



Effective Psychological and Behavioural Interventions in Obesity Management

Ó Gráda Cⁱ, Byrne Mⁱⁱ, Gaynor Kⁱⁱⁱ. Chapter adapted from: Vallis M, Macklin D, Russell-Mayhew S. Canadian Adult Obesity Clinical Practice Guidelines: Effective Psychological and Behavioural Interventions in Obesity Management (version 1, 2020). Available from: <https://obesitycanada.ca/guidelines/behavioural>. ©2020 Obesity Canada

- i) Senior Clinical Psychologist, Level 3 and 4 Obesity Services, St Columille's Hospital, Dublin
- ii) Professor, Health Behaviour Change Research Group, School of Psychology, University of Galway
- iii) Programme Manager, National Clinical Programme for Obesity and Registered Dietitian, Health Service Executive Health and Wellbeing, Dublin / ASOI

Cite this Chapter

ASOI Adult Obesity Clinical Practice Guideline adaptation (ASOI version 1, 2022) by: Ó Gráda C, Byrne M, Gaynor K. Chapter adapted from: Vallis M, Macklin D, Russell-Mayhew S. Available from: <https://asoi.info/guidelines/behavioural/> Accessed [date].

KEY MESSAGES FOR HEALTHCARE PROFESSIONALS



- **These clinical guidelines were developed based on research with individuals living with less complicated obesity and lower body weights (body mass index (BMI) < 40 kg/m² predominantly).** Individuals living with more complicated obesity may require different or more specialist psychological interventions.
- **All obesity-management interventions involve behaviour change on the part of the individual living with obesity (e.g., eating, activity, medication adherence), so behavioural-change supports should be incorporated into all obesity-management plans.** This requires a shift in the patient-healthcare professional (HCP) relationship from the HCP as the expert (teach and tell) to that of the collaborator, sensitive to the psychology of the person.
- **All clinicians working with people living with obesity can utilise behaviour change counselling, which includes:**
 - o Communication skills,
 - o The spirit of the approach (respecting patient autonomy, empathy, non-judgemental approach), and
 - o Behavioural strategies (e.g., self-monitoring, goal setting, planning, relapse control).
- **Obesity-management interventions should be evaluated based on how sustainable the behavioural components of the intervention are for the individual.** Obesity-management plans that are sustainable for the individual should be prioritised over clinician- or programme-led management plans.
- **Individuals living with obesity should be encouraged to build self-esteem and self-efficacy (confidence to**

overcome barriers to the desired behaviour), based on results that are achievable from behavioural efforts and not on idealised ideas of body weight and shape.

- **Eating behaviours, medical adherence and physical activity are outcomes of psychological and behavioural interventions and not interventions in themselves.** Behaviour-change strategies underlying dietary, medical and activity programmes should be identified (i.e., what are the change strategies by which sustainable changes to eating, medical adherence and activity are achieved?).
- **Psychological interventions, such as cognitive behavioural therapy, acceptance and commitment therapies and compassion-focused therapies, should be carried out by psychologists (clinical, counselling or health psychologists) or other HCPs who are additionally accredited in the delivery of psychological therapy.**

CORU, the authority responsible for the regulation of health and HCPs in Ireland, are currently in the process of developing a registration process for psychologists.

Once this process is complete, all psychologists working in clinical settings will be required to be CORU registered.

- **Where mental health difficulties are present, untreated or are barriers to sustainable behaviour change, referral should be made to a GP (for medical management and possible referral to appropriate mental health services) and/or a clinical or counselling psychologist (for specialist psychological assessment and intervention).**
- **Where intellectual disability or learning difficulties are present (or suspected) and are barriers to engagement, referral for additional psychological assessment and/or specialist support services may be required.**

KEY MESSAGES FOR HEALTHCARE PROFESSIONALS DELIVERING INDIVIDUAL INTERVENTIONS



- **Adopt a collaborative relationship with the patient, and carer/support worker where applicable, using the principles of motivational interviewing, to encourage the patient to choose and commit to evidence-based, sustainable behaviours associated with obesity management.**
- **Consider the use of a brief intervention framework, such as the Health Service Executive Making Every Contact Count (HSE MECC), Talking About Weight 5 A's (ask, advise, agree, assist, arrange) or Obesity Canada 5A's of Obesity Management (ask, assess, advise, agree, assist).** Discipline-specific training may be available, but the HSE MECC modules provide a broad foundation in behaviour change theory and techniques and the underlying principles of a patient-centred approach for all healthcare professionals (HCPs).
- **HCPs should share information about obesity-management success being related more to improved health, function and quality of life (QoL) resulting from achievable behavioural and psychological goals, not just on the amount of weight loss.**
- **Education should be focused on biology, bias and behaviour. Ask permission to discuss evidence regarding biological and environmental factors, including genetics (family history, the instinctual drive for food), neurohormonal functions that promote weight regain following weight loss and physical and social environments (i.e., built environment, food access/availability/security, sociocultural factors).**

- **Consider using the concept of “best weight” (i.e., the weight that a person can achieve and maintain while living their healthiest and happiest life).** This education should be shared as a means of reducing self-bias, encouraging body acceptance and supporting appropriate goals that acknowledge that weight is not a behaviour.
- **Success is related to setting achievable, sustainable goals that patients can follow, while developing confidence to overcome barriers and fostering an intrinsic motivation to maintain the plan.** Goals should positively impact health, function and quality of life.
- **Encourage the patient to:**
 - Set and sequence goals that are realistic and achievable.
 - Self-monitor behaviour.
 - Analyse setbacks using problem solving and cognitive reframing, including clarifying and reflecting on values-based behaviours. See Figure 1 for an illustration of how to support the patient in their obesity-management journey.
 - For HCPs who function within teams (including obesity specialty services), at least one member of the team should develop competency in behavioural interventions, including self-monitoring, goal setting and action planning, reinforcement management, social comparison (demonstrating/modelling behaviour), cognitive restructuring, motivational interviewing, and values-based counselling. Teams should include, or have access to, psychologists for the provision of psychological assessment and therapy. Psychological and behavioural interventions should focus on the impact of the interventions on adherence, self-efficacy, and autonomous motivation.

RECOMMENDATIONS



1. Multi-component psychological interventions (combining behaviour modification, cognitive therapy (reframing) and values-based strategies to alter nutrition and physical activity) should be incorporated into care plans for obesity management and improved health status and quality of life (Level 1a, Grade A)¹⁻⁸ in a manner that promotes adherence, confidence and intrinsic motivation (Level 1b, Grade A)⁹⁻¹³.
2. Healthcare professionals (HCPs) should provide longitudinal care with consistent messaging to people living with obesity to support the development of confidence in overcoming barriers (self-efficacy) and intrinsic motivation (personal, meaningful reasons to change), to encourage the patient to set and sequence health goals that are realistic and achievable (Level 1a, Grade A)⁹⁻¹⁵, to self-monitor behaviour (Level 1a, Grade A)^{9,13-15} and to analyse setbacks using problem-solving and adaptive thinking (cognitive reframing), including clarifying and reflecting on values-based behaviours (Level 1a, Grade A)^{9,13-15}.
3. HCPs should ask patients' permission to share information that success in obesity management is related to improved health, function and quality of life resulting from achievable behavioural goals, and not on the amount of weight loss (Level 1a, Grade A)^{16,17}.
4. HCPs should provide follow-up sessions consistent with repetition and relevance to support the development of self-efficacy and intrinsic motivation⁹⁻¹⁵. Once an agreement to pursue a behavioural path has been established (health behaviour and/or medication and/or surgical pathways) follow-up sessions should repeat the above messages in a fashion consistent with repetition (the HCP role) and relevance (the patient role) to support the development of self-efficacy and intrinsic motivation (Level 1a, Grade A).

KEY MESSAGES FOR PEOPLE LIVING WITH OBESITY



- **The main goal of psychological and behavioural interventions is to help people living with obesity to make changes that are sustainable; promote positive self-esteem, self-compassion and confidence; and improve health, function and quality of life (QoL).**
- **There is no one size fits all. Goals should be individualised and be important to the individual living with obesity and not just the clinician or intervention.**
- **There are many psychological and behavioural strategies that can be helpful. The strategies that will suit an individual best will depend on the particular goals they have chosen, their individual way of thinking about things and their life circumstances.**
A clinician can be expected to work in a way that is collaborative, understanding and non-judgemental to enable the creation of a good working relationship.
- **Obesity management may involve working around challenges such as finding time for appointments, planning food, getting medications on time, managing cravings, setting new routines for sleep or movement and managing social pressures.** Sustainable changes are more beneficial if the options chosen by the individual are consistent with their core values and do not lead to adverse effects.

Figure 1: **Healthcare Professional Model**

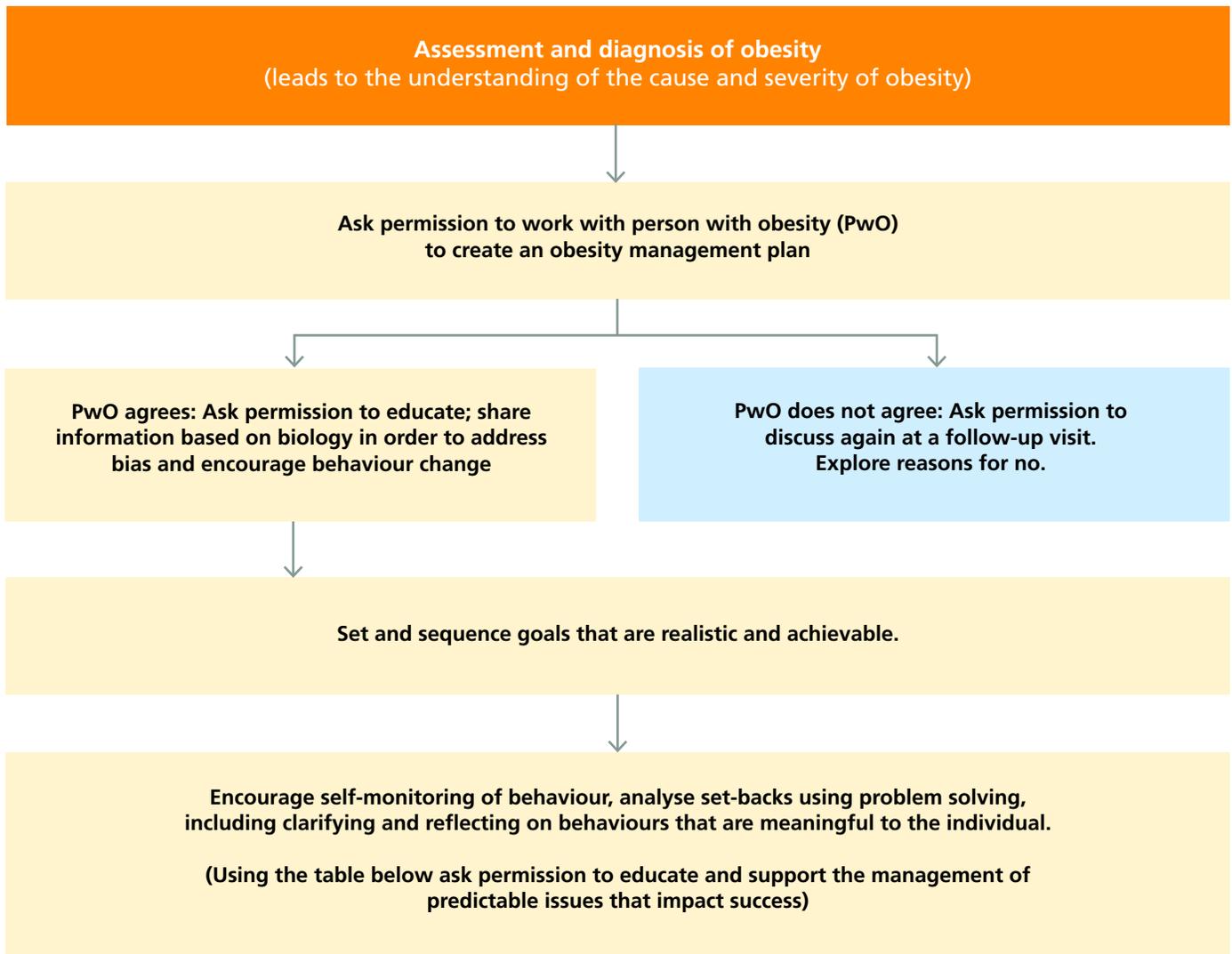


Table 1: Evidence Review

Recommendations for healthcare professionals (HCPs) working in solo practices, teams and obesity-management specialty services were based on a systematic review of the literature.

Main Finding		Evidence Level
Multicomponent behavioural interventions implemented by trained individuals (regulated HCPs) focused on calorie restriction and energy expenditure are effective:	In producing modest weight loss in individuals with overweight and obesity. ¹⁻⁷	LEVEL 1A – GRADE A
	In producing improved health status and quality of life. ^{3,8}	LEVEL 1A – GRADE A
	HCPs can be trained to effectively implement the wide range of behavioural interventions available. ^{14, 18-25}	LEVEL 1B – GRADE A
	The use of technology, such as interactive websites or mobile devices are effective as adjuncts to in person delivery of behavioural interventions (more research needed). ^{26,27}	LEVEL 1B – GRADE A
A number of specific behavioural interventions have been demonstrated to be effective, including self-monitoring, goal setting and action planning, reinforcement management, social comparison, cognitive restructuring and motivational interviewing. ^{9,10,14,15}		LEVEL 1A – GRADE A
	Behavioural interventions that impact adherence, self-efficacy and autonomous (intrinsic) motivation are associated with the best long-term outcome. ⁹⁻¹³	LEVEL 1B – GRADE A
HCPs should be informed about the powerful neurobiological underpinnings of the drive to eat (food cravings) as well as the power of food as a reinforcement (associative learning). This information should be used to establish a nonjudgmental understanding of the barriers to change in the individual living with obesity (reducing stigma) and aid in the identification of behavioural goals that are achievable in the context of the strength of this drive. ²⁸⁻³¹		LEVEL 1A – GRADE A
	Behavioural interventions that strengthen restraint (self-regulation) improve outcomes, particularly in those who report strong food cravings. ³²⁻³⁴	LEVEL 2 – GRADE B
	Acceptance and commitment therapies are value-added adjuncts to multi-component behavioural interventions. ^{35,36}	LEVEL 2 – GRADE B
	Self-bias is common and may affect outcomes. Assessing for internalised weight bias is recommended to aid with reducing bias and encouraging achievable expectations. ³⁷⁻³⁹	LEVEL 2 – GRADE B
	Coping strategies consistent with the principles of cognitive behaviour therapy and acceptance and commitment therapy can help mitigate against internalized weight bias. ^{37,40,41}	LEVEL 1B – GRADE A
	Excessive weight loss expectations do not appear to be a deterrent to behavioural interventions. ^{16,17}	LEVEL 1B – GRADE A
	Satisfaction with weight loss is associated with improved outcomes and can be encouraged as an alternative goal to achieving a specific weight. ⁴²⁻⁴³	LEVEL 1B – GRADE A

Definitions

Behavioural interventions have been traditionally seen as nutrition and exercise programmes (i.e., lifestyle interventions). In this guideline, we have decided to replace the term “lifestyle interventions” with “behavioural interventions.”

Behavioural-change interventions are programmes that help patients reach their health behaviour goals (nutrition, physical activity, sleep, stress reduction, etc.) or health goals (e.g., improved quality of life, obesity management, etc.). In this guideline, we call them “behavioural-change interventions” which include programmes that offer obesity management and standard behaviour therapy, such as goal setting, self-monitoring, stimulus control, problem solving, cognitive restructuring and relapse prevention.

Multi-component (nutrition, activity and psychological) behavioural therapy is one of the core evidence-based treatment modalities in obesity management, along with pharmacotherapy and surgery. In this guideline, psychological therapy includes interventions carried out by psychologists, such as cognitive behaviour therapy (CBT), acceptance therapies, etc. Behavioural therapy includes strategies used by all clinicians, such as motivational interviewing, goal setting, self-monitoring, stimulus control, problem solving, cognitive restructuring and relapse prevention. Behavioural therapy may include particular behavioural strategies from psychological therapies (e.g., behavioural strategies from CBT). As with pharmacotherapy and surgery, not all individuals living with obesity may need or desire psychological therapy.

Introduction

With obesity being understood as a chronic disease and not simply a consequence of poor health behaviour choices, obesity management takes on many of the principles of chronic disease management⁴⁴. There are several implications of this chronic disease perspective that are noteworthy with regard to behavioural and psychological interventions for obesity management.

Firstly, as with other chronic conditions, the outcomes that are desired from obesity-management interventions are primarily determined not by what the clinician does inside the visit but by the behavioural choices the individual makes outside of the clinic and within the context of their lives^{45,46}. As such, it needs to be recognised with psychological and behavioural interventions that outcomes are more dependent on how well they fit for the person living with obesity in the context of their lives, not what the clinician does or recommends. Early literature on behavioural treatments did not make this distinction; rather, there was a focus on interventions as characterised by the nature of the changes desired by the clinician. Early studies described behavioural interventions as nutrition or exercise interventions, in which specific behaviours were recommended to the patient and the intervention was dominated by delivering these behavioural instructions to patients. The evidence supported that such interventions were effective, at least in the short term, while participants were

engaged with clinicians around the recommended behaviours. Over time, the focus expanded to address behavioural strategies that were designed to overcome barriers to the recommended behaviours. Such studies would describe their intervention as nutrition interventions and/or exercise combined with behavioural strategies, such as goal setting, self-monitoring, problem solving, cognitive restructuring, etc. These interventions are described as multi-component behavioural interventions^{47,48}.

More recent literature has linked interventions to behavioural and psychological theory and have also begun to examine the mediators of change. That is, what are the behavioural strategies most likely to be associated with success? So, as behavioural interventions have matured, theory-driven behavioural methods designed to change eating and activity behaviours are increasingly viewed as treatments. In line with this, nutrition and exercise interventions are not only seen as treatments, but also as the outcomes of these behavioural interventions.

Secondly, when obesity management is framed in the context of chronicity and patient centricity, it becomes important to view sustained behaviour and psychological change as the goal. This again supports a shift from what the clinician is doing to what the patient can sustain in the long run. Psychological theories that address constructs, such as self-efficacy (confidence to perform a behaviour in the face of barriers), intrinsic motivation and readiness to change, support this shift from short-term (following the instructions of the clinician) to long-term change (identifying and committing to a behavioural pathway that can be incorporated into one's life). The behavioural aspects of managing obesity as a chronic condition also support a broad perspective on behaviour. That is, obesity-management behaviours go beyond nutrition and exercise interventions to include adherence to medication and/or surgery protocols when they are relevant. One way of conceptualising this is to see behavioural and psychological interventions as impacting behaviour – or the “doing” component of obesity management^{49,50}.

What is the evidence that behavioural and psychological interventions positively impact what individuals living with obesity actually do, and does this impact health, function, quality of life (QoL) and weight positively? The literature will be examined from two perspectives. Firstly, the existing literature will be evaluated to determine the evidence that multi-component behavioural interventions positively impact weight and associated health outcomes. Secondly, we will examine the psychological moderators that impact the “doing” component. There are several important contextual factors that impact sustained health-behaviour change.

- Self-reflection: When individuals can reflect on their experiences, awareness increases about important issues related to the process of change. This awareness can moderate the success of behavioural interventions. Relevant issues can include self-bias, expectations, perceptions of progress and particular patterns of behaviour. Such reflection illustrates how important psychological change is to successful behavioural management.

- **Associative learning:** This reflects the process by which particular patterns develop for individuals in their relationship with food/eating, as well as the thought processes, biological cravings and internal (e.g., emotion) or external (e.g., social/environmental) factors that can trigger and maintain these patterns. These patterns should be addressed to promote sustained behaviour change.
- **Individual:** Behaviour-change interventions are linked with self-bias, self-esteem and intrinsic motivation when mediated by behaviour that is meaningful to the individual and based on their individual values.

The outcomes of behavioural interventions go beyond weight loss. As obesity is accepted as a chronic disease, the complexity of obesity must also be recognised. Psychological and behavioural interventions are designed to change behaviour and promote adaptation to new habits and routines. The impact of behaviour change on weight is complex. Success in obesity management is broader than weight loss and should be expanded to include health-behaviour change, psychosocial functioning, physical functioning and QoL. While this perspective is consistent with current views of obesity, until recently most of the research in the area has been selectively focused on weight and associated biomedical outcomes as the primary outcome measures. For this chapter, interventions that change behaviour and impact QoL and function, independent of weight outcomes, will be considered successful.

To understand the evidence around psychological and behavioural interventions for obesity, it is critical to incorporate two of the most basic and scientifically validated models of understanding and modifying behaviours: classical conditioning and operant conditioning. Classical conditioning is an unconscious learning process based on the development of an association between a previously neutral external trigger and a naturally occurring internal response. These learned associations dominate behaviour (e.g., habits)^{48,51-53}. Classical conditioning is critical to understanding obesity because food is one of the most powerful reinforcers, and there is evidence to support that this is hard-wired in the brain. Operant conditioning is a learning process through which associations develop between a behaviour and a consequence. If a behaviour is associated with perceived positive consequences or rewards (i.e., a positive event or the removal of a negative event), that behaviour is likely to continue. Conversely, if a behaviour is associated with perceived negative consequences (i.e., a negative event or the removal of a positive event), the behaviour is less likely to continue. Consider, for example, the experience of the weight plateau. When a person has been putting significant effort into weight loss and then weight reaches a plateau, will they continue with the behaviours that have been associated with positive outcomes up to now, or stop the behaviours? If they perceive the plateau as a failure due to viewing weight loss alone as the desired positive outcome, they are likely to stop (because the positive consequence stopped). However, if they perceive the plateau as a success based on the concept of “best weight” and an understanding of the biology of obesity, they will likely continue. Many of the cognitive interventions in obesity management are

designed to help the patient reframe how they are perceiving experiences from a negative to a more positive context. It can be seen here that behaviour and psychology are heavily intertwined and how an individual interprets their circumstances will have a significant impact on how they respond.

Behavioural interventions for obesity management have evolved to become multi-component interventions, with the three main components being nutrition goals, exercise/activity goals and psychological and behaviour change strategies to support these goals. As noted above, the specifics of the nutrition and exercise goals differ from trial to trial (e.g., low carbohydrate approach, intermittent fasting, the Mediterranean diet, etc.) but share the behavioural goal of a change in eating and activity. Standard behavioural therapy strategies include goal setting, self-monitoring, stimulus control, problem solving, cognitive restructuring and relapse prevention.

The field had been lacking an organised approach to behaviour-change techniques for some time. Susan Michie and her colleagues in the United Kingdom have developed taxonomies to categorise the variety of behaviour-change techniques. This has been adapted for use in obesity. The original taxonomy, created by Abraham and Michie⁵⁴, has been revised⁵⁵ and renamed the Coventry, Aberdeen and London – Refined (CALO – RE) taxonomy. [Table 2](#) shows the 40 operationalised strategies for behavioural interventions in obesity.

A final comment about terminology is necessary. People use terms such as lifestyle interventions, behavioural-change programmes, behavioural interventions, psychological therapy, etc. interchangeably. This issue has been addressed in a previous publication⁴⁵ in which 1) behaviour change refers to new patient behaviours consistent with healthcare professional (HCP) recommendations (e.g., stopping smoking); 2) behaviour-change theories are models of how behaviour arises and can be altered (e.g., stages of change); 3) behaviour-change interventions (methods) are coordinated activities to change behaviour (e.g., the 5As of smoking cessation); and 4) behaviour-change counselling is the intervention, knowledge and skills of HCPs that foster behaviour change via the patient-HCP relationship. Behaviour change counselling defines how HCPs guide individuals from not doing to doing, and sustaining, the recommended behaviour. Behaviour-change counselling relies on practitioner skills and spirit as well as theories and interventions to facilitate behaviour change; and does so by identifying sequential steps that guide the HCP to empower the individual to engage in and sustain health behaviours in the face of barriers. In this chapter, we will use the terms psychological and behavioural intervention. This broad term encompasses both psychological therapeutic approaches carried out by psychologists (e.g., CBT) and the behaviour-change interventions and practitioner skills involved in all behaviour-change approaches. In Ireland, the Health Service Executive Making Every Contact Count framework and implementation plan for health-behaviour change provides guidance on brief behavioural interventions in routine healthcare consultations⁵⁶. Additionally, the Health Service Executive’s Model of Care for

the Management of Overweight and Obesity, launched in 2021, describes the organisation, delivery, and resourcing of healthcare services for people living with obesity. It recommends access to psychologists across Level 2, 3 and 4 services, providing clinical assessment, intervention, care and support to children, young people, families, and adults, delivering group and 1:1 intervention. Key aspects of psychology input include clinical assessment and screening for mental health, learning or behavioural difficulties, family-based interventions, a range of psychotherapeutic models (e.g., CBT, systemic therapy), as well as pre-operative psychological assessment and post-operative support.

Are psychological and behavioural interventions effective as treatment for obesity in adults?

Many studies have examined the impact of multi-component behavioural interventions for obesity management. Several meta-analyses confirm that such multi-component interventions, with a focus on calorie-reduced diet and increased physical activity as the main behavioural outcome goals, achieved through behavioural interventions, are effective in producing positive weight change and improving health and quality of life.

What is the evidence for weight change and non-weight outcomes?

Söderlund *et al.*⁵⁷ conducted a systematic review of interventions built around increased physical activity as the main behavioural goal, including participants with average body mass index (BMI) ranging from 26.9 kg/m² to 36.5 kg/m². This review concluded that the most successful interventions were those that combined physical activity with a focus on nutrition interventions and using behaviour-therapy interventions.

Ramage *et al.*¹ performed a systematic review of dietary interventions, that also included physical activity using behaviour-therapy interventions. They concluded that the strongest evidence, both for obesity management and weight-loss maintenance, was the combined diet, physical activity, and behaviour therapy approach. In a systematic review, Johns *et al.*² examined single versus multi-component interventions and concluded that, while short-term impact can be similar between single and multi-component interventions (especially for diet), long-term outcome was better with multi-component interventions. While the latter two studies included participants with BMI \geq 25kg/m², Lv *et al.*³ conducted a systematic review of behavioural interventions in those living with moderate and severe obesity (average BMIs of 37.5 kg/m² – 48.3 kg/m²). Of the behavioural interventions reviewed, they reported 32% – 97% of interventions achieved 5% weight loss while 3% – 70% achieved 10% weight loss and concluded that behavioural interventions were effective in achieving modest weight loss in this subpopulation. Similarly, Hassan *et al.*⁴ examined the impact of behavioural interventions with individuals living with severe obesity (BMI > 40 kg/m²) in a systematic review and concluded that multi-component

interventions were effective. Findings by Dombrowski *et al.*⁵ in another systematic review of behavioural interventions for obesity management (BMIs ranging from 30.1 kg/m² to 38.8 kg/m²) further support these overall conclusions. Seo and Sa⁶ performed a meta-analysis of obesity-management interventions in minority samples and concluded that moderate weight loss resulted from multi-component behavioural interventions. Witham and Avenill⁷ found evidence for moderate weight loss in seniors with overweight and obesity.

Several systematic reviews of multi-component psychological and behavioural interventions implemented in real-world primary care contexts have also been conducted. Hartmann-Boyce *et al.*¹³ found evidence for multi-component psychological and behavioural interventions implemented in commercial programmes but not within primary care settings. Booth *et al.*⁵⁸ conducted a systematic review of behavioural interventions in primary care and found a small amount of weight loss but noted a lack of theory-based psychological and behavioural interventions. Barnes and Ivezaj⁵⁹ conducted a systematic review of motivational interviewing-based interventions and reported little attention to treatment fidelity and variable results across studies. About half of the studies showed superiority of motivational interviewing and half failed to find differences from controls. It appears that more work needs to be done in primary care applications of psychological and behavioural interventions, likely work that focuses on fidelity to and competency in the delivery of the interventions.

Due to the past near-selective focus on weight loss as the primary outcome measure, there is less literature examining the non-weight outcomes of obesity management: health, function, and quality of life. Söderlund *et al.*⁵⁷ systematic review of activity-based interventions suggested that improved fitness resulted from interventions. Ramage's¹ and Hassan's⁴ systematic reviews indicated improved health indicators associated with the intervention (e.g., cholesterol, high density lipoprotein/low density lipoprotein, blood pressure), the latter with individuals living with moderate to severe obesity. QoL improvements were also reported in the Hassan systematic review.

Meta-analyses and systematic reviews provide the highest level of evidence to support the efficacy of psychological and behavioural interventions for obesity management. However, the results of the Look AHEAD (Action for Health in Diabetes) trial, a large scale, multi-centred, randomised clinical trial (RCT) that operationalised intensive behaviour therapy, are worth presenting separately⁸. In this eight-year study, 5,145 adults with overweight and obesity (including severe obesity) and type 2 diabetes were randomised to intensive lifestyle intervention or usual diabetes support and education. The lifestyle intervention in this trial can be considered state-of-the-art implementation of a multi-component psychological and behavioural intervention. Experienced interventionists (monitored over time for the maintenance of competency) implemented group and individual sessions. In the first six months there were three group and one individual session(s) each month. Monthly individual sessions continued to

month 12, but group sessions were reduced to two per month. Calorie restriction using meal plans and meal replacements along with unsupervised exercise were the target behaviours to support a goal of 7% weight loss at one year. In years two to eight, the focus of intervention was on weight and activity maintenance as well as overcoming barriers. Individual face-to-face and remote sessions and a group session occurred monthly. Psychological and behavioural interventions were based on CBT, problem solving and motivational interviewing, and were supported by a toolbox of intensive behavioural interventions (Table 2). After eight years, the lifestyle group continued to be superior to the control condition. Further, 37.9% of this group maintained a weight loss of greater than 10%. Of those that lost 10% or more by year one, 39.3% maintained this loss by year eight (average weight loss: 16%). Maintenance of weight loss was associated with increased physical activity, reduced calories, use of meal replacements, regular weight monitoring and attendance at counselling visits.

Although not specific to obesity, the United States Preventive Services Task Force in 2017 updated its systematic review of behavioural counselling to promote healthy eating and physical activity for cardiovascular risk reduction in adults without known cardiovascular risks⁶⁰. They concluded:

“The results of our updated systematic review are generally consistent in magnitude with our 2010 review on this topic. In general, nutrition interventions and physical activity behavioural interventions for generally unselected adults who were not targeted for counselling based on their cardiovascular disease risk resulted in consistent modest benefits across a variety of important intermediate health outcomes, including blood pressure, low-density lipoprotein, and total cholesterol levels as well as adiposity, with evidence of a dose response effect with higher intensity interventions resulting in greater improvements. Small-to-moderate improvements were also seen in dietary and physical activity behaviours. Very limited evidence exists on health outcomes or harmful effects of these interventions. The improvements we saw, however, in intermediate and behavioural health outcomes could translate into long-term reduction in cardiovascular disease-related events, with minimal to no harms, if such changes were maintained over time.”

There has been recent interest in behavioural interventions for obesity being delivered using technology, including phone counselling and online and app-based methods for delivering behavioural interventions. Although there is currently little literature on using technology in obesity management specifically, there are several systematic reviews looking at the use of innovative technology to deliver behavioural interventions. Okorodudu *et al.*⁶¹ conducted a systematic review of web-based interventions, mobile health interventions (phone, tablet) and active video game interventions. They were able to review seven systematic reviews/meta-analyses of web-based interventions. Evidence suggests that web-based interventions can lead to positive outcomes, although not at the level of in-person interventions and are dependent on frequency of use. Literature on the use of mobile technologies is less extensive than web-based, but Okorodudu *et al.*⁶¹ conclude

that there is value in such interventions, although more research is needed. Active video game-based interventions have been focused on children and adolescents and are outside of the scope of this chapter.

Tang *et al.*²⁶ reported a systematic review of reviews of interactive websites, smartphone applications and text messaging interventions. They concluded that the findings were mixed but promising. Self-directed interventions were able to independently promote weight loss and can augment personal contact interventions. Individualised feedback, email counselling and online social support appear to be particularly helpful. Semper *et al.*²⁷ report a systematic review of smartphone applications to promote dietary self-regulation for obesity management. Six relevant studies were identified for which goal setting was central to the intervention. The reviewers conclude that smartphone applications are effective at supporting obesity management, although future research is needed.

What are the effective strategies associated with successful psychological and behavioural intervention for obesity management?

Given that multi-component psychological and behavioural interventions are evidence-based, addressing the question of which behaviour change strategies are most effective is relevant. There is substantial literature examining this issue, and we have the benefit of multiple systematic reviews.

Hartmann-Boyce *et al.*¹³ investigated behavioural techniques and modes of delivery as they impact obesity interventions with individuals with BMI ≥ 25 kg/m². They note that most behavioural interventions do not use the wide variety of behaviour-change strategies available but focus on goal setting and action planning as well as self-monitoring and feedback (see the CALO - RE taxonomy, Table 2). Nonetheless, calorie counting, visiting a dietitian and social comparison activities were associated with greater weight loss in this systematic review. Social comparison activities included four techniques, namely providing information about others approval, providing normative information about others behaviour, modelling/demonstrating the behaviour, and facilitating social comparison. Exploratory analysis suggests the technique of modelling/demonstrating the behaviour was primarily associated with weight loss when the other three were controlled for.

Samdal *et al.*⁹ reported that the total number of behaviour-change techniques, and the use of goal setting, behaviour shaping, and stimulus control was associated with greater behaviour change in their systematic review of individuals with BMI ≥ 30 kg/m². This was especially true if person-centred psychological methods, such as motivational interviewing and autonomy support, were integrated into the intervention.

Olander *et al.*⁶² conducted a systematic review to determine the behaviour-change interventions associated with improved

self-efficacy and physical activity in behavioural treatments for obesity. The participant group had an average BMI of 34.5 kg/m². Changes in self-efficacy were associated with action planning, time management, self-monitoring and social support. There were numerous behaviour-change techniques associated with increased physical activity, with the largest effects for prompting use of cues (stimulus control), prompting practice (action planning) and prompting rewards (reinforcement management). In their systematic review, Burgess *et al.*¹² reported session attendance and increased physical activity was associated with the use of motivational interviewing, goal setting, problem solving, stimulus control, relapse prevention, behavioural contracting, dissociation, cognitive restructuring and self-reinforcement.

Teixeira *et al.*¹⁰ conducted a systematic review of what they called self-regulation mediators of the success of behavioural interventions in obesity. They reported that medium- to long-term weight control was associated with self-efficacy, self-monitoring, flexible eating restraint and positive body image. Increased physical activity was mediated by autonomous motivation, self-efficacy and self-regulation. No clear mediators of diet changes were found in this study. Zheng *et al.*'s⁶³ systematic review of self-weighing as a behavioural intervention supported regular self-weighing (greater weight loss without negative emotional effects such as anxiety or depression) in samples with average BMI < 40 kg/m². Focusing specifically on a psychological therapy, Jacob *et al.*¹⁵ conducted a systematic review of CBT interventions for weight control and concluded that there was evidence for the overall efficacy of CBT for weight, cognitive restraint and emotional eating.

Most psychological and behavioural interventions in this area have focused on weight loss, as noted above. Clifford *et al.*⁶⁴ conducted a systematic review on the effect of non-diet approaches on attitudes, behaviour and health. Fourteen RCTs and two quasi-experimental studies were identified. While limited by inconsistent definitions of the intervention and disparate outcome measures, this review found that non-diet interventions led to improvements in the psychological domains of disordered eating, self-esteem and depression. None of the interventions resulted in weight gain or worsening of blood pressure, glucose or cholesterol. Chao⁶⁵ completed a systematic review and meta-analysis of the impact of obesity management interventions on body image. Of the seven studies available for review, four were meta-analyses. Their findings suggested that relative to control conditions, the interventions had a positive impact on body-shape concern, dissatisfaction with body size and overall body satisfaction.

Burgess *et al.*¹¹ conducted a systematic review of factors that impair adherence to obesity-management interventions. They conclude that the main barriers to behavioural intervention in adults with obesity are poor motivation; lack of time; environmental, societal and social pressures; health and physical limitations; negative thoughts/moods; socioeconomic constraints; gaps in knowledge/lack of awareness and lack of enjoyment of exercise. Further, the most prominent predictors of adherence in adults with obesity are early weight-loss success, better baseline mood, being male, older age and lower baseline BMI. These highlight the importance of

addressing modifiable psychological factors, such as mood, and point to the potential higher level of support needed for those with more complicated obesity.

Evidence for addressing reflective psychological processing in behavioural obesity management

Behavioural interventions represent a pathway to changes in behavioural choices on a moment-to-moment, day-to-day basis. However, behaviour needs to be put in context with other aspects of psychological functioning. Individuals engage in cognitive-affective processes at the same time that they engage in behaviour. A core construct in psychology is how behaviour, emotion and cognition are co-occurring processes. This is relevant for obesity management as, in addition to the broader processes involved in all psychological and behaviour change, there are several additional cognitive/emotional psychological processes that can more specifically impact obesity-management behaviours. In particular, the experience of self-bias and weight-loss expectations/evaluations are relevant areas of reflective processing. These need to be understood in promoting a behavioural pathway that is patient-centred and empowering, two core aspects of the self-management of chronic conditions like obesity.

Internalised bias in obesity

An important and understudied construct in obesity-related behaviour change is weight bias, which is defined broadly as the negative attitudes and social stereotypes held about people with obesity. Explicit weight bias is the conscious, clear, demonstrated bias against individuals with obesity, while implicit weight bias encompasses the automatic unconscious thoughts typically associated with social prejudices. Internalised weight bias is the extent to which individuals living with obesity endorse negative weight-biased beliefs about themselves. Few studies have explored the relationship between obesity management and weight bias, and even fewer have considered the influence of internalised weight bias. Yet, intrinsic motivation and self-efficacy appear to be central mediators of sustained behaviour change. Further, improved QoL is a critical outcome for obesity-management interventions. As such, it stands to reason that effective behavioural and psychological interventions should contribute to reduced internalised obesity bias for these outcomes to be achieved.

Internalised weight bias has been shown to have a negative impact on outcomes that have conventionally been associated with the management of obesity. Importantly, and contrary to popular belief, weight bias does not encourage positive behaviour change. We know that when a goal is activated in the presence of an emotion that is perceived as negative (e.g., shame), motivation tends to wane. When a person is in an emotional state perceived as negative, they are motivated to get rid of the emotion and once this is achieved, the motivation for that behaviour is also gone. This is contrary to sustained behaviour, which often occurs in the face of barriers (self-efficacy).

Due to the emerging evidence about the negative psychological and emotional consequences of weight bias^{38,39,66} (explicit and internalised), it is an important consideration in behaviour-change strategies with people with obesity. For example, individuals with higher internalised weight bias report less weight loss, lower physical activity levels, higher caloric intake, greater disordered eating behaviours⁶⁷ and greater cardiometabolic risk⁶⁸.

Carels *et al.*⁶⁹ explored the impact of explicit and implicit weight bias on weight-loss outcomes in 46 healthy adults (non-smokers, free from cardiovascular disease and diabetes) classified as living with overweight or obesity (BMI > 27 kg/m²). Participants reporting less explicit weight bias at baseline had lower drop out from the behaviour-change programme. Higher weight bias scores were associated with less weight loss. More recently, Latner *et al.*⁷⁰ examined internalised weight bias with 81 women with obesity with similar results. High internalised weight bias showed associations with poorer QoL (physical and mental). Interestingly, the association between higher BMI and poorer physical QoL was found only in individuals with high levels of internalised weight bias. In fact, recent RCTs⁴¹ indicate that weight bias harms healthy eating behaviours. Mensinger *et al.*³⁸ demonstrated that across two different programmes (one conventional weight-loss programme and one weight-neutral programme) internalised weight bias moderated results. Women (n = 80; BMI > 30 kg/m²) with high internalised weight bias showed less improvement in eating behaviours and disordered eating regardless of programme type versus women with low internalised weight bias. Addressing internalised weight bias in a targeted and specific way may be a helpful addition to any behaviour-change programme.

Taken together, these studies suggest that it may be important to assess the internalised weight bias and the meaning of weight for people with obesity, particularly because of the moderating effects weight bias has demonstrated in the emergent literature. Targeting internalised weight bias as a variable of interest would address multiple forms of weight stigma (explicit and internalised) and potentially improve intended health outcomes (i.e., QoL, psychological distress). At minimum, obesity-management strategies may not be maximising the potential benefits of a given behavioural intervention by ignoring internalised weight bias. Clinicians would be advised to address internalised weight bias as par for the course of any psychological or behavioural intervention (including inducing empathy and influencing controllability attributions⁴⁰; and careful and considered use of language) 71. Hilbert *et al.*, in a study of 1,158 participants (mean BMI = 28.22 kg/m²), found that self-compassion acted as a psychological resource in managing self-bias, lowering the negative impact of internalised bias on depression, somatic symptoms and health status/QoL⁷². Self-compassion was defined as “a healthy attitude towards oneself with regards to one’s failures and inadequacies”⁷³. The latter authors point to the inclusion of compassion-focused therapies^{74,75} as a potential resource in addressing internalised bias in individuals living with overweight and obesity.

Weight-loss expectations/evaluations

It has generally been established that individuals living with obesity who pursue treatment have expectations of weight loss that exceed what obesity-management interventions can achieve. Foster *et al.*⁷⁶ reported in a behavioural trial that goal weight loss in their sample was 32% of initial weight. Wadden *et al.*⁷⁷ evaluated the weight-loss expectations of a group of women participating in a medication trial and reported that, at baseline, these women were expecting to lose approximately 25% of their weight. Despite these high expectations, when satisfaction with weight loss was assessed, those in the obesity pharmacotherapy plus behavioural and combined groups reported high levels of satisfaction. Linne *et al.*¹⁷ collected data on expectations from a clinical day unit in Sweden offering an intensive behavioural intervention over three years (real-world sample). At entry into the clinic, the weight-loss expectation for women was 32% and for men 29% of initial weight. They did not find a relationship between degree of weight-loss expectations and weight lost during the programme. Fabricatore *et al.*⁷⁸ assessed weight-loss goals (desired weight loss irrespective of treatment) from weight-loss expectations (anticipated weight loss given a specific treatment). Generally, expectations were lower than goals (20.9% versus 30.6%) and both were higher for women and those with higher BMIs. As the trial progressed, unmet expectations were not associated with attrition nor weight outcomes, but were associated with satisfaction.

Gorin *et al.*⁷⁹ did not find that unmet expectations were related to maintenance of weight loss in a group who were successful at weight loss. They did report that, despite having lost 19% at entry into this maintenance trial, 86% of the group were not satisfied. Dutton *et al.*¹⁶ replicated the unrealistic weight loss expectations in a more real-world sample, a managed care organisation in the U.S., where 10.4% weight loss was seen as disappointing, 19.7% as acceptable, 25.2% as happy and 30.9% as dream weight loss. Greater contact with a primary HCP was associated with more realistic weight-loss expectations. Dalle Grave *et al.*⁸⁰ reported data on dropouts from Italian obesity clinics and found that dropouts reported greater expected weight loss at one year and lower dream weight than completers. Collectively these data suggest that, while weight-loss expectations are exceedingly high in individuals living with obesity, these excessive expectations do not interfere with the success of interventions.

In contrast to weight-loss expectations, which can be acknowledged as an issue but not seen as a major barrier to success, satisfaction with weight loss may be a more relevant construct to assess. Baldwin *et al.*⁸¹ conducted a longitudinal study examining the relationships between satisfaction with weight loss (and weight changes over time) and weight-loss outcomes and experiences, between and within individuals. These data showed that satisfaction was related to weight loss over the trial as well as to variables such as self-control, perceived attractiveness, positive feedback and improvement in clothes fitting (outcome variables). Level of effort and thinking about weight-loss successes were positively associated with satisfaction, whereas level of frustration

was negatively associated with satisfaction. Ames *et al.*⁸² similarly found that lower levels of satisfaction with weight loss at the end of a low-calorie meal replacement intervention were associated with attrition from a behavioural follow-up intervention. Finch *et al.*⁴² suggested that weight-loss expectations might facilitate initiation of behaviour change, whereas weight-loss satisfaction might maintain the behaviours associated with obesity management. In a prospective study, they were able to show a relationship between satisfaction with weight loss and subsequent weight, both between as well as within subjects. Foster *et al.*⁸³ also reported in a small study that satisfaction with weight loss at week 40 predicted maintenance of weight loss at week 92. Calugi *et al.*⁴³ reported that satisfaction with weight loss predicted weight maintenance in those with severe obesity (BMI > 40 kg/m² or > 35 kg/m² with comorbidities). Jeffrey *et al.*⁸⁴ tried unsuccessfully to increase satisfaction with weight outcomes in a RCT.

This review of the psychological constructs of expectations and satisfaction can be informed by the literature on eating disorders, where expectations have also been examined. Polivy⁸⁵ has coined the term “false hope syndrome” in this area. The false hope syndrome results from excessive expectations of self-change, setting the person up for failure and leading to additional attempts to change, with a consequent negative psychological impact on the person.

Evidence for addressing associative learning in behavioural obesity management

Biologically, obesity is a consequence of energy intake that surpasses physiological need. Calorie intake in excess of energy needs often occurs in the absence of true physiological hunger. One reason for this may be that sensory properties of palatable food have been suggested to promote the desire to eat independent of actual energy needs^{28,30}. Not surprisingly, the reinforcing value of food is associated with BMI^{86,87} and predicts weight gain in children and adults^{88,89}. Evidence suggests that the appetite system is highly responsive to signals of palatable food available in the environment, and palatable food cues can overwhelm the body’s homeostatic satiety mechanisms^{29,90}. These food cues become powerful triggers that drive eating behaviour through associative learning (classical conditioning).

Individual differences exist in reward sensitivity, a term which speaks to:

1. The sensory, primarily opioid-based, pleasure associated with eating (the liking response)⁹¹;
2. The degree to which food and food cues elicit the motivation to eat (the wanting); and
3. The degree to which associative learning takes place in any individual⁹².

Studies have linked food-reward sensitivity to stronger food

cravings, which strengthens the argument that due to associative learning, eating behaviour may be unlike other behaviours in its intrinsic drive strength^{93,94}. The strength of this food drive is associated with food intake in laboratory studies³¹ as well as higher body weights in children and adults^{95,96}. It has been shown specifically that energy intake mediates the relationship between reward sensitivity and BMI⁹⁷.

The wanting/motivational component of reward sensitivity is primarily anatomically associated with the brain’s mesolimbic dopamine system. The brain’s reward circuitry also mediates the drives that motivate behaviours of sex, gambling, alcohol, smoking, shopping and substance use⁹². This wanting (dopamine circuitry) is characterised by learned associations. Repeated exposure to food reinforcers, internal triggers or, even more effectively, external environmental triggers, develops the capacity of those triggers to elicit dopamine release, creating conditioned cues that generate conditioned wanting^{98,99}. This process is influenced by neurobiological and genetic factors¹⁰⁰⁻¹⁰⁶. In summary, there is clear evidence that reward sensitivity is a risk factor for weight gain and obesity, with the implication that behavioural initiatives to alter food intake should be informed by this powerful internal drive coupled with strong associative learning. This evidence supports the recommendation that individuals living with obesity should be informed about the powerful neurobiological underpinnings of the drive to eat (food cravings), the ways in which internal and external cues influence these drives and be supported to develop psychological and behavioural coping skills to manage such drives.

The evidence for addressing self-regulation in behavioural obesity management

Evidence also supports the role of self-regulation or cognitive control as a moderator of obesity. Self-regulation is associated with resistance to weight gain and effectiveness of psychological and behavioural interventions^{33,34}. Self-regulation as a trait is described as a key behavioural attribute of those who lose weight and keep it off³². Obesity-management outcomes in behavioural interventions, including weight, health and QoL improvements, are primarily a product of sustained adherence to any reduced-energy diet^{107,108} and not affected significantly by the type of diet¹⁰⁹. There is evidence to suggest that lapses in self-regulation/cognitive control are mostly a result of temptation to hyper-palatable foods with high reinforcing value, although these findings were not wholly specific to individuals who were living with overweight or obesity^{110,111}. Cleobury *et al.*¹¹⁰ additionally found a proportion of individuals for whom emotional triggers, such as boredom and stress, pre-empted lapses in self-regulation.

Self-regulation/cognitive-control skills represent a key component of executive functions. Executive functions are a group of cognitive processes necessary for behavioural control. They are suggested to be governed primarily by the prefrontal cortex, with the potential to be modifiable^{112,113}. There are individual differences in the capacity to self-regulate, with lower levels thought to increase vulnerability to lapses in desired behaviour when exposed to foods

with high reinforcing value. Neuroimaging studies support this concept, showing that stronger prefrontal cortex activity following food intake is associated with lower BMI^{114,115}, decreased food craving¹¹⁶ and successful weight loss³².

Taken together, interventions that focus on the skills of self-regulation/cognitive control in the face of uncomfortable internal states (such as cravings) in reward-sensitive individuals exposed to foods with high reinforcing qualities could support desired outcomes in the treatment of obesity.

Differences in reward sensitivity and self-regulation capacity have been demonstrated to be significant risk factors for weight gain and obesity. These frame a theoretical model suggesting that interactions between a bottom-up (sensory driven) reward drive and a top-down (cognitively driven) self-regulation system strongly influence obesity risk. Anatomical correlates are:

1. The brain's reward system mediated primarily by dopamine, launching from the midbrain; and
2. The top-down regulation involving primarily the dorsolateral -prefrontal cortex.

Psychological and behavioural approaches that integrate this understanding could increase the effectiveness of obesity treatments.

Forman *et al.*³⁶ proposed a psychological treatment to “intensively focus on developing skills that teach individuals how to override drives and urges for pleasure and comfort.” The suggestion of the acceptance and commitment treatment model is that sustaining desired behaviour over the long term is dependent on the ability to self-regulate in the face of biological predispositions, uncomfortable internal states and a pervasive cue-filled obesogenic environment. In this trial, Forman compared this acceptance-based methodology to the highly effective standard behavioural therapy exemplified by the Diabetes Prevention Programme and the Look AHEAD trials. Note the authors have described the acceptance-based treatment as built on top of and including key standard behavioural therapy treatment components – an addition rather than a rebuild. Key self-regulation skills, adapted from evidence-based psychological therapies, included ability to tolerate uncomfortable internal states (e.g., urges, cravings, emotion perceived as negative), ability to tolerate a reduction of pleasure, behavioural commitment to clearly defined values and self-awareness of decision-making processes. Participants assigned to acceptance-based treatment attained significantly greater 12-month mean weight loss (13.3%) compared with those assigned to standard behavioural therapy (9.8%). In addition to restraint over impulse skills, Butryn³⁵ suggested that committing to specific behaviours which are clearly linked to a person's core values can be beneficial when confronted with difficult weight-control situations. Butryn also suggested a significant benefit to meta-cognitive awareness of decision-making processes. Psychological interventions based on acceptance and commitment therapies should be considered as adjuncts to multi-component behavioural interventions.

Conclusion

These guidelines highlight a number of important areas of focus when considering behavioural and psychological intervention in obesity-management plans. All obesity-management interventions involve behaviour change on the part of the individual living with obesity. Sustainability of change should be a key focus of obesity-management plans and requires a collaborative patient-HCP relationship sensitive to the psychology of the individual and their particular needs, values and challenges. In addition to a number of biological and environmental factors, a number of psychological factors can influence an individual's capacity to make and sustain behavioural change, including internalised bias, capacity for self-reflection and self-regulation, expectations of weight loss, the particular patterns that have developed in each individual's relationship with food and eating, and each individual's level of self-esteem and self-efficacy in approaching change. The research highlights the importance of multi-component behavioural interventions (facilitated by the behaviour-change counselling skills of communication, spirit of the approach and specific behavioural strategies) and specific psychological interventions (e.g., CBT, compassion-focused and acceptance-based therapies) aimed at facilitating change in an individual's relationship with themselves, their patterns with regard to food, eating and obesity management, and their overall capacity to sustain change. In line with this, the research highlights the importance of sharing information with individual's related to the biological complexity of living with obesity and the long-term value in focusing on the concept of “best weight” as it relates to each individual. These guidelines were developed based on research with individual's living with less-complicated obesity and BMI < 40kg/m² and more specialist psychological intervention may be required for individuals living with more-complicated obesity.

Table 2: **CALO-RE Taxonomy of Behavioural Interventions for Obesity Management**²⁸

1 – Provide information on consequences in general	11 – Prompt review of outcome goals	21 – Provide instruction on how to perform the behaviour	31 – Prompt anticipated regret
2 – Provide information on consequences to the individual	12 – Prompt rewards contingent on progress	22 – Model the behaviour	32 – Fear arousal
3 – Provide information about others' approval	13 – Prompt rewards contingent on success	23 – Teach to use prompts / cues	33 – Prompt self-talk
4 – Provide information normative information about others	14 – Shaping	24 – Environmental restructuring	34 – Prompt use of imagery
5 – Set Behavioural goals	15 – Prompt generalization of a target behaviour	25 – Agree behavioural contract	35 – Relapse prevention / coping planning
6 – Set outcome goals	16 – Prompt self-monitoring of behaviour	26 – Prompt practice	36 – Stress management / emotion control training
7 – Action planning	17 – Prompt self-monitoring of outcome	27 – Use of follow-up prompts	37 – Motivational interviewing
8 – Barrier identification / Problem solving	18 – Prompt focus on past success	28 – Facilitate social comparison	38 – Time management
9 – Set graded tasks	19 – Prompt feedback on performance	29 – Plan social support / social change	39 – General communication skills training
10 – Prompt review of behavioural goals	20 – Provide information on where and when to perform behaviour	30 – Prompt identification as a role model	40 – Stimulate anticipation of future rewards

The Effective Psychological and Behavioural Interventions in Obesity Management chapter is adapted from the Canadian Adult Obesity Clinical Practice Guidelines (the "Guidelines"), which Obesity Canada owns and from whom we have a license. ASOI adapted the Guidelines having regard for any relevant context affecting the Island of Ireland using the [ADAPTE Tool](#).

ASOI acknowledges that Obesity Canada and the authors of the Guidelines have not reviewed the Effective Psychological and Behavioural Interventions in Obesity Management chapter and bear no responsibility for changes made to such chapter, or how the adapted chapter is represented or disseminated. As Obesity Canada and the authors of the original Guidelines chapter have not reviewed the Effective Psychological and Behavioural Interventions in Obesity Management chapter, such parties, according to their policy, disclaim any association with such adapted Materials. The original Guidelines may be viewed in English at: www.obesitycanada.ca/guidelines.

Correspondence:

info@asoi.info

References

1. Ramage S, Farmer A, Eccles KA, McCargar L. Healthy strategies for successful weight loss and weight maintenance: a systematic review. *Appl Physiol Nutr Metab* 2014; 39(1): 1-20.
2. Johns DJ, Hartmann-Boyce J, Jebb SA, Aveyard P, Behavioural Weight Management Review Group. Diet or exercise interventions vs combined behavioral weight management programs: a systematic review and meta-analysis of direct comparisons. *J Acad Nutr Diet* 2014; 114(10): 1557-68.
3. Lv N, Azar KMJ, Rosas LG, Wulfovich S, Xiao L, Ma J. Behavioral lifestyle interventions for moderate and severe obesity: A systematic review. *Prev Med* 2017; 100: 180-93.
4. Hassan Y, Head V, Jacob D, Bachmann MO, Diu S, Ford J. Lifestyle interventions for weight loss in adults with severe obesity: a systematic review. *Clin Obes* 2016; 6(6): 395-403.
5. Dombrowski SU, Avenell A, Sniehotk FF. Behavioural interventions for obese adults with additional risk factors for morbidity: systematic review of effects on behaviour, weight and disease risk factors. *Obes Facts* 2010; 3(6): 377-96.
6. Seo DC, Sa J. A meta-analysis of psycho-behavioral obesity interventions among US multiethnic and minority adults. *Prev Med* 2008; 47(6): 573-82.
7. Witham MD, Avenell A. Interventions to achieve long-term weight loss in obese older people: a systematic review and meta-analysis. *Age Ageing* 2010; 39(2): 176-84.
8. Look Ahead Research Group. Eight-year weight losses with an intensive lifestyle intervention: the look AHEAD study. *Obesity (Silver Spring)* 2014; 22(1): 5-13.
9. Samdal GB, Eide GE, Barth T, Williams G, Meland E. Effective behaviour change techniques for physical activity and healthy eating in overweight and obese adults; systematic review and meta-regression analyses. *Int J Behav Nutr Phys Act* 2017; 14(1): 42.
10. Teixeira PJ, Carraca EV, Marques MM, et al. Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. *BMC Med* 2015; 13: 84.
11. Burgess E, Hassmen P, Welvaert M, Pumpa KL. Behavioural treatment strategies improve adherence to lifestyle intervention programmes in adults with obesity: a systematic review and meta-analysis. *Clin Obes* 2017; 7(2): 105-14.
12. Burgess E, Hassmen P, Pumpa KL. Determinants of adherence to lifestyle intervention in adults with obesity: a systematic review. *Clin Obes* 2017; 7(3): 123-35.
13. Hartmann-Boyce J, Johns DJ, Jebb SA, Aveyard P, Behavioural Weight Management Review G. Effect of behavioural techniques and delivery mode on effectiveness of weight management: systematic review, meta-analysis and meta-regression. *Obes Rev* 2014; 15(7): 598-609.
14. Soderlund LL, Madson MB, Rubak S, Nilsen P. A systematic review of motivational interviewing training for general health care practitioners. *Patient Educ Couns* 2011; 84(1): 16-26.
15. Jacob A, Moullec G, Lavoie KL, et al. Impact of cognitive-behavioral interventions on weight loss and psychological outcomes: A meta-analysis. *Health Psychol* 2018; 37(5): 417-32.
16. Dutton GR, Perri MG, Dancer-Brown M, Goble M, Van Vesse N. Weight loss goals of patients in a health maintenance organization. *Eat Behav* 2010; 11(2): 74-8.
17. Linne Y, Hemmingsson E, Adolffson B, Ramsten J, Rossner S. Patient expectations of obesity treatment-the experience from a day-care unit. *Int J Obes Relat Metab Disord* 2002; 26(5): 739-41.
18. Flodgren G, Goncalves-Bradley DC, Summerbell CD. Interventions to change the behaviour of health professionals and the organisation of care to promote weight reduction in children and adults with overweight or obesity. *Cochrane Database Syst Rev* 2017; 11: CD000984.
19. Fitzpatrick SL, Stevens VJ. Adult obesity management in primary care, 2008-2013. *Prev Med* 2017; 99: 128-33.
20. Tang JW, Kushner RF, Cameron KA, Hicks B, Cooper AJ, Baker DW. Electronic tools to assist with identification and counseling for overweight patients: a randomized controlled trial. *J Gen Intern Med* 2012; 27(8): 933-9.
21. Lee NJ, Chen ES, Currie LM, et al. The effect of a mobile clinical decision support system on the diagnosis of obesity and overweight in acute and primary care encounters. *ANS Adv Nurs Sci* 2009; 32(3): 211-21.
22. Goodfellow J, Agarwal S, Harrad F, et al. Cluster randomised trial of a tailored intervention to improve the management of overweight and obesity in primary care in England. *Implement Sci* 2016; 11(1): 77.
23. Byrne M, McSharry J, Meade O, Lavoie KL, Bacon SL. An international, Delphi consensus study to identify priorities for methodological research in behavioral trials: A Study protocol. *HRB Open Research* 2018; 1(11): 1-12.
24. Flocke SA, Step MM, Antognoli E, et al. A randomized trial to evaluate primary care clinician training to use the Teachable Moment Communication Process for smoking cessation counseling. *Prev Med* 2014; 69: 267-73.
25. Malan Z, Mash B, Everett-Murphy K. Evaluation of a training programme for primary care providers to offer brief behaviour change counselling on risk factors for non-communicable diseases in South Africa. *Patient Educ Couns* 2016; 99(1): 125-31.
26. Tang J, Abraham C, Greaves C, Yates T. Self-directed interventions to promote weight loss: a systematic review of reviews. *J Med Internet Res* 2014; 16(2): e58.
27. Semper HM, Povey R, Clark-Carter D. A systematic review of the effectiveness of smartphone applications that encourage dietary self-regulatory strategies for weight loss in overweight and obese adults. *Obes Rev* 2016; 17(9): 895-906.
28. Lowe MR, Butryn ML. Hedonic hunger: a new dimension of appetite? *Physiol Behav* 2007; 91(4): 432-9.
29. Zheng H, Lenard NR, Shin AC, Berthoud HR. Appetite control and energy balance regulation in the modern world: reward-driven brain overrides repletion signals. *Int J Obes (Lond)* 2009; 33 Suppl 2: S8-13.
30. Epstein LH, Carr KA, Lin H, Fletcher KD. Food reinforcement, energy intake, and macronutrient choice. *Am J Clin Nutr* 2011; 94(1): 12-8.
31. Epstein LH, Temple JL, Neaderhiser BJ, Salis RJ, Erbe RW, Leddy JJ. Food reinforcement, the dopamine D2 receptor genotype, and energy intake in obese and nonobese humans. *Behav Neurosci* 2007; 121(5): 877-86.

32. DelParigi A, Chen K, Salbe AD, et al. Successful dieters have increased neural activity in cortical areas involved in the control of behavior. *Int J Obes (Lond)* 2007; 31(3): 440-8.
33. Gettens KM, Gorin AA. Executive function in weight loss and weight loss maintenance: a conceptual review and novel neuropsychological model of weight control. *J Behav Med* 2017; 40(5): 687-701.
34. Stoeckel LE, Birch LL, Heatherton T, et al. Psychological and neural contributions to appetite self-regulation. *Obesity (Silver Spring)* 2017; 25 Suppl 1: S17-S25.
35. Butryn ML, Forman EM, Lowe MR, Gorin AA, Zhang F, Schaumberg K. Efficacy of environmental and acceptance-based enhancements to behavioral weight loss treatment: The ENACT trial. *Obesity (Silver Spring)* 2017; 25(5): 866-72.
36. Forman EM, Butryn ML, Manasse SM, et al. Acceptance-based versus standard behavioral treatment for obesity: Results from the mind your health randomized controlled trial. *Obesity (Silver Spring)* 2016; 24(10): 2050-6.
37. Pearl RL, Puhl RM. The distinct effects of internalizing weight bias: An experimental study. *Body Image* 2016; 17: 38-42.
38. Mensinger JL, Calogero RM, Tylka TL. Internalized weight stigma moderates eating behavior outcomes in women with high BMI participating in a healthy living program. *Appetite* 2016; 102: 32-43.
39. Murakami JM, Latner JD. Weight acceptance versus body dissatisfaction: Effects on stigma, perceived self-esteem, and perceived psychopathology. *Eat Behav* 2015; 19: 163-7.
40. Lee M, Ata RN, Brannick MT. Malleability of weight-biased attitudes and beliefs: a meta-analysis of weight bias reduction interventions. *Body Image* 2014; 11(3): 251-9.
41. Schvey NA, Puhl RM, Brownell KD. The impact of weight stigma on caloric consumption. *Obesity (Silver Spring)* 2011; 19(10): 1957-62.
42. Finch EA, Linde JA, Jeffery RW, Rothman AJ, King CM, Levy RL. The effects of outcome expectations and satisfaction on weight loss and maintenance: correlational and experimental analyses--a randomized trial. *Health Psychol* 2005; 24(6): 608-16.
43. Calugi S, Marchesini G, El Ghoch M, Gavasso I, Dalle Grave R. The Influence of Weight-Loss Expectations on Weight Loss and of Weight-Loss Satisfaction on Weight Maintenance in Severe Obesity. *J Acad Nutr Diet* 2017; 117(1): 32-8.
44. Coleman K, Austin BT, Brach C, Wagner EH. Evidence on the Chronic Care Model in the new millennium. *Health Aff (Millwood)* 2009; 28(1): 75-85.
45. Vallis M, Lee-Baggley D, Sampalli T, et al. Equipping providers with principles, knowledge and skills to successfully integrate behaviour change counselling into practice: a primary healthcare framework. *Public Health* 2018; 154: 70-8.
46. Vallis M. Are Behavioural Interventions Doomed to Fail? Challenges to Self-Management Support in Chronic Diseases. *Can J Diabetes* 2015; 39(4): 330-4.
47. Wadden TA, Webb VL, Moran CH, Bailer BA. Lifestyle modification for obesity: new developments in diet, physical activity, and behavior therapy. *Circulation* 2012; 125(9): 1157-70.
48. Preedy V, Watson R, Martin C. *Handbook of Behavior, Food and Nutrition*. New York: Springer-Verlag; 2011.
49. Ross R, Blair S, de Lannoy L, Despres JP, Lavie CJ. Changing the endpoints for determining effective obesity management. *Prog Cardiovasc Dis* 2015; 57(4): 330-6.
50. Sharma AM, Campbell-Scherer DL. Redefining obesity: Beyond the numbers. *Obesity (Silver Spring)* 2017; 25(4): 660-1.
51. Tate DF, Lytle LA, Sherwood NE, et al. Deconstructing interventions: approaches to studying behavior change techniques across obesity interventions. *Transl Behav Med* 2016; 6(2): 236-43.
52. Epstein LH, Leddy JJ, Temple JL, Faith MS. Food reinforcement and eating: a multilevel analysis. *Psychol Bull* 2007; 133(5): 884-906.
53. Carr KA, Daniel TO, Lin H, Epstein LH. Reinforcement pathology and obesity. *Curr Drug Abuse Rev* 2011; 4(3): 190-6.
54. Abraham C, Michie S. A taxonomy of behavior change techniques used in interventions. *Health Psychol* 2008; 27(3): 379-87.
55. Michie S, Ashford S, Sniehotta FF, Dombrowski SU, Bishop A, French DP. A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: the CALO-RE taxonomy. *Psychol Health* 2011; 26(11): 1479-98.
56. Health Service Executive (HSE). Making every contact count: A health behaviour change framework and implementation plan for health professionals in the Irish health service, 2016.
57. Sodlerlund A, Fischer A, Johansson T. Physical activity, diet and behaviour modification in the treatment of overweight and obese adults: a systematic review. *Perspect Public Health* 2009; 129(3): 132-42.
58. Booth HP, Prevost TA, Wright AJ, Gulliford MC. Effectiveness of behavioural weight loss interventions delivered in a primary care setting: a systematic review and meta-analysis. *Fam Pract* 2014; 31(6): 643-53.
59. Barnes RD, Ivezaj V. A systematic review of motivational interviewing for weight loss among adults in primary care. *Obes Rev* 2015; 16(4): 304-18.
60. Patnode CD, Evans CV, Senger CA, Redmond N, Lin JS. Behavioral Counseling to Promote a Healthful Diet and Physical Activity for Cardiovascular Disease Prevention in Adults Without Known Cardiovascular Disease Risk Factors: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2017; 318(2): 175-93.
61. Okorodudu DE, Bosworth HB, Corsino L. Innovative interventions to promote behavioral change in overweight or obese individuals: A review of the literature. *Ann Med* 2015; 47(3): 179-85.
62. Olander EK, Fletcher H, Williams S, Atkinson L, Turner A, French DP. What are the most effective techniques in changing obese individuals' physical activity self-efficacy and behaviour: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* 2013; 10: 29.
63. Zheng Y, Klem ML, Sereika SM, Danford CA, Ewing LJ, Burke LE. Self-weighing in weight management: a systematic literature review. *Obesity (Silver Spring)* 2015; 23(2): 256-65.
64. Clifford D, Ozier A, Bundros J, Moore J, Kreiser A, Morris MN. Impact of non-diet approaches on attitudes, behaviors, and health outcomes: a systematic review. *J Nutr Educ Behav* 2015; 47(2): 143-55 e1.
65. Chao HL. Body image change in obese and overweight persons enrolled in weight loss intervention programs: a systematic review and meta-analysis. *PLoS One* 2015; 10(5): e0124036.
66. Papadopoulos S, Brennan L. Correlates of weight stigma in adults with overweight and obesity: A systematic literature review. *Obesity (Silver Spring)* 2015; 23(9): 1743-60.
67. Nolan LJ, Eshleman A. Paved with good intentions: Paradoxical eating responses to weight stigma. *Appetite* 2016; 102: 15-24.
68. Pearl RL, Wadden TA, Hopkins CM, et al. Association between weight bias internalization and metabolic syndrome among treatment-seeking individuals with obesity. *Obesity (Silver Spring)* 2017; 25(2): 317-22.
69. Carels RA, Young KM, Wott CB, et al. Internalized weight stigma and its ideological correlates among weight loss treatment seeking adults. *Eat Weight Disord* 2009; 14(2-3): e92-7.
70. Latner JD, O'Brien KS, Durso LE, Brinkman LA, MacDonald T. Weighing obesity stigma: the relative strength of different forms of bias. *Int J Obes (Lond)* 2008; 32(7): 1145-52.
71. Puhl R, Peterson JL, Luedicke J. Motivating or stigmatizing? Public perceptions of weight-related language used by health providers. *Int J Obes (Lond)* 2013; 37(4): 612-9.
72. Hilbert A, Braehler E, Schmidt R, Lowe B, Hauser W, Zenger M. Self-Compassion as a Resource in the Self-Stigma Process of Overweight and Obese Individuals. *Obes Facts* 2015; 8(5): 293-301.
73. Neff KD. The development and validation of a scale to measure self-compassion. *Self and Identity* 2003; 2(3): 223-50.
74. Gale C, Gilbert P, Read N, Goss K. An Evaluation of the Impact of Introducing Compassion Focused Therapy to a Standard Treatment Programme for People with Eating Disorders. *Clinical Psychology & Psychotherapy* 2014; 21(1): 1-12.
75. Kelly AC, Carter JC, Borairi S. Are improvements in shame and self-compassion early in eating disorders treatment associated with better patient outcomes? *Int J Eat Disord* 2014; 47(1): 54-64.
76. 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(1): 79-85.
77. Wadden TA, Womble LG, Sarwer DB, Berkowitz RI, Clark VL, Foster GD. Great expectations: "I'm losing 25% of my weight no matter what you say". *J Consult Clin Psychol* 2003; 71(6): 1084-9.

78. Fabricatore AN, Wadden TA, Womble LG, et al. The role of patients' expectations and goals in the behavioral and pharmacological treatment of obesity. *Int J Obes (Lond)* 2007; 31(11): 1739-45.
79. Gorin AA, Marinilli Pinto A, Tate DF, Raynor HA, Fava JL, Wing RR. Failure to meet weight loss expectations does not impact maintenance in successful weight losers. *Obesity (Silver Spring)* 2007; 15(12): 3086-90.
80. Dalle Grave R, Calugi S, Magri F, et al. Weight loss expectations in obese patients seeking treatment at medical centers. *Obes Res* 2004; 12(12): 2005-12.
81. Baldwin AS, Rothman AJ, Jeffery RW. Satisfaction with weight loss: examining the longitudinal covariation between people's weight-loss-related outcomes and experiences and their satisfaction. *Ann Behav Med* 2009; 38(3): 213-24.
82. Ames GE, Thomas CS, Patel RH, McMullen JS, Lutes LD. Should providers encourage realistic weight expectations and satisfaction with lost weight in commercial weight loss programs? a preliminary study. *Springerplus* 2014; 3: 477.
83. Foster GD, Phelan S, Wadden TA, Gill D, Ermold J, Didie E. Promoting more modest weight losses: a pilot study. *Obes Res* 2004; 12(8): 1271-7.
84. Jeffery RW, Linde JA, Finch EA, Rothman AJ, King CM. A satisfaction enhancement intervention for long-term weight loss. *Obesity (Silver Spring)* 2006; 14(5): 863-9.
85. Polivy J, Herman C. If at first you don't succeed. False hopes of self-change. *Am Psychol* 2002; 57: 677-89.
86. Giesen JC, Havermans RC, Douven A, Tekelenburg M, Jansen A. Will work for snack food: the association of BMI and snack reinforcement. *Obesity (Silver Spring)* 2010; 18(5): 966-70.
87. Mela DJ. Eating for pleasure or just wanting to eat? Reconsidering sensory hedonic responses as a driver of obesity. *Appetite* 2006; 47(1): 10-7.
88. Hill C, Saxton J, Webber L, Blundell J, Wardle J. The relative reinforcing value of food predicts weight gain in a longitudinal study of 7--10-y-old children. *Am J Clin Nutr* 2009; 90(2): 276-81.
89. Lansigan RK, Emond JA, Gilbert-Diamond D. Understanding eating in the absence of hunger among young children: a systematic review of existing studies. *Appetite* 2015; 85: 36-47.
90. Castellanos EH, Charboneau E, Dietrich MS, et al. Obese adults have visual attention bias for food cue images: evidence for altered reward system function. *Int J Obes (Lond)* 2009; 33(9): 1063-73.
91. Davis C, Patte K, Levitan R, Reid C, Tweed S, Curtis C. From motivation to behaviour: a model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite* 2007; 48(1): 12-9.
92. Berridge KC, Ho CY, Richard JM, DiFeliceantonio AG. The tempted brain eats: pleasure and desire circuits in obesity and eating disorders. *Brain Res* 2010; 1350: 43-64.
93. Franken IH, Muris P. Individual differences in reward sensitivity are related to food craving and relative body weight in healthy women. *Appetite* 2005; 45(2): 198-201.
94. Finlayson G, King N, Blundell JE. Liking vs. wanting food: importance for human appetite control and weight regulation. *Neurosci Biobehav Rev* 2007; 31(7): 987-1002.
95. Saelens BE, Epstein LH. Reinforcing value of food in obese and non-obese women. *Appetite* 1996; 27(1): 41-50.
96. Temple JL, Legierski CM, Giacomelli AM, Salvy SJ, Epstein LH. Overweight children find food more reinforcing and consume more energy than do nonoverweight children. *Am J Clin Nutr* 2008; 87(5): 1121-7.
97. Epstein LH, Carr KA, Lin H, Fletcher KD, Roemmich JN. Usual energy intake mediates the relationship between food reinforcement and BMI. *Obesity (Silver Spring)* 2012; 20(9): 1815-9.
98. Cheng JJ, de Bruin JP, Feenstra MG. Dopamine efflux in nucleus accumbens shell and core in response to appetitive classical conditioning. *Eur J Neurosci* 2003; 18(5): 1306-14.
99. Sunsay C, Rebec GV. Real-time dopamine efflux in the nucleus accumbens core during Pavlovian conditioning. *Behav Neurosci* 2008; 122(2): 358-67.
100. Stice E, Spoor S, Bohon C, Small DM. Relation between obesity and blunted striatal response to food is moderated by TaqIA A1 allele. *Science* 2008; 322(5900): 449-52.
101. Wang GJ, Volkow ND, Logan J, et al. Brain dopamine and obesity. *Lancet* 2001; 357(9253): 354-7.
102. Burger KS, Stice E. Greater striatopallidal adaptive coding during cue-reward learning and food reward habituation predict future weight gain. *Neuroimage* 2014; 99: 122-8.
103. Demos KE, Heatherton TF, Kelley WM. Individual differences in nucleus accumbens activity to food and sexual images predict weight gain and sexual behavior. *J Neurosci* 2012; 32(16): 5549-52.
104. Guo J, Simmons WK, Herscovitch P, Martin A, Hall KD. Striatal dopamine D2-like receptor correlation patterns with human obesity and opportunistic eating behavior. *Mol Psychiatry* 2014; 19(10): 1078-84.
105. Stice E, Yokum S, Burger KS, Epstein LH, Small DM. Youth at risk for obesity show greater activation of striatal and somatosensory regions to food. *J Neurosci* 2011; 31(12): 4360-6.
106. Volkow ND, Wang GJ, Telang F, et al. Low dopamine striatal D2 receptors are associated with prefrontal metabolism in obese subjects: possible contributing factors. *Neuroimage* 2008; 42(4): 1537-43.
107. Fitzpatrick SL, Coughlin JW, Appel LJ, et al. Application of Latent Class Analysis to Identify Behavioral Patterns of Response to Behavioral Lifestyle Interventions in Overweight and Obese Adults. *Int J Behav Med* 2015; 22(4): 471-80.
108. Alhassan S, Kim S, Bersamin A, King AC, Gardner CD. Dietary adherence and weight loss success among overweight women: results from the A TO Z weight loss study. *Int J Obes (Lond)* 2008; 32(6): 985-91.
109. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. *N Engl J Med* 2009; 360(9): 859-73.
110. Cleobury L, Tapper K. Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *J Hum Nutr Diet* 2014; 27(4): 333-41.
111. Thomas JG, Doshi S, Crosby RD, Lowe MR. Ecological momentary assessment of obesogenic eating behavior: combining person-specific and environmental predictors. *Obesity (Silver Spring)* 2011; 19(8): 1574-9.
112. Alonso-Alonso M, Pascual-Leone A. The right brain hypothesis for obesity. *JAMA* 2007; 297(16): 1819-22.
113. van den Bos R, de Ridder D. Evolved to satisfy our immediate needs: self-control and the rewarding properties of food. *Appetite* 2006; 47(1): 24-9.
114. Le DS, Pannacciulli N, Chen K, et al. Less activation of the left dorsolateral prefrontal cortex in response to a meal: a feature of obesity. *Am J Clin Nutr* 2006; 84(4): 725-31.
115. Le DS, Pannacciulli N, Chen K, et al. Less activation in the left dorsolateral prefrontal cortex in the reanalysis of the response to a meal in obese than in lean women and its association with successful weight loss. *Am J Clin Nutr* 2007; 86(3): 573-9.
116. Small DM, Zatorre RJ, Dagher A, Evans AC, Jones-Gotman M. Changes in brain activity related to eating chocolate: from pleasure to aversion. *Brain* 2001; 124(Pt 9): 1720-33.