Review

Behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity: a systematic review and meta-analysis

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Summary

Poor adherence to lifestyle intervention remains a key factor hindering treatment effectiveness and health outcomes for adults with obesity. The aim of this systematic review and meta-analysis is to determine if behavioural treatment strategies (e.g. goal setting, motivational interviewing, relapse prevention, cognitive restructuring etc.) improve adherence to lifestyle intervention programmes in adults with obesity. Randomized controlled trials that investigated the use of behavioural treatment strategies in obesity management were identified by systematically reviewing the literature within Medline, PsycINFO, CINAHL, SPORTDiscus and Web of Science from their inception to August 2016. This meta-analysis shows that behavioural treatment interventions have a significant positive effect on session attendance (percentage) and physical activity (total min/week) in adults with obesity ($M = 17.63$ (95% confidence interval (CI) $= 10.77, 24.50$), $z = 5.0337$, $P < 0.0001$ and $M = 105.98$ (95% CI $= 58.64, 153.32$), $z = 4.3878$, $P < 0.0001$, respectively). This meta-analysis of randomized controlled trials provides evidence that behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity. These strategies should be routinely incorporated into lifestyle intervention, obesity management and weight loss programmes with the aim of improving engagement and adherence. If adherence were improved, treatment effectiveness, health outcomes and the ultimate burden of chronic disease could also be improved.

Keywords: Adherence, behavioural treatment, meta-analysis, obesity.

Introduction

Lifestyle intervention and weight loss programmes designed for adults with obesity (body mass index >30 kg/m^2) frequently report disappointing outcomes and reduced effectiveness due to poor attendance and adherence rates (1–11). Adults with obesity have been shown to have significant and unique barriers to behaviour change (12); therefore, implementing the lifestyle modifications required to reach treatment goals can prove extremely challenging. As knowledge alone is typically insufficient to alter behaviour, behavioural treatment strategies are commonly adopted with the aim of assisting individuals to develop the set of skills required to overcome barriers and modify their behaviours (13–15). It has been suggested that by incorporating behavioural approaches in obesity treatment, individuals are better able to adhere to lifestyle intervention programmes and sustain behaviour change in the long term. The behavioural treatment strategies commonly used in the behavioural treatment of obesity are summarized below.

Self-monitoring

Throughout treatment, individuals are asked to actively monitor a variety of target behaviours and related factors, commonly diet, physical activity, mood and weight (16). The act of self-monitoring can raise awareness of positive and detrimental habits, provide on-going feedback to the

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individual and their treating team, enhance motivation and offer accountability. Often considered the cornerstone of behavioural treatment of obesity, it has been shown to improve weight loss (17–19) and facilitate behaviour change (20,21).

Stimulus control

This incorporates a variety of techniques aimed at modifying the external environment to make it more conducive to supporting behaviour change goals (13). Stimulus control can be used to increase or decrease specified behaviours and are best individualized. Examples include not buying temptation foods, only eating at the table, using smaller crockery and laying out exercise clothes the night before.

Motivational interviewing

This is a form of collaborative conversation aimed at enhancing an individual's own motivation and commitment to behaviour change (22). The effective use of motivational interviewing requires a skilled and practiced clinician who is able to move away from the traditional teaching style of consultation. Rather than educate, the clinician directs the individual towards self-motivational statements, or 'change talk', in an attempt to explore ambivalence and shift their readiness to change (23).

Behavioural contracting

A contract or agreement may be reached between an individual and their treating team to outline the consequences and/or rewards that would follow certain pre-identified behaviours or outcomes. This is thought to enhance motivation and accountability to cooperate with treatment plans.

Cognitive restructuring

This involves challenging problematic thoughts, emotions and ideas that undermine efforts and hinder treatment adherence (24,25). It commonly involves managing unrealistic weight loss expectations (26), all-or-nothing thinking and negative thoughts/moods (27).

Dissociation

This attentional strategy can be used to dissociate from both temptation foods and perceived effort sensations during low to moderately intense physical activity, thereby enhancing adherence to dietary and exercise programmes (28).

Self-reinforcement

This incorporates reinforcement in the form of both self-reward and self-punishment, the former appearing more effective than the latter (29). The type of reinforcement most effective for motivating behaviour change is highly individual. Extrinsic motivators or incentives such as money or a new outfit are common; however, the power of intrinsic motivation (self-enjoyment or satisfaction from achieving a goal) should not be underestimated (30).

Relapse prevention and Problem solving

This is aimed to assist individuals use problem-solving solutions to cope effectively when faced with barriers and pre-identified high-risk situations (31). Both relapse prevention and problem-solving methods have been shown to produce significantly greater long-term weight loss and programme adherence when compared with standard behaviour therapy (32).

Goal setting

A key component of cognitive behavioural therapy, goal setting has been shown to be effective in focusing attention (33) and providing structure to treatment. Goals must be specific, measurable, attainable, realistic and time-framed (34) to facilitate a clear assessment of success. Regular monitoring and re-evaluation of set goals is crucial.

Determining which behavioural strategies will prove useful is clearly individual and most likely transient throughout the different stages of an intervention. However, for most people, a combination of several techniques will prove most effective. In order to conceptualize these strategies and the combinations most likely to facilitate change and support adherence, it is important to recognize that most are based primarily on a number of overarching behavioural models and theories. Interventions aimed at improving adherence are often based on these behavioural models and theories and therefore employ the associated behavioural strategies within their treatment. Those commonly used in the behavioural treatment of obesity are summarized below.

The *trans-theoretical model* involves individuals progressing through a series of behaviour change stages: pre-contemplation, contemplation, preparation, action and maintenance (35,36). Research demonstrates that when there is a mismatch between the stage of change and the behavioural treatment strategy, attrition rates are high (31); therefore, ensuring the behavioural treatment strategies selected match an individual's stage of change is important for adherence. Behavioural contracting and self-monitoring, for example, may not be appropriate for

somebody who is still in the pre-contemplation or contemplation stages of change.

The *health belief model* and *decision theory* both involve an individual weighing the pros and cons of taking action, in this case making a positive health behaviour change (37,38). A decisional balance sheet is commonly used to promote awareness of the benefits of making a change, as well as highlight the potential barriers that may need addressing. Goal setting, problem solving, relapse prevention and motivational interviewing are just a few examples of behavioural treatment strategies that may be called upon when discussing the pros and cons of taking action.

The *theory of reasoned action* postulates that a certain change in behaviour can be predicted based on an individual's intention to perform it, which is influenced by personal attitude as well their perception of the social norm regarding a particular behaviour (31,39). The *theory of planned behaviour* incorporates both subjective norms and personal attitudes but also regards self-efficacy as a key factor in predicting behaviour (40). An understanding of both of these theories is crucial when determining the most effective behavioural treatment strategies to employ. Cognitive restructuring may prove useful if there are problematic thoughts regarding a particular action. Likewise, motivational interviewing may improve self-efficacy.

Social cognitive theory also considers an individual's self-efficacy to be an important determinant of behaviour change, along with their outcome expectations of a particular behaviour. Social cognitive theory proposes that human functioning is dependent on the reciprocal and interactive nature of personal, behavioural and environmental factors (41–44). It is frequently cited within adherence interventions, with increases in self-efficacy often associated with improvements in the behaviour being studied (31).

Self-determination theory posits that an individual's motivation, performance and well-being are related to his or her social and environmental conditions (30). Intrinsic and extrinsic motivation are core constructs of self-determination theory. Identifying an individual's intrinsic and extrinsic motivators will assist when goal setting, behavioural contracting and while considering self-reinforcement options, to name a few.

While taking a behavioural approach has been shown to increase the effectiveness of weight loss programmes (14,45–48), this is the first systematic review and meta-analysis to investigate the efficacy of behavioural treatment strategies with regards to adherence. Although a number of behavioural treatment strategies have been summarized separately, they are typically used collectively in both research and clinical practice (49) and, for this reason, will be assessed as one within this review. We hypothesize that incorporating behavioural treatment strategies will improve adherence to lifestyle intervention programmes in adults with obesity. If adherence to health recommendations and lifestyle intervention programmes were improved, treatment effectiveness, health outcomes and the ultimate burden of chronic disease could also be improved.

Methods

Literature search

The following databases were searched from their inception to August 2016: Medline, PsycINFO, CINAHL, SPORT-Discus and Web of Science. The following search terms were used: obes* AND (adherence OR compliance OR attrition) AND (lifestyle OR behavio* OR intervention) AND ('self-efficacy' OR 'problem solving' OR motivation* OR 'self-regulation' OR cognitive). Additional studies were also identified from reference lists of included studies and review articles retrieved from the primary search.

Study selection

Studies were included if they were peer-reviewed randomized controlled trials published in the English language; the sample populations had a body mass index (BMI) ≥ 30 kg/m^2; they investigated the use of behavioural treatments in obesity management; and adherence was an outcome variable. Studies were excluded if there was insufficient data available to complete the meta-analysis, and authors were unable to provide the required data.

Data extraction and analysis

For each study, sample size, mean and standard deviation were extracted for both intervention and control groups for a range of adherence measures. Where necessary, study authors were approached for additional data if needed for completion of the meta-analysis. The meta-analysis was performed using R Foundation for Statistical Computing (50) and its associated meta-analysis package Metafor (51). A random effects meta-analysis was performed using restricted maximum likelihood estimation.

As this meta-analysis focuses specifically on participant adherence, an intention to treat approach was required for accuracy and transparency. For the studies that did not use an intention to treat approach (52–54), reported data was re-calculated to account for drop-outs. The equations used to re-calculate mean (*M*) and standard deviation (*SD*) are as follows:

$$M(\text{including dropouts}) = M(\text{excluding dropouts}) * n(\text{excluding dropouts}) / n(\text{including dropouts});$$
$$SD(\text{including dropouts}) = SD(\text{excluding dropouts}) * \sqrt{n(\text{excluding dropouts})} - 1 / \sqrt{n(\text{including dropouts})} - 1.$$

The outcome variable of session attendance was measured in several different ways within the included studies,

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the two most common being number of sessions attended and percentage of sessions attended. In order to include as many studies as possible within the meta-analysis, those studies using number of sessions attended (number) were subjected to further calculations to convert mean and standard deviations to percentage of sessions attended (percentage). The following calculations were used:

$$M(\text{percentage}) = M(\text{number})/$$
$$\text{total number of possible sessions} * 100;$$
$$SD(\text{percentage}) = n/(n-1) * \sqrt{sp^2}$$

where:

$$sp^2 = 100^2/n^2 * (s^2 + M^2) - P^2$$

Results

The systematic literature search identified 30 studies investigating the use of behavioural treatments in obesity management. After all 30 articles were read in full, nine studies remained that met the inclusion criteria and had adequate data to be included within the meta-analysis. One of these studies had two interventions included within one paper (55), while another had three studies (across three countries) written within one paper (56). This therefore allowed for statistical analysis to be completed on 12 interventions. The dependency between results from the same study was accounted for using a multi-level modelling approach.

Study characteristics

The included studies investigated a variety of behavioural treatment strategies, including motivational interviewing, goal setting, self-monitoring, problem solving, stimulus control, relapse prevention, behavioural contracting, dissociation, cognitive restructuring and self-reinforcement. A range of adherence outcome measures were used, including session attendance (number, percentage), attrition, dietary intake (total calories/day, % calories from fat, protein and carbohydrates, fruit and vegetable serves/day), physical activity (frequency, total min/week, total METS/week, Kcal/week/kg, total steps/day) and self-monitoring compliance (number of diaries completed; level of completion of diaries, number of days blood glucose was monitored, number of days calories were recorded). The adherence outcomes measured within the included studies are shown in Table 1.

Statistical analysis was performed for the adherence measures session attendance (percentage) and physical activity (total minutes/week). These two were chosen due to sufficient studies measuring these outcome variables. Control groups obtained standard fitness/wellness centre practices (53,55,57), a standard behavioural weight loss programme (23,58,59), typical health education/counselling (54,56) or a relaxation intervention (52).

Overall findings

This meta-analysis shows that behavioural treatment interventions have a significant positive effect on adherence in adults with obesity. The average effect size for session attendance (percentage) was 17.63 (95% confidence interval (CI) = 10.77, 24.50), $z = 5.0337$, $P < 0.0001$; see Fig. 1. The average effect size for physical activity (total min/week) was 105.98 (95% CI = 58.64, 153.32), $z = 4.3878$, $P < 0.0001$; see Fig. 2. A considerable heterogeneity level was noted for both session attendance and physical activity ($Q = 32.518$, df = 9, $P = 0.0002$ and $Q = 8.8429$, df = 3, $P = 0.0315$, respectively). Publication bias was assessed using funnel plots; however, given the limited availability of studies, we are unable to draw any definite conclusions regarding publication bias. A summary of the characteristics and effect sizes of the included studies can be seen in Table 2.

Discussion

This systematic review and meta-analysis aimed to investigate if behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity. Behavioural treatment strategies were found to significantly improve adherence, with significant positive effects found for both session attendance (percentage) and physical activity (total min/week). Improvements were also seen in a vast array of other adherence markers, including attrition rates (52,55–57), self-monitoring (58) and other physical activity outcomes such as physical activity frequency (52,58) and steps/day (54).

Strength and limitations of this review and reviewed studies

This systematic review and meta-analysis is the first to investigate if behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity. While the behavioural treatment of obesity is a popular topic of commentary for narrative reviews, the critical and systematic appraisal of formal research within this area was timely. It was also crucial to fill this gap within the literature because adults with obesity are a vulnerable group with extremely poor rates of adherence and less willingness to adhere to healthcare recommendations (60).

A considerable heterogeneity level was noted for both session attendance and physical activity, indicating the

Table 1 Adherence outcomes measured within the included studies

Adherence outcome	Study	Measure
Session attendance	Berfort et al. (2008) (23)	Sessions attended (n)
	Schelling et al. (2009) (52)	Sessions attended (n)
	Annesi et al. (2011) (53)	Session attendance ratio (%)
	Annesi et al. (2008) (55)	Session attendance ratio (%)
	Smith et al. (1997) (58)	Sessions attended (n)
	Annesi et al. (2003) (56)	Session attendance ratio (%)
	Annesi et al. (2000) (57)	Session attendance ratio (%)
Physical activity	Berfort et al. (2008) (23)	Minutes of physical activity/week
		Energy expenditure (kcal/kg/week)
	Schelling et al. (2009) (52)	Minutes of physical activity/week
		Weekly physical activity sessions
	Carels et al. (2007) (59)	Minutes of physical activity/week
	Silva et al. (2010) (54)	Minutes of physical activity/week
	Smith et al. (1997) (58)	Exercise frequency (days)
Attrition	Schelling et al. (2009) (52)	Participant dropout
	Annesi et al. (2008) (55)	Participant dropout
	Annesi et al. (2003) (56)	Participant dropout
Dietary intake	Berfort et al. (2008) (23)	Total daily calories
		% Calories from fat
		Daily fruit/vegetable intake
	Carels et al. (2007) (59)	Total daily calories
		% Daily intake of fat, protein and carbohydrates
Self-monitoring compliance	Berfort et al. (2008) (23)	# Of self-monitoring logs turned in
		Level of completion of self-monitoring logs
	Smith et al. (1997) (58)	# Of diaries turned in
		# Of days glucose monitored
		# Of days calories recorded

presence of variation in true effect sizes underlying the included studies. The magnitude of the intervention effects may therefore hold less value; however, since nearly all included studies trend towards positive outcomes, the positive direction of the effect is still a significant finding. Also, since clinical and methodological diversity are bound to occur in a meta-analysis, some may argue that statistical heterogeneity is inevitable (61). The limited availability of

studies to include within this meta-analysis is another cause of heterogeneity and one that simply reflects the need for more research to be conducted in this area. Publication bias is also problematic to draw conclusions on due to the small number of studies available for inclusion.

A few limitations were detected within the included studies. Firstly, three of the included studies (52–54) did not use an intention to treat approach. When adherence is a
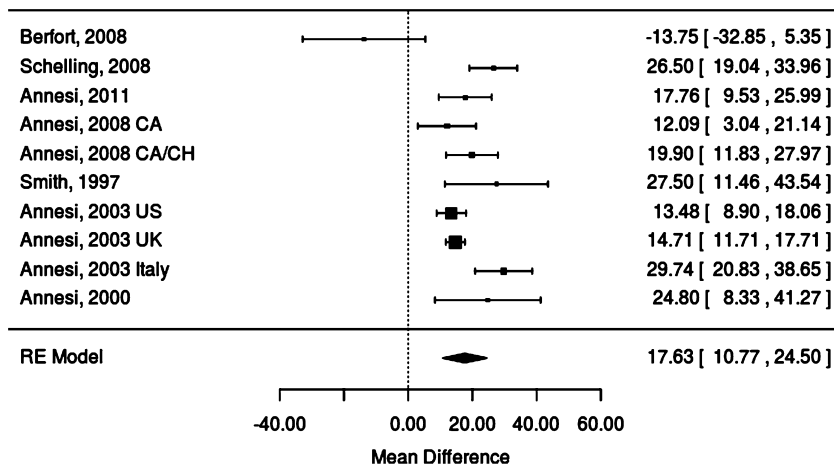

Berfort, 2008	-13.75 [-32.85 , 5.35]
Schelling, 2008	26.50 [19.04 , 33.96]
Annesi, 2011	17.76 [9.53 , 25.99]
Annesi, 2008 CA	12.09 [3.04 , 21.14]
Annesi, 2008 CA/CH	19.90 [11.83 , 27.97]
Smith, 1997	27.50 [11.46 , 43.54]
Annesi, 2003 US	13.48 [8.90 , 18.06]
Annesi, 2003 UK	14.71 [11.71 , 17.71]
Annesi, 2003 Italy	29.74 [20.83 , 38.65]
Annesi, 2000	24.80 [8.33 , 41.27]
RE Model	17.63 [10.77 , 24.50]

Figure 1 Forest plot with combined results of meta-analysis for behavioural treatment strategies effect on session attendance (*n* = 10). Mean difference and 95% confidence interval shown.
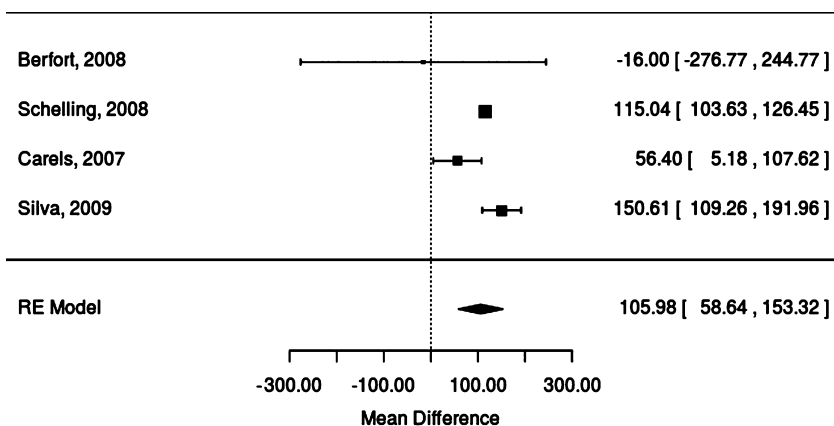
Figure 2 Forest plot with combined results of meta-analysis for behavioural treatment strategies effect on physical activity (*n* = 4). Mean difference and 95% confidence interval shown.

key outcome variable, dropouts must be included within the final results in order to provide clear and transparent findings. This review accounted for dropouts within these studies by re-calculating their raw data. Secondly, many studies investigating the effect of behavioural treatment strategies could not be included within this review as they did not include a control group within their study design. We encourage researchers to ensure that a control group is utilized so that the true effect of an intervention can be measured.

Finally, an array of adherence outcomes were measured within the included studies, but only two – session attendance and physical activity – were reported frequently enough to warrant statistical testing. Dietary change was only measured within two of the included studies (23,59). This is a major limitation of the included studies and, consequently, this review as it is difficult to adequately measure adherence to lifestyle intervention programmes when dietary change is not one of the primary outcome measures. There is currently no accepted standard for reporting on adherence, and as a consequence, it is extremely difficult to pool findings on adherence outcomes. This issue has been discussed previously in a paper titled *Measuring and reporting attrition from obesity treatment programs: A call to action* (10). If there were standard outcome measures used to assess adherence, then interventions aimed at improving adherence could be more appropriately analysed and incorporated within clinical practice.

Clinical implications

The findings within this review highlight the importance of routinely incorporating behavioural treatment strategies into the management of obesity. They are novel, have significant implications for improving programme effectiveness and should be of interest to those at all levels of obesity management. High attrition rates and poor adherence are major factors hindering treatment effectiveness

and health outcomes for adults with obesity, with the consequences seen across clinical, community and research settings. The impact cannot be underestimated or downplayed as 'standard', as is so often reported in obesity research.

Significant steps must be taken to ensure adherence and attrition rates are improved, starting at the initial programme design phase. It is therefore recommended that all lifestyle intervention, obesity management and weight loss programmes incorporate a strong foundation of behavioural treatment. A combination of individually tailored strategies, implemented within a multi-disciplinary setting, will be best able to assist adults with obesity to overcome barriers and sustain behaviour change in the long term. Using a behavioural approach also has the added benefit of ensuring that barriers to behaviour change are being addressed in the initial phases of lifestyle intervention and at regular intervals throughout and that individualized treatment plans are being developed accordingly. This simple yet crucial step is often overlooked, especially in busy, time-poor clinical settings. While some may argue that behavioural approaches are becoming more frequent within obesity treatment and due credit must be given where this is the case, we believe that significant opportunities still remain within real-world clinical settings.

Research implications

Further research needs to be conducted to determine the effectiveness of using behavioural treatment strategies in real-world clinical settings. To date, a substantial portion of the research has been conducted in university-based clinic programmes (14). The effects may vary in community settings where there is potentially less time, resources and motivation to engage in behavioural treatment from both adults with obesity and their treating team.

While a significant positive effect on adherence has been shown, there is still much to learn regarding which

Table 2 Included study characteristics and effect sizes

Study	*N*: Intervention/control	Behavioural treatment strategies investigated	Adherence measure(s)	Effect size	Confidence interval (95%)
Berfort *et al.* (2008) (23)	20/23	Motivational interviewing Goal setting Self-monitoring Problem solving Stimulus control Social skills Relapse prevention	Attendance (percentage ratio) Physical activity (minutes/week)	−13.75 −16.00	−32.85, 5.35 −276.77, 244.77
Schelling *et al.* (2009) (52)	18/20	Motivational interviewing Problem solving	Attendance (percentage ratio) Physical activity (minutes/week)	26.50 115.04	19.04, 33.96 103.64, 126.45
Annesi *et al.* (2011) (53)	73/64	Goal setting Behavioural contracting Cognitive restructuring Stimulus control Dissociation Self-reward Problem solving	Attendance (percentage ratio)	17.76	9.53, 25.99
Annesi *et al.* (2008) (55)	81/64	Goal setting Behavioural contracting Cognitive restructuring Stimulus control Dissociation Self-reward Problem solving	Attendance (percentage ratio)	12.09	3.04, 21.14
Annesi *et al.* (2008) (55)	128/64	Goal setting Behavioural contracting Cognitive restructuring Stimulus control Dissociation Self-reward Problem solving	Attendance (percentage ratio)	19.09	11.83, 27.97
Smith *et al.* (1997) (58)	6/10	Motivational interviewing Self-monitoring Goal setting Problem solving	Attendance (percentage ratio)	27.50	11.46, 43.54
Annesi *et al.* (2003) (56) United States	307/291	Goal setting Relapse prevention Dissociation Cognitive restructuring Stimulus control Self-reinforcement Behavioural contracting	Attendance (percentage ratio)	13.48	8.90, 18.06
Annesi *et al.* (2003) (56) United Kingdom	540/525	Goal setting Relapse prevention Dissociation Cognitive restructuring Stimulus control Self-reinforcement Behavioural contracting	Attendance (percentage ratio)	14.71	11.71, 17.71
Annesi *et al.* (2003) (56) Italy	50/49	Goal setting Relapse prevention Dissociation Cognitive restructuring Stimulus control Self-reinforcement Behavioural contracting	Attendance (percentage ratio)	29.74	20.83, 38.65
Annesi *et al.* (2000) (57)	13/35	Goal setting Relapse prevention Cognitive restructuring Behavioural contracting	Attendance (percentage ratio)	24.80	8.33, 41.27

Table 2 *Continued*

Study	N: Intervention/ control	Behavioural treatment strategies investigated	Adherence measure(s)	Effect size	Confidence interval (95%)
Carels *et al.* (2007) (59)	28/27	Motivational interviewing	Physical activity (minutes/week)	56.40	5.18, 107.62
Silva *et al.* (2010) (54)	123/116	Motivational interviewing Goal setting Self-monitoring Problem solving Cognitive restructuring	Physical activity (minutes/week)	150.61	109.26, 191.96

strategies are the most effective and how they combine additively or synergistically to influence behaviour change. There are numerous questions still unanswered with significant future research potential; for example:

• Can strategy type be matched to the individual? How does baseline self-efficacy, stage of change or mood modify which strategy is best suited? What about matching to personality?
• How should the behavioural approach be modified and adapted over the course of treatment?
• Does setting and/or implementation method moderate the effects? That is, is face-to-face treatment most efficacious, or can social media and technology be used to our advantage?
• Obesity is a chronic and progressive condition requiring life-long intervention and support (12,62) – how can we practically provide long-term behavioural intervention across the lifespan?

Finally, researchers are encouraged to address the issue of adherence, especially when conducting interventions in obesity management. While there is a gap within the literature for research with a focus on adherence specifically, there is also a need for interventions of all types to routinely measure and report markers of adherence, such as attendance, attrition and compliance with diet and physical activity recommendations. This will aid our understanding of the determinants of adherence and inform future direction for lifestyle intervention programme design.

Conclusion

This meta-analysis of randomized controlled trials provides evidence that behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity. The findings within this review provide novel insight to clinicians working in obesity and have important implications for lifestyle intervention programme design. These strategies should be routinely incorporated into lifestyle intervention, obesity management and weight loss programmes with the aim of improving engagement and

adherence. Further research is required in this area to increase our understanding of the factors that contribute to adherence and how we can better assist adults with obesity. If adherence were improved, treatment effectiveness, health outcomes and the ultimate burden of chronic disease could also be improved.

Conflict of interest statement

No conflict of interest was declared.

Author contributions

All authors were involved in study design, literature search and writing of the article equally.

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