups. Xu et al., (2017) found that the cohort which received a wide-ranging programme of intervention showed a considerable increase in time spent on physical activities from 815.9±420.6 mins per week to 855.1±405.6 minutes per week. However, this was not the case with the control group, which showed no change of statistical significance. The invention programme therefore increased activity by 46.0 mins per week, a substantial impact. Wang et al., (2018) also found that children in the intervention group were significantly more likely to increase the time they spent exercising, versus their counterparts (adj. Odds ratio = 1.15, 95% confidence interval = 1.06–1.25). Finally, Liu et al., (2019) also reported that students within the intervention group significantly increased the frequency with which they engaged in moderate-to-rigorous activities, versus children within the control arms (mean differences: 1.37; 95% CI = 1.49 to 1.60; $p < 0.0001$). Thus, the three findings demonstrate a consistent intervention effect in terms of levels of physical activity, amongst Chinese school-going children of the ages between 7 and 13 years.

3.4.4 Dietary Intake Results

Wang et al., (2018) did not look at the children's feeding habit as an outcome and how the intervention may have affected their dietary intake. Conversely, Liu et al., (2019) cited that the percentage of children consuming sugar-sweetened beverages significantly increased (OR: 0.56; 95% CI: 0.42 to 0.74; $p < 0.0001$). However, there were no statistically significant differences when comparing the control and intervention clusters with regard to the self-reported consumption of vegetables, fruit and red meat.

The results were in contrast to Xu et al., (2015), who reported that the consumption of red meat amongst children in the intervention clusters significantly reduced when compared to those in the control clusters (OR = 1.50, 95% CI = 1.15, 1.95). However, Xu et al.'s (2015) findings suggested no significant differences in dietary intake in terms of the consumption of sweetened beverages or fried snacks. Finally, Xu et al., (2017) did not explore children's dietary intake directly but reported the glucose and lipid concentrations for children pre- and post-intervention, as a surrogate measure of healthy dietary intake. As mentioned, reported measures provide better evidence for the impact of any given intervention and are less likely to be subject to bias, unlike the self-reported measures. Accordingly, Xu et al., (2017) reported that in the intervention clusters, there was a significant improvement in cholesterol for -0.32 mmol/L (95% CI: -0.34, -0.30; $p<0.001$) and blood serum glucose for -0.20 mmol/L (95% CI: -0.24, -0.16; $p<0.001$) concentrations.

3.4.5 Results of Sedentary Life

Only the research of Xu et al., (2015) looked at sedentary lifestyle as an outcome. For example, even though Liu et al., (2019) recognized the sedentary lifestyle as a factor contributing to obesity/overweight, the research did not find any significant effect of the intervention on self-reported sedentary behaviours. Accordingly, Xu et al., (2015) assessed the degree to which the participants watched television and used computer, although this data was self-reported and was potentially vulnerable to response bias. Besides, Xu et al., (2015) reported a statistically significant decrease in the computer and TV frequency of use (OR = 1.41, 95%CI = 1.09, 1.84) following the exposure to the intervention when comparing clusters. Therefore, across studies, there was a notable lack of outcomes pertaining to sedentary behaviour amongst Chinese school children.

3.5 Quality Assessment of Included Studies

The assessment of bias for each study was determined by using the Cochrane Collaboration Risk of Bias Tool (CCRBT). This tool is cited as promoting a structured and accurate process of critical appraisal (Higgins et al., 2011). The findings from the risk of bias assessment are detailed below, along with the quality assessment table attached subsequently.

3.5.1 Assessment of Bias

All the four studies were subjected to the assessment which used the six characteristics of the tool. Notably, one researcher evaluated every article in accordance with the six critical domains of the tool. Accordingly, (Table 2) highlights the CCRBT assessment results. In line with the CCRBT descriptions, all the domains with a 'HIGH BIAS RISK' are labelled 'NO' while 'YES' denotes domains which have "LOW BIAS RISK'. Similarly, the label 'UNCLEAR' refers to the elements which have 'UNCLEAR BIAS RISK'. In cases where each of the six fields received a positive response, and no significant errors were identified in other sections, a study was given a low risk of bias rating. However, a study was rated as being at high risk of bias if it received a negative response in any of the following significant fields: (i) sequences generated randomly, (ii) distribution hidden, (iii) staff and respondents did not know the groups to which they had been allocated and (iv) evaluation of the results was 'blind'. Finally, in cases where a study received 'unclear' in at least one of these four significant fields of the Cochrane Collaboration Risk of Bias Tool, it was rated as having an unclear risk of bias. Consequently, a summary of all the sources' evaluations was made in order to provide the bias rating.

Table 2: Assessment of Bias (Cochrane Collaboration Risk of Bias Tool)

No	Article record number?	1	2	3	4
	Authors Name and Year? **Bias Domain?**	Liu et al., (2019)	Wang et al. (2018)	Xu et al. (2017)	Xu et al. (2015)
1.	Random sequence generation	Yes	Yes	Yes	Yes
2.	Allocation concealment	Yes	Yes	Yes	Unclear
3.	Blinding of participants and personnel	No	No	No	Unclear
4.	Blinding of outcome assessors	Yes	Yes	Yes	Yes
5.	Incomplete outcome data	Yes (lifestyle behaviours)	No	No	No
6.	Selective outcome reporting (Based on statistical significance)	No	Yes	Yes	Yes
7.	Other sources of bias	Yes (Selection Bias)	Unclear	Unclear	Unclear
	Rating of Risk of Bias	**High risk of bias**	**Low risk of bias**	**Low risk of bias**	**Low risk of bias**

Two of the studies (Xu et al., 2017 and Wang et al., 2018) were deemed to have a low risk of bias. On the other hand, (Liu et al., 2019) had a significantly high bias risk, while (Xu et al., 2015) had an unclear bias risk. Nonetheless, across studies, the overall quality was good. For instance, all of the studies fully described their study protocol, which included their methods of randomisation and adjustment for clusters. In turn, this completeness of reporting acts to promote the credibility of the studies' findings; especially given that Richardson, Garner and Donegan (2016) have found that such detail is frequently under-reported in the dissemination of cluster RCTs. All four studies also used random allocation when assigning schools to either the intervention or control groups. This is because random allocation involves assigning participants or clusters by chance, rather than being influenced by factors such as the researcher, any attributes of the unit of research or the preferences of any participants (Pannucci and Wilkins, 2010). Consequently, random allocation reduces the risk of selection bias, which occurs when the process of recruitment and group allocation results in systematic differences between study groups (Kim and Shin, 2014).

Furthermore, from a wider perspective, cluster RCTs produce a particularly strong form of evidence given the nature of investigating school-based interventions in comparison to other RCT designs (Richardson, Garner and Donegan, 2016). This is because school-based interventions present a high risk of contamination (Magill et al., 2019; Parfrey, 2015), meaning that there is a potential for bias as a participant from one group may have regular contact with a member assigned to a different study group and therefore, may be influenced by this contact (Moberg and Kramer, 2015). Thus, as school-based interventions require the comparison of outcomes amongst children attending the same school who have consistent contact; a cluster RCT was a robust choice of study design given the subject of interest.

Nonetheless, it is still essential to consider the risk of contamination when conducting a cluster RCT (Siepmann et al., 2016). For example, when comparing the potential for contamination in Xu et al.'s (2015) versus Xu et al.'s (2017) study, the findings of the former are more likely to have been affected. This is because the clusters in Xu et al.'s (2015) research were all schools within the same city, whereas Xu et al.'s (2017) clusters were located in six different cities. Consequently, children living within the same urban community may be more likely to have contact with children in a different cluster. The RCT was reasonably identified as high risk because bias due to contamination in Xu et al.'s (2015) study is considered unlikely, although the research may have been affected by contamination. Besides, the World Population Review (2019) documents that Nanjing City has an estimated population of 8,270,500 persons and, therefore, bias due to contamination is significantly less likely.

According to the studies of Karanicolas, Farrokhyar, and Bhandri (2010), the technique of blinding represents a critical methodological feature of any RCT, significantly contributing to the strength of the evidence provided by the study design. The authors also agree that blinding directly minimises the risk of performance bias after randomisation. Besides, Kornell and Hausman (2017) attest that performance bias describes the situation where the collection and interpretation of data may be affected by a researcher's or participant's awareness of group allocation (i.e. children adhere better to an intervention due to their awareness of being studied).

Consequently, another limitation across all studies was the lack of participants' knowledge of which group they were assigned to, but it is important to note that this was entirely dictated by the nature of the interventions that all four studies examined. Of course, it would not have been possible to implement a school-based intervention and then measure outcomes without the children, their parents or school staff members being aware of their participation into the studies. In this regard, the lack of participant blinding was not deemed to have had a significant impact on the quality of the findings within or across studies. Accordingly, all of the studies gained ethical approval to conduct their studies and provided the findings.

Liu et al., (2019) implemented a rigorous process of evaluation to elucidate the quantity and quality of delivery for each element of their intervention. In turn, this rigorous process of ensuring fidelity to the intervention promoted the validity of the findings, minimising the potential for data to be incorrectly ascribed to the effect of the intervention (Lloyd et al., 2017). Therefore, this is a strong example of why Liu et al.'s study was of particularly good quality in design, versus the other studies included in this review.

A high risk of bias was found in Xu et al.'s (2015) study in terms of the number of children who were lost to follow-up, with a total of 6.3% (n=1108) of the sample lost. Reasons for loss to follow-up were illness and participants having another engagement on the day of the post-intervention survey. Nonetheless, this loss to follow-up had the potential to result in attrition bias, a form of selection bias that frequently affects RCTs (Dettori, 2011). This is because as participants leave the study, they are likely to do so in a manner that causes systematic differences between the intervention and control groups (Lewin et al., 2018). In turn, any subsequent findings may then be a result of these differences between study groups, rather than the effect of the intervention or exposure of interest, and this affects the validity of the findings (Nunan, Aronson and Bankhead, 2018). Accordingly, loss to follow-up was unevenly distributed between the intervention and control clusters in Xu et al.'s (2015) study, but statistical analysis determined that there were no significant differences between the control and intervention clusters, in terms of mean BMI at either baseline or post-intervention. During the statistical analysis, no significance differences between the intervention and control clusters at baseline were reported. This was with the exception of Liu et al.'s (2019) study, where the children in the control group consumed vegetables more frequently than those in the intervention cluster.

This is especially true when compared to Xu et al.'s (2015) work, which, as already mentioned, was impacted by loss to follow-up, resulting in a significant reduction in sample size. The study was therefore underpowered and of poor quality in terms of whether statistical analysis could detect differences between the two groups (Noordzij et al., 2010). Subsequently, this may lead to type II errors, whereby researchers fail to reject the null hypothesis (Rothman, 2010). Therefore, irrespective of whether the participants lost during the follow-up period in Xu et al.'s (2015) study caused significant differences between groups, a sample smaller than the number indicated in power calculations (Kim, 2015). Furthermore, this weakness of the study was considered to be especially pertinent, given that the researchers found that reductions in BMI in the control group were only approaching significance.

Two studies were also noted to be at low risk of bias due to their methods of assessing lifestyle behaviours, which gathered data from the children using self-reporting questionnaires (Liu et al., 2019; Xu et al., 2015). Consequently, this has the potential to result in recall bias, whereby a participant does not accurately remember events in retrospect (Althubaiti, 2016). The validity of self-reported data may also be affected by response bias, which refers to the tendency for a respondent to answer a question truthfully, or not (Rosenman, Tennekoon and Hill, 2011). Pertinent to the studies measuring the levels of exercise and dietary intake included in this review, other empirical evidence demonstrates that children do exhibit response bias, and the data was gathered directly from the participating children (von Baeyer et al., 2009; Fritzley, Lindsay and Lee, 2012). To assess this risk of bias, Xu et al., (2015) measured the internal reliability of the data derived from the questionnaires, by calculating a Cronbach's alpha coefficient. However, this determined that reliability was only moderate (0.6). On the other hand, Liu et al., (2019) failed to state whether this was assessed in their study, which represented the one notable methodological limitation in an otherwise well-designed study.

Finally, all of the included studies had a study period of 12 months, with measurements for outcomes obtained at baselines of six and twelve months. It should be noted that the baselines may have limited the validity of the findings as the follow-up period was insufficient to detect any long-term effects of the intervention. Therefore, all the findings are not suggestive of intervention effects in the long term, rather they consider the short-term period.

4. Discussion

4.1 The SLR Findings and their Comparison to the Current Knowledge Base

The review findings revealed that school-focused obesity interventions are effective in childhood obesity curbing. The primary outcome which this study aims to identify is a decrease in the level of childhood obesity. This outcome measured in relation to BMI, waist circumferences and weight levels. Secondary outcomes included changes in dietary habits, alterations in levels of physical activity, marked changes in sedentary behavior and changes in health-related knowledge amongst student. Many studies support the role of school-focused interventions in achieving the primary and secondary outcomes of the review. Xu et al., (2016), Chen et al., (2015), and Verjans-Janssen et al., (2018), agree that school-focused measures have a positive impact on the primary objectives such as BMI and weight of children. Accordingly, Meng et al., (2013) assert that school-based interventions are cheaper than other methods.

Moreover, the included studies in this review documented that school-based interventions are effective in the reduction of childhood obesity in different ways. For example, three studies were able to show more significant statistical evidence of the effectiveness of school-based interventions on the reduction of BMI among students (Xu et al., 2015; Xu et al., 2016; Wang et al.; 2018). Several studies, however, did not note any statistically significant, or even positive impacts of school-based interventions on the BMI of the students (Adab et al., 2018; Liu et al., 2019).

Three studies, Xu et al., (2017), and Liu et al., (2019) and Wang et al., (2018), reported that the interventions reduced the new cases of obesity/overweight. However, Xu et al., (2015) highlighted no significant change in the body weight status of participants after the interventions. Similarly, only Xu et al., (2017) included waist circumference as an outcome, unlike other studies, the findings indicated that the interventions resulted in weight loss among children but were not conclusive on the children's waist circumference. Notably, definitive conclusions cannot be made on the consistency of the current literature with the effectiveness of school-focused interventions on both BMI and weight for various factors. The timing of data collection, the methods for measuring indicators of the variables, and even regional variation can also contribute to differences in the results. Conversely, the included studies in the review may have employed designs and methods that are systematic and reproducible, which, in turn, may have increased the validity of findings regarding the participant's weight, BMI, and waist circumference. For example, the studies of Majdzadeh et al., (2015) and Sharma (2006) give an unbiased estimate of intervention effect on weight, BMI and waist circumference because they employed the intention-to-treat analysis and also sought ethical approval.

The review also compares the physical activity data between the structured literature review findings and the existing research. All included studies reported the physical activity level of the participants as a study outcome, and the researchers found out that the levels of physical activity increased after the interventions. In general, the children who were in the experimental groups who received the intervention were also were more likely to exercise longer than the baseline or control group. Similarly, eight existing studies evaluated the effectiveness of school-focused interventions in terms of increasing the physical activity time of participants. There are an understanding and agreement among prominent researchers that schools operate as change agents and the studies significantly found a positive relationship between school-focused methods and children's physical activities (Amini et al., 2016; Aceves-Martins et al., 2016; Bleich et al., 2018; Treu et al., 2016; Tucker &Lanningham-Foster 2015; Feng et al., 2017; Hynynen et al., 2015; Hills, Dengel&Lubans 2015). Moreover, Hegarty et al., (2016) reported the importance of physical activities in reducing childhood obesity and found that children who exercised often were less sedentary and were more likely to improve the quality of their health and life. The study has suggested effective school-based interventions such as standing desks for children given the contribution that classroom time makes to lack of physical activity (Hegarty et al., 2016). The results of the study were valid because the researchers used large sample sizes, long-period follow-ups, the RCT design, and the intention-to-treat analysis (Hegarty et al., 2016). Hills, Dengel, and Lubans (2015) concluded that positive changes in lifestyle choices, including increased levels of exercise and reduced sedentary activity, were the result of the school placing values with that behaviour that resulted in a change in the group culture and peer reinforcement of that change.

Another focus of this SLR was the extent to which the school-based intervention was able to create positive impacts on the children's dietary intake. Two studies reported a significant reduction in the consumption of unhealthy food like red meat among the children participants and an increase in healthy dietary intake (Xu et al., 2015; Xu et al., 2017). Nonetheless, the study of Wang et al., (2018) did not investigate how the interventions would affect dietary intake among children in China, while Liu et al., (2019) did note the indicator, but did not find a statistical difference in dietary change regarding self-reported dietary behaviours. Hence, the review established a positive relationship between children's dietary intake and interventions.

Similarly, the current knowledge base reports a significant reduction in the children's consumption of unhealthy food and an increase in healthy dietary intake due to school-based interventions. For instance, three studies reported evidence to support the secondary outcome objective of effective school-focused interventions in improving healthy dietary intake (Burgermaster et al., 2016; Lambrinou et al., 2018; Lobstein et al., 2015).

Burgermaster et al., (2016) also promoted healthy eating bahaviour, including the reduction of sugar and fried foods and increased intake of fruits and vegetables. There were supported by many other studies which indicated that school-based interventions are associated with increased knowledge of healthy lifestyle bahaviours. (Richards, Clark and Boggis, 2015; Farrimond, 2013; Mustajoki, 2017). The obvious reason for the similarity in the findings between the review and the existing literature is the existing studies (Burgermaster et al., 2016; Lobstein et al., 2015; Lambrinou et al., 2018) and the review (Xu et al., 2017; Xu et al., 2015; Wang et al., 2018; Liu et al., 2019) both sought ethical approval in their research in line with the recommendations of Mustajoki (2017), Farrimond (2013),and Richards, Clark and Boggis (2015). Notably, experts advise that ethical approval typically supports improved reliability and validity and helps to ensure that participants are not harmed in the conducting of research (Richards, Clark &Boggis 2015). Thus, the existing studies supported the findings of this review, that school-based interventions can be an effective way to encourage healthy food choices and knowledge.

Furthermore, the included studies also considered the impacts of the interventions on children's knowledge and attitude. Liu et al., (2019), Wang et al., (2018), Xu et al., (2015), and Xu et al., (2017) found that the interventions were successfully increased the participants' understanding of healthy lifestyle bahaviours. However, Wang et al., (2018) and Xu et al., (2015) did not consider attitude as an outcome. Liu et al., (2019) and Xu et al., (2017) assessed the impacts of the interventions on the children's attitude. Liu et al., (2019) observed a positive effect of the interventions on the attitudes of the participants. On their part, Xu et al., (2017) did not record any significant improvement in the participant's attitude as a result of the interventions.

On the other hand, the existing studies also associated school-based interventions to increased knowledge of healthy lifestyle bahaviours (Richards, Clark and Boggis,2015; Farrimond, 2013; Mustajoki, 2017). Thus, the existing studies support the findings of the review that school-focused interventions are effective in enhancing knowledge and healthy eating bahaviours among children. However, the three studies did not consider attitude as a possible outcome. The similarity in findings is due to ethical approval and the common use of the RCTs in both the existing studies and the review.

Finally, the results of the SLR on the participant's sedentary behaviour contradict the current literature. Of the four studies in the review, only Xu et al., (2015) looked at sedentary lifestyle as an outcome. However, no significant effect of the interventions was found. It should be noted that the quality of findings was high, and the sample sizes used in all the included studies were reasonably large, except for Xu et al., (2015). Thus, the interventions did not affect sedentary bahaviour but were most likely effective in reducing childhood obesity in other aspects.

On the contrary, researchers in existing literature have found when parents become involved in school-based interventions to support healthy student lifestyles, the impact is greater in relation to the reduction in sedentary behaviours and the subsequent increase in physical activity (Gråstén, 2017; Hegarty et al., 2016; Verjans-Janssen et al., 2018). The results of the review contradict the existing literature for various reasons. For an instant, the review findings such as the results of Xu et al., (2015) may have been an inconsistent due loss to follow-up (74 children).

4.2 SLR Findings' Implications for Public Health Policy and Practice

According to the structured literature review, school-based interventions were effective in reducing obesity among children. This review synthesized and consolidated this evidence showing that overweight and obesity and obese children can improve their weight, their BMI, and their healthy lifestyle behaviours when they are supported to do so in the context of school. In this regard, research and evidence have resulted in public health recommendations for healthcare providers and parents to monitor and ensure that children's weight and BMI are within a normal range (Xu et al., 2015; Xu et al., 2017).

In order to better support parents and other stakeholders, it has also been stated that both physicians and nurses need to be aware and capable of addressing the underlying factors of childhood obesity (Quintal & Oliveira, 2017; Upton, 2017). All stakeholders, including healthcare professionals such as doctors and nurses, parents and educators could be offered training in relation to promoting healthy lifestyles, exercise, nutrition, and risks. There have also been calls in the literature for the development of new approaches to identify and address the socioeconomic inequality which is a major factor in obesity (Hayes et al., 2019). This would also indicate that the interventions and treatments for obesity need to be available to the most vulnerable in society, including those of low socioeconomic status, and with a focus on children.

One example of a tool to support parents which could have immediate effects is showing them how to determine their child's BMI, and also determining whether it is in a healthy range for their age, gender and height. Children learn the behaviours that lead to obesity from their parents and their adult role models, and adults must therefore also make changes to their lifestyle choices in order to support children. In this regard, health professionals need to provide parents with advice and basic training to promote healthy lifestyles among children. (Nurwanti et al., 2018)

It should also be noted that it is a major goal of public health authorities to ensure that there are policies and programs in place which help to ensure proactive healthcare and population health goals which include obesity reduction, and global institutions such as the World Health Organization (2018) recommend and promote healthy lifestyles in their own countries and share information which could be of help in other contexts, such as research studies. Study findings have indicated that the population affected by poverty in urban, developed nations carry the highest predicted prevalence of obesity because of the high sedentary prevalence of a sedentary lifestyle and poor diet choices (Congdon 2019). It is the inverse in developing countries, where it is the most affluent in urban areas who are at risk of obesity and the lifestyle habits which predict it (Low 2010). Authorities in government and in the school need to be aware of the importance of these health policies to children's life development and work with public health authorities to implement various means of improving the supports to avoid and manage obesity through education, awareness and physical activity during school time.

There were multiple frameworks and categorizations that were used in included studies, and this makes it difficult to better understand how different programs of obesity prevention or reduction compared to one another. The common theme among them, however, was motivating and empowering students to make healthy changes to their lifestyle and supporting nutrition and exercise through awareness of their importance (Liu et al., 2019; Wang et al., 2018; Xu et al., 2015; Xu et al., 2017).

Alternative approaches create the context for decision making when it comes to implementing policies related to best practices. Given that children do not often have control over what, or how much they eat, parents and households need to be aware that the habits, purchasing patterns and healthy choices of the adults in the family make a great impression on children as they are growing up (Clarke et al., 2015; Kang, 2017; WHO 2017). In other words, parents need to make sure that the children have choices, and that all choices are healthy ones. Ideally, households should not have junk food as a regular grocery item, and meals should be regular and nutritious so that children are not tempted by junk food (Bhurosy&Jeewon 2014). Both at school and at home, Ahima (2014) described how physical activity was most likely to engage children when it was focused on play, such as sports, skipping rope and competitions.

4.3 Recomendaciones for Further Research

Further research is needed in order to better understand the phenomenon and causes of childhood obesity as well as the science of implementing effective interventions to combat obesity. These include research to understand geopolitical factors, similarities, and differences in relation to the effectiveness of school-based obesity intervention programs, but also the use of big data and regression analysis to identify less obvious factors and independent variables, and the cost-effectiveness of programs in relation to their efficacy.

The cost of implementing interventions provide an important counterpoint to the effectiveness of interventions and knowing with accuracy helps to support research to determine value, cost-effectiveness and the business case for policies and programs to reduce obesity which is implemented through schools. This also necessarily includes the cost of conducting evaluations and research summaries in relation to continuous improvement and ensuring the value of the interventions. Understanding the economics of interventions requires knowing the savings of the positive outcomes and assessing it in light of the cost of the intervention, and this provides for the strongest justification and rationale for a policy change that could support implementation across school systems (Melnyk & Morrison-Beedy 2012).

Stakeholders should be consulted prior to the implementation of interventions, including the children, their parents, and the public or taxpayer which bears the costs (Finkelstein 2017). Further research could, therefore, look at how each of the stakeholders plays a part in maintaining obesity rates or changing them for the better, and these should include an understanding of the relative costs. For example, parent-based interventions may be cheaper than school-focused interventions.

5. Conclusion

The structured literature review revealed that school-based interventions to reduce obesity in China were often successful in increasing physical activity, reducing BMI and weight, and increasing awareness of healthy lifestyle factors.

The review was not conclusive in relation to factors such as waist circumference, sedentary behaviour, and attitude changes that resulted from interventions as many studies did not report on these variables. In general, because there were few studies focusing on the area of school-based obesity intervention in China, further studies are needed to better understand how to address the problem and prevent it in the future. While school-based interventions lead to positive impacts, it is not enough, and it must occur in the context of changes to the lifestyle choices at the level of households and families, as well as increasing the potential healthy choices available to everyone. In the meantime, more work is needed to better understand the factors of school-based obesity interventions that help to ensure the success of programs as well as the cost-effectiveness and business case. This provides important evidence for stakeholders and governments to assess the best ways forward to support the health of children, and in the context of this study the future population of adults in China.

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