Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain

K. Elfhag and S. Rössner

Obesity Unit, Karolinska University Hospital Huddinge, Stockholm, Sweden

Received 21 June 2004; revised 30 September 2004; accepted 4 October 2004

Address reprint requests to: K Elfhag, Obesity Unit, M73, Karolinska University Hospital, SE-141 86 Stockholm, Sweden. E-mail: Kristina.Elfhag@medhs.ki.se

Summary

Weight loss is difficult to achieve and maintaining the weight loss is an even greater challenge. The identification of factors associated with weight loss maintenance can enhance our understanding for the behaviours and prerequisites that are crucial in sustaining a lowered body weight. In this paper we have reviewed the literature on factors associated with weight loss maintenance and weight regain. We have used a definition of weight maintenance implying intentional weight loss that has subsequently been maintained for at least 6 months. According to our review, successful weight maintenance is associated with more initial weight loss, reaching a self-determined goal weight, having a physically active lifestyle, a regular meal rhythm including breakfast and healthier eating, control of over-eating and self-monitoring of behaviours. Weight maintenance is further associated with an internal motivation to lose weight, social support, better coping strategies and ability to handle life stress, self-efficacy, autonomy, assuming responsibility in life, and overall more psychological strength and stability. Factors that may pose a risk for weight regain include a history of weight cycling, disinhibited eating, binge eating, more hunger, eating in response to negative emotions and stress, and more passive reactions to problems.

Introduction

Overweight and obesity are today recognized to be amongst the major public health problems of our society. The long-term weight loss results in weight loss programmes are usually modest (1–3). Most patients who lose weight will regain the weight.

Thus, clearly, we need to better understand why weight maintenance is so difficult and how it can be promoted. The identification of factors associated with weight loss maintenance can enhance our understanding of the behaviours and prerequisites that are crucial in sustaining a lowered body weight. Such knowledge has implications for what strategies should be trained and encouraged in treat-ment, the advice given at the weight maintenance phase as well as the selection of persons with a reasonable prospect for a long-term success in obesity treatments. The latter is a necessity for effective use of the limited resources available to treat the increasing number of obese people today. It also enables a professional awareness of the risk of exposing a patient to additional adverse psychological consequences of experiencing failure in treatment (1).

We were interested in describing research findings on factors of potential importance for weight maintenance. A further aim was to attempt to reach a coherent model of factors affecting weight maintenance, as this research area is often characterized by scattered findings without comprehensive frameworks.

Methods in evaluating weight loss maintenance

A definition of what constitutes weight maintenance should first be considered. Weight loss maintenance implies keeping a weight loss result that has been accomplished by treatment interventions or by one's own efforts. This would be the general definition shared across studies performed. The specific criteria used, however, differ. Examples of definitions are 'achieving an intentional weight loss of at least 10% of initial body weight and maintaining this body weight for at least one year' (4), or 'losing at least 5% of baseline body weight between baseline and follow-up, and maintaining that weight or less for a further two years' (5). Others have classified 'winners' and 'losers' based on losing or regaining more than, for example, 2 body mass index points after weight loss (6). To enable a review of the literature using very different definitions of weight maintenance we have used a more inclusive definition of weight maintenance that implies an initial weight loss that has been subsequently maintained for at least 6 months.

Another methodological consideration is that the time of assessment for evaluation of weight maintenance can differ. Pre-treatment factors determining later weight loss maintenance have the greatest informative value for recommendations on treatment assignments. Sometimes the patients are instead assessed at the time of discharge from active treatment and further weight development is predicted from these characteristics. Another common approach is to retrospectively identify those who can be classified as successful weight loss maintainers, and describe the behavioural characteristics of these persons as they manifest at the time of 'success'. Changes during treatment based on repeated measures have also been analysed in studying weight maintainers. The latter approaches can give information on the behaviours and strategies that could be more focused and encouraged in treatment programmes rather than on treatment assignment.

In our evaluation of factors affecting weight maintenance, we have included studies with these different methodological approaches. The studies include patient samples as well as general population samples. With this rather broad inclusion criterion, a fuller description of possible factors in weight maintenance could be derived.

The aim of this paper was to make a conceptual review of factors in weight maintenance that can contribute to an understanding of the critical individual characteristics and that could lead to a model to be further considered. The focus is mainly on behavioural and psychosocial factors that could describe the persons succeeding or failing to maintain a weight loss. It has been suggested that behavioural and psychological factors can be of particular importance for weight maintenance and should receive more attention (4,7).

We wanted to cover a fair range of potential factors in weight maintenance that could add to a comprehensive understanding, and we have given priority to papers in accordance with this purpose. The review is limited to articles written in English and published in peer-reviewed journals from 1980 to August 2004 covering adult samples. Literature was identified by searches performed in the computerized databases Medline and PsychInfo, and also from citations in identified articles.

The methodological data for the included studies that report results on weight maintenance are displayed in Appendix 1. The data shown are time of duration for the active weight loss phase and the weight maintenance phase, weight lost during active phase, type of interventions if any, and time of assessment. These data are reported to the extent that it was possible to extract information. The studies with results related only to weight loss and not weight maintenance are not listed in Appendix 1. The studies on weight maintenance have a defined shift from weight loss to a maintenance phase. Long-term weight outcome after gastric surgery lacking such a weight loss phase is, however, also considered. Some studies have evaluated the weight loss outcome for the total period rather than for the weight maintenance period. When this is so, this is reported in the column on *Assessment*. Initial body weights are given for the samples when such data were available, otherwise the body weights at the time of weight maintenance evaluation is given.

Factors in weight loss maintenance

Weight loss goals

It seems common for patients to have unrealistic expectations about the weight loss that will be achieved in treatment. In one study, none of the participants achieved the 'dream weight' that they had hoped for and most of them even ended up with a weight loss that before treatment they had considered as a failure, even though the standard treatment program was well designed and executed (8). Heavier patients, especially men, had lower target weights (9). That expectations about goal weights can be unrealistic has been confirmed in other studies (10). However, according to these results, men were more realistic in their approach to what could be achieved with a weight loss regimen than women.

The weight goals may be one factor to consider with regard to weight maintenance. Those who later maintained their weight have been found to have achieved their self-determined goal weight (11–13). It has been suggested that the failure to reach a self-determined weight may discourage the person's belief in their ability to control their weight, which will result in an abandonment of weight maintenance behaviours (14). This would mean that mod-

ifying weight loss goals can be important for subsequent results. Others have, however, questioned such a conclusion, arguing that the critical factor for long-term outcome may rather be the greater initial weight loss in those reaching their goal weight (12).

According to a small pilot study, having the participants seek only modest initial weight loss did not improve the weight maintenance (15). Another recent study has related the self-reported goal weight to later long-term weight loss and found no detrimental relationship, as suggested in earlier literature. A higher dream weight loss was, on the contrary, weakly associated with a greater long-term weight loss, and also with better mood, confidence in success and optimism at baseline (16). This suggests there can even be a role of optimism to be considered in the desire to reach a lower body weight. Unrealistic optimism is known to be a common psychological mechanism that can be healthy and adaptive, and that can also promote better health behaviours (17). A conclusion on weight loss goals is therefore that it can be a good prognostic sign to reach a self-determined goal weight, but we do not know enough about the mechanisms in this to state any clinical advice yet.

Weight loss patterns

Initial weight loss has been identified as a predictor for later weight loss, and also for weight loss maintenance in various treatments (12,18), further illuminated in an overview (19). The greater the initial weight loss, the better is the subsequent outcome. Such a predictor tells us that there is a consistent weight loss pattern from the beginning of the treatment. Initial weight loss can also reflect a better compliance with the treatment (18). It has been noted that the findings on initial weight loss challenge the clinical opinion that weight loss achieved at a slow rate would be better (19).

According to other results, larger amounts of weight loss during the total intentional weight loss phase have predicted more weight regain (20). It is still unclear how the early weight loss response that predicts long-term outcome should be defined. The complexity in evaluating the predictive value of weight loss patterns can be illustrated by a recent analysis of two long-term clinical trials with orlistat (21). In this analysis, weight loss of >5% body weight after 12 weeks of diet and orlistat was a good indicator of 2-year weight loss, whereas ≥2.5 kg initial weight loss during the 4-week lead-in (22) and ≥10% weight loss after 6 months did not add significantly to the prediction of the 2-year outcome.

Time of duration of weight loss has also been studied. The longer the weight loss has been maintained, the better the chances for further continuation of a lower body weight are (4,20). The subjects who have maintained weight losses

during a longer time report that they use less effort in continued weight control (23). The pleasure derived from controlling weight was not changed over time, suggesting a shift in balance towards overall greater pleasure that can promote further maintenance of body weight.

Physical activity

Physical activity is related to long-term weight maintenance according to many findings (4,5,24,25). Physical activity can facilitate weight maintenance through direct energy expenditure, and can also improve physical fitness which facilitates the amount and intensity of daily activities (26). Physical activity can also improve well-being, which may in turn facilitate other positive behaviours needed for weight maintenance (27).

Walking is one of the most frequent aspects of physical exercise reported by study participants; cycling and weight lifting also have some popularity (4). In the Sibutramine Trial on Obesity Reduction and Maintenance study (STORM-study), leisure time activity predicted weight maintenance in sibutramine treatment (18). Such leisure time physical activity included time spent in walking and cycling, and also implied less time spent in watching television. It is suggested these factors can discriminate a sedentary lifestyle from a more active one even better than a measure of sports activity.

A higher number of pedometer recorded daily steps (28) and other measures including everyday activities (29) has likewise been found among weight maintainers. A more impaired physical functioning in daily life implying limitations in the ability for ambulation, such as walking, has correspondingly predicted later weight relapse (30). Perceiving barriers in the life situation for carrying out physical activity has also been related to poorer weight maintenance, whereas confidence seen in self-efficacy concerning exercise may promote long-term weight management (31).

According to one review, the results on physical activity in weight gain are, however, not consistent (32). Prescribing exercise in experimental designs was, for example, only modestly related to later outcomes. Poor compliance in carrying out the exercise protocol was discussed as one reason for such discouraging results (33).

Dietary intake

Weight loss maintenance is obviously associated with lower total caloric intake (34) and reduced portion sizes (35). More specifically, weight maintenance is also associated with reduced frequency of snacks (36) and less dietary fat (4,5,29,36,37).

Reduction of particular food types such as French fries, dairy products, sweets and meat (38) and cheese, butter,

high-fat snacks, fried foods and desserts (39) has also been seen in persons better maintaining their weight. The importance of high quality foods such as fruits and vegetables (36) and healthy eating (40) has also been noted.

Changes towards a more regular meal rhythm has been identified as helpful in long-term weight loss (36), and regularly eating breakfast has furthermore been reported more often among weight maintainers (24,41). It is suggested that breakfast can reduce hunger, making the breakfast eaters choose less energy dense foods during the rest of the day, as well as giving better energy to perform physical activity during the day (41).

Eating patterns

Generally, eating behaviour has been evaluated during ongoing treatments. The most common measure of eating behaviours is the Three Factor Eating Questionnaire (TFEQ) (42), measuring eating restraint, disinhibition and hunger. Restraint means trying to resist from eating by conscious determination in order to control body weight. Disinhibition measures loss of control over eating, and the hunger scale shows the experience of hunger feelings and cravings for food.

Eating restraint is known to be associated with a lower amount of food intake (43), and the restraint increases with successful weight loss in behaviour modification treatments (30,44). This means restriction of food intake is accompanied by weight loss.

The contrary pattern, a decrease in eating restraint and increase in disinhibition have accordingly been found for those regaining their body weight (4,20). These types of data tell us that restraint in food intake leads to less food consumed and thus more weight loss, and that the control over food intake is crucial for weight development in programmes emphasizing the participants' efforts to reduce food intake by will.

Attempts to use data on eating patterns somewhat more prospectively, by comparing the eating patterns at the time of discharge from treatment in evaluating subsequent weight development, have also been made. In line with the earlier information on eating patterns, this revealed that reduction of disinhibited eating (6) and increase in cognitive restraint (45,46) during active treatment were positive predictors of post-treatment weight reduction and weight maintenance. Higher levels of dietary disinhibition assessed after an intentional weight loss phase (20) or during weight maintenance (28) have, in accordance with this, predicted weight regain. More hunger according to the TFEQ at discharge has also been shown to be a negative predictor of post-treatment weight development (6). This means more intense hunger and disinhibited eating poses a problem for subsequent overconsumption.

Another study has analysed pre-treatment data on eating behaviours as predictors of weight development after treatment (47). These results revealed that a high pre-treatment score on the TFEQ hunger scale predicted weight regain at follow-up after very low calorie diet (VLCD)-treatment. With more intense hunger initially, a VLCD treatment has thus not provided a solution to the participants eating behaviour on a more long-term basis. Often, however, the pre-treatment TFEQ scores have not provided predictive information on subsequent weight loss (30,44).

On the issue of control over eating behaviours, it has furthermore been suggested that more flexible control over eating behaviour is associated with weight maintenance rather than rigid control (48). Although eating restraint is often reported to be related to weight loss in behavioural treatments, such restraint has also been associated with periods of overeating, and is suggested to be a risk factor for the development of eating disorders (49). The rigid controls that could be considered as risk factors for such a subsequent total breakdown of controls can be described as a dichotomous 'all or nothing' approach to weight and eating. It implies extreme behaviours such as attempts to totally avoid sweets and liked foods. The flexible controls are rather characterized by a 'more or less' approach that can be adopted as a more long-term task (48).

Regainers have described that during dieting, they did not permit themselves any of the food they really enjoyed and therefore felt deprived (24). Recent research results show that maintaining initial treatment changes towards more flexible control predicts better long-term weight loss results (36), and flexible and rigid controls have been related to lower and higher body weights respectively (50). This suggests that rigid controls should not be encouraged in treatment of obese patients, and that flexible controls should rather be supported.

Binge eating

Binge eating constitutes a more pronounced problem in obese eating behaviour that has been recognized in the last few decades (51). The prevailing suggested definition of binge eating (Binge Eating Disorder), although still not a formal diagnosis, includes the consumption of large quantities of food without being in control of this behaviour, and also the experience of distress about the binge eating (52).

Binge eating as assessed after weight loss has predicted more subsequent weight regain (20). Gainers had more binge episodes per month in the initial assessment, and had also increased their number of binge episodes at one-year follow-up. A more profound disturbance in obese eating behaviour such as this can thus pose a problem in weight maintenance. Binge eating has also been related to a history of weight cycling (53), which would reflect prior failures in

maintaining weight loss. In obesity surgery, the weight regain after 5 years has been found to be considerably higher in binge eaters than in the patients without binge eating (54).

However, others conclude that binge eating status seems to be a weak prognostic indicator of weight regain, but that this relationship can be mediated by psychological dysphoria (53). In yet other studies, binge eating was not related to long-term weight loss outcome (55). Such a finding would suggest that although binge eating obviously implies more profound difficulties with eating behaviour, the binge eaters could also benefit from standard obesity programmes.

Self-monitoring

Self-monitoring means observing oneself and one's behaviour. Self-monitoring of body weight and food intake are important factors in weight loss as well as weight loss maintenance (4,56,57). Weight maintenance seems to require an ongoing adherence to weight-related behaviours. Regularly weighing oneself is an example of self-monitoring, as is recording the food intake consumed. Self-monitoring of food intake is suggested to reflect one component of cognitive restraint known to be important for weight control. It could also be suggested that these persons continue to use self-monitoring strategies that have been learned during the treatment phase (4). In weight regainers, self-monitoring has been shown to decline with time (20).

Being more aware and vigilant with regard to weight control has likewise been found to characterize weight maintainers according to interviews (13,24). The maintainers were, for example, more conscious about their dietary intake and made more conscious decisions with regard to food selection (13). Maintainers were also more aware that they needed to be conscious of their weight-related behaviours (24). The regainers on the other hand found it too difficult to remain in the state of prolonged consciousness needed to watch themselves over time (13).

Life events and social support

The surrounding environment and the life events facing the person trying to lose and maintain weight can facilitate as well as hamper the outcome. Experiencing stressful life events or rating one's life as stressful has been associated with weight regain (58–60). In follow-up assessments, the patients who regained weight after treatment have reported more psychosocial crises including major illnesses and bereavements (58) and personal or family stress and a busy schedule (60). Interviews with successful persons suggest that their maintenance of weight may depend on stable circumstances after the active behaviour changes (61). The

critical life events in this study included areas such as family relations and social activities.

Social support is considered to be an important aid for weight maintenance (62,63). Participating in a maintenance support group (60) as well as receiving support from friends (56,64) and having people available for social support (24) have been related to better weight maintenance.

According to a systematic review of family involvement in weight control, there are, however, mixed results for spouse's involvement. Sometimes there is an improved outcome at follow-up, sometimes there are better results for treating the members alone (65). In one study, weight maintenance was better for women treated together with their spouse, both being targeted for weight loss and social support strategies, whereas the men did better when treated alone (66). In two other studies including the spouses to provide support, comprising female and male participants respectively, weight maintenance was better for the women treated alone (67). For the men treated alone, better outcome was seen in one-year maintenance but with no difference at 2-year follow-up (56). Although support from the social context is often helpful, involvement from a close life partner is therefore not always unequivocally positive and can for some persons even interfere with long-term outcome.

Receiving prolonged treatment interventions and continuous professional support in the weight maintenance phase has often been found to improve treatment outcomes (68). Professional contact may, for example, enhance vigilance and motivation and provide encouragement and support. Such interventions, however, constitute a prolonged treatment phase based on the view of obesity as a chronic condition rather than factors in weight maintenance. A question has been raised whether such interventions can lessen the patient motivation to take responsibility for lifestyle changes (69). An essential component in an alternative view is instead to support the patient's full responsibility for lifestyle changes from the onset of treatment.

Stress and coping

Stress as an important risk factor has received additional attention. It can be more specifically the ability to cope with the stress that is crucial for the individual possibility to sustain the weight rather than the actual number of life changes and circumstances that are potential stressors (36,70,71). A common definition of coping refers to cognitive and behavioural efforts used to manage external and internal demands that are appraised as taxing, or that exceed the resources of the person (72).

The research findings on regainers describe poor coping strategies. A common characteristic identified in regainers is that they tend to eat in response to stressful or negative life events and negative emotions that can be evoked by

stressors in everyday life (24,70) and the tendency to use eating to regulate mood (13,24). Rather than using direct ways to handle problems in life, it was further common to use escape-avoidance ways of coping that included eating, sleeping more and passively wishing that the problem would vanish (24). Persons likely to regain their weight have also reported being more help-seeking as a way to cope with dietary lapse, such as seeking help from a friend, spouse or family member, or to start a weight-loss programme (73). This finding was discussed as suggesting a lack of self-sufficiency or self-efficacy. Others, however, have shown contrary results on help-seeking and weight maintenance (24).

Maintainers as compared with regainers have been reported to be able to cope more easily with cravings (74), and to use direct coping in relapse situations (73). Such direct coping included treating the relapse as a small mistake, recover and lose again, increase exercise and start controlling food intake (73). Being active and doing something (anything) rather than being passive in response to an overeating episode and regaining control quickly, has also predicted better weight maintenance (56). The maintainers furthermore seem more prone to use effective problem solving skills and confrontive ways of coping with demands in life (24,70). This included finding new solutions, using concepts taught in treatment (70) or using other strategies such as relaxation techniques or even working more (24).

Overeating clearly is an unfortunate coping strategy in obesity, and it can reflect the absence of a mobilization of more efficient coping. Having a passive orientation can sometimes represent a less successful approach than finding one's own solutions and being more active. Personality factors can be important for the ability to find coping strategies to be used in various life situations rather than reverting to old eating habits.

Coping capacity has also been shown to increase during treatment of obese patients (75). The improvements in coping were considered to be general treatment effects as they were not dependent on type of treatment. Greater improvements in coping were found among the patients who had lost most weight.

Attitudes

Persons who were less prone to attribute the reason for their obesity to medical factors have been shown to be more successful in later maintaining weight loss (40). Moreover, the successful persons were more motivated to lose weight for reasons that related to having confidence in oneself rather than pressures from others or medical reasons. The confidence factors more specifically included increasing self-esteem, liking oneself more and feeling better with oneself (40).

Retrospective studies of successful weight maintainers have shown more concern with weight, shape and appearance in women successfully maintaining a lower body weight (76). The women were described as having developed a 'healthy narcissism' about their appearance and physical condition. Pride in appearance has been rated among the top four factors facilitating weight maintenance in another study, although it did not differ between weight maintainers and weight regainers (60). Caring about one's appearance and physical condition can thus be important for the motivation to control body weight.

The natural weight increase in female adolescents has also been shown to be somewhat less with higher physical appearance self-esteem as well as social self-esteem (77). It is suggested these young women can have higher levels of self-efficacy in weight controlling behaviours. A tendency to evaluate the self-worth in terms of weight and shape has, however, been associated with weight regain (13). Weight regainers have been found to see themselves as not just heavy, but also ugly (24).

Another study has described how women who had maintained their achieved weight loss were more self-confident and capable of taking responsibility over their lives and were found to assume responsibility for their need to lose weight. They had developed their own personally individualized diets, exercise and maintenance plans, and had also become more active outside the home (76). Personal strategies in weight maintainers have also been described by others (24). These women used strategies for weight control that were specific to the individual lifestyle, in personal weight loss plans that fit to their lives. Finding such personally adjusted strategies in weight control could be considered as a sign of psychological strengths and coping abilities as well as an awareness of one's own role in weight control.

Other results agreeing with the notion that taking responsibility for one's life is important for weight development have shown that maintainers attribute their success to their own determination and patience (74). The specific responses given were often related to having a definitive commitment and making up one's mind.

Motivation

Motivation for weight reduction would be one of the most obvious aspects in weight control, and it has been suggested from a literature search that many studies do find that a higher pre-treatment motivation is related to greater weight loss (78), although a few studies have found no relationship (79). In our search, we found few results on direct measures of initial motivation for weight loss with regard to subsequent weight maintenance, though. In one study weight regainers more commonly reported low motivation as an obstacle than the weight maintainers in follow-up assessments (60). A test developed to assess weight loss

readiness and motivation, the Weight Loss Readiness Test (WLRT) (80) has, however, failed to predict weight loss (78,81), with no data found on the test in relation to weight maintenance. Unpublished data from the WLRT at our obesity unit revealed no expected relationship to weight loss nor weight loss maintenance (K Elfhag & S Rössner, unfinished manuscript).

Locus of control

Locus of control concerns the extent to which control over one's life is experienced as internal or external. With an internal locus of control the outcome in life is perceived as a consequence of one's own actions, and that it is hence possible to influence how the future will turn out. An external locus of control rather means perceiving life as being determined by fate, chance or luck or being under the control of powerful others (82).

There are varying results concerning the relationship between locus of control and weight reduction (83). Some studies found that an internal locus of control is related to more weight loss, whereas other studies failed to identify a difference between 'internals' and 'externals' on locus of control. With regard to weight maintenance, some studies have likewise reported that those with an internal locus of control are more successful, interpreted as a better ability to assume full responsibility over one's own actions (83). A more specific measure of the locus of control over health (84) was, however, unrelated to weight maintenance (85).

Another specific locus of control scale targeting body weight has also been constructed, the Weight Locus of Control Scale (WLCS) (86), showing some relationship with weight loss (86) but with no information on weight maintenance. More internal control on this WLCS has in later research been related to having more confidence in weight loss behaviours whereas external control was related to perceiving external reasons for being overweight, perceiving several barriers to physical activity and being dissatisfied with the social support received (87).

Autonomy seen in autonomous motivation has predicted more regular attendance to a weight loss programme and better weight loss maintenance (85). Such autonomy implies an internal locus of causality for behaviour as opposed to controlled behaviours that have an external locus of causality. According to the self-determination theory, the probability that a person will persist with a behaviour or not depends on the extent to which they believe the idea for initiating and subsequently continue to regulate the behaviour which comes from within themselves (88). The participants who wanted to take part in the programme and lose weight by their very own decision were thus more successful.

To conclude, locus of control, or at least some aspect thereof, can sometimes be beneficial for later outcome. An internal locus of control would also have some resemblance to the concept of 'self-efficacy' (87) that has also received much attention in weight management.

Self-efficacy

Self-efficacy means a confidence in the personal ability to manage life obstacles and accomplish an achievement such as weight loss (89). Self-efficacy also entails the expectation of success.

Self-efficacy regarding weight loss (90), the ability to handle emotions and life situations (56) and exercise (31) have been related to later weight loss maintenance. Follow-up data on weight maintainers have also shown that they have more confidence in the ability to manage the weight than the weight regainers (60). With higher self-esteem, weight reduction was furthermore subsequently maintained over a longer period of time (83).

In another study, being more 'assured' was found to describe a subset of patients. These 'assured' were more independent and goal directed, and they had greater self-confidence about weight control, felt they 'had what it takes' for weight control and were not prone to give up easily (91). This would describe a greater self-efficacy. These more assured participants retained a lower body weight than the other subgroup described as 'disbelievers', but only until 2-year post-treatment when they had regained just as much as the disbelievers. Being a disbeliever implied a lower faith in the ability to control weight and giving up easily. Moving from being such a disbeliever to becoming more assured during treatment was also linked to a more favourable weight loss outcome. This shows that treatment interventions can also strengthen the self-confidence during treatment, leading to better outcomes. Improvements in self-efficacy in obesity treatments have also been described by others (92).

Personality

The personality characteristics enabling a more comprehensive understanding of the various behavioural manifestations are so far insufficiently studied in the research on weight development. According to studies that have used the personality inventory Karolinska Scale of Personality (KSP) (93), a scale for Socialization, has been positively related to weight loss maintenance in two studies (94,95). Scores for verbal aggression were related to weight maintenance in one of the studies (95) and anxiety, monotony avoidance and suspiciousness were negatively related to weight loss maintenance in the other (94). Others have, however, concluded that the personality traits measured by KSP did not appear to be important predictors of weight loss or relapse in obesity treatment (96).

The results on socialization found in two of the studies suggest the patients who were more successful had a greater capacity for close relationships. This means a more complete personality development with regard to relating to other people (97). More perceived initial dysfunctions in social interactions has furthermore predicted weight relapse (30).

Higher anxiety and monotony avoidance which were negatively related to weight loss maintenance in one of the studies (94) have also been found to describe the obese as compared to reference groups, along with more impulsivity, according to the KSP and other personality inventories (98–100). This personality pattern has been compared to an impulsivity syndrome with ego-weakness and to drug addiction (94,98). Others using the KSP report a profile similar to the ones found for bulimics and alcoholics, and the possibility of similar personality factors being associated with excessive eating and drinking have been discussed (101). Although the major theories in personality psychology during the last decades have covered obesity and the psychology of eating to a very small extent, repeated impulse breakthroughs for the immediate satisfaction of drives has been described within the borderline personality organization for some types of psychogenic obesity as well as for drug addiction (102).

Other studies on personality specifically aiming at weight loss maintenance are sparse. The data from self-report inventories such as the Minnesota Multiphasic Personality Inventory (MMPI or MMPI-2) (104), have generally given little or no predictive information about weight loss maintenance (104,105), although some sparse findings have been reported, such as hypochondria predicting poorer treatment outcome in bariatric surgery, as rated by the surgeons 4 years later rather than in a measure of weight maintenance (106).

For weight loss results only there are some more research findings, often revealing a trend towards psychopathology being associated with poorer weight loss in obesity treatments (107–109). Such psychopathology has been assessed with personality inventories such as the MMPI, the Millon Clinical Multiaxial Inventory-III and the Rorschach test. Psychopathology defined as more general symptoms on the Symptom Check List 90, however, showed no relationship to later weight loss results (110). Still, the subsequent 'winners' in weight maintenance had more improvements in symptoms of psychopathology during the treatment phase, and the authors therefore suggest there is some relationship between psychopathology and successful weight reduction (110). More generally, persons with psychopathology are, of course, considered to be more difficult to treat (111,112).

Dichotomous thinking implying a simplified 'black-and-white' approach has been described to characterize weight regainers whereas more flexible thinking characterized the maintainers (13). This would also describe an aspect of personality functioning with more mature thinking and balance in the maintainers.

To summarize, these trends suggest that healthier traits reflecting a more completely developed and integrated personality, including areas such as relating and ego-strengths with impulse control and overall better functioning, can imply better chances to maintain the weight loss. In accordance with this psychological pattern, research has shown that middle-aged women who had stayed slim had better psychosocial adaptation and psychological health (113).

However, the research findings in this area were sparse and many of the personality instruments used are very sensitive to capture psychopathology, implying risks for over-pathologizing. Personality inventories covering variations in the normal personality could reveal personality patterns that include adaptive traits and strengths.

Depression, mood and psychiatric diagnoses

Depression is a central aspect in obese patients entering treatment, as there is an overlap between obesity and mood disorders (114). Depression has sometimes been associated with weight regain. More self-reported depressive symptoms at an initial assessment after weight loss have been associated with weight regain, although they did not contribute as a predictor (20), and psychiatric diagnoses seem to interfere with long-term weight control (115). Lower degrees of depression have been found among the persons recovering from weight relapses than in those who do not, also suggesting that a relative 'success' in body weight control is related to less depressive symptoms than a further increase in body weight development (116).

However, several studies have reported no relationship between depression and weight maintenance (117) or even contradictory findings, with a positive relationship between initial depression and weight loss outcome after gastric bypass (118,119). Lower initial well-being has also been associated with better weight maintenance in non-surgical treatments (35,59).

Taken together, some negative impact of depression and more severe dysfunctions, but maybe not overall mood, on weight loss maintenance could be considered. More detailed research is needed on the specific aspects and reasons for initial depression and long-term outcome. One reasonable possibility is that being dissatisfied and even experiencing suffering about the present obese condition implies greater motivation for making changes, whereas more pathology and severe depression having another aetiology can interfere with weight control.

Weight cycling

Weight cycling refers to the repeated loss and regain of weight although there is no standard definition for weight cycling (120). A history of weight cycling has been found to be associated with weight regain after obesity treatment (20,121,122). It has been suggested that weight maintenance behaviours such as reduced dietary fat and physical exercise should be trained before new weight reduction attempts are made for these patients (121). Patients reporting repeated dietary attempts that would be related to weight cycling, have also been found to be more prone to regain weight (31,47), but a lack of association between number of previous slimming attempts and weight maintenance has also been reported (123).

Weight cycling is important to consider here, as it represents failure in weight maintenance followed by renewed attempts to reduce weight. Weight cycling has sometimes been associated with mental distress and psychopathology (124,125), although others who found no such relationship concluded that weight cycling does not seem to impact psychological health in an adverse way (126). Considering the research findings linking weight cycling with distress, mental distress could of course also characterize the person being more prone to diet and having more difficulties in sustaining the weight lost rather than being a consequence of the weight cycling.

More disturbed eating behaviours and a higher prevalence of binge eating have also been noted among weight cyclers (125). The greater the number of weight loss efforts was, the greater the occurrence or severity of binge eating was. Whether weight cycling causes binge eating or vice versa could, however, not be resolved.

The body weight variation in weight cycling has furthermore been related to negative health outcomes such as cardiovascular disease and increased mortality (125). Some results also suggest that short-term changes in weight may be related to long-term increase of body weight and more obesity (127).

Discussion

Methodological considerations in research on weight loss maintenance

Some methodological issues in studying weight maintenance should be mentioned. Our main interest was to make a conceptual review that could give more understanding for behavioural and psychosocial factors in weight maintenance. We have made no attempt to establish the relative importance of each factor or the interaction among them. Physical activity is, for example, not always related to weight loss maintenance, or is not important in overall models including other factors (73). Very few dietary factors such as fat and energy density have been shown to be clearly associated with obesity using evidence-based principles and long-term evaluation of weight loss (128). It is often difficult to understand whether fat reduction, high fibre or protein diets, physical activity or behavioural changes play the major role in achieving the desired effects (128). Isolating the individual importance of each contributing factor using improved methodology has been suggested to facilitate understanding of the strategies for successful long-term weight loss maintenance (128).

Trying to establish the relative importance of different factors would, however, also impose problems. Some factors may turn out to be strongly related to weight maintenance, such as more initial weight loss and reducing calorie intake, but they provide little understanding for the underlying processes that were important for these manifestations. There is also a need to consider the total situation of critical factors in weight maintenance simultaneously. Weight control is a very complex process that depend more on changing the whole personal life than on changing single behaviours. Long-term weight reduction was, for example, better in those who had made five or more behavioural improvements compared with those who had made fewer changes (36). An interaction among all these factors is also likely. A combination of psychology and physiology may, for example, give us more understanding of the mechanisms in weight loss maintenance (129).

Moderators, mediators and matching

The factors we have reviewed can also be described as moderators and mediators (130). Moderators are the pre-treatment characteristics that can identify for whom a treatment works. Mediators are the mechanisms that can identify why a treatment effect is achieved. We have described moderators as well as mediators for weight maintenance. The moderators were the pre-treatment characteristics such as internal motivation, binge eating and weight cycling. Examples of mediators were the important behavioural changes such as increasing cognitive restraint and reducing the intake of dietary fat. Some characteristics were moderators as well as mediators. Self-efficacy and self-confidence, for example, lead to better outcome results but can also be improved during treatment.

Moderators identify for whom, but also under which circumstances treatments have different effects. This is the principle that would allow the information needed to match patients to treatment, for which there has been a call in obesity research (131). The role of different treatments and the patient–treatment interaction is obviously of importance in the management of obesity. Factors in weight loss and weight loss maintenance are often considered to be very general. This would likely be the case with some factors, but other predictors of treatment outcomes in obe-

sity could be more specifically related to the type of treatment evaluated. One type of treatment approach can suit some persons well, whereas quite another approach would suit others, and this would lead to different patterns concerning maintenance of weight loss.

For example, obesity surgery creates quite another situation for weight maintenance than behaviour modification does, and each of these situations can be better suited to patients with different characteristics. One study has shown that patients with substantial weight loss through means of surgery compared with patients using non-surgical means differed in their behaviours to maintaining weight loss. The surgical group reported eating considerably more dietary fat and less carbohydrate and protein than the non-surgical controls, and further had lower levels of physical activity (132). Another study reported that persons who had chosen liquid formulas through formal programmes to reduce their weight rely more on dietary strategies such as counting calories and higher dietary restraint in order to maintain their weight loss, whereas persons who lost weight by their own means used more physical exercise and also weighed themselves more often to maintain their weight loss (133). Different pre-treatment factors characterizing the patients succeeding in such different treatment conditions could provide even more valuable knowledge, helping us to guide patients to suitable treatments.

Weight loss programmes with therapeutic interventions helping the patient to recognize and deal with emotions would further help some patients to eat less, whereas receiving nutritional knowledge and help in creating more structure over eating and lifestyle behaviour will target the needs of others, manifested as different weight loss patterns. Pharmacological treatments also create very specific

prerequisite for weight loss and weight maintenance if the drug is used on a more prolonged basis. A satiety-enhancing drug, for example, may give the most striking results for patients who are particularly vulnerable to the need for food and the influence of physical demands such as hunger (134). A drug working locally by reducing the fat absorption could be most efficient for others. As the drug creates adverse side-effects if dietary prescriptions are not adhered to, the forced necessity to pay more attention to food consumed and the adherence to better eating habits could perhaps provide help related to self-monitoring and meal structure. These are examples to illustrate how future research could more specifically consider the type of treatment interventions in relation to the individual characteristics. Increasing such knowledge could make optimal individual treatment choices possible, leading to better long-term results.

Concluding model

We have described factors that may act as moderators and mediators in promoting weight maintenance or act as obstacles for long-term success. Some of the major factors are listed in Table 1 to enable an overview. Some cautions should be mentioned. The majority of studies described are based on behaviour modification treatments or individual dieting efforts in samples predominantly consisting of women, as can be seen in Appendix 1. The conclusions may therefore foremost be generalized to women in such traditional weight loss conditions.

A hypothetical model would include that the person has reached a decision about wanting to lose weight. He or she has a desire to lose weight to achieve something positive, like becoming more confident and feeling better about

Weight maintenance	Weight regain
An achieved weight loss goal	Attribution of obesity to medical factors
More initial weight loss	Perceiving barriers for weight loss behaviours
Physically active lifestyle	History of weight cycling
Regular meal rhythm	Sedentary lifestyle
Breakfast eating	Disinhibited eating
Less dietary fat, more healthy foods	More hunger
Reduced frequency of snacks	Binge eating
Flexible control over eating	Eating in response to negative emotions and stress
Self-monitoring	Psychosocial stressors
Coping capacity	Lack of social support
Capacity to handle cravings	More passive reactions to problems
Self-efficacy	Poor coping strategies
Autonomy	Lack of self-confidence
'Healthy narcissism'	Psychopathology
Motivation for weight loss: more confidence	Motivation for weight loss: medical reasons, other persons
Stability in life	Dichotomous thinking
Capacity for close relating	

Table 1 Factors associated with weight loss maintenance and weight regain after intentional weight loss according to a literature review

oneself. This decision is internal and accompanied by a sense of confidence in the ability to make it. There is less focus on external hindrances such as medical reasons, dissatisfaction with lack of support or hindrances to exercise, but rather an internal focus on the inherent ability, power and also responsibility to make changes. Although the direct findings of motivation were sparse, this is a description of a firm motivation.

Depression and psychiatric disorders may be obstacles for weight control, but some dissatisfaction with the present life situation seen in persons feeling less well may motivate for making changes.

Pronounced initial weight loss and having reached a goal weight may illustrate the successful start in carrying out the decision to lose weight. The behavioural changes made, on which weight loss depends, confirm what is essential and obvious for weight control – to eat healthier, with more regularity and with improved control over eating, and more physical activity.

The psychological part of a model can be further elaborated, as inferred from overall findings in the literature. The balance, stability and maturity of the person appear to be important for the outcome. A consistent pattern emerges where the person likely to succeed in maintaining a lower body weight has a personality functioning with more strengths and stability. Such strengths include a capacity for control and also the ability to handle relapses in a balanced way and to recover again. The thinking style inherent in flexible control implies greater maturity.

Personality factors would also contribute to the ability to find coping strategies to be used in various life situations rather than to revert to old eating habits. Finding coping strategies to handle cravings and stressful situations in life reflect an ability to use creativity and thinking, and to come up with one's own solutions. The personally adjusted weight control strategies in the weight maintainers likewise reveal creativity and strengths such as autonomy and self-sufficiency. Trying out various solutions and doing other things rather than eating – which could be a variety of things – could also facilitate success.

The ability to create and sustain a meal structure and alter food habits can also imply psychological resources such as a more organized personality functioning. Self-monitoring suggests self-awareness and a self-inspective ability, and self-efficacy would likewise constitute a strength. A 'healthy narcissism' implying that there is at least some energy invested in oneself, with caring for oneself, one's appearance and physical status, can also be considered as an asset.

On the other hand, the regainer had more problems and difficulties in self-management, and had less efficient ways to handle obstacles in weight maintenance seen in difficulties in managing internal demand states such as cravings. The possibility of biological disturbances causing greater

hunger contributing to the factors found in the weight regainers should also be considered. Struggling with hunger would lead to some of the behavioural manifestations such as disinhibition, binge eating and cravings and also to an overall discouragement and impaired self-confidence.

There are some cautions in giving clinical recommendations. It seems quite likely that a person with better prospects to succeed in long-term outcome has more determination, strengths and capacities. However, patients with poorer prospect (seen in more problems in eating behaviours, life situation and overall functioning, and also less available social support) could indeed be considered to be in greater need of help. Some patients may, however, need treatment interventions targeting other areas of their life before they have a chance to be successful in a standard weight loss programme. Others, as we can see, can actually improve in critical areas such as self-confidence and problematic eating behaviours during a weight loss programme. Yet others may not have reached a decision about losing weight. There is too much complexity to allow simplified recommendations. Thorough pre-treatment assessments of the patients may lead to better professional decisions, and taking the time for such careful evaluations before treatment assignment may prove to be cost-efficient in the end.

The findings on autonomy, assuming responsibility and creating personal weight control plans in the maintainers should also be considered. These trends suggest that fixed weight loss plans on eating and living may not lead to successful long-term outcomes. The patients should rather be encouraged to find their very unique personal solutions and inner capacities.

'The successful weight maintainer'

To illustrate the factors affecting weight loss maintenance that we have described, a profile characterizing the 'successful weight maintainer' can also be suggested. This ideal person starts losing weight successfully quite early in treatment and reaches the self-determined weight loss goal. Our ideal weight maintainer leads an active life with less television watching and rather more leisure time activities such as walking and cycling. He or she continues to monitor the weight-related behaviours, is in control over eating behaviour and is not overly disturbed by hunger. Food intake is kept at a lower lever, the meal rhythm is regular, always including breakfast, and healthy foods are chosen in favour of high fat food. Snacking is reduced. Cravings can somehow be dealt with. If experiencing a relapse though, our weight maintainer can manage to handle this in a balanced way without exaggerating this as a detrimental failure. Controls are flexible rather than rigid and there is a self-sufficiency and autonomy.

Not surprisingly, this ideal weight maintainer has less problematic functioning and instability such as depres-

sion, binge eating and weight cycling but instead more stability of weight patterns, eating and emotions. The life situation is also more stable, with less stressful life events. Support is provided by the social context, although our weight maintainer may prefer to rely on his or her own solutions.

It seems that approaching the issue of weight control from a psychological viewpoint could give a better understanding of obesity behaviours. To summarize, we have reviewed a variety of potential factors in weight maintenance and have made an attempt to synthesize these in a comprehensive model. Although there are many methodological challenges associated with reviewing factors in weight maintenance, such attempts are needed to enable more understanding for weight management. Our review can contribute to further hypothesis testing and a conceptual framework in this area.

References

1. Wooley SC, Garner DM. Obesity treatment: the high cost of false hope. *J Am Diet Assoc* 1991; **91**: 1248–1251.
2. Lean ME. Obesity – what are the current treatment options? *Exp Clin Endocrinol Diabetes* 1998; **106**: 22–26.
3. Jeffery RW, Drewnowski A, Epstein LH, Stunkard AJ, Wilson GT, Wing RR, Hill DR. Long-term maintenance of weight loss: current status. *Health Psychol* 2000; **19**: 5–16.
4. Wing RR, Hill JO. Successful weight loss maintenance. *Annu Rev Nutr* 2001; **21**: 323–341.
5. Crawford D, Jeffery RW, French SA. Can anyone successfully control their weight? Findings of a three-year community-based study of men and women. *Int J Obes Relat Metab Disord* 2000; **24**: 1107–1110.
6. Cuntz U, Leibbrand R, Ehrig C, Shaw R, Fichter MM. Predictors of post-treatment weight reduction after in-patient behavioral therapy. *Int J Obes Relat Metab Disord* 2001; **25**: S99–S101.
7. Byrne SM. Psychological aspects of weight maintenance and relapse in obesity. *J Psychosom Res* 2002; **53**: 1029–1036.
8. Foster GD, Wadden TA, Vogt RA, Brewer G. What is a reasonable weight loss? Patients' expectations and evaluations of obesity treatment outcomes. *J Consult Clin Psychol* 1997; **65**: 79–85.
9. Foster GD, Wadden TA, Phelan S, Sarwer DB, Sanderson RS. Obese patients' perceptions of treatment outcomes and the factors that influence them. *Arch Intern Med* 2001; **161**: 2133–2139.
10. Linne Y, Hemmingsson E, Adolfsson B, Ramsten J, Rössner S. Patient expectations of obesity treatment – the experience from a day-care unit. *Int J Obes Relat Metab Disord* 2002; **26**: 739–741.
11. Marston AR, Criss J. Maintenance of successful weight loss: incidence and prediction. *Int J Obesity* 1984; **8**: 435–439.
12. Jeffery RW, Wing RR, Mayer RR. Are smaller weight losses or more achievable weight loss goals better in the long term for obese patients? *J Consult Clin Psychol* 1998; **66**: 641–645.
13. Byrne S, Cooper Z, Fairburn C. Weight maintenance and relapse in obesity: a qualitative study. *Int J Obes Relat Metab Disord* 2003; **27**: 955–962.
14. Cooper Z, Fairburn CG. A new cognitive behavioural approach to the treatment of obesity. *Behav Res Ther* 2001; **39**: 499–511.
15. Foster GD, Phelan S, Wadden TA, Gill D, Ermold J, Didie E. Promoting more modest weight losses: a pilot study. *Obes Res* 2004; **12**: 1271–1277.
16. Linde JA, Jeffery RW, Finch EA, Ng DM, Rothman AJ. Are unrealistic weight loss goals associated with outcomes for overweight women? *Obes Res* 2004; **12**: 569–576.
17. Taylor SE, Kemeny ME, Reed GM, Bower JE, Gruenewald TL. Psychological resources, positive illusions, and health. *Am Psychol* 2000; **55**: 99–109.
18. van Baak MA, van Mil E, Astrup AV, Finer N, Van Gaal LF, Hilsted J, Kopelman PG, Rössner S, James WP, Saris WH. Leisure-time activity is an important determinant of long-term weight maintenance after weight loss in the Sibutramine Trial on Obesity Reduction and Maintenance (STORM trial). *Am J Clin Nutr* 2003; **78**: 209–214.
19. Astrup A, Rössner S. Lessons from obesity management programmes: greater initial weight loss improves long-term maintenance. *Obes Rev* 2000; **1**: 17–19.
20. McGuire MT, Wing RR, Klem ML, Lang W, Hill JO. What predicts weight regain in a group of successful weight losers? *J Consult Clin Psychol* 1999; **67**: 177–185.
21. Rissanen A, Lean M, Rössner S, Segal KR, Sjöstrom L. Predictive value of early weight loss in obesity management with orlistat: an evidence-based assessment of prescribing guidelines. *Int J Obes Relat Metab Disord* 2003; **27**: 103–109.
22. European Agency for the Evaluation of Medical Products, Committee for Proprietary Medicinal Products, European Public Assessment Report (EPAR). *Xenical*. EMEA: London, 1998.
23. Klem ML, Wing RR, Lang W, McGuire MT, Hill JO. Does weight loss maintenance become easier over time? *Obes Res* 2000; **8**: 438–444.
24. Kayman S, Bruvold W, Stern JS. Maintenance and relapse after weight loss in women: behavioral aspects. *Am J Clin Nutr* 1990; **52**: 800–807.
25. Schoeller DA, Shay K, Kushner RF. How much physical activity is needed to minimize weight gain in previously obese women? *Am J Clin Nutr* 1997; **66**: 551–556.
26. Saris WH. Fit, fat and fat free: the metabolic aspects of weight control. *Int J Obes Relat Metab Disord* 1998; **22**: S15–S21.
27. Hughes JR. Psychological effects of habitual exercise: a critical review. *Prev Med* 1984; **13**: 66–78.
28. Fogelholm M, Kukkonen-Harjula K, Oja P. Eating control and physical activity as determinants of short-term weight maintenance after a very-low-calorie diet among obese women. *Int J Obes Relat Metab Disord* 1999; **23**: 203–210.
29. Leser MS, Yanovski SZ, Yanovski JA. A low-fat intake and greater activity level are associated with lower weight regain 3 years after completing a very-low-calorie diet. *J Am Diet Assoc* 2002; **102**: 1252–1256.
30. Karlsson J, Hallgren P, Kral J, Lindroos AK, Sjöström L, Sullivan M. Predictors and effects of long-term dieting on mental well-being and weight loss in obese women. *Appetite* 1994; **23**: 15–26.
31. Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Metcalfe LL, Blew RM, Sardinha LB, Lohman TG. Pretreatment predictors of attrition and successful weight management in women. *Int J Obes Relat Metab Disord* 2004; **28**: 1124–1133.
32. Fogelholm M, Kukkonen-Harjula K. Does physical activity prevent weight gain – a systematic review. *Obes Rev* 2000; **1**: 95–111.
33. Neumark-Sztainer D, Kaufmann NA, Berry EM. Physical activity within a community-based weight control program: program evaluation and predictors of success. *Public Health Rev* 1995; **23**: 237–251.

34. Kathan M, Pleas J, Thackery M, Wallston KA. Relationship of eating activity self-reports to follow-up weight maintenance of obesity. *Behav Ther* 1982; **13**: 521–528.

35. Jeffrey RW, Bjornson-Benson WM, Rosenthal BS, Kurth CL, Dunn MM. Effectiveness of monetary contracts with two repayment schedules on weight reduction in men and women from self-referred population samples. *Prev Med* 1984; **15**: 273–279.

36. Westenhoefer J, von Falck B, Stellfeldt A, Fintelmann S. Behavioural correlates of successful weight reduction over 3 y. Results from the Lean Habits Study. *Int J Obes Relat Metab Disord* 2004; **28**: 334–335.

37. French SA, Jeffery RW. Current dieting, weight loss history, and weight suppression: behavioral correlates of three dimensions of dieting. *Addict Behav* 1997; **22**: 31–44.

38. French SA, Jeffery RW, Forster JL, McGovern PG, Kelder SH, Baxter JE. Predictors of weight change over two years among a population of working adults: the Healthy Worker Project. *Int J Obes Relat Metab Disord* 1994; **18**: 145–154.

39. Holden JH, Darga LL, Olson SM, Stettner DC, Ardito EA, Lucas CP. Long-term follow-up of patients attending a combination very-low calorie diet and behaviour therapy weight loss programme. *Int J Obes Relat Metab Disord* 1992; **16**: 605–613.

40. Ogden J. The correlates of long-term weight loss: a group comparison study of obesity. *Int J Obes Relat Metab Disord* 2000; **24**: 1018–1025.

41. Wyatt HR, Grunwald GK, Mosca CL, Klem ML, Wing RR, Hill JO. Long-term weight loss and breakfast in subjects in the National Weight Control Registry. *Obes Res* 2002; **10**: 78–82.

42. Stunkard AJ, Messick S. The Three Factor Eating Questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; **29**: 71–83.

43. Lindroos AK, Lissner L, Mathiassen ME, Karlsson J, Sullivan M, Bengtsson C, Sjöström L. Dietary intake in relation to restrained eating, disinhibition, and hunger in obese and nonobese Swedish women. *Obes Res* 1997; **5**: 175–182.

44. Björvell H, Aly A, Langius A, Nordström G. Indicators of changes in weight and eating behaviour in severely obese patients treated in a nursing behavioural program. *Int J Obesity* 1994; **18**: 521–525.

45. Westerterp-Plantenga MS, Kempen KP, Saris WH. Determinants of weight maintenance in women after diet-induced weight reduction. *Int J Obes Relat Metab Disord* 1998; **22**: 1–6.

46. Lejeune MP, Van Aggel-Leijssen DP, Van Baak MA, Westerterp-Plantenga MS. Effects of dietary restraint vs exercise during weight maintenance in obese men. *Eur J Clin Nutr* 2003; **57**: 1338–1344.

47. Pasman WJ, Saris WH, Westerterp-Plantenga MS. Predictors of weight maintenance. *Obes Res* 1999; **7**: 43–50.

48. Westenhoefer J. The therapeutic challenge: behavioral changes for long-term weight maintenance. *Int J Obes Relat Metab Disord* 2001; **25**: S85–S88.

49. Tuschl RJ. From dietary restraint to binge eating: some theoretical considerations. *Appetite* 1990; **14**: 105–109.

50. Dykes J, Brunner EJ, Martikainen PT, Wardle J. Socioeconomic gradient in body size and obesity among women: the role of dietary restraint, disinhibition and hunger in the Whitehall II study. *Int J Obes Relat Metab Disord* 2004; **28**: 262–268.

51. Stunkard AJ. Eating patterns and obesity. *Psychiatr Q* 1959; **33**: 284–292.

52. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. DSM-IV, APA: Washington, DC, 1994.

53. Sherwood NE, Jeffery RW, Wing RR. Binge status as a predictor of weight loss treatment outcome. *Int J Obes Relat Metab Disord* 1999; **23**: 485–493.

54. Pekkarinen T, Koskela K, Huikuri K, Mustajoki P. Long-term results of gastroplasty for morbid obesity: binge-eating as a predictor of poor outcome. *Obes Surg* 1994; **4**: 248–255.

55. Gladis MM, Wadden TA, Vogt R, Foster G, Kuehnel RH, Bartlett SJ. Behavioral treatment of obese binge eaters: do they need different care? *J Psychosom Res* 1998; **44**: 375–384.

56. Jeffery RW, Bjornson-Benson WM, Rosenthal BS, Lindquist RA, Kurth CL, Johnson SL. Correlates of weight loss and its maintenance over two years of follow-up among middle-aged men. *Prev Med* 1984; **13**: 155–168.

57. McGuire MT, Wing RR, Klem ML, Hill JO. Behavioral strategies of individuals who have maintained long-term weight losses. *Obes Res* 1999; **7**: 334–341.

58. Dubbert PM. Physiological and psychosocial factors associated with long-term weight loss maintenance. *Miss RN* 1984; **46**: 20.

59. Sarlio-Lahteenkorva S, Rissanen A, Kaprio J. A descriptive study of weight loss maintenance: 6- and 15-year follow-up of initially overweight adults. *Int J Obes Relat Metab Disord* 2000; **24**: 116–125.

60. DePue JD, Clark MM, Ruggiero L, Medeiros ML, Pera V Jr. Maintenance of weight loss: a needs assessment. *Obes Res* 1995; **3**: 241–248.

61. Tinker JE, Tucker JA. Environmental events surrounding natural recovery from obesity. *Addict Behav* 1997; **22**: 571–575.

62. Perri MG, Sears SF Jr, Clark JE. Strategies for improving maintenance of weight loss. Toward a continuous care model of obesity management. *Diabetes Care* 1993; **16**: 200–209.

63. Wolfe WA. A review: maximizing social support – a neglected strategy for improving weight management with African-American women. *Ethn Dis* 2004; **14**: 212–218.

64. Wing RR, Jeffery RW. Benefits of recruiting participants with friends and increasing social support for weight loss and maintenance. *J Consult Clin Psychol* 1999; **67**: 132–138.

65. McLean N, Griffin S, Toney K, Hardeman W. Family involvement in weight control, weight maintenance and weight-loss interventions: a systematic review of randomised trials. *Int J Obes Relat Metab Disord* 2003; **27**: 987–1005.

66. Wing RR, Marcus MD, Epstein LH, Jawad A. A 'family-based' approach to the treatment of obese type II diabetic patients. *J Consulting Clin Psychol* 1991; **59**: 156–162.

67. Black DR, Lantz CE. Spouse involvement and a possible long-term follow-up trap in weight loss. *Behav Res Ther* 1984; **22**: 557–562.

68. Perri MG, Sears SF, Clark JE. Strategies for improving maintenance of weight loss. *Diabetes Care* 1993; **16**: 200–209.

69. Mustajoki P, Pekkarinen T. Maintenance programmes after weight reduction – how useful are they? *Int J Obes Relat Metab Disord* 1999; **23**: 553–555.

70. Gormally J, Rardin D. Weight loss and maintenance and changes in diet and exercise for behavioral counseling and nutrition education. *J Couns Psyhol* 1981; **28**: 295–304.

71. Grilo CM, Shiffman S, Wing RR. Relapse crises and coping among dieters. *J Consult Clin Psychol* 1989; **57**: 488–495.

72. Folkman S, Lazarus RS. The relationship between coping and emotion: implications for theory and research. *Soc Sci Med* 1988; **26**: 309–317.

73. Dohm FA, Beattie JA, Aibel C, Striegel-Moore RH. Factors differentiating women and men who successfully maintain weight loss from women and men who do not. *J Clin Psychol* 2001; **57**: 105–117.

74. Ferguson KJ, Brink PJ, Wood M, Koop PM. Characteristics of successful dieters as measured by guided interview responses and Restraint Scale scores. *J Am Diet Assoc* 1992; **92**: 1119–1121.

75. Ryden A, Karlsson J, Sullivan M, Torgerson JS, Taft C. Coping and distress: what happens after intervention? A 2-year follow-up from the Swedish Obese Subjects (SOS) study. *Psychosom Med* 2003; **65**: 435–442.

76. Colvin RH, Olson SB. A descriptive analysis of men and women who have lost significant weight and are highly successful at maintaining the loss. *Addict Behav* 1983; **8**: 287–295.

77. French SA, Perry CL, Leon GR, Fulkerson JA. Self-esteem and change in body mass index over 3 years in a cohort of adolescents. *Obes Res* 1996; **4**: 27–33.

78. Teixeira PJ, Palmeira AL, Branco TL, Martins SS, Minderico CS, Barata JT, Silva AM, Sardinha LB. Who will lose weight? A reexamination of predictors of weight loss in women. *Int J Behav Nutr Phys Act* 2004; **1**: 12.

79. Edell BH, Edington S, Herd B, O'Brien RM, Witkin G. Self-efficacy and self-motivation as predictors of weight loss. *Addict Behav* 1987; **12**: 63–66.

80. Brownell KD. Dieting readiness. *Weight Control Dig* 1990; **1**: 5–10.

81. Fontaine KR, Wiersema L. Dieting readiness test fails to predict enrollment in a weight loss program. *J Am Diet Assoc* 1999; **99**: 664.

82. Rotter JB. Generalized expectancies for internal versus external locus of reinforcement. *Psychol Monographs (General Appl)* 1966; **80**: 1–28.

83. Nir Z, Neumann L. Relationship among self-esteem, internal-external locus of control, and weight change after participation in a weight reduction program. *J Clin Psychol* 1995; **51**: 482–490.

84. Wallston BS, Wallston KA, Kaplan GD, Maides SA. Development and validation of the Health Locus of Control (HCL) Scale. *J Consult Clin Psychol* 1976; **44**: 580–585.

85. Williams GC, Grow VM, Freedman ZR, Ryan RM, Deci EL. Motivational predictors of weight loss and weight-loss maintenance. *J Pers Soc Psychol* 1996; **70**: 115–126.

86. Saltzer EB. The weight locus of control (WLOC) scale: a specific measure for obesity research. *J Pers Assess* 1982; **46**: 620–628.

87. Holt CL, Clark EM, Kreuter MW. Weight locus of control and weight-related attitudes and behaviors in an overweight population. *Addict Behav* 2001; **26**: 329–340.

88. Deci EL, Ryan RM. *Intrinsic Motivation and Self-Determination in Human Behavior*. Plenum: New York, 1985.

89. Bandura A. Self-efficacy mechanism in human agency. *Am Psych* 1982; **37**: 122–247.

90. Rodin J, Elias M, Silberstein LR, Wagner A. Combined behavioral and pharmacologic treatment for obesity: predictors of successful weight maintenance. *J Consult Clin Psychol* 1988; **56**: 399–404.

91. Dennis KE, Goldberg AP. Weight control self-efficacy types and transitions affect weight-loss outcomes in obese women. *Addict Behav* 1996; **21**: 103–116.

92. Clark MM, Abrams DB, Niaura RS, Eaton CA, Rossi JS. Self-efficacy in weight management. *J Consult Clin Psychol* 1991; **59**: 739–744.

93. Schalling D, Edman G. *The Karolinska Scales of Personality (KSP) Manual: an Inventory for Assessing Temperament Dimensions Associated with Vulnerability for Psychosocial Deviance*. Department of Psychiatry. Karolinska Institutet: Stockholm, Sweden, 1993.

94. Jönsson B, Björvell H, Levander S, Rössner S. Personality traits predicting weight loss outcome in obese patients. *Acta Psychiatr Scand* 1986; **74**: 384–387.

95. Rydén O, Hedenbro JL, Frederiksen SG. Weight loss after vertical banded gastroplasty can be predicted: a prospective psychological study. *Obes Surg* 1996; **6**: 237–243.

96. Poston WS 2nd, Ericsson M, Linder J, Nilsson T, Goodrick GK, Foreyt JP. Personality and the prediction of weight loss and relapse in the treatment of obesity. *Int J Eat Disord* 1999; **25**: 301–309.

97. Guntrip H. *Schizoid Phenomena Object-relations and the Self*. Hogarth Press: London, 1986.

98. Björvell H, Edman G, Rössner S, Schalling D. Personality traits in a group of severely obese patients in two self-chosen weight reducing programs. *Int J Obesity* 1985; **9**: 257–266.

99. Ryden A, Sullivan M, Torgerson JS, Karlsson J, Lindroos AK, Taft C. Severe obesity and personality: a comparative controlled study of personality traits. *Int J Obes Relat Metab Disord* 2003; **27**: 1534–1540.

100. Fassino S, Leombruni P, Piero A, Daga GA, Amianto F, Rovera G, Rovera GG. Temperament and character in obese women with and without binge eating disorder. *Compr Psychiatry* 2002; **43**: 431–437.

101. Palme G, Palme J. Personality characteristics of females seeking treatment for obesity, bulimia nervosa and alcoholic disorders. *Personality Individual Differences* 1999; **26**: 255–263.

102. Kernberg O. *Borderline Conditions and Pathological Narcissism*. Aronson: New York, 1975.

103. Dahlstrom WG, Welsh GS, Dahlstom LE. *An MMPI Handbook. Vol. 1. Clinical Interpretation*. University of Minnesota Press: Minneapolis, MN, 1982.

104. Lauer JB, Wampler R, Lantz JB, Madura JA. MMPI profiles of female candidates for obesity surgery: a cluster analytical approach. *Obes Surg* 1996; **6**: 28–37.

105. Grana AS, Coolidge FL, Merwin MM. Personality profiles in the morbidly obese. *J Clin Psychol* 1989; **45**: 762–765.

106. Webb WW, Morey LC, Castelnuvo-Tedsco P, Scott HW. Heterogenity of personality traits in massive obesity and outcome prediction of bariatric surgery. *Int J Obesity* 1990; **14**: 13–20.

107. Barrash J, Rodriguez EM, Scott DH, Mason EE, Sines JO. The utility of MMPI for the prediction of weight loss after bariatric surgery. *Int J Obesity* 1987; **11**: 115–128.

108. Rowe JL, Downey JE, Faust M. Psychological and demographic predictors of successful weight loss following silastic ring vertical stapled gastroplasty. *Psychol Rep* 2000; **86**: 1028–1036.

109. Elfhag K, Rössner S, Lindgren T, Andersson I, Carlsson A-M. Rorschach personality predictors of weight loss with behavior modification in obesity treatment. *J Pers Assess* 2004; **83**: 293–305.

110. Cuntz U, Leibbrand R, Ehrig C, Shaw R, Fichter MM. Predictors of post-treatment weight reduction after in-patient behavioral therapy. *Int J Obesity* 2001; **25**: S99–S101.

111. Kernberg O. *Severe Personality Disorders. Psychotherapeutic Strategies*. Yale Univeristy Press: New Haven, CT, 1984.

112. Blanck G, Blanck R. *Ego Psychology: Theory and Practice*. Columbia University Press: New York, 1994.

113. Baghaei F, Rosmond R, Westberg L, Hellstrand M, Landen M, Eriksson E, Holm G, Björntorp P. The lean woman. *Obes Res* 2002; **10**: 115–121.

114. McElroy SL, Kotwal R, Malhotra S, Nelson EB, Keck PE, Nemeroff CB. Are mood disorders and obesity related? A review for the mental health professional. *J Clin Psychiatry* 2004; **65**: 634–651, quiz 730.

115. Jenkins I, Djuric Z, Darga L, DiLaura NM, Magnan M, Hryniuk WM. Relationship of psychiatric diagnosis and weight loss maintenance in obese breast cancer survivors. *Obes Res* 2003; **11**: 1369–1375.

116. Phelan S, Hill JO, Lang W, Dibello JR, Wing RR. Recovery from relapse among successful weight maintainers. *Am J Clin Nutr* 2003; **78**: 1079–1084.

117. Wadden TA, Foster GD, Wang J, Pierson RN, Yang MU, Moreland K, Stunkard AJ, VanItallie TB. Clinical correlates of short- and long-term weight loss. *Am J Clin Nutr* 1992; **56**: 21S–24S.

118. Averbukh Y, Heshka S, El-Shoreya H, Flancbaum L, Geliebter A, Kamel S, Pi-Sunyer FX, Laferrere B. Depression score predicts weight loss following Roux-en-Y gastric bypass. *Obes Surg* 2003; **13**: 833–836.

119. Dubovsky SL, Haddenhorst A, Murphy J, Liechty RD, Coyle DA. A preliminary study of the relationship between preoperative depression and weight loss following surgery for morbid obesity. *Int J Psychiatry Med* 1985; **15**: 185–196.

120. National Task Force on the Prevention and Treatment of Obesity. Weight cycling. *JAMA* 1994; **272**: 1196–1202.

121. Haus G, Hoerr SL, Mavis B, Robison J. Key modifiable factors in weight maintenance: fat intake, exercise, and weight cycling. *J Am Diet Assoc* 1994; **94**: 409–413.

122. Ball GD, Gingras JR, Fimrite A, Villetard K, Kayman S, McCargar LJ. Weight relapsers, maintainers, and controls: metabolic and behavioural differences. *Can J Appl Physiol* 1999; **24**: 548–558.

123. Hansen D, Astrup A, Toubro S, Finer N, Kopelman P, Hilsted J, Rössner S, Saris W, Van Gaal L, James W, Goulder For The SSGM. Predictors of weight loss and maintenance during 2 years of treatment by sibutramine in obesity. Results from the European multi-centre STORM trial. Sibutramine Trial of Obesity Reduction and Maintenance. *Int J Obes Relat Metab Disord* 2001; **25**: 496–501.

124. Foreyt JP, Brunner RL, Goodrick GK, Cutter G, Brownell KD, St Jeor ST. Psychological correlates of weight fluctuation. *Int J Eat Disord* 1995; **17**: 263–275.

125. Brownell KD, Rodin J. Medical, metabolic, and psychological effects of weight cycling. *Arch Intern Med* 1994; **154**: 1325–1330.

126. Simkin-Silverman LR, Wing RR, Plantinga P, Matthews KA, Kuller LH. Lifetime weight cycling and psychological health in normal-weight and overweight women. *Int J Eat Disord* 1998; **24**: 175–183.

127. Jeffery RW, McGuire MT, French SA. Prevalence and correlates of large weight gains and losses. *Int J Obes Relat Metab Disord* 2002; **26**: 969–972.

128. Astrup A. Dietary fat and obesity: still an important issue. *Scandinavian Journal of Nutrition* 2003; **2**: 50–57.

129. Wing RR. Behavioral interventions for obesity: recognizing our progress and future challenges. *Obes Res* 2003; **11**: 3S–6S.

130. Kraemer HC, Wilson GT, Fairburn CG, Agras WS. Mediators and moderators of treatment effects in randomized clinical trials. *Arch Gen Psychiatry* 2002; **59**: 877–883.

131. Brownell KD, Wadden TA. Etiology and treatment of obesity: understanding a serious, prevalent and refractory disorder. *J Consult Clin Psychol* 1992; **60**: 505–517.

132. Klem ML, Wing RR, Chang CC, Lang W, McGuire MT, Sugerman HJ, Hutchison SL, Makovich AL, Hill JO. A case-control study of successful maintenance of a substantial weight loss: individuals who lost weight through surgery versus those who lost weight through non-surgical means. *Int J Obes Relat Metab Disord* 2000; **24**: 573–579.

133. McGuire MT, Wing RR, Klem ML, Seagle HM, Hill JO. Long-term maintenance of weight loss: do people who lose weight through various weight loss methods use different behaviors to maintain their weight? *Int J Obes Relat Metab Disord* 1998; **22**: 572–577.

134. Elfhag K, Rössner S, Carlsson A-M, Barkeling B. Sibutramine treatment in obesity: predictors of weight-loss including Rorschach personality data. *Obes Res* 2003; **11**: 1391–1399.

Appendix 1. Methodological description of the weight maintenance studies included in the review

Study	Sample type n (% women)	Initial body weight or weight at evaluation (E)	WL method	WL period	WL in active phase	WM phase	Intervention during WM	Assessment for evaluation of WM factors
Ball et al. 1999 (122)	Community 29 (100)	E: Mean 26 (± SD 1) kg m⁻²	Any (individual)	Not specified	≥20%	≥2 years	None	Follow-up
Black et al. 1984 (67)	Community recruited 36 (100)	Mean 76 kg	Behaviour modification	10 weeks	Mean 3 (± 2) to mean 5 (± 2) kg	4 years	None (weighted by their physician 3 times)	Baseline (different treatment conditions)
Byrne et al. 2003 (7)	Community 76 (100)	BMI ≥30 kg m⁻² in	Any (individual)	Not specified	≥10%	≥1 year	None	Follow-up interviews
Colvin et al. 1983 (76)	Community 54 (76)	Not reported	Any (individual)	Not specified	≥20%	≥2 years	None	Follow-up
Crawford et al. 2000 (5)	Community 854 (80)	Mean around 27 (± SD 5) kg m⁻²	None/educational	1 year	≥5%	2 years	Annual visits	1–3-year changes
Cuntz et al. 2001 (6)	Clinical 138 (84)	Mean 45 (± SD 9) kg m⁻²	Behaviour modification	10 weeks	Mean 6.9 (± 7.7) kg	18 months	None	After active WL
Dennis et al. 1996 (91)	Clinical/community recruited 109 (100)	Mean 31 (± SD 3) kg m⁻²	Behaviour modification	9 months	Mean 8.5 (± 6.6) kg	2 years	None	Baseline + during WL and WM
DePue et al. 1995 (60)	Clinical 107 (75)	>30% ideal weight	VLCD + behaviour modification	26 weeks	Mean 27.4 kg	≥10 months	Maintenance program (6 months)	Follow-up
Dohm et al. 2001 (73)	Community 1212 (54)	E: Mean WM 24 (± 3) mean WR 29 (± 6) kg m⁻²	Any (individual)	Not specified	≥10% of highest	≥3 years	None	Follow-up
Dubbert, 1984 (58)	Clinical 62 (77)	Average 90 kg	Behaviour modification	4 months	Average 7 kg	3 years	None	Follow-up
Ferguson et al. 1992 (74)	Community 142 (51)	E: Mean 24 kg m⁻²	Any (individual)	Not specified	≥15%	≥1 year	None	Follow-up
Fogelholm et al. 1999 (28)	Community recruited 85 (100)	Mean 34 kg m⁻²	Diet + VLCD + counselling	12 weeks	Mean 13.5 (± 0.4) kg	40 weeks	Walking program/weekly meetings	During WM
Foster et al. 2004 (15)	Clinical 17 (100)	Mean 35 (± 3) kg m⁻²	Modifying WL goals + behaviour modification	40 weeks	6 (± 5)%	1 year	Monetary deposit	Baseline treatment intervention
French et al. 1994 (38)	Worksite 3552 (54)	Mean 26 (± 5) kg m⁻²	Any (individual)/weight control classes for 8%	Not specified	Not reported	2 years	None	Baseline
French et al. 1997 (37)	Community 999 (100)	Mean 30 (± 6) kg m⁻²	Any (individual)	Not specified	≥4.5 kg	≥1 year	Education/none	Follow-up
Gormally et al. 1981 (70)	Community 112 (100)	Mean 79.4 (± 9) kg	Behaviour modification	16 weeks	Mean around 7 kg	7 months	None	Follow-up interviews

Appendix 1. *Continued*

Study	Sample type n (% women)	Initial body weight or weight at evaluation (E)	WL method	WL period	WL in active phase	WM phase	Intervention during WM	Assessment for evaluation of WM factors
Gladis et al. 1998 (55)	Clinical 118 (100)	Mean 36 (±6) kg m⁻²	Behaviour modification	48 weeks	Mean around 15 kg	1 year	None	Baseline
Hansen et al. 2001 (123)	Clinical 467 (NR)	Mean 37 (±4) kg m⁻²	Sibutramine	6 months	≥5%	18 months	Sibutramine/placebo	Baseline
Haus et al. 1994 (121)	Worksite 29 (52)	Mean 121 (±17) kg	Behaviour modification	6 months	Mean around 9 kg	42 months	None	Baseline
Holden et al. 1992 (39)	Clinical 118 (68)	Mean 41 (±9) kg m⁻²	VLCD + behaviour modification	Mean 1 year	Mean 31 kg at 1 year	3.3 years	None/group sessions	Follow-up interviews
Jeffery et al. 1984 (56)	Community recruited 89 (0)	Mean 100 kg	Behaviour modification	15 weeks	Mean 13.5 (±6) kg	2 years	None	Baseline + admission + during WM
Jeffery et al. 1998 (12)	Clinical 130 (47)	Average 31 kg m⁻²	Behaviour modification	18 months	Maximum mean 12.4 (±5.7) reached in 27 weeks on average	1 year	None	Baseline, during WL, admission Total 30 months WL evaluated
Jeffery et al. 2002 (127)	Community 823 (79)	Mean 27 (±5) kg m⁻²	Education/none	1 year	≥5% lost or gained	2 years	Education/none	Baseline + during WM
Jenkins et al. 2003 (115)	Clinical 48 (100)	Mean 119 kg	Counselling	2 years	Mean around 7%	6 months	None	Baseline Total 30 months WL evaluated
Jönsson et al. 1986 (94)	Clinical 28 (79)	Mean 119 kg	Jaw fixation	Mean 7 months	Mean 27 kg	1 year	None	Baseline
Karlsson et al. 1994 (30)	Community recruited 60 (100)	Mean around 40 kg m⁻²	Diet	8 months	Mean around 8 kg	16 months	Counselling + group meetings	Baseline + during WL
Kathan et al. 1982 (34)	Clinical + community 44 (86)	Mean 109 kg	Behaviour modification	6 months	Mean 3.8 kg	18 months	None	Follow-up interviews
Kayman et al. 1990 (24)	Community 108 (100)	NR	Any (individual)	Not specified	≥20%	≥2 years	None	Follow-up interviews
Klem et al. 2000 (23)	Community 931 (81)	24 (±4) kg m⁻²	Any (individual)	Not specified	≥13.6 kg	≥2 years	None	Follow-up
Lejune et al. 2003 (46)	Community recruited 40 (0)	Mean 32 (±2) kg m⁻²	Exercise +/diet	13 weeks	Mean 15 (±6) kg	40 weeks	None	Changes baseline – admission
Leser et al. 2002 (29)	Community recruited 38 (100)	>30 kg m⁻²	VLCD	6 moths	Mean 19.2 (±7)%	3 years	None	Follow-up
Linde et al. 2004 (16)	Community recruited 302 (100)	Mean 34 kg m⁻²	Cognitive interventions	8 weeks	Mean 2.8%	16 months	Follow-up visits	Baseline
McGuire et al. 1999 (57)	Community 238 (53)	Mean around 27 kg m⁻²	Any (individual)	Not specified	Mean around 17 kg for 69 weight maintainers	≥1 year	None	Total 18 months WL evaluated Follow-up

Appendix 1. *Continued*

Study	Sample type n (% women)	Initial body weight or weight at evaluation (E)	WL method	WL period	WL in active phase	WM phase	Intervention during WM	Assessment for evaluation of WM factors
McGuire et al. 1999 (20)	Community 714 (80)	Mean 25 (± 4) kg m⁻²	Any (individual)	Not specified	≥13.6 kg	≥2 years	None	During WM
Marston et al. 1984 (11)	Community 54 (81)	NR	Any (individual)	Mean 9 months	Goal weight reached	1–2 years	None	After weight loss
Nir et al. 1995 (83)	66 (100)	Mean 76 kg	Behaviour modification	10 weeks	Mean 6.6 kg	2 years	Follow-up interviews	Baseline
Ogden, 2000 (40)	Slimming club members 142 (100)	Mean around 33 kg m⁻²	Any (individual)	Not specified	Went from >30 kg m⁻² to <30 kg m⁻²	≥3 years	Slimming club	Follow-up
Pasman et al. 1999 (47)	Clinical 67 (100)	Mean 32 (± 0.5) kg m⁻²	VLCD	2 months	9.7 kg	14 months	Fibre/fibre + caffeine + chromium-picolinate/none	Baseline/admission
Pekkarinen et al. 1994 (54)	Clinical 27 (70)	Mean 50 kg m⁻²	Bariatric surgery	NA	Mean around 56% 1 year postop	≥2 years	Follow-up visits	Baseline
Phelan et al. 2003 (116)	Community 2400 (79)	E: Mean 25 (± 4) kg m⁻²	Any (individual)	Not specified	≥13.6 kg	2 years	None	Changes baseline – year 1
Poston et al. 1999 (96)	Clinical 102 (78)	Mean 39 (± 6) kg m⁻²	Diet, behaviour modification	8 weeks	Mean around 8.5 kg	1 year	A 1-week booster program	Baseline
Rodin et al. 1988 (90)	Community recruited/clinical 55 (85)	Mean around 92 kg	Behaviour modification +/tenuate/placebo	20 weeks	Mean around 8 kg	6 months	None	Admission
Rydén et al. 1996 (95)	Clinical 20 (80)	Mean 42 (± 10) kg m⁻²	Gastric surgery	NA	Mean around 15 kg (postop)	3 years	Follow-up visits	Baseline Total 3-year period evaluated
Sarlio-Lähteenkorva et al. 2000 (59)	Community (twin cohort) 717 (46)	>27 kg m⁻²	Any (individual)	6 years	≥5%	9–15 years	None	During WL and WM
Schoeller et al. 1997 (25)	Community recruited 32 (100)	Mean around 90 kg	Any (individual)	1 year	≥12 kg	1 year	None	After WL, during WM
Sherwood et al. 1999 (53)	Community recruited 444 (100)	Mean 84 (± 7) kg	Behaviour modification	6 months	Mean 8 (± 1) kg	1 year	Maintenance sessions/none	Baseline Total 18 months WL evaluated
Teixeira et al. 2004 (31)	Community recruited 158 (100)	Mean 31 (± 4) kg m⁻²	Behaviour modification	4 months	5.1 kg (6.2%)	1 year	Online contact/none	Baseline Total 16 months WL period evaluated
Tinker et al. 1997 (61)	Community 41 (71)	>30 kg m⁻²	Any (individual)	Not specified	Went from >30 kg m⁻² to <30 kg m⁻²	Mean 4.5 years	Recurrent interviews	Interviews at baseline, during WL and WM
Van Baak et al. 2003 (18)	Clinical 261 (82)	Mean 37 (± 4) kg m⁻²	Sibutramine	6 months	Mean 12.4 (± 4.6)%	1.5 years	Sibutramine/placebo	0–6 + 12–24 months changes

Appendix 1. *Continued*

Study	Sample type n (% women)	Initial body weight or weight at evaluation (E)	WL method	WL period	WL in active phase	WM phase	Intervention during WM	Assessment for evaluation of WM factors
Wadden et al. 1992 (117)	Clinical 76 (100)	Mean 39 (±1) kg m^{-2}	VLCD/behaviour modification	4–6 months	14.5 (±1.2) kg	1 year	None	Baseline
Westenhoefer et al. 2004 (36)	Commercial weight loss programme 1247 (89)	Mean 31 (±5) kg m^{-2}	Counselling + formula diet	44 weeks on the average	Mean 8.2 (±4.3) kg after 10 weeks	>2 years on the average	Prolonged program participation +/follow up assessments	Baseline, during WL and WM. Changes baseline – week 10 studied. Total 3 years WL evaluated
Westerterp-Plantenga et al. 1998 (45)	Community recruited 27 (100)	Mean 32 (±0.5) kg m^{-2}	VLCD + counselling	8 weeks	Mean 10.7 (±0.4) kg	2 years	8 weeks repeated program after 1 year	Baseline/admission
Williams et al. 1996 (85)	Clinical 52 (73)	Mean 40 kg m^{-2}	VLCD + counselling	6 months	20% on average	23 months	None	Baseline + during WL
Wing et al. 1991 (66)	Clinical 98 (50)	Mean 36 (±6) kg m^{-2}	Behaviour modification	20 weeks	Mean 9 (±7) kg	1 year	None/monetary deposit	Baseline randomization
Wing et al. 1999 (64)	Community recruited 166 (51)	Mean 31 (±4) kg m^{-2}	Behaviour modification	4 months	Mean around 8 (±4) kg	6 months	Follow-up visits/+ social support/monetary deposit	Baseline+admission + during WM
Wing et al. 2001 (4)	Community 3000 (80)	NR	Any (individual)	Not specified	≥13.6 kg	5.5 years on average	None	During WM
Wyatt et al. 2002 (41)	Community 2959 (80)	E: Mean 25 (±5) kg m^{-2}	Any (individual)	Not specified	≥13.6 kg	≥1 year, 6 years on average	None	During WM

WL, weight loss; WM, weight maintenance; WR, weight regain.
n = sample size at onset of the study; NR, not reported; NA, not available.
BMI, body mass index; VLCD, very low calorie diet.
'Behaviour modification' includes common dietary counselling and prescriptions, whereas 'Dietary treatment' does not include behaviour modification treatment.