REVIEW PAPER

JMS Journal of Medical Science

Does a healthy lifestyle reduce the risk of obesity in type 1 diabetes?

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https://doi.org/10.20883/medical.e1127

Keywords: diabetes type 1, diet, physical activity, sleep quality

Received 2024-08-28
Accepted 2025-04-02
Published 2025-06-30

How to Cite: Michalski M, Zozulińska-Ziółkiewicz D. Does a healthy lifestyle reduce the risk of obesity in type 1 diabetes? Journal of Medical Science. 2025 June;94(2);e1127. doi:10.20883/medical.e1127

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ABSTRACT

A healthy lifestyle is recommended for every person with type 1 diabetes. Unfortunately, the incidence of type 1 diabetes is steadily increasing. Many studies confirm that maintaining a balanced diet or incorporating physical activity helps to maintain good health over the long term. It helps to balance the diabetes metabolically and to prevent the development of excessive body weight. Making appropriate lifestyle modifications, as recommended by researchers and associations, will undoubtedly help with this. This study aims to analyse the impact of a healthy lifestyle, including a balanced diet, sleep hygiene, psychological conditions, insulin therapy and physical activity, on metabolic control and the prevention of excess body weight in patients with type 1 diabetes. The introduction and alignment of the described components in patients with type 1 diabetes contribute to better metabolic control of the disease and reduce the risk of excessive body weight.

Introduction

Since 1975, the global prevalence of obesity has almost tripled, and in 2019, it was estimated that comorbidities such as diabetes contributed to five million deaths [1]. Since 1980, the incidence of diabetes has quadrupled, becoming one of the leading causes of premature death. In the US, type 1 diabetes accounts for approximately 5.6% of all adult-onset diabetes cases. Although historically associated with thin people, type 1 diabetes is now shaped by factors beyond autoimmunity. The number of people with type 1 diabetes is projected to increase globally from 3.7 million in 2021 to 13.5–17.4 million in 2040. In the context of dynamic socio-economic and nutritional changes, accelerated pancreatic β-cell damage due to obesity is becoming increasingly apparent [2]. Everyone's lifestyle largely determines their health.

Changing lifestyle and, most importantly, aspects of it, such as diet, physical activity, sleep quality and mental state, is the first and most crucial step in the management of diabetes [3]. Unfortunately, excessive body weight, defined as overweight or obesity, is increasingly seen in

people with type 1 diabetes [4]. The present work is a narrative review. Search engines such as PubMed, Google Scholar, and Wiley Online Library for the period June 2024 – August 2024) were analysed. The search terms used were mainly: „diabetes type 1", „obesity", „overweight" and the search terms respectively under the search terms: „diet", „physical activity", „sleep", „psychological condition". The results of studies indicate that people, either with type 1 diabetes or obesity, do not engage in health behaviour more intensively than healthy individuals.

Furthermore, a strong need for social approval was associated with the level of health behaviour in the study groups, which may suggest that the already average level of health behaviour is due to a desire to present oneself in a more positive light [3]. Nevertheless, special attention should be paid to the educational aspect so that an increasing number of type 1 diabetes recipients take care not only of metabolic compensation but also of their body weight. A healthy lifestyle can help to maintain a healthy body weight and reduce the risk of obesity. This study aims to analyse the impact of a healthy lifestyle, including a balanced diet, sleep hygiene, psychological conditions, insulin therapy and physical activity, on metabolic control and prevention of excess body weight in patients with type 1 diabetes. These factors will be discussed in this study.

Balanced diet

The word 'diet' derives from Classical Greek and means 'diaita' or 'lifestyle'. Already at this stage, it can be deduced that it is one of the most important elements of a healthy lifestyle, i.e., one that does not negatively affect the body's functions. Diet is primarily about nutrition, which plays a key role in the therapeutic process and also reduces the risk of obesity. Every patient should take care to control metabolic alignment through lifestyle changes, including eating habits. The challenge is to develop an appropriate plan to support individuals to make lifestyle changes [5]. Adherence to recommended dietary recommendations can improve tissue insulin sensitivity and glycaemic control, thereby improving lifestyle and quality of life. Unfortunately, it appears that adherence to a rational pattern of proper nutrition is probably one of the most challenging elements of diabetes management [6]. It appears that excessive body weight, until recently mainly associated with type 2 diabetes, is increasingly observed in people with type 1 diabetes. DuBose et al. evaluated a population of children and adolescents with type 1 diabetes from countries such as Germany, Austria, and the USA. The study group had a higher body mass index (BMI) than reference values. Twelve per cent were diagnosed as obese and 24 per cent were overweight [7]. On the other hand, Minges et al., in their study, confirm that BMI values above the norms for normal weight occur in up to one in three children diagnosed with type 1 diabetes [8]. At this point, it should be emphasised that there is no single dietary pattern that all people with type 1 diabetes should follow. Each patient should have an individualised nutrition plan. Of course, it is recommended to emphasise the importance of eating raw vegetables, choosing whole grain products and eliminating the consumption of refined sugar. According to the American Diabetes Association, individualisation of dietary recommendations is recommended to take into account metabolic status, clinical goals, personal preferences, and socio-cultural considerations [9]. Individuals with type 1 diabetes and coexisting obesity may benefit from diet plans with reduced calories, lower total carbohydrate and glycaemic index, and higher fibre and lean protein [10]. Although low-carbohydrate (<130 g carbohydrate/day) and ketogenic (<55 g carbohydrate/day) diets are becoming increasingly popular and advertised as the gold standard in weight-loss therapy, there is limited evidence for their use in type 1 diabetes, as some concerns have been raised mainly about the risk of hypoglycaemia and ketoacidosis [11]. The ketogenic diet is a way of eating characterised not only by a low carbohydrate intake, but also by an increased intake of fats and proteins. Due to the low carbohydrate intake, the body has to change and find new sources for peripheral tissues and the brain, leading to the breakdown of fatty acids in the liver and the formation of ketone bodies, which is unfavourable for diabetics [12]. The ACTION research group evaluated in young adults with type 1 diabetes and overweight or obesity the effects of a hypocaloric low-carbohydrate diet, a hypocaloric low-fat diet and a Mediterranean diet without calorie restriction

on body weight and glycaemia. A three-month diet, regardless of macronutrient distribution or calorie restriction, resulted in weight loss while improving or maintaining HbA1c levels without increasing the risk of hypoglycaemia in adults with type 1 diabetes [13]. Although the Mediterranean diet is considered the 'gold standard' for dietary patterns, there is insufficient evidence for its effectiveness in type 1 diabetes [14]. A study by Mottalib et al. involving patients with type 1 diabetes and metabolic syndrome compared the effects of a Mediterranean diet without calorie restriction with a low-fat diet. The results proved to be similarly beneficial in terms of waist circumference, anthropometric, and metabolic outcomes in both trials [14]. It should be particularly noted that the above studies mention the Mediterranean diet as a diet without caloric restriction, which is significantly needed in the development of excessive body weight as well as in the maintenance of normovolemia. There is evidence to suggest that the Palaeolithic diet has a positive effect on monitoring glucose homeostasis, but other studies have not confirmed these results. This diet includes eating vegetables, fruit, meat, fish, eggs, and nuts, and avoiding dairy products, oils, and legumes. It is often classified as a low-carbohydrate diet, low in sodium and rich in fat, potassium and antioxidants. However, the paleo diet and the diet recommended by the American Diabetes Association share similar effects. The Palaeolithic diet can affect the body and the organism, especially with type 2 diabetes, as it affects HbA1c values or anthropometric parameters. However, the results of recent studies evaluating the effect of the Palaeolithic diet on glucose homeostasis are inconclusive. Therefore, well-designed long-term studies are needed to confirm the efficacy of the Palaeolithic diet in diabetic patients, especially in type 1 diabetes [15]. According to the recommendations of the Diabetes Poland (PTD), the proportion of carbohydrates in the diet should be about 45% of daily energy requirements, fats 25–40%, and protein 15–20% [16]. Adequate carbohydrate intake in the patient's diet is one of the first steps towards a rational diet, which can prevent excessive weight gain in the future. Healthy eating habits can include refrigerating starchy products after cooking, as this results in the retrogradation of starch, which becomes an unabsorbable product in the human digestive tract due to the reduction in available carbohydrates. When starch is cooled, amylose molecules and long amylopectin chains form double helices and lose their ability to bind water. The crystallised form of starch may be resistant to enzymatic degradation in the small intestine, thus reducing the digestible starch concentration in cooked starch products [17,18]. A Study by Stróżyk et al. confirms the relevance of the occurrence of such a phenomenon. Consumption of rice that has undergone a cooling process has resulted in a lower increase in postprandial blood glucose levels in people with type 1 diabetes [19]. The phenomenon may be beneficial for people with diabetes, as the conversion of starch into an unabsorbable form may contribute to lower postprandial glucose values and less glycaemic variability. In addition, the presence of resistant starch lowers the glycaemic index of a given meal. It is the diet based on the principles of a low glycaemic index (GI) that is considered the most beneficial for health and is not only recommended for diabetic patients. People with type 1 diabetes who eat rationally and follow a low glycaemic index diet have better glycaemic control. In addition, a low GI diet may have a beneficial effect on lipid concentrations [20]. Higher BMI in people with type 1 diabetes has also been shown to be directly associated with higher LDL-C and non-HDL-C values [21]. A healthy lifestyle also includes regularity of meal intake. Studies indicate that adolescents who did not eat breakfast compared to peers who ate breakfast daily had a higher risk of excessive body weight. Interestingly, a similar phenomenon was observed about dinner consumption. Those who ate dinner regularly throughout the week had a lower risk of being overweight than those who ate dinner irregularly [22,23]. Unfortunately, unhealthy and potentially dangerous practices of wanting to balance body weight or following widely available fad diets, such as skipping insulin doses, excessive fasting, stimulating vomiting, and using laxatives in type 1 diabetes, are common strategies [24]. A study by Lawrence et al. found that among adolescents who had ever tried to lose weight, healthy weight loss practices, i.e., diet and exercise, were the most common. In contrast, unhealthy practices (fasting, use of diet aids, vomiting or use of laxatives, and skipping insulin doses) were less common. All unhealthy weight

loss practices, except fasting, were more common in women than in men. Diets, fasting and use of dietary aids were more common in adolescents with type 2 diabetes than in those with type 1 diabetes [24]. Unhealthy weight loss practices are more common in overweight or obese women and may be influenced by depression and their perception of their body shape [25]. Analysing the studies, it is clear that there is insufficient data to show an association between carbohydrate-restricted diets and ketogenic diets with weight gain or loss among people with type 1 diabetes. Nutrition education by specialised treatment teams is important to enable weight reduction with metabolic compensation.

Physical activity

High levels of sedentary lifestyles and low levels of physical activity are associated with the development of obesity, with an increased risk of premature mortality and the development of some chronic diseases. Incorporating moderate to high-intensity physical activity can reduce the mortality risk associated with excessive sedentary lifestyles. Understanding the relationship of these behaviours can help practitioners determine whether to prioritise interventions targeting sedentary lifestyle, physical activity or both components [26]. The introduction of physical activity is important for weight reduction not only in healthy people, but also among individuals with type 1 diabetes, who are often overweight [27]. The most important thing is to change the lifestyle, and this cannot be done without including physical activity. Regular physical exercise is a key element in the prevention and treatment of obesity. In people with type 1 diabetes, participation in sports was a barrier in the past; today, the opposite is true. A typical barrier to weight control in type 1 diabetes is a reluctance to engage in exercise for fear of hypoglycaemia, which may occur during, after or overnight after exercise [28]. Adequate patient education regarding insulin dosing and carbohydrate adjustment to maintain stable blood glucose levels during exercise should alleviate patients' fear of hypoglycaemia [29]. Unfortunately, the fear of a sudden drop in blood glucose during exercise can lead to avoidance of exercise, which negatively affects overall health. Among the causes of fear of hypoglycaemia, we can include the experience of hypoglycaemic episodes in the past and the fear of their recurrence, or unfamiliarity with how to prevent and manage hypoglycaemia during exercise. However, there are strategies to cope with the fear of hypoglycaemia, such as appropriate education on diet, glycaemic monitoring, adjusting the intensity and type of exercise to individual needs and abilities, and psychological support. Regular exercise in people with type 1 diabetes not only prevents the development of excessive body weight, but also improves overall fitness, and allows, with skilful insulin adjustment, to improve glycaemic outcomes [30]. The positive factors following the introduction of physical activity are many more. Regular physical activity leading to weight loss has a positive effect on the cardiovascular system, reducing visceral adipose tissue [31]. It is essential to have good glucose control before exercising, as both too low and too high values can lead to serious health consequences. If glucose levels are too low, there is a risk of hypoglycaemia, which can result in weakness, dizziness and even unconsciousness. In the case of hyperglycaemia, the body may not be able to use glucose effectively as an energy source, leading to increased fat burning and production of ketone bodies. In extreme cases, this can lead to ketoacidosis – a life-threatening condition that manifests as dehydration, abdominal pain, nausea and confusion. This is why it is a good idea to monitor your glycaemia before training and balance it appropriately to make exercise safe and effective. A group of people with type 1 diabetes are at risk of high blood pressure, triacylglycerol and LDL cholesterol levels and low HDL levels. These factors are associated with an increased risk of vascular disease [32]. In some cases, there is a reduction in apolipoprotein B, which is proatherogenic and associated with premature mortality in type 1 diabetes [33]. Physical activity also increases levels of the anti-atherogenic apolipoprotein. The consensus in research is that these benefits are independent of changes in glycaemic control and body weight, and that they are most pronounced in individuals with an unfavourable lipid profile [34]. Unfortunately, with the development of overweight and obesity comes the development of lipid disorders and other cardiovascular diseases, which is why

it is so important to incorporate physical activity in patients with excess body weight and type 1 diabetes to prevent all these adverse complications, including microvascular complications [35]. For microvascular complications, it is important to note that studies confirm that there is a correlation between the presence of complications impairing the ability to undertake physical activity and not physical activity reducing diabetes complications [36]. Physical activity and exercise recommendations in people with type 1 diabetes and coexisting obesity should be tailored to the specific needs of the individual, including the challenges of blood glucose control during exercise and the presence of diabetes-related complications [28]. Given the prevalence of overweight and obesity among adolescents with type 1 or type 2 diabetes, health professionals caring for adolescents with diabetes need to pay particular attention to prevention [24]. In their study, Semiz et al. evaluated the effectiveness of a diabetes camp for adolescents diagnosed with type 1 diabetes to balance insulin dose with activity level and diet. Using a pretest-posttest design without a comparison group, the intervention delivered during the 10-day camp used social physical activity and food education programmes. Twenty-eight adolescents participated in the study, eight of whom were overweight or obese. The average weight loss was 0.9 kg after the first 10 days of the camp [37]. However, weight loss can be achieved with regular exercise, especially if there is a small reduction in total daily insulin doses [38]. Regular exercise facilitates weight loss, thereby increasing insulin sensitivity, which in turn helps to maintain normal blood glucose levels [31]. It is important to appropriately adjust the duration and type of physical exercise so that it is most beneficial in every measure. According to Diabetes Poland, people with type 1 diabetes without established clinically significant chronic diabetic complications can undertake any type of physical exercise, including maximum intensity. Obese people with diagnosed type 1 diabetes are recommended to do 200–300 minutes of exercise per week, leading to an energy deficit of 500–750 kcal/day [16]. To achieve the expected results in terms of weight reduction and metabolic control of diabetes, key factors such as the type of physical activity (aerobic vs. resistance or mixed), preprandial status (fasting vs. non-fasting activity), active insulin levels, blood glucose levels at the start of the activity, glucose trends preceding the activity, the composition of the last meal or snack, and the intensity and duration of the activity should be considered [39]. Physical activity is selected individually according to the patient's needs and capabilities. This can be summarised as walking is good for everyone, but sport is good for a select few. Exercise can benefit everyone, regardless of condition. Physical activity should be varied, not according to the type of diabetes, but according to the age and physical strength of the patient, the anti-diabetic treatment used, and the presence of diabetes and related diseases.

Insulin therapy

Insulin therapy is a key component of the treatment of type 1 diabetes. It improves glycaemic control, but can also lead to weight gain. Different insulin regimes, which can include multiple insulin injections, insulin pump therapy and the use of varying insulin analogues, can affect this aspect in various ways. Studies analysing the impact of continuous subcutaneous insulin infusion compared to multiple injections show differences in their effect on body weight, namely better glycaemic control and less weight gain. A meta-analysis of studies showed that the use of insulin pumps is associated with more stable glucose levels and a reduced risk of hypoglycaemia. Intensive insulin therapy can lead to weight gain, with some studies suggesting that insulin pumps may mitigate this effect by adjusting the insulin dose more precisely to the body's needs (40). Contemporary research indicates that the choice of insulin type can affect a patient's body weight. For example, some basal insulins, such as insulin degludec, may be associated with less weight gain compared to other long-acting insulins. A meta-analysis of randomised clinical trials showed that insulin degludec may be associated with less weight gain compared to insulin glargine U100. This mechanism may be due to the more stable action of insulin degludec, which reduces the risk of hypoglycaemia and thus the need for additional calorie intake. Studies on the faster-acting insulin FIASP indicate its potential benefit in controlling glucose levels without excessive impact on body weight, although its long-term

impact requires further study (41,42). Considering glycaemic monitoring, regularly checking blood glucose levels allows insulin doses to be adjusted and hypoglycaemia to be avoided, which can reduce the need for additional calorie intake. Modern insulin regimes, such as insulin pumps and new insulin analogues, can help to improve glycaemic control and reduce weight gain. However, therapy must be appropriately tailored to the individual patient's needs, taking into account nutritional education and physical activity.

Sleep hygiene

Sleep is part of a healthy lifestyle, as important as a balanced diet and physical activity. Although everyone devotes roughly a third of their life to it, the importance of sleep is often ignored. According to the National Sleep Foundation, the optimal amount of sleep for an adult is between seven and nine hours per night. Sufficient and uninterrupted sleep allows people to rest, concentrate and be productive. It also affects health. In addition, insufficient sleep can affect glycaemic control in adolescents with type 1 diabetes [43]. Evidence is rapidly accumulating indicating that chronic partial sleep loss may increase the risk of obesity and diabetes. Laboratory studies in healthy volunteers have shown that experimental sleep restriction is associated with adverse effects on glucose homeostasis. Insulin sensitivity decreases rapidly and significantly without adequate compensation for beta-cell function, resulting in an increased risk of diabetes. Prospective epidemiological studies conducted on both children and adults are consistent with a causal role of short sleep in increased diabetes risk. Sleep restriction is also associated with dysregulation of neuroendocrine control of appetite, with a decrease in the satiety factor, leptin, and an increase in the hunger-stimulating hormone, ghrelin. Sleep loss may therefore alter the ability of leptin and ghrelin to accurately signal caloric requirements, acting together to produce an internal misperception of insufficient energy availability [44].

Overweight and obesity in adolescents with type 1 diabetes are now increasingly common and are associated with health consequences. Overweight in adolescents diagnosed with type 1 diabetes is associated with infrequent naps, longer time spent in front of a screen and skipping breakfast and dinner [45]. Regarding the first factor, some studies support this theory. Estrada et al. examined the sleep process to determine its relationship with obesity, diabetes and insulin resistance. Using a patient self-report questionnaire, the authors found that regular naps were significantly and inversely associated with overweight, including high BMI, high body fat percentage and greater waist circumference. A lower prevalence of obesity was associated with regular naps in adolescents. The high prevalence of insufficient sleep in young people with type 1 diabetes and their relatives detected in this study may have significant health implications [46]. Diet therapy remains an essential component of behavioural treatment.

Psychological conditioning

The World Health Organisation (WHO) psychological dimension is one of the core areas that concern quality of life. It concerns both positive and negative feelings. Unfortunately, the prevalence of depression is three times higher in people with type 1 diabetes compared to the general population [47]. Psychological assessment and cognitive-behavioural therapy, including the setting of specific, achievable and relevant goals, as well as self-monitoring of food intake and exercise, and education, should be included in the routine clinical management of obesity in type 1 diabetes [48]. Many authors also note the presence of reduced tissue sensitivity to insulin during adolescence. This can, in a person with type 1 diabetes, lead to uncontrolled increases in insulin doses, resulting in significant weight gain, one of the most critical risk factors for the development of abnormal eating behaviour [49,50]. Jones et al. found that skipping insulin doses was the most common weight loss strategy used by patients [51]. Uncontrolled appetite resulting from hypoglycaemic episodes and inappropriate insulin dosing is common in young people with diabetes [52]. Other risk factors related to the nature of the disease include frequent weight control, high concentration of food (especially carbohydrates), dietary restrictions or accurate calculation of carbohydrate content in meals [53]. In addition to socio-cultural factors, psychological behaviours make people with type 1 diabetes just as prone to

inappropriate eating behaviours as healthy individuals. These are related to the proper management of the disease, in which attention to diet and body is an integral part of treatment [54,55].

Conclusions

- Overweight and obesity are growing problems among people with type 1 diabetes, which can negatively affect the course of the disease and increase the risk of complications.
- A key element in the prevention of excess body weight is patient education, which should be implemented as early as the diagnosis of diabetes.
- A healthy lifestyle, including an appropriate diet, regular physical activity, quality of sleep and a good psychological approach, significantly improves the quality of life of patients.
- The effectiveness of preventive and therapeutic interventions depends on complete awareness of the patient and consistent adherence to the recommendations of the treatment team.

Recommendations for clinical practice:

- Early patient education – educational programmes on healthy lifestyles should be implemented as early as the diagnosis of type 1 diabetes.
- Individualisation of recommendations – dietary strategies and physical activity plans should be tailored to the patient's age, lifestyle and preferences.
- Continuous weight monitoring – regular monitoring of weight and metabolic parameters should be an integral part of diabetes care.
- Support from a multidisciplinary team – the patient should have access to diabetes educators, dietitians and physical activity specialists to help maintain a healthy lifestyle.
- Patient motivation and engagement are essential to building patient awareness of the long-term benefits of adhering to health recommendations.

Summary

There is a growing problem of overweight and obesity in people with type 1 diabetes. Preventive measures, consisting mainly of education, should be implemented at the stage of diagnosis of type 1 diabetes. Every person with type 1 diabetes, at any stage of the disease, should make a special effort to maintain a normal weight. A healthy lifestyle does not lead to a full recovery of type 1 diabetes, but it can provide a comfortable, long and fulfilling life for the patient. A healthy lifestyle can improve metabolic control and reduce the risk of complications, but it will not restore pancreatic function or cause beta-cell regeneration on its own. Curing type 1 diabetes would require stopping the autoimmune process and restoring insulin production, which is not currently possible with available treatments. However, it requires full awareness and adherence to the recommendations made by the treatment team. All the factors listed are closely related and closely associated with weight among people with type 1 diabetes. The most substantial support in the literature is, of course, diet and physical activity, but there is a compelling need to study new things. Nevertheless, the long-term effects of specific diets, the optimisation of physical activity programmes and the effectiveness of psychological interventions require further research.

Acknowledgements

Conflict of interest statement
The authors declare no conflict of interest.

Funding sources
There are no sources of funding to declare.

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