

## **Health behaviour change considerations for weight loss and type 2 diabetes mellitus: Nutrition, physical activity and sedentary behaviour**

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### **Abstract (60 words)**

Good nutrition, regular physical activity and low levels of sedentary behaviour are important to the prevention, management and treatment of obesity and type 2 diabetes mellitus (T2DM). Self-management requires individuals to have the capability to enact, opportunity to enable and motivation to perform relevant health behaviours. These behaviours, and the bio-psycho-social drivers of them, should be considered when working in the area of T2DM.

### **Key Points:**

- Behaviour is essential in the prevention, management and treatment of type 2 diabetes, but cannot be achieved by simply telling people what to do.
- To adapt eating behaviour, physical activity and sedentary behaviour, individuals must have the capability to enact, opportunity to enable and motivation to perform (or avoid) the new behaviour. These components form the COM-B system and must all be present.
- Additional training to understand behaviour change and effective communication is needed to build capacity for health professionals to support individuals with T2DM.

**Keywords:** Diabetes, Eating behaviour, Physical activity, Sitting, Behaviour change

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## **Introduction**

An estimated 422 million adults worldwide<sup>1</sup>, with 4.7 million of these in the UK<sup>2</sup>, are living with diabetes, of which approximately 90% are Type 2 Diabetes Mellitus (T2DM). There has been a rise in T2DM over the last decade, directly correlating with increased rates of obesity<sup>3,4,5</sup>. Individuals living with obesity tend to have elevated levels of free fatty acids, which can cause muscular insulin resistance, impacting blood glucose control, leading to T2DM and its associated health complications<sup>5</sup>. Behavioural interventions to support weight loss, weight loss maintenance and diabetes self-management are therefore essential<sup>6</sup>, with specific focus on nutrition, physical activity and sedentary behaviour.

## **Obesity, weight loss and type 2 diabetes mellitus**

Weight loss, weight loss maintenance and blood glucose control are considered important targets in T2DM management<sup>7,8</sup>. Diabetes UK<sup>9</sup> recommends prioritising a sustained weight loss of  $\geq 5\%$  in individuals who are overweight for effective glycaemic control, although sustained weight loss of  $>7\%$  is deemed optimal<sup>7</sup>. This degree of weight loss can reduce HbA1c (the measured amount of glucose level in the blood over 2-3 months) by 0.6-1.2%<sup>10</sup>, while T2DM remission can be achieved in 86% of individuals who reduce their weight by  $>15$  kg<sup>11</sup>.

Weight loss with calorific deficit can positively influence glycaemic control in individuals with T2DM<sup>12</sup>. Improved blood pressure levels and reduction in diabetes-related medication can also be obtained via weight loss<sup>13</sup>. A low-energy liquid diet (for 3 months), followed by a period (2-8 weeks) of re-introduction to food used in the 'Counterweight-plus' programme<sup>14</sup>, has been shown to put T2DM into remission in the DiRECT trial<sup>11</sup>. Significant weight loss ( $M=10.0$ kg;  $SD=8.0$ ) was achieved, and diabetes remission was linked to the degree of weight loss maintained at 12 months<sup>11</sup>.

Behaviour change is essential to the success of weight loss programmes, and central to the prevention, management and treatment of obesity<sup>15</sup>. However, it is important to note that obesity is not a behaviour<sup>16</sup>. It cannot be changed overnight, and it is not possible to directly influence weight loss unless an individual undergoes surgery to remove excess skin. Individuals living with obesity, also did not reach their weight status overnight, and were likely influenced by a multitude of bio-psycho-social factors<sup>15</sup>. These include genetics, thoughts, feelings and interactions with their physical and social environment. To support self-management, a focus must be placed on behaviours that can be directly influenced, rather than outcomes of behaviour. Engaging in any new behaviour, and/or changing old patterns of

behaviour is not as simple as following an instruction to do so. The underlying principles of behaviour and behaviour change must, therefore, be understood.

### **The importance of behaviour for the self-management of type 2 diabetes mellitus**

Behavioural factors related to eating behaviour, increasing physical activity and reducing sedentary behaviour are important for the prevention and management of obesity<sup>15,16</sup> and have been shown to influence the risk of developing T2DM.<sup>17,18</sup> The first stage of treatment after diagnosis is usually recommendation for behaviour change in these areas, with the aim of improving glycaemic control<sup>19</sup>. If this is unsuccessful, medication is prescribed to support the individual with their glycaemic management<sup>20</sup>. All aspects of successful self-management of T2DM and treatment optimisation are, therefore, dependent on behaviour.

Human behaviour is, however, complex. Theoretical frameworks can help to enhance the likely success of interventions that aim to change behaviours such as healthy eating, physical activity, reducing sedentary behaviour or medication adherence<sup>21</sup>. The Behaviour Change Wheel<sup>22</sup> uses a system called COM-B designed to understand how Capability (e.g. knowledge and skill), Opportunity (e.g. social and environmental influence) and Motivation (e.g. confidence, identity, habit and emotion) interact to influence Behaviour through a behavioural diagnosis. The Theoretical Domains Framework (TDF)<sup>23</sup> helps to understand behaviour further, with a focus on the bio-psycho-social factors that influence behaviour, mapping them to COM-B. This helps separate potential ambiguity when using the COM-B system. For example, a barrier linked to Psychological Capability could be due to both a lack of Knowledge (a TDF domain linked to not knowing what to do or why) or poor Memory (a TDF domain linked to forgetting to do something). Each of these TDF domains would require a different Intervention Function. For example, 'Education' would be needed to increase 'Knowledge', or 'Enablement' to enhance 'Memory'. In turn, these would require different Behaviour Change Techniques (BCTs) when attempting to intervene to support behaviour change using a standardised taxonomy<sup>24</sup>. For example, giving information on health consequences would be used to increase knowledge; or prompts and cues to enable memory.

While individuals are often motivated to avoid the negative consequences of having diabetes, they do not always understand the impact of health behaviours on long-term outcomes<sup>25</sup>. In addition to knowledge, social opportunity (e.g. social support, cultural norms) and identity (e.g. in relation to body image) have been highlighted as barriers to healthful behaviors<sup>25</sup>. When considering approaches to use to support T2DM, a recent review of BCTs used within online self-management programmes found that 'feedback on behaviour', 'information on consequences of behaviour', 'problem solving' and 'self-monitoring' were instrumental in their

effectiveness<sup>26</sup>. Other work has shown the most common BCTs used are: 'prompts/cues', 'instruction on how to perform the behaviour', 'information about health consequences', 'restructuring the social environment', 'adding objects to the environment', 'social support (practical)', and 'goal setting (behaviour)'<sup>27</sup>. The HEAL-D intervention, targeted at an African and Caribbean population with T2DM in the UK, suggested the use of 'social support', 'social comparison', 'credible sources' and 'demonstration of behaviour' as key behaviour change techniques<sup>25</sup>. It is noted that certain BCT's may be effective for some individuals, but ineffective for others, dependant on factors such as personality, psychological state and general characteristics<sup>28</sup>. Interventions that include specific BCTs can significantly enhance physical activity and reduce HbA1c levels<sup>29</sup>. Moreover, using a higher number of BCTs has been found to be related to better weight loss outcomes<sup>30</sup>. More research is needed to identify not only the most common BCTs and volume used, but also the most effective BCTs to overcome COM-B barriers to self-management behaviours in those with T2DM.

### **Communication in the delivery of behaviour change techniques**

Telling someone what to do will not be enough to change complex behaviours. Motivational interviewing (MI)<sup>31,32</sup> is an effective communication style for assisting with behaviour change in the management of T2DM. This includes increasing physical activity, consumption of fruit and vegetables and improving medication adherence, leading to reduced HbA1c<sup>33</sup>. Furthermore, MI has shown promise for improving dietary behaviours and weight loss. However, in a review of literature, fidelity of delivery was infrequently recorded<sup>34</sup>. Investment in MI training should be given to equip practitioners with the knowledge and skill to engage patients in the consultation process, resist telling them what to do, and allowing focus on what is desired and achievable in relation to behaviour change and outcomes. Furthermore, skill is needed to understand the patient's perspective, evoke a sense of empowerment, ensure that the client feels supported and that they have a plan going forward<sup>35-39</sup>. Effective consultations should use core communication skills to support behaviour change such as using the RULE (Resist the righting reflex; Understand your client's motivation; Listen to your client; Empower your client) and OARS (Open-ended questions, Affirmations, Reflective listening, Summaries), which can be linked to suitable BCTs<sup>35-39</sup>. The GROW (Goal, Reality, Options, Will/Way forward)<sup>40</sup> model is also useful from a health coaching perspective to guide conversations around nutrition, physical activity and sedentary behaviour with a natural start (goal) and finish (way forward)<sup>35,39,41</sup>.

### **Eating behaviour and type 2 diabetes mellitus**

A change to dietary intake is recommended as part of a personalised management plan for people living with T2DM. The aim of nutritional advice is to help manage glucose levels,

support weight loss and reduce the risk of CVD<sup>9</sup>. There is no evidence to suggest that one single dietary approach is most effective, however, consideration should be given to the amount and quality of carbohydrate within a dietary plan, as this is the primary determinant of glycaemia. Carbohydrate counting is considered an important approach for managing glycaemia but could have limited relevance for individuals who do not use insulin<sup>42</sup>. Meta-analyses have reported clinically small but significant reductions in HbA1c in response to low glycaemic index diets<sup>43,44</sup>. However, large RCTs have suggested low glycaemic index diets may be no more effective than standard diet education<sup>45</sup>. Dietary fibre can delay the digestion and absorption of glucose and increase satiety, which can help with weight loss. Intake of dietary fibre is associated with improved glycaemia and a lower prevalence of hypertension, obesity and metabolic syndrome in individuals living with T2DM<sup>46,47</sup> and should thus be considered when making changes to dietary behaviour.

There are a range of other dietary approaches that could be adopted to achieve health benefits in individuals living with T2DM, such as low-fat diets, low energy diets, Mediterranean and DASH (Dietary Approaches to Stop Hypertension) diets. The American Diabetes Association<sup>48</sup> and Diabetes UK<sup>9</sup> recommend the use of a Mediterranean diet or a DASH eating pattern to improve glycaemia, lipid profile and reduce the risk of CVD. Adopting a Mediterranean diet can result in significantly greater improvements in HbA1c than standard diabetes care<sup>49</sup>. Furthermore, following the DASH diet for 8 weeks can significantly reduce HbA1c, fasting glucose, body weight, blood pressure and lipids<sup>50</sup>. A healthcare professional with suitable expertise in nutrition should work with individuals to develop an effective and sustainable personalised plan based on these dietary guidelines and approaches to achieve the best possible outcomes. This could be achieved by enabling the development of capability, through enhancing knowledge of nutrition and skills for preparation; opportunity, through enabling social support and changes that may be needed to physical and social environments (e.g. what food is in the home/who else is influencing that environment); and motivation, in terms of encouragement, building confidence and strategies to overcome habitual and emotional eating patterns (e.g. finding alternative behaviours to eating when experiencing low mood). It should be recognised, however, that while capability (knowing what to do/how to do it) and motivation (wanting to do it/overcoming habit or emotion) are in the individual's control, opportunity is related to external factors such as social networks and environmental context and resources. Those who are living in food insecure households or without support from friends and family, have less opportunity to eat healthful foods, or even eat at all. This impacts on the individual's ability to manage their T2DM<sup>51</sup>, potentially putting them at risk of adverse consequences.

## **Physical activity, sedentary behaviour and type 2 diabetes mellitus**

Regular engagement in moderate-to-vigorous physical activity (MVPA) is a cornerstone strategy for effective management of T2DM<sup>52</sup>. Adults with T2DM should accumulate  $\geq 150$  minutes/week of MVPA or  $\geq 75$  minutes/week of vigorous physical activity spread over 3 days with no more than 2 consecutive days without activity. Additionally, resistance exercise should be performed 2-3 times/week on non-consecutive days<sup>52</sup>. Regular physical activity helps to manage glycaemia, reduce the risk of diabetes and CVD, and improve overall health, wellbeing and quality of life<sup>53,54</sup>. One of the most important adaptations to physical activity is increased glucose uptake into muscle and the liver. This occurs via insulin-dependent and non-insulin-dependent (i.e. mediated by muscular contractions) pathways, which can last for up to 48 hours after a single session of exercise<sup>55</sup>. Engaging in regular MVPA and resistance training can improve insulin sensitivity, HbA1c and lipid profile in the long-term, independent of weight loss<sup>56,57</sup>. Physical activity has been reported as one of the best non-pharmacological treatments for the control of T2DM<sup>58</sup>. However, adherence to regular physical activity in this population is low<sup>59</sup>. Engagement in physical activity should be encouraged in clinical practice and is the focus of the Sport England WeAreUndefeatable campaign, which targets those with long-term conditions such as T2DM<sup>60</sup>.

Sedentary behaviour has now emerged as an independent risk factor for poor cardiometabolic health that should be considered in addition to physical activity<sup>61</sup>. Sedentary behaviour is defined as any waking behaviour characterised by a low energy expenditure whilst in a sitting, laying or reclined posture<sup>62</sup>. This behaviour is distinctly different to being physically inactive, which refers to an individual not meeting physical activity guidelines<sup>62</sup>. Individuals who engage in the highest amounts of sitting have a significantly increased risk of T2DM and CVD than individuals who sit the least<sup>18</sup>. Engaging in prolonged bouts of sedentary behaviour is adversely associated with cardiovascular health<sup>63</sup> and there is consistent evidence that breaking up sitting with 2-5 minutes of light or moderate-intensity walking every 20-30 minutes attenuates postprandial glucose responses<sup>18,64,65</sup>. Current evidence, therefore, suggests that adults with T2DM should reduce and break up sedentary time in addition to engaging in regular aerobic and resistance exercise<sup>52</sup>.

Behavioural interventions aimed at increasing physical activity vary in terms of their content, implementation and effectiveness. A meta-analysis suggested that HbA1c improvements in participants with T2DM were greater in physical activity interventions that were underpinned by a theoretical model of behaviour change and were  $\geq 6$  months in duration<sup>66</sup>. There were also specific BCTs that appeared to be associated with clinically significant improvements in HbA1c, such as goal setting, time management, barrier identification/problem-solving, and

planning social support/social change<sup>66</sup>. Health professionals working in this area should aim to support capability, such as ensuring knowledge of physical activity guidelines and how often to break up sitting time, ways to prompt memory and strategies to plan to be more active and/or sit less. They could also support opportunity, by enabling individuals to identify who can help them and how they can change their environment to facilitate more activity and reduce sedentary behaviour. Finally, they can support motivation, by building confidence in the ability to be more active, while raising awareness of habitual behaviour and emotional factors that may be having a negative impact.

### **The use of apps in the management of Type 2 diabetes**

Smartphone apps offer a convenient, flexible and cost-effective way in which interventions could be delivered to promote health behaviour change. This approach has the potential to reach a large proportion of the population with 78% of people in the UK having used a smartphone in 2018<sup>67</sup>. A number of studies have evaluated the effectiveness of health apps that enable people to self-manage their T2DM<sup>68</sup>. The majority of these apps allow the user to self-monitor and receive feedback on glucose levels, dietary intake, physical activity and sedentary behaviour. These behaviours are often targeted simultaneously within a single app and health coaching has often been provided remotely based on data recorded by the app<sup>69,70</sup>. A meta-analysis of interventions using mobile phone apps demonstrated their effectiveness for reducing HbA1c in adults with T2DM in the short (3-6 months) and longer-term (9-12 months)<sup>71</sup>. For health practitioners and patients with T2DM that are considering using these types of health and wellbeing apps, the National Health Service provides a library (several of which are designed for diabetes use) that have been deemed to be clinically safe and secure to use<sup>72</sup>.

Apps that include BCTs such as 'providing information', 'action planning', 'self-monitoring', 'goal setting' and 'reward' have led to improvements in nutrition<sup>73,74</sup>. However, more research is needed to ascertain the efficacy of apps for changing dietary intake in T2DM. The combination of exergame apps with apps that self-monitor steps may not be effective for increasing physical activity levels<sup>75</sup>, whereas apps using 'goal setting', 'self-monitoring of behaviour' and 'feedback' combined with a wearable activity tracker have significantly increased physical activity<sup>76</sup>. Apps that include 'self-monitoring', 'feedback' and 'prompts/cues' have been effective over short periods for reducing sedentary behaviour<sup>77</sup>. The MyHealthAvatar-Diabetes app was developed to reduce and break up sitting time, to in turn improve overall health and wellbeing in people living with T2DM<sup>41</sup>. This app used a range of BCTs, such as 'goal setting', 'action planning', 'self-monitoring', 'feedback on behaviour' and 'prompts/cues'. In a feasibility trial<sup>41</sup>, the MyHealthAvatar-Diabetes app was found to be

acceptable for use by adults with T2DM and showed preliminary efficacy for increasing the number of breaks in sitting per day and improving glucose tolerance and psychological wellbeing. The effectiveness of smartphone apps for managing glycaemia in adults with T2DM has been demonstrated, however, further research is required regarding their ability to improve dietary intake, physical activity and reduce sedentary behaviour in this population.

## **Conclusion**

Health behaviours related to nutrition, physical activity and sedentary behaviour are important to the prevention, management and treatment of T2DM. Research highlights their role in weight loss, glycaemic control and metabolic health, however, human behaviour is complex, and simply being told what to do is often not enough for long term effective behaviour change. Self-management behaviours for T2DM require individuals to have the capability to enact, opportunity to enable and motivation to perform relevant behaviours. These aspects can be influenced by a multitude of factors such as knowledge, memory, environment, social support, cognitions, identity, habit and emotion. Using psychological theory can help to understand these determinants, while also highlighting to health professionals areas to target during consultation and intervention. Mobile apps hold potential to support behaviour change, and thus the self-management of T2DM at a wide-scale, and should be considered as part of a tailored treatment approach. Health care professionals would benefit from using behaviour change theory and effective communication skills to support self-management behaviours. Future work should develop training and build capacity in these areas.

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