Reframing interventions for optimal child nutrition and childhood obesity: the importance of considering psychological factors.

Authors: L. Newson[1,2], & J. Abayomi[3]

[1] School of Psychology, Research Centre for Brain and Behaviour, Faculty of Health, Liverpool John Moores University, Liverpool, UK.

[2]Liverpool Centre for Cardiovascular Science

[3]Faculty of Health, Social Care and Medicine, Edgehill University, Liverpool, UK.

Primary correspondence: Dr Lisa Newson, l.m.newson@ljmu.ac.uk

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ABSTRACT

This review aims to emphasise the impact of poor nutrition on children's health and psychological wellbeing, urging those involved in childhood obesity or nutrition services to broaden their intervention approach. Poor nutrition and childhood obesity affect physical and psychological health. The stress of living with obesity further impacts quality of life, wellbeing and self-esteem. Children living with obesity may experience adverse childhood events and stress, and young people are able to recall the impact of psychosocial issues such as experiencing stigma and discrimination. Food is often a coping mechanism for managing negative emotions, perpetuating cycles of emotional coping and unhealthy eating behaviours. UK guidelines recommend family-based, multi-component weight management interventions for children living with obesity. Interventions mainly target health behaviours and utilise behaviour change techniques attempting to directly improve diet and physical activity as behavioural outcomes. Whilst these interventions may show some improvements in psychological wellbeing, there is limited consideration or understanding of the underlying mechanisms of action which indirectly influence engagement and the sustainability of the behaviour change. Lack of attention and inclusion of psychosocial variables in intervention implementation may help explain the variable effectiveness reported across childhood obesity interventions. In conclusion, enhancing the effectiveness of childhood obesity interventions requires a broader approach that fully incorporates psychosocial factors. Those responsible for commissioning, designing and implementing these interventions should adopt a holistic approach that addresses psychological and emotional needs while incorporating underlying mechanisms of action. This shift in focus could result in more sustainable and comprehensive treatment for childhood obesity.

Reframing interventions for optimal child nutrition and childhood obesity: the importance of considering psychological factors.

This review aims to emphasise the impact of poor nutrition on children's health and psychological well-being, urging those involved in childhood obesity or nutrition services to broaden their intervention approach. A range of evidence is presented which reviews: The importance of childhood nutrition; Childhood obesity and nutrition; The impact of obesity on psychological, psychosocial health and eating behaviour; A mention of mental health- psychiatric diagnosis; Empowering Voices: Children and Young People Living with Obesity; Childhood Obesity Interventions, and finally, a Conclusion which offers a summary of the key issues and calls for health professionals to consider various psychological factors relevant to supporting optimal child nutrition and obesity.

The importance of childhood nutrition

Childhood nutrition plays a crucial role in a child's growth, physical and cognitive development, and overall well-being[1]. Healthy eating patterns support disease prevention efforts by reducing the risks of nutritional deficiencies alongside the risks of developing obesity and other non-communicable diseases (such as certain cancers and metabolic disorders). UK evidence suggests that adherence to dietary guidelines during childhood is associated with better health outcomes (for example, improved cardiometabolic profile), suggesting that adopting a healthy diet has long-term benefits to child health[2, 3].

A healthy diet occurs when daily eating patterns include adequate nutrient and energy intake to meet individual energy needs. Optimal childhood nutrition provides ideal quantities of the essential nutrients and energy needed for physical growth and cognitive development. Nutrients such as proteins, vitamins, minerals, and carbohydrates are essential for building strong bones, muscles, and organs, particularly during rapid periods of growth[4]. Micronutrients like omega-3 fatty acids, iron, iodine, zinc, and B vitamins contribute to brain and cognitive development, memory, and learning abilities[5]. Nutrient-rich diets positively influence cognitive function, concentration, and academic performance[6].

However, evidence consistently shows that many children have suboptimal diets worldwide, resulting in limited adherence to national and international dietary guidelines[7-9]. The World Health Organisation (WHO) European Childhood Obesity Surveillance Initiative (COSI) analysed over 132,489 diets of children across 23 European countries and reported that fewer than half (42.5%) consumed fruit, and less than a quarter (22.6%) consumed fresh vegetables daily[10]. Similar

findings have been reported in the UK, with data revealing poor compliance with the UK's dietary recommendations[11]. Specifically, dietary analysis for implementation of child dietary recommendations is notably very low or low for consumption of free sugars, fish, saturated fat and fibre, as well as for fruit, vegetables and salt. These dietary intakes are suboptimal, and neglecting good nutrition could lead to serious short-term adverse impacts on children's growth, development, and future long-term health. For example, inadequate zinc intake during childhood can lead to detrimental effects on attention and short-term memory[12]. Inadequate iron intake leading to iron deficiency in childhood can negatively impact overall intelligence and cognitive development[13]; there is growing evidence regarding the prevalence of brain disorders such as Attention Deficit Hyperactivity Disorder (ADHD) and iron deficiency during early life[14, 15]. Insufficient vitamin D during childhood has been linked to the onset of various conditions, including rickets, multiple sclerosis (MS)[16] and prediabetes[3]. Moreover, a diet containing high levels of saturated fat, refined carbohydrates and processed food products is associated with poorer mental health in children and adolescents[17]. Furthermore, there is a significant association between mental wellbeing and diet, with lower fruit and vegetable consumption in adolescents showing lower mental wellbeing[18].

In addition to these health risks, a poor diet increases the chance of developing childhood obesity[19]. Healthy eating and good quality nutrition are promoted as key elements in the prevention of childhood obesity[20, 21]. The European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition published a position paper on the role of diet and food habits on childhood obesity[21]. This position paper summarises a range of dietary and eating behaviours that may support the prevention of obesity (including for example: breast-feeding; parenting styles; dietary patterns; eating behaviours; meal frequency, composition and portion size)[21]. A similar position paper on this subject is written by the Global Federation of International Societies of Paediatric Gastroenterology, Hepatology and Nutrition (FISPGHAN)[20]. Whilst there are clear nutritional guidelines and position statements aimed at promoting healthy eating and preventing obesity, it is concerning to observe that children globally and in the UK are not consistently following these recommendations; this presents significant future public health risks as these children transition into adulthood. Interventions to encourage nutritious diets and healthier eating habits to date have yielded varying levels of success.

Key learning point: Nutrient deficiencies and poor diets have consequences which include various psychological and cognitive challenges (to recap: having a negative impact on brain and cognitive development[5], cognitive functioning, concentration, memory[6], attention[12], intelligence[13], poor mental health[17] and lower mental wellbeing[18], links to ADHD[14, 15], and

lower academic performance[6]). Hence healthcare and public health professionals need to consider how they assess these psychological and cognitive needs, and how any challenges associated with such needs are integrated into population based or targeted interventions. The WHO[22] has recognised that healthy eating interventions, for example, in school settings, must go beyond measuring physical outcomes (i.e. diet) and include cognitive and academic outcomes as part of their evaluations. Despite ongoing efforts to promote healthy eating and prevent childhood obesity, the yearly increase in childhood obesity rates worldwide highlights the need for more effective strategies and interventions.

Childhood obesity

In 2015, 107.7 million children were living with obesity worldwide[23], and in 2018, the WHO reported that childhood obesity is one of the most serious challenges of the 21st century[24]. Childhood obesity has profound and wide-ranging impacts on an individual's health[25]. These effects can manifest both in the short term, have long-term implications into adulthood, and may significantly impact morbidity and mortality[26-28]. Specifically, children living with obesity are at higher risk of developing type 2 diabetes[29] and increased risk of developing cardiovascular diseases[30] such as high blood pressure, high cholesterol levels, and atherosclerosis later in life. Non-alcoholic fatty liver disease (NAFLD) is more common in children living with obesity and can lead to inflammation and liver damage[31]. Childhood obesity can affect bone development and increase the risk of fractures[32]. Excess weight places additional stress on the joints and may lead to osteoarthritis and musculoskeletal pain[33]. Obesity can contribute to respiratory problems like asthma and sleep apnoea, further impacting a child's overall health and quality of life[34]. Oral morbidity is increased in children and adolescents with obesity. Conditions like gastroesophageal reflux disease (GERD) and gallstones can be more common in children living with obesity[34]. Childhood obesity also increases the risk for autoimmune diseases such as multiple sclerosis, Crohn's disease, arthritis, and type 1 diabetes[31]. Obesity can disrupt hormonal balance, potentially leading to conditions like polycystic ovary syndrome (PCOS) in girls and may contribute to early puberty, which might carry additional physical and emotional challenges[34]. Children living with obesity are more likely to become adults with obesity, further increasing the risk of chronic diseases, such as cancer[35]. The combination of obesity-related health issues can reduce life expectancy and overall quality of life.

Obesity and Nutrition: For those already living with overweight or obesity, promoting and supporting a healthy diet has been recommended as a priority[36]. Specifically, for those living with obesity, dietary improvements such as reducing the consumption of energy-dense foods, processed

150 foods and sugar drinks are among some of the modifiable behaviours recommended[37, 38]. Children
151 living with obesity are reported to have low vitamin D[3, 39, 40], low iron[41, 42] and various other
152 deficiencies (and the impact of these deficiencies is described above).

153 **Key learning point:** In addition to the nutritional challenges facing the general population,
154 children living with obesity are at much higher risk of current and future health issues. This should
155 be considered with reference to the 'double burden malnutrition' phenomenon, defined by WHO as
156 the '*coexistence of under nutrition along with overweight, obesity or diet-related non-communicable*
157 *disease*[43]. Double burden malnutrition can exist at an individual, household or population level.
158 Globally, children in low-income households are more likely to experience deficiencies of essential
159 micronutrients (such as iron), alongside living with overweight and obesity. However, double
160 burden malnutrition is more common in middle-income countries, experiencing rapid changes in
161 economic circumstances and access to food[43]. Promoting good nutrition and healthy eating habits
162 must address all forms of malnutrition.

163 **The impact of obesity on psychological, psychosocial health and eating behaviour**

164 There is clear evidence highlighting the co-directional relationship between psychological
165 wellbeing and childhood obesity[44]. Children living with obesity are frequently exposed to
166 psychological stress, such as stigmatisation, discrimination, teasing, bullying[45, 46] and other forms
167 of social marginalisation. These and other psychological stresses expose children to additional
168 emotional and physical impacts, such as reduced quality of life, lower self-esteem, lower self-worth,
169 depressive symptoms, body dissatisfaction, functional impairment (for example, less agility, limited
170 ability to engage in activities) adverse social functioning, social withdrawal, difficulties in forming
171 and maintaining peer relationships[47, 48], as well as difficulties communicating and lower academic
172 achievement[49, 50], all of which may further affect their physical, psychosocial health, quality of life
173 and wellbeing.

174 The impact of psychological factors on children living with obesity is highly variable.
175 However, given the wide range of factors that could be impacted, further consideration, assessment,
176 and intervention should be integrated into childhood weight management and healthy eating
177 interventions. For example, not all children living with obesity recognise their diagnosis or accept
178 this as a negative view of their body image[51]. However, negative body image can be evident for
179 some children living with obesity. Cognitive factors such as self-identity, attitudes, beliefs and
180 knowledge about obesity, food, nutrition and healthy behaviours can influence decisions, including
181 food choice[51].

In a review of the link between stress and childhood obesity[52], stress has been highlighted as a significant factor in contributing to and maintaining childhood obesity[53]. Children living with obesity are more likely to experience stress at home, and daily stresses significantly impact their eating behaviours[54]. Food can be a coping mechanism for dealing with stress, anxiety, or other negative emotions, and can lead to a cycle where eating becomes associated with emotional coping. Stress can be defined as a "negative response that results from threatening stimuli, external events or conditions that adversely affect a person's well-being"[52] (for example, experiencing social discrimination, stigma, teasing or bullying for those living with obesity). Stress is considered in the context of chronic (ongoing prolonged) stress, and acute stress (brief stress), and its impact on childhood obesity risk. Stress can influence behaviour and affect psychological wellbeing; it can promote changes in sleep, cognition, and perception of pain and may change biological responses such as endocrine, immune and metabolic functioning[55]. The cause-and-effect debate regarding stress and obesity is still under investigation (as are many psychological variables), but stress and obesity are entwined. The Obesity Medicine Association (2022)[55] has produced a clinical practice statement which summarises the links between obesity, stress and psychiatric disease (focusing on adult literature). Which suggests that obesity and its negative health effects can heighten both physical and mental stress, potentially leading to unhealthy behavioural changes. These changes in biological functions, including the endocrine, immune, and metabolic systems, contribute to a cycle of worsening obesity, a process known as an adiposopathic stress cycle[55] (i.e. 'sick-fat', see Bays et al., [56] for further information on this topic).

A possible link to the stress response is poor emotional regulation. In this context, the behaviours and actions of the child living with obesity are influenced by their emotions, how they experience these emotions, and how they communicate them to others. Ineffective emotional regulation has been modelled to link stress and obesity, suggesting that stress and ineffective emotional regulation lead to unhealthy eating behaviours such as emotional eating and other maladaptive behaviours, such as sleep difficulties or reduced physical activity[57]. For example, adolescents who have higher levels of stress are more likely to engage in emotional eating [58]. Psychological factors can profoundly impact a child's relationship with food, eating patterns, and overall health. Additional emotional factors, such as boredom, sadness, and happiness, can trigger eating behaviours[59]. Children may turn to food for comfort or to cope with their emotions, which can lead to overeating or consuming unhealthy foods. Children living with obesity are reported to experience higher levels of emotional eating[52]. A clear summary of emotional-induced eating (emotional eating), dietary restraint, stress and eating behaviour, and family, parental and environmental stress are identified as possible contributing factors to childhood obesity[52].

There are biological (genetic/physiological) factors which are significantly associated with taste preferences and subsequent consumption of specific food types (for example, sweet, bitter and fat tastes[60]). Children with higher body mass index are reported to have bitter taste sensitivity, and girls may present with low sensitivity to sweet taste[61]. Some of these biological mechanisms are apparent through the activation of various areas within the brain (including the frontal, parietal, occipital, and temporal lobes, as well as the hypothalamus, thalamus, amygdala, hippocampus, and ventral tegmental areas), all of which can be influenced and activated by specific foods, especially those rich in sugar, fat, and salt[55]. Activation of these areas in the brain, may directly impact eating behaviours, triggering cravings and initiating a cycle of seeking out specific foods for their pleasurable effects[55]. For example, a cross-sectional study on adolescents living with obesity reported that nearly half (47.9%) met a food addiction diagnosis[62]. Food addiction has been linked to impairment of the brain reward circuits[63] and research into the field of obesity and food addiction in adolescents suggests that such occurrences increase the likelihood of adolescents reporting significant increased anxiety of gaining weight, dieting, and thin body preoccupation[62]. Biological factors can change taste preferences and directly impact eating behaviour, and early experiences with food can also shape an individual's food choice preferences[64]. In addition, to biological, cognitive and psychological factors, eating patterns may also be influenced by social, environmental and cultural factors, such as group norms, peer pressure, parenting practices and the desire to fit in[51, 65]. Children's eating habits are influenced by their social circles, including family, friends, school teachers and peers. Psychological factors can play a role in forming and maintaining these habits, whether they are healthy or unhealthy.

Key learning point: Individual interventions to promote healthy eating or support weight management, in the case of those living with obesity, need to consider how they help children navigate all these possible influences. The underlying, complex, and various biological mechanisms for the development (and maintenance) of childhood obesity need to be accounted for in future obesity prevention and treatment interventions. Understanding the interplay between various psychological factors and eating habits is essential for promoting healthy eating and achieving optimal weight management behaviours for those living with obesity. Strategies addressing emotional eating, promoting self-awareness and encouraging a positive relationship with food, which can contribute to more balanced eating habits.

A mention of mental health- psychiatric diagnosis

According to the Mental Health of Children and Young People in England survey[66] in 2022, around 18% of children aged 7-16 had a probable mental health disorder leading to poor social and

economic outcomes. These mental health diagnoses included clinical depression, clinical anxiety, eating disorders including binge eating, and ADHD. The number of children seeking help for mental health concerns has risen in the UK. About 50% of lifelong mental health issues start by age 14, making it crucial to explore the connection between childhood obesity and childhood mental health[67]. Negative experiences during childhood, such as abuse, parental stress, trauma, and family discord, have been linked to behaviours that contribute to weight gain. The higher the exposure to psychological adversity, the greater the risk of developing obesity[68].

Several reviews have evaluated research on the onset or co-morbidity of mental health and childhood obesity[48, 69]. For example, a systematic review and meta-analysis evaluated data from 143603 children and reported that the prevalence of clinical depression among children living with obesity was 10.4%[70]. The review suggested that children who perceive themselves as having obesity, can develop negative body image, leading to depression. Moreover, the analysis found that females living with obesity had significantly higher odds of concurrent and future depression compared with females not living with obesity, but this finding was not the same for boys[70]. In boys, the connection between body dissatisfaction and BMI is more complex; for example, boys may be more likely to underestimate their weight or not recognise obesity[69]. Another review evaluating the psychological consequences of childhood obesity[48] highlighted that there is limited research that separates out gender and childhood obesity, but also that boys living with obesity are at higher risk of depression compared to boys of normal weight. The evidence for the direct association between clinical anxiety and childhood obesity is more uncertain, although children living with obesity are likely to be at increased risk of developing anxiety[48].

There is further evidence to link obesity to co-morbidity of emotional and behavioural disorders (e.g., ADHD) and eating disorders. Adolescent girls living with obesity are more likely to engage in extreme weight-control behaviours, such as vomiting, using laxatives, fasting, or other methods, which may lead to restrictive eating disorders[71].

The relationship between the cause and effect of childhood obesity and the various psychopathologies, however, remains inconclusive[48]. Evidence across this field can be contradictory, possibly due to analysing confounding variables differently, considering a variety of psychometric variables, or target populations (clinical versus community populations, overweight versus obese etc.). It is noteworthy that mental health diagnosis or symptomology is not a given for those living with childhood obesity, and many children do not experience these issues.

Key learning point: It is important to understand and consider possible co-directional relationships between the mental health and psychological needs of children living with obesity[72].

Given this varied evidence, prevalence, cause or consequence, children living with obesity should be assessed and monitored for mental health symptomology and screened for appropriate treatment (before, during and after any intervention for childhood obesity). If a child or adolescents meets pathway criteria for onwards referral to psychological support services, this should be supported. However, if an onwards referral is not made (for whatever reason), or the mental health challenges are not considered (prior to, or after onwards referral) at a level for psychological therapy, then those delivering weight management or nutrition interventions should remain aware of, and considerate of these individual psychosocial challenges.

Empowering Voices: Children and Young People Living with Obesity

Despite the evidence that psychological challenges may impact children living with obesity, there is limited evidence regarding their reported experiences, perceptions, and reflections on living with obesity and their emotional and psychological needs.

However, children and adolescents are insightful to their experiences of living with obesity and can offer valuable reflections on their experiences which we should learn from and integrate their opinions, experiences and needs back into our healthcare services and interventions. For example, in a UK study[73], adolescents living with obesity reflected on their experiences of engaging in the national healthy school programme within their secondary school environment and how this general promotion of healthy eating to all school children reinforced their vulnerability to bullying, stigmatisation and social isolation within the school environment. It is important that strategies to engage in population-based health promotion activities, consider the impact (possibly negative) and prior to implementation, action is taken to mitigate possible negative impacts, in this case for those who may have difficulties engaging in healthy eating behaviours or who are living with obesity. Better still, it would be best practice to involve those living with obesity or experiencing challenges implementing healthy eating interventions, to be part of the co-design of any such population-based health promotion activities.

A recently published and significant study is the ACTION Teens global survey[74] which evaluated various psychological factors and considered the lived experiences of adolescents living with obesity. Survey data was collected on 5275 adolescents living with obesity from 10 countries. The study reported that two-thirds of the adolescents living with obesity considered it comparable or more impactful than living with another serious health condition, such as cancer, heart disease, diabetes, depression, and anxiety[74]. Most of the adolescents perceived their weight as ‘above normal’, thus indicating they recognised their status as living with obesity; 85% reported being worried about its impact on their health, and a significant number had attempted weight loss

recently. Nearly half of adolescents indicated that their weight frequently or always caused unhappiness (44%), and their body often or always made them feel insecure (37%)[74]. With reference to eating behaviour specifically, the adolescents acknowledged a lack of hunger control as the greatest difficulty in achieving weight loss, followed by a lack of motivation and enjoyment of unhealthy food as the most significant weight loss barriers. This study reported that over two-thirds of adolescents said they could lose weight if they 'set their mind to it' and that weight loss was entirely their responsibility. Finally, adolescents living with obesity defined successful weight loss as 'feeling better about themselves'[74].

Adolescents living with obesity and attending weight management interventions have acknowledged the benefit of receiving support to improve their wellbeing and self-esteem and valued intervention input beyond focusing on weight-loss behaviours[75]. Adolescents desire to lose weight has been motivated by a feeling of being proud and being normal, improving their social acceptance and activities, not wanting to be like other overweight people (especially family members), reflecting on past negative experiences, and not wanting to experience bullying but to be happy[75]. A qualitative systematic review[76] has summarised the perceptions and reflections of adolescents living with overweight or obesity attending lifestyle obesity treatment interventions, and one of the outcomes acknowledged that adolescents were greatly driven by the desire to enhance their body image and increase social desirability. This evidence explores adolescent's experiences and highlights how psychological and emotional factors shape their perceptions, experiences, and support needs while living with obesity. It also underscores the impact of these factors on their eating behaviours.

Younger children are also able to offer valuable insight into their experiences of living with obesity. A UK qualitative study[51] explored the beliefs and experiences of attending a multi-component family-based childhood obesity intervention. The analysis examined children's (aged 5-15 years old) expectations of attending the weight management intervention and how this influenced subsequent behaviour (such as engagement in dietary change). Families who predicted that the intervention would have positive effects on their lives were more likely to attend, believing that it would help parents seek support from other parents, help children to make friends, improve their social relationships and self-confidence and facilitate the parents and children to gain new skills and knowledge. However, families who did not attend, emphasised their existing understanding of healthy eating and did not recognise the benefits of attending such a service. In comparison to the adolescents from the ACTION Teens global survey[74], in this study, the younger children and families made social comparisons to others with obesity, but primarily sought to downplay the severity of their obesity, and made social comparisons to distance themselves from

other children living with obesity, and also compared obesity to more serious conditions, such as cancer.

Key learning point: This evidence highlights the importance of understanding the psychological perspectives and needs of those referred into a weight management intervention, and that healthcare professionals should help individuals acknowledge and reflect on their needs, that may include psychological changes (in addition to physical behaviour change, i.e., diet/ physical activity). Children and young people offer insight towards understanding the factors that influence their behaviours and decisions in attending, engaging, and implementing the advice from weight management and healthy eating interventions. The psychosocial challenges and factors acknowledged from the young people are noteworthy, and they describe how these factors may or may not be addressed through the current interventions available.

Childhood Obesity Interventions

The current UK recommendations for children living with obesity are to attend a family-based multi-component weight management intervention[77]. Multi-component refers to programmes that focus on a combination of behavioural outcomes such as achieving healthy eating, optimal nutrition, increased physical activity, reduction in sedentary behaviours, and health outcomes such as reducing BMI or improving cardiovascular markers. The intervention may utilise a range of behaviour change techniques (BCTs) aimed at impacting directly and indirectly (see mechanisms of action below) on these behavioural outcomes[78]. A review[79] analysing 217 childhood obesity interventions found that most studies report weight change as the primary outcome. Despite offering a behavioural intervention, only half (48%) of the studies reported behavioural outcomes, such as assessing changes to moderate-to-vigorous physical activity, reductions in television viewing, and improvements in dietary intake [79]. Notably, only 20% of the studies systematically reported psychosocial outcomes, with the most common being quality of life, and only 5% of the studies recorded mental health outcomes (such as depression)[79]. Hence, psychological health (as outlined previously) is not typically the primary focus of childhood obesity, weight management or healthy eating interventions. However, self-esteem is included in UK National Institute of Health and Care Excellence (NICE)[77] clinical guidelines which recommends including self-esteem as a possible intervention outcome.

A more recent umbrella meta-analysis, reanalysed data from 26 other meta-analyses, and summarised the outcomes and various components of childhood obesity interventions[80]. Across the studies, the components of the interventions were often categorised into different "types" of support, such as diet-only, diet combined with physical activity, lifestyle-only, lifestyle combined

with diet, and diet combined with physical activity and sedentary behaviour. Typically, childhood obesity interventions tended to prioritise diet and physical activity, with the term "lifestyle" encompassing other aspects. However, it can be argued that this approach does not adequately consider the psychological or emotional aspects of intervention types. Given the various psychological and emotional needs of children living with obesity (as previously described within this review), it is limiting that psychological components in the intervention design are rarely considered [80].

Numerous analyses and meta-analyses have assessed the effectiveness of childhood obesity interventions, but their success rates vary across studies[79, 81-83]. Evidence shows that participating in interventions promoting behaviour change outcomes, such as increased physical activity and good nutrition and implementing various BCTs, is associated with improved psychological outcomes[17, 18]. This evidence appears to be echoed through some of the reflections given by children and adolescent's perceptions of their lived experiences (See earlier considerations above). Furthermore, evidence suggests that participating in childhood obesity interventions may also improve psychosocial functioning[84]. For example, attendance at weight management interventions for those living with obesity was found to reduce the prevalence and risk for eating disorder symptomology[85].

A systematic review[86] of BCTs (using an adapted CALO-RE BCT taxonomy[87]) assessed 9 childhood obesity weight management interventions and 8 obesity prevention interventions. Of the 9 childhood obesity management interventions, 6 were deemed effective in terms of achieving weight change and 4 out of 8 were effective for the preventative interventions[86]. The analysis of BCTs utilised, found that of the 41 BCTs available, on average interventions used 7.5 BCTs. Techniques commonly used in effective weight management interventions included: individual information; environmental restructure; role model; stress management; communication skills; and practice. It is not known from the evidence base which BCTs are effective, or which combination of BCTs should or should not be included within a given intervention. However, it is noteworthy that there is limited focus on specific support to change psychosocial challenges, only two of the interventions reported using stress management/emotional control training, and one reported using motivational interviewing as a specific BCT, though not effective. Whilst childhood obesity interventions focus on behaviour change outcomes, the consistency, application and effectiveness of using various techniques available is questionable in intervention design and implementation. Another review[88], which focused on obesity prevention promoting feeding practices in children under 2 years of age, also reported the utilisation of BCTs in the intervention implementation. This

review found a limited number and range of BCTs were adopted, and the review also questioned the theoretical underpinning and application of such theory in intervention delivery[88].

If interventions do focus on behavioural outcomes and therefore apply behaviour change methods, understanding the concept of behaviour change and how BCTs operate in such interventions is worth unpicking. BCTs might include methods such as goal setting, problem-solving, knowledge and information, or self-monitoring[78], and are directed towards a specific behavioural outcome, for example, achieving healthy eating. The BCTs themselves are thought to directly impact the behavioural outcome (i.e., If a specific behaviour change technique (BCT), such as setting goals for dietary planning, is implemented, the intended behavioural change—in this case, dietary modification—will take place). However, given the varied success of interventions (which report implementing BCTs), it is evident that the behavioural outcomes are not always achieved, or indeed may be achieved but are not sustained in the longer term.

BCTs can also act on a behavioural outcome indirectly. This can be explained in terms of the BCTs processes of change or mechanisms of action, which target predictors of behaviour (or determinants)[89, 90]. Determinants are psychological variables or regulatory processes that are causal antecedents of the target behaviour change and subsequently impact the behavioural or health outcomes[91]. In other words, the BCT may engage in a mechanism of action that triggers, enhances or engages various factors. It is here that BCTs have the potential to influence psychological variables (such as some of those mentioned earlier, e.g., self-esteem, self-confidence). See example in Table 1 below.

TABLE 1

Although the contributing role of various psychosocial factors is known, there are few interventions which focus specifically on supporting the psychological needs of children living with obesity. However, some research has shown psychological approaches to be effective. For example, a multi-component intervention employed cognitive-behavioural techniques, together with nutrition education and the promotion of physical activity and demonstrated positive outcomes for children (aged 6-12 years old) living with obesity. These successful outcomes included BMI change, reduced energy intakes, and improvements in lifestyle habits, emotional and social problems at 5 years follow-up[92]. Other interventions applying cognitive–behavioural /skill building techniques have also reported successful outcomes[93, 94]. UK Clinical guidelines, NICE[77, 95] recommend using BCTs, positive parenting skills, diet changes, and physical activity routines. The intervention should be tailored to the need of the child and also include both the child and parents. NICE[95] acknowledges the role of BCTs within interventions (such as self-monitoring, stimulus control and

goal-setting), and calls for more evidence to explore the psychological interventions and methods which may help improve outcomes for those attending weight management interventions. It is important to note that NICE recognises that adolescents living with obesity are more likely to experience emotional and behavioural problems, diminished quality of life, and behaviours like binge eating compared to adolescents with a healthy weight[77, 95]. However NICE guidance[95] does not provide healthcare professionals with specific instruction on how to recognise individual needs, or when or how to support their psychological, cognitive or emotional needs. Further NICE[95] suggests that consideration of psychological aspects is 'beyond the scope' of their guidance. It could be interpreted therefore that psychological needs of children living with obesity are considered beyond the scope of childhood obesity interventions, which would be a very narrow and limited view and may help explain the lack of inclusion and guidance for health professionals implementing psychological support into interventions.

To consolidate this evidence and establish a meaningful comprehension, we can utilise the behaviour science COM-B[96] (Capability, Opportunity, Motivation-Behaviour) model (as summarised in Table 2). This model allows us to dissect childhood obesity interventions, revealing potential gaps in achieving a personalised approach to treatment in not fully considering the psychological and emotional needs of children with obesity.

The COM-B model suggests that for a given behaviour to occur, an individual must have the capability and opportunity to engage in the behaviour, and the strength of motivation to engage in the behaviour must be greater than for any other competing behaviour[94]. Considering the psychological factors of childhood obesity becomes imperative in this context, as capability, opportunity and motivation play a crucial role in shaping behaviour and behaviour change for those living with obesity.

TABLE 2

Conclusion

This review has highlighted various impacts of poor nutrition on clinical and psychological wellbeing. The impacts of childhood obesity on health and psychological wellbeing are also outlined. Significantly flagged by the WHO[43] is the double burden of malnutrition which is apparent, though little attention has been given to this in the childhood obesity literature. [97]

Given the numerous and intricate health impacts linked to both the causes and consequences of obesity, it is crucial for health professionals to assess individual needs, inclusive of psychological and emotional needs, and for the design and implementation of childhood obesity interventions to

incorporate these varied needs. Childhood obesity interventions typically centre around BCTs aimed at directly altering health behaviours, such as adopting a healthy diet. However, this approach may overlook the underlying mechanisms responsible for driving these behaviours and how these might be changed (see example described previously). Consequently, the success of adopting new behaviours tends to be limited and not sustained over time. BCT mechanisms of action operate indirectly, meaning that BCTs should not only target the behavioural outcome itself, but also engage these underlying mechanisms. For instance, it might involve addressing issues like low self-esteem, anxiety, low confidence, or providing coping mechanisms to manage bullying. When addressing childhood obesity it's imperative that interventions address these psychological needs through the mechanisms of action. Unfortunately, this aspect is currently lacking in childhood obesity treatment interventions, and this is evident in the feedback from children and adolescents living with obesity in their reflections, evaluations and expectations of treatment interventions[51] [74].

Further research is required to explore the psychological and emotional mechanisms of action within the behaviour change interventions for treating and preventing obesity. It would be helpful to develop an assessment checklist or other resources to assist health professionals in considering the various health, psychological and cognitive needs of individual children living with obesity. However, in the absence of such tools, clinicians and other health professionals working within the field of childhood obesity, or indeed more broadly promoting health behaviours such as dietary change**,** should be mindful of these various causes and consequences of obesity, and therefore should evaluate their intervention offer, to ensure that it is personalised to meet the (changing) psychological and emotional needs of individuals, and thereby provide a comprehensive offer which may be more likely to change their health and lifestyle behaviours. Health professionals may find it helpful to utilise the COM-B model as an initial step to evaluate their intervention offer and consider if there are additional ways that they could tailor their intervention towards meeting individual needs.

It is important to note that the impact of psychological and psychosocial variables on a child or adolescent living with obesity can vary widely[98] . Some children living with obesity have no adverse psychological or psychological impairments. Others are significantly negatively affected with co-morbid mental health (e.g., depression, anxiety, eating disorders), whilst others are not. Some children and adolescents have lower self-esteem and confidence or experience higher levels of stress, stigma, bullying and teasing, with poor coping and communication skills, whilst others do not. Psychological factors, symptomology, and mental health presentation, can change overtime[98].

There is a need to investigate and assess the individual needs and experiences of each child or adolescent living with obesity using objective measures. Once that assessment has explored these issues, an appropriate personalised intervention can be offered (recommendation to utilise a model such as COM-B to help assess and formulate an individual's health behaviour change needs). However, assessment is not a one-time pre-intervention task. Children living with obesity should be monitored and supported as they engage in weight-management efforts, and consideration of their (changing) psychosocial and emotional needs should be part of the behaviour-change efforts, hence seeking to increase the likelihood of achieving the desired behavioural outcome (e.g., weight maintenance, healthier eating).

It is important to note that this review aims to encourage those working in the field of childhood obesity and nutrition to reconsider their intervention design and implementation when working directly with children and families seeking to improve their diet behaviour or engage in childhood obesity interventions. The review highlights various psychological and psychosocial factors that may be a cause or consequence of living with childhood obesity, though this review is not exhaustive and various other factors and mechanisms may be relevant. The review does not consider the wider context of childhood obesity, such as the obesogenic environment[99], including the environmental, economic, political and cultural factors that may also impact on the prevalence and indeed management of childhood obesity.

In summary, to enhance the effectiveness of obesity interventions, it is crucial to broaden the focus and include psychology fully into the design of childhood obesity interventions[100] and look beyond the physical behavioural outcomes as the only focus of the intervention. Those commissioning, designing and implementing childhood obesity interventions should therefore consider a more holistic approach that, considers the psychological and emotional needs, and incorporates the underlying mechanisms of action, which could lead to a more sustainable and effective treatment for childhood obesity.

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health professionals to understand why it is important to consider the psychological needs of children and young people living with obesity.

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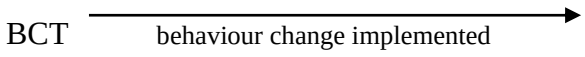
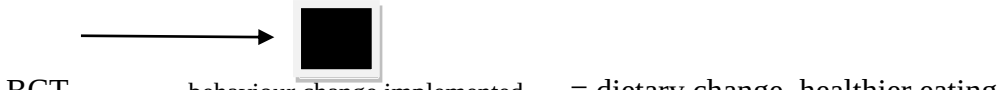
Table 1: A simple illustration to understand mechanisms of behaviour change to impact on a behavioural outcome- dietary change (healthier eating).

Aim: To understand the process of dietary change
Client: An individual living with obesity
Behavioural outcome: Dietary change, healthier eating.
Targeting dietary change: We may attempt to initiate dietary behaviour changes to encourage healthy eating. Implementing a BCT, such as goal setting, to change what food is being eaten. This is a direct behaviour change approach towards a behavioural outcome.



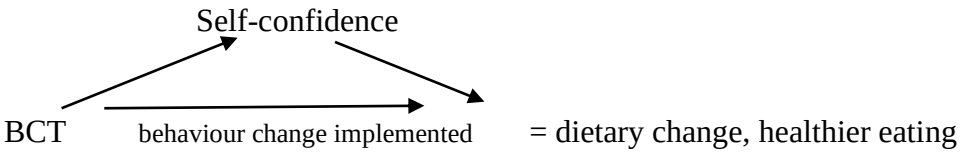
However, the change in dietary behaviour may not be achieved successfully or may not be sustained. There is a block, interference or other process preventing the implementation of the behaviour change.



If we consider, why that behaviour has not been implemented or why might the behaviour not be sustained. Ask, what is happening for this individual?
Re-consider client: client has low self-confidence.

Then we may reconsider our approach- to target the self-confidence, as a determinant of the behavioural outcome (dietary change). To use the BCT to set goals, to help improve and recognise self-confidence (e.g, in ability to cook, choose healthy foods, to choose healthy food at times of stress, other as appropriate to the needs of the client).

Then through its mechanism of action, the BCT might effectively engage and enhance the person's self-confidence.



Consequently, the individual may gain a heightened sense of assurance in their capacity to make healthier dietary choices. This improvement in self-confidence, set in motion by the BCT, has the potential to indirectly steer the person's behaviour toward adopting and maintaining a healthier diet. This, in turn, contributes to endeavours aimed at managing and preventing obesity.

*this is a very simple example, though an individual may be operating a number of mechanisms of action.

796 ***Table 2 An example of utilising the COM-B model[94] to highlight weaknesses in current childhood obesity intervention, regarding***
797 ***lack of consideration for psychological and emotional support, embedded with the behaviour change mechanism of action.***

COM-B component.	**Explanation**	**Application of COM-B element with reference to childhood obesity evidence**
Capability	Refers to an individual's psychological and physical capacity to engage in the behaviour. Physical capability considers if an individual possesses the necessary knowledge and skills required to perform the target behaviour. Psychological capability refers to an individual's capacity to engage in the required thought processes, comprehension, and reasoning to perform the target behaviour.	Current interventions mainly focus on enhancing individuals' capability by providing information and skills related to healthy eating, and physical activity. However, they often neglect the psychological capabilities, like self-worth coping strategies, management of stigma, etc. that can significantly impact one's ability to maintain healthy behaviours. Children living with obesity, may experience a range of cognitive, emotional and psychological challenges (attention, memory, concentration, learning abilities) that reduce their capability to engage in the target behaviour.
Opportunity:	Opportunity refers to the physical and social external factors that influence or prompt behaviour. Physical opportunity is influenced by the built environment and social opportunity is influenced by the cultural context that dictates how individuals think about things	Interventions primarily address the physical environment's opportunities (e.g., access to healthy foods). Although, they may miss the opportunity to create supportive psychosocial environments that help individuals deal with emotional barriers, like anxiety, bullying, stigma; or the social perceptions of obesity).
Motivation:	Motivation refers to all the cognitive processes that initiate and direct behaviour, not just goals and conscious decision-making.	While interventions aim to motivate behaviour change, they may not adequately consider the complex motivations related to psychological wellbeing. Whist interventions may promote BCT to set goals

	Reflective motivational processes (evaluations and plans) and automatic motivational processes (emotions and impulses).	and plan for dietary change (reflective motivational processes). Interventions may be missing aspects which address the automatic motivational processes, such as the desire to improve self-esteem or reduce stress, reduce low mood symptomology, or recognise biological drivers on their motivations (e.g., cravings/addictions) for eating specific foods etc.

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