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Title: The effects of multi-component weight management interventions on weight loss in adults with intellectual disabilities and overweight/obesity: A systematic review and meta-analysis of randomised controlled trials

Abstract

Background: Adults with intellectual disabilities have been shown to experience higher rates of obesity in comparison to the general population.

Aim: To examine the effectiveness of randomised controlled trials of multi-component weight management interventions for adults with intellectual disabilities and overweight/obesity.

Methods and procedures: A systematic search of six electronic databases was conducted from database inception to January 2016. Risk of bias was assessed by the Cochrane Collaboration tool. Behavioural change techniques were defined by coding against the Coventry Aberdeen London REfined (CALO-RE) taxonomy. Meta-analyses were conducted as Weighted Mean Difference (WMD) between intervention and control/comparator intervention.

Outcomes and results:

Six randomised controlled trials were included. The interventions did not adhere to clinical recommendations [the inclusion of an energy deficit diet (EDD), physical activity, and behaviour change techniques]. Meta-analysis revealed that current multi-component weight management interventions are not more effective than no treatment (WMD: -0.38 kg; 95% CI -1.34 kg to 0.58 kg; $p = 0.44$).

Conclusion and implications: There is a paucity of randomised controlled trials of multi-component weight management interventions for adults with intellectual disabilities and overweight/obesity. Current interventions, based on a health education approach are ineffective. Future long-term interventions that include an EDD and adhere to clinical recommendations on the management of obesity are warranted.

Keywords

Intellectual disabilities; Multi-component weight management intervention, obesity, weight loss, meta-analysis.

What this paper adds

Evidence on the effects of weight management interventions in adults with intellectual disabilities and overweight/obesity thus far has included heterogenous study designs and sample populations which limits interpretation of the effect of the intervention due to risk of confounding factors. This review adds to the current literature by including only randomised controlled trials of multi-component weight management interventions. Furthermore, this review also aims to add to the findings of previous narrative reviews by quantifying and providing a more accurate account of the effect(s) of the interventions.

1. Introduction

The prevalence of obesity is currently of epidemic proportions [World Health Organisation (WHO), 2015]. Obesity is associated with increasing the risk of numerous chronic diseases including cardiovascular disease, type II diabetes, and some cancers [Scottish Intercollegiate Guideline Network (SIGN), 2010; National Institute of Clinical Evidence (NICE), 2014].

Adults with intellectual disabilities have consistently been shown to experience higher rates of obesity in comparison to the general population (Melville, Hamilton, Hankey, Miller, & Boyle, 2007; Melville, Cooper, Morrison, Allan, Smiley, & Williamson, 2008; Bhaumik, Watson, Thorp, Tyrer, & McGrother, 2008; Hsieh, Rimmer, & Heller, 2014). Obesity incidence has been reported to be as high as 50% for adults with intellectual disabilities (NICE, 2014). The aetiology of obesity for this population group is complex with many non-modifiable and modifiable determinants. Rates of overweight and obesity are reported to be higher in specific groups of adults with intellectual disabilities including women (Bhaumik *et al.*, 2008; Melville *et al.*, 2008), adults with mild to moderate level of intellectual disabilities (Emerson, 2005; Melville *et al.*, 2007), and individuals with genetic syndromes including Down syndrome (Hsieh *et al.*, 2014; Melville *et al.*, 2008). Moreover, unhealthy lifestyle habits consistent with those in the general population have been shown to be more prevalent in adults with intellectual disabilities, including increased energy intake through dietary indulgence of readily available, energy dense food, the adoption of sedentary lifestyles and reduced time spent engaged in physical activities (McGuire, Daly, & Smyth, 2007; Finlayson *et al.*, 2009).

Furthermore, the high rates of obesity have shown to exacerbate the already considerable health needs of adults with intellectual disabilities and significantly contribute to their reduced life expectancy (Cooper, Melville, & Morrison, 2004). Therefore, the management of obesity is a major public health priority for this population group (NICE, 2007).

International clinical guidelines on the management of obesity aim to challenge these lifestyle habits by advocating multi-component weight management interventions as the treatment of choice to support individuals to achieve a clinically important weight loss of 5-10% of initial body weight, associated with health improvements [National Institute of Health (NIH) 2000; SIGN 2010; NICE 2014; Yumuk *et al.*, 2015]. Current recommendations on multi-component weight management interventions include: (i) an energy deficit diet (EDD) of 600kcal reduction in total energy intake per day, (ii) support to increase physical activity; (iii) behaviour change techniques; (iv) an active weight maintenance component; and (v) a 12-month intervention/follow up period. However, adults with intellectual disabilities experience barriers and have limited access to evidence based health services (NICE, 2007; Van Schrojenstein & Walsh, 2008). Moreover, there is insufficient evidence on which to formulate effective weight management interventions for this population group (Spanos, Melville & Hankey, 2013).

Systematic reviews of studies focussed on lifestyle interventions for the management of obesity in adults with intellectual disabilities have previously been conducted (Doherty, Jones, Chauhan, & Gibson, 2017; Hamilton, Hankey, Miller, Boyle, & Melville, 2007; Jinks, Cotton, & Rylance, 2011; Spanos *et al.*, 2013). However, there are limitations with the current available evidence. These include the limited use of systematic methodology to effectively select and extract the available evidence (Hamilton *et al.*, 2007; Jinks *et al.*, 2011). The identification of intervention components in previous reviews was informed based on information from the study titles and methods of the primary studies and was not based on standardised definitions of behaviour change methods (Docherty *et al.*, 2017; Hamilton *et al.*, 2007; Jinks *et al.*, 2011; Spanos *et al.*, 2013). Recent research has emphasised the importance of elucidating the ‘active ingredients’ of these interventions in order to identify the effective and ineffective components and also to assist with development and implementation of future interventions (Abraham & Michie, 2008; Michie, Ashford, Sniehotta, Dombrowski, Bishop, & French, 2011; Michie *et al.*, 2013). A number of taxonomies of behaviour change techniques have been developed to assist with the identification, and characterisation of behaviour change techniques (Abraham

& Michie, 2008; Michie, Ashford, Sniehotta, Dombrowski, Bishop, & French, 2011; Michie *et al.*, 2013). For example, the Coventry Aberdeen London REfined (CALO-RE) taxonomy developed by Michie and colleagues (2011) consists of a 40-item checklist of behaviour change techniques to help people change their physical activity levels and eating behaviours and therefore is particularly pertinent to defining the intervention components of multi-component weight management interventions. Finally, a limitation identified in previous reviews was the inclusion of heterogeneous study designs, which are, subject to bias and associated with reverse causality (Bowling & Ebrahim, 2005; Flanders, Lin, Pirkle, & Caudill, 1992). In order to facilitate decisions on the most effective approach for weight management for adults with intellectual disabilities, it is important that systematic reviews are based on high quality evidence from randomised controlled trials [Medical Research Council (MRC), 2000]. The main aim of this study is to fulfil the gaps in the evidence-based identified in previous reviews by synthesising the available evidence on solely multi-component weight management interventions for adults with intellectual disabilities and overweight/obesity. This review will add to previous narrative reviews by conducting a meta-analysis to provide a more accurate and quantitative estimate of the effect of the interventions. Additional objectives also include: to identify the components of the interventions and to determine whether they meet the criteria recommended by clinical obesity guidelines; and to assess if participants achieved a clinically important weight loss of 5-10% of initial body weight.

2. Methods

This study was completed following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009).

2.1 Search strategy

A systematic search of six electronic databases: Medline, Embase, Cochrane Library, Cumulative Index of Nursing and Allied Health Literature (CINHAL), PsychINFO, and Education Resource Information Centre (ERIC) was conducted from 1946 to and including January 2016. Protocols and trials of studies were also searched for in the International Standard Randomised Controlled Trial Number (ISRCTN) trials registry. The full search

strategy for Medline is presented in the online supporting information (Appendix A) and was adapted for each database. It included terms used to identify relevant studies such as MeSH subject heading, key words and phrases including intellectual disabilities, nutrition, physical activity and behaviour therapy. The search strategy also involved hand searching of previous systematic reviews and the reference lists of identified relevant studies.

2.2 Inclusion and exclusion criteria

Studies were assessed for their eligibility for inclusion in this review if they recruited adults (≥ 18 years) diagnosed with intellectual disabilities (participants with Down Syndrome were included) and overweight and obesity (Body Mass Index (BMI) ≥ 25 kg/m²); followed a randomised controlled trial design of a multi-component intervention including three components: diet, physical activity, behaviour change strategies [based on the criteria used in a systematic review of multi-component weight management reviews in the general population (Loveman *et al.*, 2011)]; and reported an objective measure of body weight or BMI at baseline and follow up. Studies were excluded from this review if they were not published in English language journals, were not classified as lifestyle interventions i.e. offered surgical or pharmacological intervention or if participants were special Olympians (due to the higher levels of physical activity in the population group) or had the following genetic syndromes as their origin of intellectual disabilities: Prader-Willi Syndrome, Cohen Syndrome or Bardet-Biedl syndrome. Individuals with genetic syndromes and obesity represent only a small proportion of the intellectual disabilities population and require intensive support for weight management including prescription of a very low-calorie diet, restricted access to food and in some cases pharmacological intervention (Goldstone, Holland, Hauffa, Hokken-Koelega, & Tauber, 2008). Individuals with Down syndrome were included as they do not have a genetic cause of obesity. The inclusion of adults with Down syndrome in weight management interventions is a priority for this subpopulation of adults with intellectual disabilities as individuals with Down syndrome have higher rates of obesity than participants without Down syndrome (Bhaumik *et al.*, 2008; Hsieh *et al.*, 2014; Melville *et al.*, 2008).

2.3 Study selection

The literature search was performed by the first author (LH). Titles and abstracts of identified studies were screened and obviously irrelevant studies excluded. Full texts of studies were

sought and assessed by two reviewers independently (LH, CM) for inclusion. Consensus on included studies was discussed and agreed with the final list of studies included in this review.

2.4 Data extraction

Data from primary studies was extracted by one reviewer (LH). In cases where there were duplicate publications or a protocol paper published all versions of the study were considered to maximise the extraction of all available information. Data extracted included general study details such as the author, title and year of publication; participant characteristics; research objectives; intervention components (i.e. duration and frequency of the intervention sessions); quantitative outcome measures of body weight and result statistics such as means and standard deviations of pre and post and change in body weight. The identification of behaviour change techniques was conducted independently by two reviewers (LH, CH) who then compared ratings and discussed any discrepancies to reach a consensus and final score. The methodology section of studies detailing intervention components was screened against the CALO-RE taxonomy (Michie *et al.*, 2011). If a behaviour change technique was identified it was coded 'yes,' and if the technique was absent or there was insufficient detail to determine if a technique was utilised it was coded 'no'.

2.5 Risk of bias

Risk of bias was assessed using the Cochrane Collaboration's tool for assessing risk of bias including assessment of random sequence generation, allocation concealment, blinding of participants and researchers and blinding of outcome assessment, attrition bias, selective reporting and other potential sources of bias (Higgins *et al.*, 2011). Each risk of bias domain was rated as low, unclear or high risk of bias based on the criteria by the Cochrane Collaboration (Higgins *et al.*, 2011). This was conducted independently by two reviewers (LH, CH) and consensus agreed as above. Examination of publication bias was assessed by funnel plots of the weighted mean difference (WMD) and the standard error of the WMD of the included studies.

2.6 Data analysis

This review categorised studies by research design into those that examined the efficacy of a multi-component weight management intervention against a control intervention (no treatment/treatment as usual) and studies that utilised a comparator intervention. The interventions in the latter study design typically involved two multi-component interventions, one with additional

components and for the purpose of this review was defined as a more comprehensive multi-component weight management intervention and one with a less intense comparator intervention.

Meta-analyses were included in this review to critically evaluate and statistically combine results of comparable studies. The aim of the meta-analyses was to increase the numbers of observations and the statistical power from primary studies to provide an estimate of the effect size of multi-component weight management interventions. As previous reviews have identified a small number of weight management interventions (Docherty *et al.*, 2017; Hamilton *et al.*, 2007; Jinks *et al.*, 2011; Spanos *et al.*, 2013), it was projected that only a small number of studies would be eligible for inclusion in the analysis. There are limitations that need to be acknowledged when conducting meta-analyses with small numbers of studies including an increase in the unreliability of the summary estimate and confidence interval, and the impact of variability of study effects on the pooled estimate. Therefore, the results of this meta-analysis should be interpreted with caution. Full details of the methods used to conduct the analysis are described. Meta-analyses was performed using Comprehensive Meta-Analysis (Version 3 for Windows: Biostat, Englewood, Colorado, USA). The effect size for each study was calculated as the difference in the mean change in body weight in the multi-component intervention minus the mean change in body weight in the control or comparator intervention (Borenstein, Hedges, Higgins, & Rothstein, 2009). Participants with overweight/obesity were only included in the analysis. The authors of studies were contacted where required to request their data to provide sufficient information to conduct this secondary analysis (McDermott *et al.*, 2012; Beeken *et al.*, 2015; Bergström, Hagströmer, Hagberg, & Elinder, 2013). The mean change in body weight and standard deviation (SD) of the change was directly included in the analysis, however, in studies that reported pre and post data only on body weight, the SD of the mean change was calculated (Higgins *et al.*, 2011) based on similar studies reporting the variance of both pre and post intervention data and the variance of the mean change in body weight (Fox Haniotes, & Rotatori, 1984; McDermott *et al.*, 2012; Beeken *et al.*, 2015).

A random effects meta-analysis was conducted to provide summary estimates (DerSimonian & Laird, 1986). WMD of studies comparing multi-component interventions to a non-active control group and studies comparing the multi-component intervention to a comparator intervention. To assess heterogeneity, Cochran's Q statistic, with $p < 0.05$ indicating evidence of statistical heterogeneity was applied with the level of heterogeneity assessed by the I^2

statistic, with $I^2 \geq 50\%$ indicating substantial heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003).

3. Results

3.1 Literature search

The results of the systematic search revealed 3008 studies in total. The duplicates were removed and 2607 study titles and their abstracts were screened for their eligibility. Studies identified as obviously irrelevant i.e. single component diet or physical activity studies were excluded. Full texts of 40 studies were sought and assessed for their inclusion in the review based on the criteria above. Six studies met the criteria and were included in the review. The process of the study selection and reasons for exclusion of studies is illustrated in Figure 1.

**INSERT Figure 1: PRISMA flow diagram of search and study selection process
(Adapted from Moher *et al.* 2009)**

3.2 Study characteristics

An overview of the study and participant characteristics is illustrated in Table 1. Six studies met the inclusion criteria and of these, four studies were conducted in the USA (Fox *et al.*, 1984; Fisher, 1986; McDermott *et al.*, 2012; Pett *et al.*, 2013), one study in Sweden (Bergström *et al.*, 2013) and one study in the UK (Beeken *et al.*, 2013). Participants lived in their own home (McDermott *et al.*, 2012), family/parents' home (Fox *et al.*, 1984; McDermott *et al.*, 2012; Pett *et al.*, 2013), and residential homes (Bergström *et al.*, 2013; McDermott *et al.*, 2012). In the study by Bergström *et al.*, (2013) participants lived in group homes or supported living. Both accommodation types had their own flat with additional common rooms. Participants in supported living required less support from carers. Participants in the study by Beeken *et al.*, (2013) lived in the community although the accommodation type was not described. Fisher, (1986) also did not report accommodation type of participants. The active intervention period was on average 4.5 months (range: 2-15 months). Participant follow up of outcome measures were at three, six and 12 months post intervention. One study did not conduct follow up appointments with participants ((Bergström *et al.*, 2013). The duration of intervention sessions was on average between 60 and 90 minutes, with the overall sessions (comprising diet, physical activity, and behaviour change) conducted between one to two times per week. Study sessions

were conducted in a group format for all studies, led by health professionals such as dietitians (Beeken *et al.*, 2013), recreation specialists (Fox *et al.*, 1984) and health educators (McDermott *et al.*, 2012). Interventions were also delivered by carers who received training on the intervention components (Bergström *et al.*, 2013; Pett *et al.*, 2013).

INSERT Table 1. Overview of study characteristics of multi-component weight management interventions

3.3 Participant characteristics

In total 698 participants were included in the primary studies. The sample size of studies ranged from 16 to 443 participants. Participants recruited to the studies had mild to moderate levels of intellectual disabilities. The mean age range of participants was between 20-39 years. Participants' weight status ranged from underweight to obese. In general, most of the studies included adults with overweight and obesity, with inclusion of BMI ≥ 25 kg/m² (Fox *et al.*, 1984; Fisher, 1986; Beeken *et al.*, 2013; Pett *et al.*, 2013). Two studies did not limit inclusion to their study based on weight status. However, the authors of the studies by Bergström *et al.*, (2013) and McDermott *et al.*, (2012) provided raw data and therefore, meta-analysis of participants with overweight/obesity only was conducted.

3.4 Risk of bias

Risk of bias rating for each domain across studies was primarily rated at low risk or insufficient information was provided and therefore these studies were judged as unclear to assess their risk of bias (42.9% and 50.0%, respectively). High risk of attrition bias occurred in one study where greater than 50% of the participants withdrew from the intervention (McDermott *et al.*, 2012). One study was subject to reporting bias, not providing adequate information on outcomes and/or not reporting outcome results (Fisher, 1986). The other potential sources of bias present (Pett *et al.*, 2013), related to the study design, with randomisation being applied to only two out of the three intervention groups. An overview of the risk of bias for each domain, categorised per study is presented in Figure 2. As only six studies, three with a control and three with a comparator intervention were identified, funnel plots asymmetry was not appropriate due the limited number of studies to provide adequate power to reliably test for presence of publication bias (Higgins & Green, 2011).

INSERT Figure 2. Risk of bias assessment. Adapted from the Cochrane Handbook (Higgins *et al.*, 2011).

3.5 Intervention components

3.5.1 Diet component

The majority of studies were focussed on a health education approach, providing general information on healthy balanced diet including for example food groups, portion sizes and healthy meals and snacks. The information was conveyed in a number of formats from images to food games (Beeken *et al.*, 2013), demonstrations and tasting of foods (Bergström *et al.*, 2013).

3.5.2 Physical activity component

The physical activity constituent varied across studies from a structured format incorporated as part of the intervention (Pett *et al.*, 2013), lifestyle physical activity (Fisher, 1986; Fox *et al.*, 1984; McDermott *et al.*, 2012) to a health education approach (McDermott *et al.*, 2012; Beeken *et al.*, 2013; Bergström *et al.*, 2013). The structured physical activity component was performed once per week and included aerobic based activities, strength/ muscular endurance activities and stretches to increase flexibility (Pett *et al.*, 2013). Studies incorporating lifestyle physical activities included activities such as walking and activities that can be done in the home such as calisthenics (e.g. jumping jacks) (Fisher, 1986; Fox *et al.*, 1984; McDermott *et al.*, 2012) ranging from targets of 10 minutes to 30 minutes for example in the study by Fisher, (1986). The ‘dose’ of physical activity prescribed could only be quantified in two studies (Fisher, 1986; Pett *et al.*, 2013). The weekly amount of physical activity in these studies varied from 70 minutes to 210 minutes per week. Only one study (Fisher, 1996) in this review achieved the current physical activity recommendations [150 minutes of moderate intensity physical activity per week (American College of Sports Medicine, 2007)].

3.5.3 Behaviour change component

In total only 26 out of the 40 behaviour change techniques from the CALO-RE taxonomy were utilised across interventions. The mean number of techniques used was 10 (range: 2-21). The techniques consistently identified in the interventions were: prompt practice; provide

instruction on how to perform the behaviour; barrier identification/problem solving; action planning; prompt self-monitoring of behaviour; model/demonstrate the behaviour; plan social support/social change; and stress management/emotional control training. The frequency of each technique across studies is reported in Table 2. However, a lack of reporting and clear definitions of intervention components made the extraction of the active techniques implemented in the interventions challenging. In addition, different labels were used across studies which reflect the same techniques (i.e. self-monitoring, completion of diaries).

3.5.4 Weight maintenance component

The effectiveness of weight maintenance interventions in the included studies was not extensively investigated. Only one study incorporated a weight maintenance period following a period of weight loss (Fox *et al.*, 1984). However, this was only short in duration (five weeks) and was technically not distinct from the weight loss phase as weight loss was continued to be encouraged throughout this period. Moreover, none of the interventions investigated the sustainability of change in body weight following completion of the active intervention period.

INSERT Table 2. Frequency of behaviour change techniques

3.4 Carer involvement

Carers were defined as anyone who provided support to participants with intellectual disabilities and included paid carers in community-based organisations, residential homes, and family/parent carers. The engagement of carers in the studies was diverse, ranging from specifically targeting the delivery of the intervention to carers with a focus to increase the knowledge of carers in order to support healthy lifestyle change in adults with intellectual disabilities (Bergsrotem *et al.*, 2013). Interventions included additional intervention sessions for carers in conjunction to intervention sessions with participants (Pett *et al.*, 2013) and also provided one of training sessions prior to the inception of the intervention with adults with intellectual disabilities (Fox *et al.*, 1984; Beeken *et al.*, 2013; Beeken *et al.*, 2015). Two studies did not include the involvement of carers for support in any aspect of their interventions (Fisher, 1986; McDermott *et al.*, 2012).

3.5 Effects of the interventions

3.5.1 Multi-component weight management intervention vs control intervention

Three studies examined the efficacy of a multi-component weight management interventions against a no treatment control intervention (Figure 3). There was no significant difference in body weight change between the multi-component interventions and control interventions post intervention (WMD: -0.38 kg; 95% CI -1.34 kg to 0.58 kg; $p = 0.44$) or at 12 months follow up (Figure 4: -1.15 kg; 95% CI -4.15 kg to 1.86 kg; $P = 0.45$). Statistical heterogeneity was not present. Within group (pre-post) changes in body weight were non-significant. All of the studies, reported minimal changes (less than 1 kg) in the intervention group which could be attributed to natural fluctuations in body weight.

INSERT Figure 3. Weighted mean difference in body weight (kg) between the multi-component interventions and control interventions (Post intervention).

INSERT Figure 4. Weighted mean difference in body weight (kg) between the multi-component interventions and control interventions (12-month follow up).

3.5.2 Multi-component weight management intervention vs comparator intervention

Three studies utilised a comparator intervention to investigate directly compare the efficacy of the multi-component interventions (Figure 5). The studies included a more comprehensive intervention with additional intervention components in comparison to the less intense multi-component intervention. Two studies included additional behaviour change techniques, which primarily provided increased social support either from peers or carers (Fox *et al.*, 1984; Pett *et al.*, 2013), while one study investigated the effect of a more structured physical activity intervention with graded targets (Fisher, 1986). The WMD was 0.55 kg (95% CI -2.94 kg to 2.05 kg; $P = 0.700$) post intervention. Statistical heterogeneity in effect sizes was not present ($Q(2) 0.7$, $P = 0.69$; $I^2 = 0.0\%$). Studies reported no between group differences, however, the within group changes in body weight in the study by Fox *et al.*, (1984) illustrated that both interventions were effective in changing body weight, with a weight change of -4.77 kg in both interventions. Exploration of no between intervention effect was primarily due to minimal changes in weight loss in both multi-component interventions (Fisher, 1986) and in one case a greater weight loss favoured the comparator intervention (Pett *et al.*, 2013).

Figure 5. WMD in body weight (kg) between the multi-component interventions and the comparator interventions (Post intervention).

3.6 Clinical effectiveness

The results of the within group effect sizes reported small clinically insignificant results. For example, the study by Bergström *et al.*, (2013), although contributed to the pooled effect size favouring the multi-component intervention in comparison to no treatment, the within group weight change of -0.85 kg (SD 7.53 kg) cannot be considered an effective weight management intervention for adults with intellectual disabilities and overweight/obesity (Stevens, Truesdale, McClain, & Cai, 2006). Clinical guidelines for the management of obesity recommend that for individuals with a BMI between 25-35 kg/m², a 5-10% weight loss is required to reduce health risks associated with obesity (SIGN 2010; NICE 2014). No clinically important weight losses were not reported in the results of the studies included in this review. Only one study reported to have a mean percentage weight loss greater than 5% in participants at the end of the 15-week intervention period (Fox *et al.*, 1984). However, a clinically important weight loss was not maintained in the study by Fox *et al.*, (1984) at 12 months from baseline (Stevens *et al.*, 2006).

4. Discussion

4.1 Principle findings

This systematic review synthesised the available evidence of randomised controlled trials of multi-component weight management interventions in adults with intellectual disabilities. This is the first review to provide a quantitative estimate of the effect of the intervention and also to use reliable methods to try and identify the effective elements of the intervention. Similarly, to previous reviews (Docherty *et al.*, 2017; Hamilton *et al.*, 2007; Jinks *et al.*, 2011; Spanos *et al.*, 2013), this review demonstrated that there are few studies designed to challenge overweight/obesity in adults with intellectual disabilities. The main findings from the meta-analysis revealed that current multi-component interventions did not support a clinically meaningful weight loss of 5-10% and were not more effective than no treatment control interventions. Meta-analyses directly comparing intervention components between two multi-component weight management interventions also revealed non-significant results. This was

primarily due to the homogeneity of the components included in the comparator interventions (Fisher, 1986; Fox *et al.*, 1984; Pett *et al.*, 2013).

4.3 Comparison with clinical recommendations

4.3.1 Intervention components

Multi-component interventions included in this review were predominantly focused on a health education approach and did not adhere to clinical recommendations (SIGN 2010, NICE 2014). In particular, none of the studies included an EDD. This may in part explain the lack of effect of current multi-component weight management interventions and is consistent with clinical recommendations in the general population which don't support generalised health education approaches for the treatment of obesity. Based on the principles of energy balance, future weight management interventions should aim to adhere to recommendations on an EDD and aim to invoke a 600kcal deficit with the individuals' prescription dependent on their age, gender and current body weight. Furthermore, physical activity is demonstrated to be an integral component of the management of overweight/obesity (Berk, Hubert, & Fries, 2006; Kavouras *et al.*, 2007; McTiernan *et al.*, 2007), however, only one study reported to achieve physical activity levels consistent with current recommendations (Fisher, 1986). This is in agreement with the available evidence which has continuously demonstrated that individuals with intellectual disabilities experience additional barriers to being physically active (Bodde & Seo, 2009; Hawkins & Look, 2006) and subsequently engage in low levels of physical activity (Fernhall & Unnithan, 2002; Melville *et al.*, 2011). Recommendations formed from strategies to promote physical activity in adults with intellectual disabilities (Stanish & Frey, 2008) highlights that physical activity needs to be modified to accommodate the abilities of individuals with intellectual disabilities. Therefore, future studies need to take into consideration the low baseline levels of physical activity of adults with intellectual disabilities and obesity (Melville *et al.*, 2011) and develop methods to reduce time spent in sedentary behaviours and gradually increase physical activity participation to the level required to facilitate weight loss (SIGN 2010; NICE 2014).

The importance of the incorporation of behaviour change techniques into weight management interventions has been shown to be crucial in supporting changes in attitudes and adoption of practices of healthier lifestyle habits (SIGN 2010; NICE 2014). The number of behaviour change techniques included in this review varied between studies. The key behaviour change

techniques shown to be effective in supporting weight loss in the general population include goal setting, self-monitoring, and providing feedback on performance (SIGN 2010; NICE 2014). Only one of these techniques, provide self-monitoring of behaviour, was frequently implemented across studies.

This review identified the behaviour change techniques reported in multi-component weight management interventions, however, it is uncertain if these techniques are effective due to the lack of weight changes observed. Caution is warranted over the application of all techniques in the CALO-RE taxonomy, as these may not be applicable for adults with intellectual disabilities due to limitations in the cognitive abilities and level of understanding. For example, provision of information on the consequences of behaviour in general has shown to be an effective technique in increasing physical activity in obese adults (Dombrowski, Snihotta, Avenell, Johnston, MacLennan, & Araújo-Soares, 2012), however, it was reported that some participants with intellectual disabilities did not have the capacity to understand the health implications of not engaging in healthy lifestyle habits (Bergström *et al.*, 2013). The question over the accessibility of behaviour change techniques in individuals with intellectual disabilities is in agreement with a recent systematic review which identified the behaviour change techniques of lifestyle change interventions in individuals with intellectual disabilities (Willems, Hilgenkamp, Havik, Waninge, & Melville, 2016) also using the CALO-RE taxonomy. The authors reported concern over the applicability of complex behaviour change techniques included in the taxonomy and the capabilities of adults with intellectual disabilities. To adapt complex behaviour change interventions for adults with intellectual disabilities, it is recognised that increased social support from carers may be required in future research to help implement effective behaviour change techniques (NICE, 2007).

4.3.2 Social support

In addition to the intervention components, it is recognised that multi-component weight management interventions need to be tailored to an individual's needs and support provide if necessary to enable comprehension and effective delivery of the intervention (NICE, 2007). Carers have shown to have an important role in supporting weight loss in adults with intellectual disabilities (Hamilton *et al.*, 2007; Spanos *et al.*, 2013). The included studies involved carers to varying degrees to support participants to make healthy lifestyle choices. Only one study directly compared the effect of increased social support from carers (Pett *et al.*, 2013). However, the addition of social support from carers did not provide an additive benefit

in supporting weight loss. This was primarily thought to be due to a lack of commitment from carers engaged in the study. It was reported that only eight of 18 parent carers who inquired about the study took part and it was speculated by the authors that this was due to participant burden and lack of time; therefore, these reasons may have also been present in the carers who participated, and could be a potential explanation to the limited weight loss in comparison to the participant with intellectual disabilities only intervention. Furthermore, a source of bias in terms of an imbalance between the intervention groups may have contributed to this result. The authors reported that the presence of Down syndrome was a predictor of weight loss and therefore may have resulted in the increased weight loss in the comparator intervention. Overall, this review provided insufficient evidence to quantify the effect of increased support from carers on change in body weight. However, it is important for future studies to consider the differentiating level of support required for all adults with intellectual disabilities and to tailor the involvement and support provided by carers accordingly.

4.3.3 Weight maintenance

Clinical guidelines recognise the importance of weight maintenance interventions following a period of weight loss to sustain healthy lifestyle changes (SIGN 2010; NICE 2014). This lack of weight maintenance interventions in adults with intellectual disabilities and overweight/obesity is in agreement with the available evidence of weight management interventions in the general population (Avenell *et al.*, 2004; Loveman *et al.*, 2011). However, future studies should aim to adhere to evidence based recommendations and implement longer term distinguished weight maintenance periods to examine the impact of multi-component interventions to prevent weight regain.

4.3.4 Long term follow up

The lack of studies reporting a clinically significant weight loss could also be explained by the duration of the intervention. In general, the active intervention period of studies was of short duration (~ three months) with the exception of Bergström *et al.*, (2013). Clinical guidelines advocate a minimum 12-month study period (including the intervention and follow up) to examine the efficacy of the intervention. Only two studies examined the efficacy of multi-component weight management interventions at this time point (Fox *et al.*, 1984; Bergström *et al.*, 2013), therefore inference on the sustainability of interventions is limited. Research in the general population shows that the trend in weight change for most adults in the following a

period of initial weight loss, is weight regain over time (Avenell *et al.*, 2004). Therefore, future studies are required to assess the long-term effect of the intervention.

4.4 Strengths and limitations

To the authors knowledge, this is the first systematic review to synthesise and quantify the effect of the available evidence of multi-component weight management interventions on change in body weight in adults with intellectual disabilities and overweight/obesity. The inclusion of randomised controlled trials provides a more valid and reliable estimate of the effect of the intervention. However, the results of this review should be interpreted cautiously due to the small number of studies identified in this review, which limit assessment of publication bias and exploring heterogeneity between study findings. Furthermore, the systematic identification of behaviour change techniques against a standardised taxonomy provides an insight into the active components included in weight management interventions.

A limitation of this review is in terms of the generalisability of the results. The findings do not extend to all adults with intellectual disabilities, as the studies in this review only included participants with mild to moderate level of intellectual disabilities. As obesity is not exclusive to this subgroup of people with intellectual disabilities, it is important for future studies to consider the differentiating level of support required for all adults with intellectual disabilities and to tailor the involvement and support provided by carers accordingly.

4.5 Implications for future research

This review highlights that the current evidence of multi-component interventions based on a health education approach are not effective for weight management in adults with intellectual disabilities and overweight/obesity. Future studies of multi-component weight management interventions should aim to meet clinical recommendations on the management of obesity, in particular the inclusion of an EDD and social support from carers. Long term studies including an active weight maintenance period of at least six months duration and comprising at least a minimum 12 months intervention period overall are required to investigate the efficacy of this approach to weight management in supporting the sustainability of weight loss in adults with intellectual disabilities and overweight/obesity. In order to elucidate the effective techniques for weight management in adults with intellectual disabilities future studies are required that actively report the behaviour change techniques and facilitate direct comparison of intervention

components. Moreover, to generalise the results more studies are required to be conducted internationally and include adults with all levels of intellectual disabilities.

5. Conclusions

Overall there is a paucity of available evidence of weight management interventions in adults with intellectual disabilities. The current evidence of weight management interventions based on a health education approach were ineffective as they did not support individuals with intellectual disabilities and overweight/obesity to achieve a significant weight loss or report clinically important weight losses in comparison to no treatment. Interpretation of these findings may be due to the limited adherence of interventions to clinical recommendations. Research should aim to adopt rigorous randomised controlled trials to support evidence based recommendations on the management of overweight/obesity in adults with intellectual disabilities.

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6. References

- Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health psychology, 27*(3), 379.
- Avenell, A., Broom, J., Brown, T. J., Poobalan, A., Aucott, L., Stearns, S. C., et al. (2004). Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. *Health Technology Assessment, 8*(21): 1-182.
- Beeken, R. J., Lally, P., Wahlich, C., Omar, R., Marston, L., Wilson, R., et al. (2015). Piloting a manualised weight management programme for overweight and obese persons with mild-moderate learning disabilities: Results of the shape up-LD study. *Obesity Facts, 8*, 189.
- Beeken, R. J., Spanos, D., Fovargue, S., Hunter, R., Omar, R., Hassiotis, A., et al. (2013). Piloting a manualised weight management programme (Shape Up-LD) for overweight and obese persons with mild-moderate learning disabilities: Study protocol for a pilot randomised controlled trial. *BMC Trials, 14*(1), 71-80.
- Bergström, H., Hagströmer, M., Hagberg, J., & Elinder, L. S. (2013). A multi-component universal intervention to improve diet and physical activity among adults with intellectual disabilities in community residences: a cluster randomised controlled trial. *Research in Developmental Disabilities, 34*(11), 3847-3857.
- Berk, D. R., Hubert, H. B., & Fries, J. F. (2006). Associations of changes in exercise level with subsequent disability among seniors: a 16-year longitudinal study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61*(1), 97-102.
- Bhaumik, S., Watson, J. M., Thorp, C. F., Tyrer, F., & McGrother, C. W. (2008). Body mass index in adults with intellectual disability: distribution, associations and service implications: a population-based prevalence study. *Journal of Intellectual Disability Research, 52*(4), 287-298.
- Bodde, A. E., & Seo, D. C. (2009). A review of social and environmental barriers to physical activity for adults with intellectual disabilities. *Disability and Health Journal, 2*(2), 57-66.
- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H.R. (2009). Introduction to meta-analysis. Chichester, UK. John Wiley & Sons, Ltd.
- Bowling, A., & Ebrahim, S. (2005). Handbook of health research methods: investigation, measurement and analysis. Berkshire, UK. McGraw-Hill Education.
- Cooper, S.A, Melville, C.A., & Morrison, J. (2004). People with intellectual disabilities: their health needs differ and need to be recognised and met. *British Medical Journal, 329*, 414-415.
- DerSimonian, R., & Laird, N. (1986). Meta-analysis in clinical trials. *Controlled clinical trials, 7*(3), 177-188.
- Doherty, A. J., Jones, S. P., Chauhan, U., & Gibson, J. M. (2017). An integrative review of multicomponent weight management interventions for adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities, 0*: 1-13.
- Dombrowski, S. U., Sniehotta, F. F., Avenell, A., Johnston, M., MacLennan, G., & Araújo-Soares, V. (2012). Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: a systematic review. *Health Psychology Review, 6*(1), 7-32.
- Emerson, E. (2005). Underweight, obesity and exercise among adults with intellectual disabilities in supported accommodation in Northern England. *Journal of Intellectual Disability Research, 49*(2), 134-143.
- Fernhall, B., & Unnithan, V. B. (2002). Physical activity, metabolic issues, and assessment. *Physical Medicine and Rehabilitation Clinics of North America, 13*(4), 925-947.

- Flanders, W. D., Lin, L., Pirkle, J. L., & Caudill, S. P. (1992). Assessing the direction of causality in cross-sectional studies. *American journal of epidemiology*, 135(8): 926-935.
- Finlayson, J., Jackson, A., Cooper, S. A., Morrison, J., Melville, C., Smiley, E., et al. (2009). Understanding predictors of low physical activity in adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 22(3), 236-247.
- Fisher, E. (1986). Behavioral weight reduction program for mentally retarded adult females. *Perceptual & Motor Skills*, 62(2), 359-62.
- Fox, R. A., Haniotes, H., & Rotatori, A. (1984). A streamlined weight loss program for moderately retarded adults in a sheltered workshop setting. *Applied Research in Mental Retardation*, 5(1), 69-79.
- Goldstone, A. P., Holland, A. J., Hauffa, B. P., Hokken-Koelega, A. C., & Tauber, M. (2008). Recommendations for the diagnosis and management of Prader-Willi syndrome. *The Journal of Clinical Endocrinology & Metabolism*, 93(11): 4183-4197.
- Hamilton, S., Hankey, C. R., Miller, S., Boyle, C., & Melville, C. A. (2007). A review of # weight loss interventions for adults with intellectual disabilities. *Obesity Reviews*, 8(4), 339-45.
- Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., et al. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*, 116(9), 1081-1093.
- Hawkins, A., & Look, R. (2006). Levels of engagement and barriers to physical activity in a population of adults with learning disabilities. *British Journal of Learning Disabilities*, 34(4), 220-226.
- Higgins, J. P., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., et al. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *British Medical Journal*, 343, d5928. Retrieved from: www.cochrane-handbook.org.
- Higgins JPT, Green S. (editors). (2011). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0. The Cochrane Collaboration. Retrieved from: www.cochrane-handbook.org.
- Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *British Medical Journal*, 327 (7417), 557-60.
- Hsieh, K., Rimmer, J. H., & Heller, T. (2014). Obesity and associated factors in adults with intellectual disability. *Journal of Intellectual Disability Research*, 58(9), 851-863.
- Jinks, A., Cotton, A., & Rylance, R. (2011). Obesity interventions for people with a learning disability: an integrative literature review. *Journal of Advanced Nursing*, 67(3), 460-71.
- Kavouras, S. A., Panagiotakos, D. B., Pitsavos, C., Chrysohoou, C., Anastasiou, C. A., Lentzas, Y., et al. (2007). Physical activity, obesity status, and glycemic control: the ATTICA study. *Medicine and Science in Sports and Exercise*, 39(4), 606.
- Loveman, E., Frampton, G. K., Shepherd, J., Picot, J., Cooper, K., Bryant, J., et al. (2011). The clinical effectiveness and cost-effectiveness of long-term weight management schemes for adults: a systematic review. *Health Technology Assessment*, 15(2).
- McDermott, S., Whitner, W., Thomas-Koger, M., Mann, J. R., Clarkson, J., Barnes, T. L., et al. (2012). An efficacy trial of 'Steps to Your Health', a health promotion programme for adults with intellectual disability. *Health Education Journal*, 71(3), 278-290.
- McGuire, B. E., Daly, P., & Smyth, F. (2007). Lifestyle and health behaviours of adults with an intellectual disability. *Journal of Intellectual Disability Research*, 51(7), 497-510.
- McTiernan, A., Sorensen, B., Irwin, M. L., Morgan, A., Yasui, Y., Rudolph, R. E., et al. (2007). Exercise effect on weight and body fat in men and women. *Obesity*, 15(6), 1496-1512.

- Medical Research Council (MRC). (2000). A framework for the development and evaluation of RCTs for complex interventions to improve health. London UK: MRC.
- Medical Research Council (MRC). (2008). Developing and evaluating complex interventions: new guidance. London UK: *Medical Research Council*. Retrieved from: <http://www.mrc.ac.uk/documents/pdf/complex-interventions-guidance/>
- Melville, C. A., Boyle, S., Miller, S., Macmillan, S., Penpraze, V., Pert, C., et al. (2011). An open study of the effectiveness of a multi-component weight-loss intervention for adults with intellectual disabilities and obesity. *British Journal of Nutrition*, 105(10), 1553-1562.
- Melville, C. A., Cooper, S. A., Morrison, J., Allan, L., Smiley, E., & Williamson, A. (2008). The prevalence and determinants of obesity in adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 21(5), 425-437.
- Melville, C. A., Hamilton, S., Hankey, C. R., Miller, S., & Boyle, S. (2007). The prevalence and determinants of obesity in adults with intellectual disabilities. *Obesity Reviews*, 8(3), 223-230.
- Melville, C. A., Mitchell, F., Stalker, K., Matthews, L., McConnachie, A., Murray, H. M., et al. (2015). Effectiveness of a walking programme to support adults with intellectual disabilities to increase physical activity: walk well cluster-randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, 12(1), 1.
- Michie, S., Ashford, S., Sniehotta, F. F., Dombrowski, S. U., Bishop, A., & French, D. P. (2011). A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: the CALO-RE taxonomy. *Psychology & Health*, 26(11), 1479-1498.
- Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., et al. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, 46(1), 81-95.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264-269.
- National Institute for Health and Clinical Excellence (NICE). (2007). Behaviour Change at Population, Community and Individual Levels. UK London: NICE.
- National Institute for Health and Clinical Excellence (NICE). (2014). Obesity: identification, assessment and management of overweight and obesity in children, young people and adults. *CG189*. UK London: NICE.
- National Institute of Health (NIH), N., National Heart, Lung, and Blood Institute, & North American Association for the Study of Obesity. (2000). The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults." *NIH Publication Number DO-4084*, 35-38.
- O'Donovan, G., Blazeovich, A. J., Boreham, C., Cooper, A. R., Crank, H., Ekelund, U., et al. (2010). The ABC of Physical Activity for Health: a consensus statement from the British Association of Sport and Exercise Sciences. *Journal of Sports Sciences*, 28(6), 573-591.
- Pett, N., Clark, L., Eldredge, A., Cardell, B., Jordan, K., Chambless, C., et al. (2013). Effecting healthy lifestyle changes in overweight and obese young adults with intellectual disability. *American Journal on Intellectual & Developmental Disabilities*, 118(3), 224-43.
- Scottish Intercollegiate Guideline Network (SIGN). (2010). Management of Obesity: A

- National Clinical Guideline. UK Edinburgh: SIGN.
- Spanos, D., Melville, C.A., & Hankey, C.R. (2013). Weight management interventions in adults with intellectual disabilities and obesity: A systematic review of the evidence. *Nutrition Journal*, 12, 1-16.
- Stanish, H. I., & Frey, G. C. (2008). Promotion of physical activity in individuals with intellectual disability. *salud pública de méxico*, 50, s178-s184.
- Stevens, J., Truesdale, K. P., McClain, J. E., & Cai, J. (2006). The definition of weight maintenance. *International Journal of Obesity*, 30(3), 391-399.
- van Schroyen Lantman-de, H. M., & Walsh, P. N. (2008). Managing health problems in people with intellectual disabilities. *British Medical Journal*, 337, a2507.
- Willems, M., Hilgenkamp, T. I., Havik, E., Waninge, A., & Melville, C. A. (2016). Use of behaviour change techniques in lifestyle change interventions for people with intellectual disabilities: A systematic review. *Research in Developmental Disabilities*.
- World Health Organization. Overweight and obesity factsheet. 2015. Retrieved from: <http://www.who.int/mediacentre/factsheets/fs311/en/>
- Yumuk, V., Tsigos, C., Fried, M., Schindler, K., Busetto, L., Micic, D., et al. (2015). Obesity Management Task Force of the European Association for the Study of Obesity. European guidelines for obesity management in adults. *Obesity facts*, 8(6), 402-424.

7. Figures and Tables

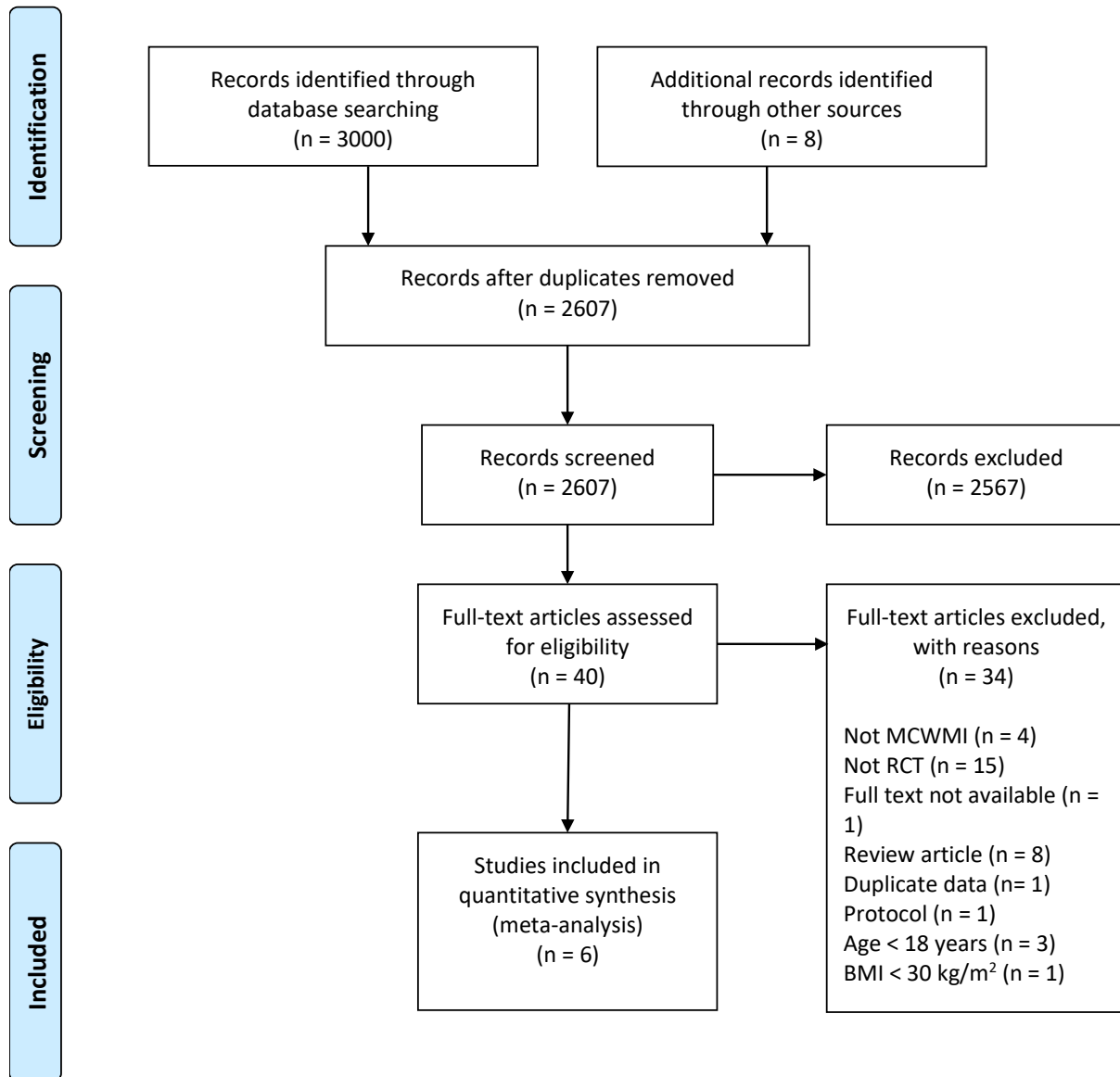


Figure 1. PRISMA flow chart (Adapted from Moher *et al.*, 2009).

Reference	Random sequence generation (selection data)	Allocation concealment (selection bias)	Blinding of participants and researchers (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome bias (attrition bias)	Selective outcome reporting (reporting bias)	Other bias
Beeken (2013/2015)	+	?	?	+	+	?	+
Bergstorm (2013)	+	+	?	?	+	+	+
Fisher (1986)	?	?	?	?	+	-	+
Fox (1984)	?	?	?	?	+	+	+
McDermott (2012)	?	?	?	?	-	+	+
Pett (2013)	?	?	?	?	+	+	-

Figure 2. Risk of bias assessment of studies included in the review of multi-component weight management interventions for adults with intellectual disabilities and obesity. Adapted from the Cochrane Handbook (Higgins *et al.*, 2011).

Reference	Intervention		Control		Mean difference (95% CI)
	Mean (SD)	N	Mean (SD)	N	
Beeken <i>et al.</i> (2013)	0.00 (2.79)	21	0.30 (3.49)	19	-0.30 (-2.25 to 1.65)
Bergström <i>et al.</i> (2013)	-0.85 (7.53)	26	2.36 (4.26)	18	-3.21 (-7.06 to 0.64)
McDermott <i>et al.</i> (2012)	-0.13 (2.76)	106	0.04 (3.38)	35	-1.17 (-1.03 to 0.70)
Pooled Estimate (Random Effect)		153		72	-0.38 (-1.34 to 0.58)

Tests for heterogeneity: $p = 0.32$, $I^2 = 12.4\%$, $T^2 = 0.1$

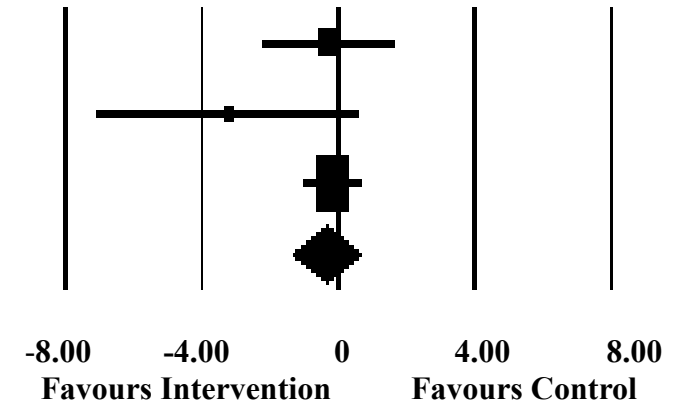


Figure 3. Weighted mean difference in body weight (kg) between the multi-component interventions and control interventions (Post intervention).

Reference	Intervention		Control		Mean difference (95% CI)
	Mean (SD)	N	Mean (SD)	N	
Bergström <i>et al.</i> (2013)	-0.85 (7.53)	26	2.36 (4.26)	18	-3.21 (-7.06 to 0.64)
McDermott <i>et al.</i> (2012)	-0.58 (5.33)	56	-0.57 (4.26)	49	0.00 (-1.87 to 1.86)
Pooled Estimate (Random Effect)		82		67	-1.15 (-4.15 to 1.86)
Tests for heterogeneity: $p = 0.14$, $I^2 = 53.5\%$, $T^2 = 2.8$					

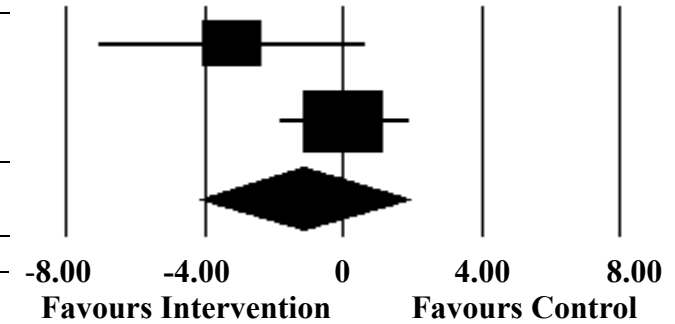


Figure 4. Weighted mean difference in body weight (kg) between the multi-component interventions and control interventions (12 month follow up).

Reference	Intervention		Control		Mean difference (95% CI)
	Mean (SD)	N	Mean (SD)	N	
Fisher, (1986)	-0.60 (2.10)	8	-1.00 (2.20)	9	0.40 (-1.65 to 2.45)
Fox <i>et al.</i> (1984)	-4.77 (3.08)	8	-4.77 (2.56)	8	0.00 (-2.78 to 2.78)
Pett <i>et al.</i> (2013)	-0.82 (3.72)	11	-2.72 (4.66)	11	1.90 (-1.62 to 5.42)
Pooled Estimate (Random Effect)		27		28	0.55 (-0.94 to 2.05)
Tests for heterogeneity: $p = 0.69$, $I^2 = 0.0\%$, $T^2 = 0.0$					

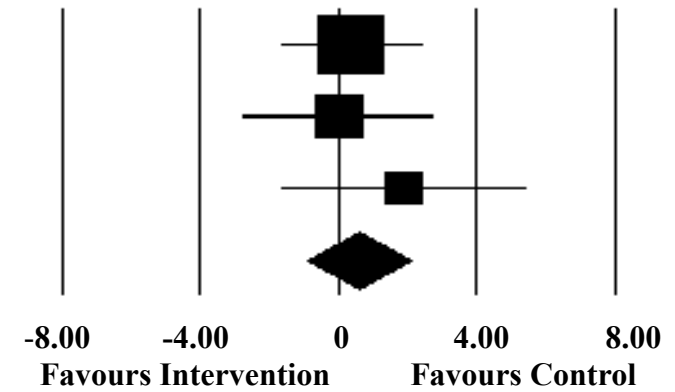


Figure 5. Weighted mean difference in body weight (kg) between the multi-component interventions and the active comparator interventions (Post intervention).

Table 1. Overview of study characteristics of multi-component weight management interventions

Reference	Study Population		Duration of active intervention (follow up)	Interventions	Attrition
Beeken <i>et al.</i>, (2013/2015)	Shape UP-LD intervention N = 25 Age: ≥ 18 years BMI: ≥ 25 kg/m ² ID: Mild/Moderate	Control Treatment as usual N = 25 Age: ≥ 18 years BMI: ≥ 25 kg/m ² ID: Mild/Moderate	12 weeks (3 months/6 months)	Session duration: 90 minutes Session frequency: 1/week Delivery: Sessions conducted in groups by a health professional	Shape UP-LD Enrolled: N = 25 Completed: N = 22 Control: Enrolled: N = 25 Completed: N = 17 Attrition rate: 22%

Bergström et al., (2013)	Intervention N = 73 Age: 36.2 (10.1) years BMI: 30.0 (7.6) kg/m ² Gender: Male n = 27 (42.2%) Female n = 37 (57.8%) ID: Mild/Moderate	Control Waiting list control N = 66 Age: 39.4 (11.3) years BMI: 28.5 (6.6) kg/m ² Gender: Male n = 29 (43.9%) Female n = 37 (56.1%) ID: Mild/Moderate	12-15 months	Session duration: 90 minutes Session frequency: Not specified Delivery: Sessions conducted by care staff after a period of training	Intervention Enrolled: N = 73 Completed: N = 63 Control Enrolled: N = 66 Completed: N = 66 Attrition rate: 7.2%
Fisher et al., (1986)	Behaviour Self-control plus physical activity intervention N = 8 Age: ≥ 20 Weight status: Obese, 20% above desired weight for height	Behaviour Self-control intervention Comparator intervention N = 9 Age: ≥ 20	8 weeks (4 weeks)	Session duration: 60 minutes Session frequency: 2/week	Attrition rate: 0%

	Gender: Female ID: Mild/Moderate	Weight status: Obese, 20% above desired weight for height Gender: Female ID: Mild/Moderate		Delivery: Sessions were delivered in groups.	
Fox et al., (1984)	Behaviour Therapy + Buddy Reinforcement N = 8 Age: 27.5 (5.4) years Weight status: % overweight 34.7 (18.5) % Gender: Male n = 4 (50%) Female n = 4 (50%) IQ: 46.3 (12.1)	Behaviour Therapy Comparator intervention N = 8 Age: 29.5 (7.2) years Weight status: % overweight 44.4 (35.4) % Gender: Male 3 Female 5 IQ: 42.1 (8.4)	15 weeks (12 months)	Session duration: 60 minutes Session frequency: 2/week for 10 weeks weight loss, followed by 1/week for 5 weeks weight maintenance Delivery: Sessions conducted in groups by a recreational therapist	Attrition rate: 0%

McDermott et al., (2012)	STYH intervention N = 216 Age: 39 (range: 19-65) years BMI: 32.5 (range: 18.5 - 71.3) kg/m ² Gender: Male n = 218 (49.2%) Female n = 225 (50.8%) ID: Mild/Moderate	Control No treatment N = 216 Age: 39 (range: 19-65) years BMI: 32.5 (range: 18.5 -71.3) kg/m ² Gender: Male n = 218 (49.2%) Female n = 225 (50.8%) ID: Mild/Moderate	8 weeks (12 months)	Session duration: 90 minutes Session frequency: 1/week. Delivery: Sessions were conducted in groups by a health educator.	Total Enrolled: 443 Total Completed: 196 Attrition rate: 55.8%
Pett et al., (2013)	Intervention with young adults N = 12 Age: 23.6 (3.1) years BMI: 39.0 (8.0) kg/m ² Gender: Male n = 4 (36.4%) Female n = 7 (63.6%) ID: Mild/Moderate	Intervention with young adults + parents Comparator intervention N = 11 Age: 25.6 (4.8) years BMI: 37.3 (5.2) kg/m ² Gender: Male n = 5 (45.5%) Female n = 6 (54.5%) ID: Mild/Moderate	12 weeks (3 months)	Session duration: 90 minutes Session frequency: 2/week Delivery: Sessions were conducted in groups by recreational centre staff	Young adults Enrolled: 12 Completed: 11 Young adults + parents Enrolled: 11 Completed: 11

Attrition rate:

4.3%

Table 2. Frequency of behaviour change techniques

Behaviour Change Techniques	N	%
26. Prompt practice	6	100.0
21. Provide instruction on how to perform the behaviour	4	66.7
8. Barrier identification/problem solving	4	66.7
7. Action planning	3	50.0
16. Prompt self-monitoring of behaviour	3	50.0
22. Model/demonstrate the behaviour	3	50.0
29. Plan social support/social change	3	50.0
36. Stress management/emotional control training	3	50.0
1. Provide information on consequences of behaviour in general	2	33.3
5. Goal setting (behaviour)	2	33.3
6. Goal setting (outcome)	2	33.3
10. Prompt review of behavioural goals	2	33.3
11. Prompt review of outcome goals	2	33.3
13. Provide rewards contingent on successful behaviour	2	33.3
17. Prompt self-monitoring of behavioural outcome	2	33.3
18. Prompting focus on past success	2	33.3
19. Provide feedback on performance	2	33.3
24. Environmental restructuring	2	33.3
39. General communication skills training	2	33.3
9. Set graded tasks	1	16.7
12. Prompt rewards contingent on effort or progress towards behaviour	1	16.7
14. Shaping	1	16.7
20. Provide information on where and when to perform behaviour	1	16.7
27. Use of follow-up prompts	1	16.7
35. Relapse prevention/coping planning	1	16.7
40. Stimulate anticipation of future rewards	1	16.7
2. Provide information on consequences of behaviour to the individual	0	0.0
3. Provide information about others' approval	0	0.0

4. Provide normative information about others' behaviour	0	0.0
15. Prompting generalisation of a target behaviour	0	0.0
23. Teach to use prompts/cues	0	0.0
25. Agree behavioural contract	0	0.0
28. Facilitate social comparison	0	0.0
30. Prompt identification as role model/position advocate	0	0.0
31. Prompt anticipated regret	0	0.0
32. Fear arousal	0	0.0
33. Prompt self-talk	0	0.0
34. Prompt use of imagery	0	0.0
37. Motivational interviewing	0	0.0
38. Time management	0	0.0
