



RESEARCH ARTICLE

A SYSTEMATIC REVIEW OF THE SHORT AND LONG TERM EFFECTIVENESS OF FAMILY-BASED INTERVENTIONS IN REDUCING CHILDHOOD OBESITY AMONG CHILDREN AGED 2-18 YEARS OLD LIVING IN THE UK

<sup>1</sup>Adaobi Chinwe Abia, <sup>2</sup>Dr. Catherine Hayes, <sup>3,\*</sup>Prof. Adelani Tijani

<sup>1</sup>RN, RM, BSc, MSc (Nursing), Faculty of Applied Sciences, University of Sunderland, United Kingdom

<sup>2</sup>Principal Lecturer, Faculty of Applied Sciences, University of Sunderland, United Kingdom

<sup>3</sup>Department of Nursing Sciences, Bayero University, Kano Nigeria

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ABSTRACT

**Aims:** The prevalence of childhood obesity is a significant public health concern. Family-based intervention programmes have incorporated behavioural, dietary and lifestyle changes which are theoretically underpinned. Few reviews to date have determined the effectiveness of family-based interventions in reducing childhood obesity on a long-term basis. The aim of this research was to systematically review the short and long term effectiveness of family-based interventions in reducing childhood obesity among children aged 2-18 years old living in the UK.

**Method:** An electronic search was conducted using DISCOVER, PUBMED, SCIENCE DIRECT, SPORT SCIENCE and GOOGLE SCHOLAR and by searching reference lists using a predefined search strategy. The review included a randomised controlled trials, quasi-randomised trial, cohort studies and programme evaluations. The primary outcomes measures included BMI, BMI z-score/percentile, waist circumference and weight in kg. Risk of bias and quality of evidence of selected studies were assessed using Effective Public Health Practice Project Tool.

**Results:** The review identified 3100 articles of which 10 met the inclusion criteria. Out of the ten studies, five were randomised studies, three were cohort studies and two were programme evaluations. The participants' ages were between 4 and 18, intervention duration ranged from 8 weeks to 1 year and follow-up period ranged between 3 months and 2 years. All the reviewed studies incorporated more than one family-based interventions- lifestyle, behavioural, dietary and physical activity; nine out of ten studies established parental involvement but three studies reported active parents' participation.

**Conclusions:** Family-based interventions showed varying degree of changes in adiposity of the participant children on a short-term basis and a promising advantage of a long term effect. However, the long lasting benefits of family-based weight management programme lacks strong evidence from high methodological quality studies as well as limited proof on the link between parents involvement and the effectiveness of the programme.

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INTRODUCTION

Using Ecological System Theory as a theoretical perspective (Figure 1), a child's weight status is evaluated in the context of gender, age, nutrition, activity and genetic predisposition to obesity (Waters et al., 2011).

The genetic aetiology of obesity relates to factors that can directly influence the risk of eating disorder development as well as metabolic conditions (hypothalamic-pituitary-adrenal axis) in changing body fat content (Dunham-Snary, 2013).

From this perspective, the predisposition to obesity is an inheritable condition (Life Course Theory), often contested due to the ambiguity of the complex genetic pathway identified by scientists (<http://www.nhs.uk/Conditions/Obesity/Pages/Causes.aspx>).

\*Corresponding author: Prof. Adelani Tijani,  
Department of Nursing Sciences, Bayero University, Kano Nigeria.

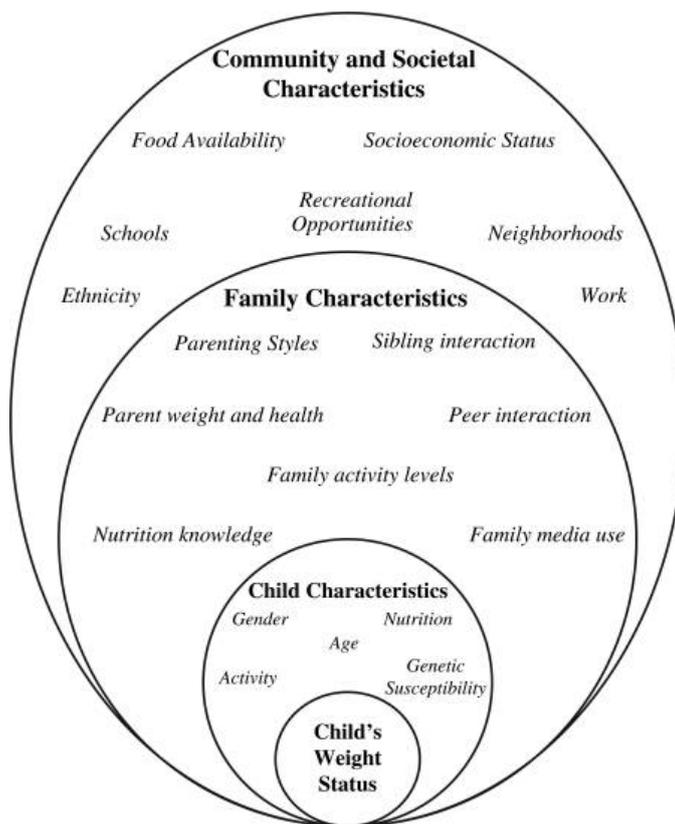
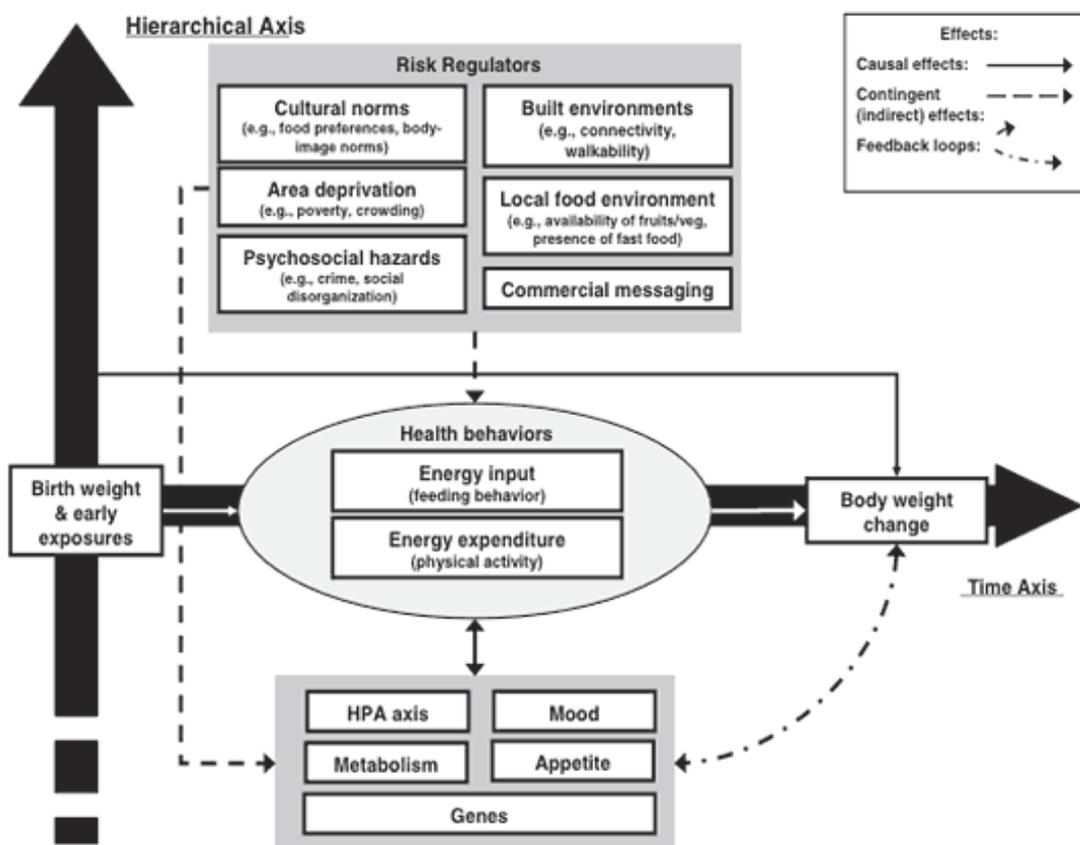


Figure 1. Ecological System Model of Childhood Obesity/Overweight (Skelton *et al.*, 2006)



\*HPA = Hypothalamic-pituitary-adrenal axis.

Figure 2. The multilevel model for addressing obesity (Huang *et al.*, 2009)

The thrifty genotype hypothesis that genetic variation increases susceptibility to childhood obesity in some people (Loring, 2014) emphasised that the environmental and behaviour factors such as high-calorie food supply, eating habits and increased sedentary behaviours are significant initiating factors in the development and progression of childhood obesity rather than changes in genetic or biological factors alone (Krebs *et al.*, 2007). For instance, when a child is used to snacking on high sugary or fatty foods coupled with poor physical activity which maybe as a result of parents busy life style or negative built environment, these factors supersede genetic predisposition to obesity, with the same outcome (Teevale, 2010). Profiling any child in the aetiological causes of childhood obesity from a theoretical perspective necessitates an acknowledgement of the significance of socioeconomic status of a child's family, their cultural norms and their family characteristics. Shrewsbury and Wardle (2008) argued that the distribution of childhood obesity across the UK populace is disproportionately varied in terms of socioeconomic factors, gender, geographical location, age or ethnicity (Shrewsbury and Wardle, 2008); thus affecting children living in the most deprived regions more often (Knai *et al.*, 2012). Further evidence supporting this stance was provided by Chan and Woo (2010) whose study outlines that obesity in children is a complex disorder that results from multifactorial influences from genetic, behavioural and environmental causes that enhance obesogenic behavior (Chan and Woo, 2010). This is consistent with the multilevel framework used to highlight how best the prevention of childhood obesity might be achieved, (Figure 2).

### **Psychosocial Influences**

Nevertheless, within the psychosocial context, Koch *et al.* (2008) in a cross-sectional study proved that when children experience sexual, physical or emotional abuse, neglect or separation from parents there is a high tendency that some may find solace in food (binge eating) which subsequently results in excessive weight gain (Koch *et al.*, 2008). This is further supported by the Stress Vulnerability Model Zubin *et al.*, 1977 and the 'Stress Bucket Model', which demonstrates that an individual's state of well-being depends on their vulnerability threshold and the proportional relationship of their ability to cope (Brabban and Turkington, 2002). Therefore, in an obesogenic environment which promotes sedentary behaviours due to high technology innovations –such as video games, kids automatic and electric scooters- and increased availability of low-cost energy dense foods, children at the vulnerability borderline of obesity can move from the threshold level of being overweight to being obese (Krug *et al.*, 2013). Furthermore, based on the risk regulators of the multilevel framework, factors like area deprivations, cultural norms, local food environment, and commercial messaging which are all interconnected influence a child's vulnerability threshold, which in turn can lead to obesity.

### **Aims of the Study**

The aim of this study was to evaluate the short and long term effectiveness of family-based interventions in reducing childhood obesity among children aged 2-18 years old living in the UK via a systematic review of the published literature.

## **METHODOLOGY**

Undertaking a systematic review was chosen as a mechanism of summarising the findings of individual studies relative to one another to make available evidence more accessible to decision makers (Brownson *et al.*, 2010). Exploring the effectiveness of the short and long term effectiveness of family interventions in reducing childhood obesity provided an opportunity to provide a precise and reliable estimate of an intervention's effectiveness. PICO (Population, Interventions, Comparators, and Outcomes) was applied when formulating the review question, ensuring that the methodological approach adopted was appropriate in answering the review question. Within the context of the populations, interventions and comparators of any research, Higgins (2008) posited that there is high possibility of misinterpretation of words. For this reason, the research words / terminology were standardised through the provision of operational definitions so that interpretation bias could be avoided (Higgins *et al.*, 2011).

### **Contextual Framing of the Study**

Since public health interventions aim to promote community or a wider population effect by addressing changes at individual level within a structural policy changes, the use of a conceptual framework as a guiding pathway in the review is vital in order to minimise bias ([www.crd.york.ac.uk/crdweb/](http://www.crd.york.ac.uk/crdweb/)). This study utilised Ecological System Theory and the Multilevel Framework for addressing obesity as both guided understanding of the findings from the use of family-based interventions in reducing childhood obesity (Skelton *et al.*, 2006). These models also provide a better understanding of why people adopt behavioural changes that is pioneered by family-based intervention as well as possible barriers to the successful implementation or the individual impact of family based interventions. This review was an exploratory study that critically analysed both short and long term studies on the effect of family-based interventions in reducing childhood obesity in the UK, having specified what 'reduction' entails (prevention, treatment or management), 'Short and Long-term Studies' refers to the time period of intervention duration and outcome measures of the selected studies.

### **Selection and Retrieval of the Published Literature**

Applying the PICOS (Population, intervention, comparison, outcomes and study design) framework to identify relevant studies on different family-based interventions-physical activity, behavioural modification and dietary changes and ensured the best published evidence was identified (Santos *et al.*, 2010). Published articles from 2005 to 2015 were searched on the following electronic databases: MEDLINE-OVID, GOOGLE SCHOLAR, PUBMED, SPORTSCIENCE, CINAHL, SCIENCE DIRECT, PSYCHINFO, DISCOVER, AND PSYCNET. According to Glanz and Bishop (2010), reviews of public health interventions have a tendency to cut across several disciplinary areas and topics, which can be attributed to the fact that most interventions hinge on psychosocial interventions (Glanz and Bishop, 2010). Searches were therefore not restricted to publication types and neither did the intervention duration time period limit the search.

Figure 3. Inclusion and Exclusion Criteria (PICO)

<p><b>Box 1: PICOS Criteria</b></p> <p><b>Population-</b> main participants are overweight or obese children and youth aged 2years to 18 years old.</p> <p><b>Interventions-</b> behavioural (diet, lifestyle, exercise) that aim to reduce, treat, prevent or manage childhood obesity or overweight. Intervention must be family-based programs that involves the whole family that is, those that share same accommodation or at least a family member and the obese child or just the child.</p> <p><b>Comparators-</b> no intervention, waiting list or standard care.</p> <p><b>Outcomes-</b> primary outcome measures: changes in adiposity (BMI, BMI SDS, BMI z-score, waist circumference or weight in kg). Secondary outcome measures: children’s quality of life, eating habits at home, consumption of unhealthy foods, reduction in sedentary behaviours, increased fruits and vegetable consumption, children’s psychological stability or improvement.</p> <p><b>Study design-</b> randomised controlled trials, cohort studies or programme evaluation, and written in English language as there can be an interpretation bias if other languages were included.</p>	<p><b>Box 2: Inclusion and Exclusion Criteria</b></p> <p>Studies were included if:-</p> <ul style="list-style-type: none"> <li>•Reported a family-based intervention for reducing, preventing, and treating or managing childhood obesity, irrespective of the delivery settings (community, home, hospital or other facilities in the community).</li> <li>•Involved the whole family that is, those that share same accommodation or at least a parent/ carer and the obese child or just the obese child.</li> <li>•The studies aimed at weight loss using behavioural changes on diet, lifestyle, or exercise strategies.</li> <li>•The interventions targeted overweight or obese children or adolescents aged 2-18years having body mass index of <math>\geq 85^{\text{th}}</math> percentile for same sex and age.</li> <li>•The studies involves Short or long-term time period of intervention duration and outcome measures.</li> <li>•Randomised controlled trials with a no intervention, waiting list or standard care comparison group; or if they are cohort studies or programme evaluations that reported on the pre and post intervention measures.</li> <li>•Studies reported data on one or more weight related outcomes such as; changes in BMI z-score/SDS, BMI, BMI percentile, weight in kg or waist circumference.</li> <li>• Studies were conducted and delivered in the UK.</li> <li>•Studies were published in English.</li> </ul> <p>Studies were excluded if:</p> <ul style="list-style-type: none"> <li>•Focused on adults or children below 2 years old.</li> <li>•Studies were literature reviews.</li> <li>•Intervention are not family-based, that is, school-based, involved bariatric surgery or pharmacological.</li> <li>•The intervention programmes enrolled children with specific medical problems that may have an impact on obesity.</li> <li>•Results were published in any other language other than English.</li> </ul>
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**Keywords**

Keywords used in searching for studies included: family-based intervention, child, adolescent, obesity, reduction, treatment, prevention, weight management.

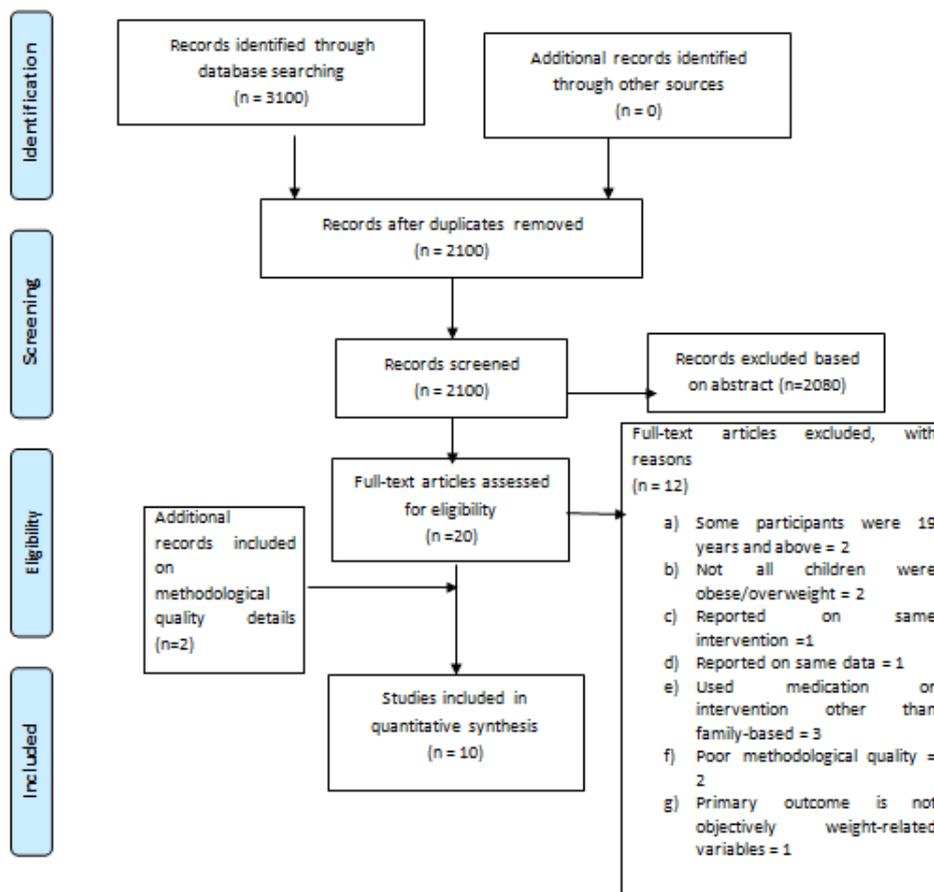


Figure 4. Flow chart of the selection of studies used in this review, based on PRISMA<sup>21</sup>

In addition, different types of RCTs were included in the systematic review. The contextual geographical setting of the studies was considered as this review focused on family-based intervention done in the UK, which has an impact on the ecological validity of the final study and its representations. Reference lists of primary studies and reviews identified by the database searches were scanned for more studies of direct relevance. Upon reaching of saturation in the development of new articles, the process of selection was deemed to be complete. Articles identified by this stage were then screened in relation to the devised inclusion and exclusion criteria.

### ***Inclusion and Exclusion Criteria***

Details regarding the PICOS criteria (population, intervention, comparators, outcomes and study design) for this review and the inclusion and exclusion criteria are provided in box 1 and 2 (Figure 3) respectively (Moher *et al.*, 2009).

### ***Study Selection***

The electronic database search yielded 3100 relevant articles. After screening the title, abstract and removing duplicates, there were 20 articles that met the inclusion and exclusion criteria were retrieved for full text eligibility review. Among these 20 articles, 12 were excluded on the basis of methodological quality. Two studies were added to the included articles based on the basis of a high degree of methodological quality. Figure 4 below shows the search and selection results.

### ***Quality Assessment***

The methodological quality of the included studies was assessed using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies ([http://www.ehphp.ca/PDF/Quality%20Assessment%20Tool\\_2010\\_2.pdf](http://www.ehphp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf)). Although this evaluation tool was used in place of the proposed quality assessment tool (Van Tulder, 2003) for this review, this changed was due to the fact that Van Tulder's criteria are suitable for RCTs and half of the included studies in this review were not RCTs (Van Tulder *et al.*, 2003). The EPHPP assessment tool, according to Armijo-Olivo *et al.* (2012) has been validated and recommended in rating the methodological quality and validity of RCTs, quasi-experiment and uncontrolled studies (Armijo-Olivo *et al.*, 2012; Voss and Rehfuss, 2013). This tool was developed to be used in systematic reviews to appraise articles that studied public health prevention of chronic diseases, promotion of family health in order to ascertain methodological bias. In other words, EPHPP tool aids researchers in identifying high quality literatures that are used to support decision-making process; precisely when designing, implementing and evaluating public health programs and policies (Yost *et al.*, 2014). Each article was rated based on the six methodological criteria: selection bias, study design, confounders, blinding, data collection methods, and withdrawal and dropouts. Each criterion was rated on a three-point scale: a weak, moderate, or strong and global rating for each article was calculated. Two additional criteria –intervention integrity and analyses- are provided in the tool but were not involved in the global rating.

Studies with two or more weak rating in the criteria had a global rating of 'weak', studies having one weak rating got a global rating of 'moderate', and studies having no weak rating was given a 'strong' global rating ([http://www.ehphp.ca/PDF/Quality%20Assessment%20Tool\\_2010\\_2.pdf](http://www.ehphp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf)). Meanwhile, two articles were excluded based on their methodological weakness. However, rating criteria were modified for some category to improve the suitability of the tool for the intervention under review.

## **DISCUSSION AND FINDINGS**

***In relation to the overall aims of the study, the most salient findings could be thematically identified in terms of their significance:***

### ***Interpreting Family Participation***

Parental and/or the whole family participation was established in almost all the studies (n=9) reviewed except for one study. While six weight reduction programmes targeted the whole family (Towey *et al.*, 2011; Robertson *et al.*, 2012; Sacher *et al.*, 2010; Edwards *et al.*, 2006; Coppins *et al.*, 2011; Watson *et al.*, 2015). Three of these studies reported that active parental involvement significantly improved child adoption of behavioural changes in dietary, reduce sedentary behaviour and increased physical activity as parents are the main mediator of change in moulding children's behaviour; thus, leading to improved BMI z-score in children's post intervention results (Towey *et al.*, 2011; Edwards *et al.*, 2006; Watson *et al.*, 2015). This is supported in further literature that highlights that parental involvement encourages sustainability of children's positive health behaviours, and to that, help maintain weight loss for a longer period (Ewald *et al.*, 2014). This was also the case of three studies (Croker *et al.*, 2012; Hughes *et al.*, 2008; Pittson and Wallace, 2011) that involved at least a parent and the targeted child, one of these studies reported the significance of parents participation; which is in keeping with the multilevel framework for preventing childhood obesity (Pittson and Wallace, 2011).

This shows that when parent regulates their children's behaviour in terms of positive feeding behaviour and physical activity the child's body weight changes towards a healthier BMI. However, this does not mean that risk regulators such as: area deprivation, psychosocial hazards, built environment and commercial messaging- cannot further influence the child's body weight change (Huang *et al.*, 2009). Meanwhile, the other five studies that did not report on the impact of parental participation on weight related outcomes but involved either the whole family or at least a parent/carer and the child, witnessed some degree of improved BMI z-score in the children (Robertson *et al.*, 2012; Sacher *et al.*, 2010; Coppins *et al.*, 2011; Croker *et al.*, 2012; Hughes *et al.*, 2008). Therefore, based on the unique name 'family-based', methodologically robust primary researches are needed to further establish the link between parental participation and improved weight related outcomes as well as the impact of the whole family involvement on family-based weight reduction program for children.

### **Effectiveness of Family-based Interventions Components and Techniques on Weight-related Outcomes**

Various family-based programmes interventions and behavioural techniques that promoted weight reduction among children were identified. While the scope and focus of these components varied, they all geared towards achieving same goal which is to establish behavioural and micro-environmental changes in the obese child as well as their family thereby resulting to decreased BMI. Findings of all the studies showed that family-based programmes components and techniques were effective in achieving varying degree of weight reduction in the child participant and parent, the whole family or just the child. This was obvious as all studies incorporated more than one components and strategies of the intervention programme. The most common intervention methods employed by all studies were activity session, education and behavioural change technique. This signifies that as childhood obesity is multifactorial, interventions that uses different approaches is beneficial in achieving weight reduction which is supported by the ecological system theory and multilevel framework for addressing childhood obesity (Chan and Woo, 2010; Young et al., 2007; Grief and Miranda, 2010). In view of the above statement, Grief and Miranda (2010) in their review found that when family-based intervention uses a single strategy, it tends to fail in achieving weight loss compared to multiple approaches in treating obesity (Grief and Miranda, 2010). Since multidisciplinary professionals were involved (physical activity instructor, dietician and psychologist) in the delivery of their intervention, this can be interpreted as way of ensuring that the right information and methods are carried out, so as to reduce bias and promote trustworthiness in the delivery of the intervention components.

However, given that only three of the studies (Sacher et al., 2010; Hughes et al., 2008; Duckworth et al., 2009) reviewed were considered strong based of EPHPP criteria, the other seven studies were either methodologically weak or moderate as they were program evaluations (Towey et al., 2011; Pittson and Wallace, 2011), uncontrolled studies with inadequate internal validity (Robertson et al., 2012; Edwards et al., 2006; Watson et al., 2015), RCTs with high participants attrition rate (Croker et al., 2012) or RCT lacking blinding (Coppins et al., 2011). This implies that there are lack of high-quality study designs on family based interventions in reducing childhood obesity as it replicates in other recent reviews within this dispensation (Upton et al., 2014; Kothandan, 2014; Kelishadi and Soleiman, 2014). The intervention durations ranged from 8 weeks to 1 year and despite various differences in delivery settings, each intervention program had a significant effect on the BMI z-score of their participants except for the RCTs were irrespective of their recorded decrease in BMI z-score, had no significant between group differences. Four of the selected RCT studies in this review, (Sacher et al., 2010; Croker et al., 2012; Hughes et al., 2008; Duckworth et al., 2009) witnessed no significant between-group differences in the intervention components and strategies used in relation to weight loss as both the intervention groups and the control groups had nearly same level of weight loss; except for the study by Coppins et al, (2011) that reported a borderline significance (Coppins et al., 2011).

The intervention duration period, which is the longest (1 year) among the other RCTs the supported the theory that effective weight loss is a continuous and gradual process (Young et al., 2007). Sacher et al, (2010) and Hughes et al. (2008) observed significant between-group differences in favour of the interventions in the areas of changes in physical activity, reduced sedentary behaviour and self-esteem (Sacher et al., 2010; Hughes et al., 2008). Changes in weight-related outcomes were mainly reported in all studies as short-term benefits to the child participants and families involved. However, there are limited evidence to affirm if the recorded short-term benefits are long lasting as 6 studies provided some degree of long term benefits to participants (Sacher et al., 2010; Hughes et al., 2008; Coppins et al., 2011; Watson et al., 2015; Croker et al., 2012). Among these studies, only two studies (Sacher et al., 2010; Hughes et al., 2008) reported a decrease in BMI z-score from baseline to 12 month in the intervention group compared to control group and at 24 months two studies (Robertson et al., 2012; Coppins et al., 2011) reported reductions in BMI z-score and BMI percentile respectively. Regarding physiological measures, only two studies reported significant positive changes (Sacher et al., 2010; Croker et al., 2012).

Over all, the findings of this review found that among children aged 2-18 years old living in the UK, the use of family-based intervention program in reducing childhood obesity was beneficial as the selected studies recorded some degree of weight loss in both short and long-term basis. These findings are consistent with four previous systematic reviews (Ewald et al., 2014; Upton et al., 2014; Sussner et al., 2006; Oude Luttikhuis et al., 2009).

### **Comparison of the interventions with theoretical underpinning and those without**

According to Carroll et al. (2007), evidence has shown that when a public health intervention is theoretically supported, it provides room to better understand the adaptability of that intervention as well as its implementation fidelity (Carroll et al., 2007). In order to create an understanding of the effect of theoretical framework in family-based intervention, this review went further to compare the level of outcomes between the interventions that were underpinned by a theoretical framework and those that did not. Based on the findings, both the seven studies (Towey et al., 2011; Sacher et al., 2010; Edwards et al., 2006; Watson et al., 2015; Croker et al., 2012; Hughes et al., 2008; Pittson and Wallace, 2011) that used theoretical underpinnings and the three studies (Robertson et al., 2012; Coppins et al., 2011; Duckworth et al., 2009), that did not specify using theory reported a short-term decreased BMI in their participants. This implies that the use of theory in delivering family-based weight management program does not directly influences weight loss outcomes but guides the effective delivery of the interventions, as supported by the extant literature (Glanz and Bishop, 2010). Using the ecological system theory and multilevel framework for addressing obesity in children it can be seen that family-based intervention programmes target the contributors of obesity development and barriers to positive lifestyle changes at the family and individual level in order to reduce childhood obesity.

The dissemination of the findings of this review is aimed at starting up further actions on different levels –families, stakeholders, food and entertainment industries, clinicians, communities, and policy-makers- so as to create a lasting effect in reducing obesity in children.

### Conclusion

Family-based intervention reduces childhood obesity among children aged 2-18years old living in the UK. They demonstrate a promising long-term benefit on children's weight reduction. It is apparent that it is beneficial for parents to introduce and accustom their children with positive behavioural habits in relation to both diet and physical activity. It is also apparent that parental modification of immediate family environment to foster positive health behaviours could further improve the effectiveness of these interventions and contribute to maintaining weight loss in the long term.

Based on the findings of this review, it is evident that there are limited available primary researches that are methodologically robust in terms of determining the efficacy of family-based interventions for the reduction of childhood obesity in the UK. Research is also necessary to establish the link between parental involvement and improved weight related outcomes on a long-term basis as well as the impact of the whole family involvement on family-based weight reduction programmes for children. This review focused on all interventions of family-based weight management programmes (dietary, lifestyle, behavioural changes and physical activity) thereby contributing to a broad research field.

### Ethical Approval

Formal ethical approval for this study was granted by the University of Sunderland Ethics Committee.

### Conflicts of Interest

There were no potential conflicts of interest in relation to the execution of this project.

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No funding was received for the execution of this research project.

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