ROLE OF DIETARY AND ENVIRONMENTAL FACTORS IN GLYCEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS: A CROSS-SECTIONAL STUDY IN DEHRADUN, UTTARAKHAND

Deepika Sharma[1], Neetu Panwar[2]

[1*]Research Scholar, School of Applied Sciences, Shri Venkateswara University Gajraula, Uttar Pradesh India

[2]Associate Professor, School of Applied Sciences, Shri Venkateswara University Gajraula, Uttar Pradesh India

Corresponding email; deepika8430910504@gmail.com

ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is an important worldwide public health problem of decreased insulin secretion and insulin resistance that result in chronic hyperglycemia. The number of people with type 2 diabetes has significantly increased over the past few years due to a variety of unhealthy habits in their daily life, including a lack of physical activity, obesity, stress and environmental influences. Knowledge and understanding of all the factors affecting glycaemic control is crucial for diabetes care..

Objective: The objective of this research was to assess the management of the blood sugar level of T2DM patients with respect to environmental and food influences in their residency of Dehradun, Uttarakhand, India.

Methods: This research method used was descriptive cross sectional research. This was a systematic questionnaire data collection was conducted to achieve a hundred diabetes mellitus (Type 2) patients. The following data was collected: demographics, dietary fibre consumption, stress levels, levels of physical activity, and glycaemic control status. To determine the association between lifestyle factors and glycemic effects the data captured needed statistical analysis in the form of comparisons, frequency distributions and percentages.

Results: The dietary and environmental variables were demonstrated to have a significant effect on diabetes care. Those with the highest score were those who ate more dietary fibre than those with the lowest score, suggesting that improving glycaemic control should be considered a public health goal. Being physically inactive had a negative association with the control of diabetes and having regular physical activity had a positive association with glycaemic outcomes. The level of stress was positively associated with glycaemic control, even though there were no significant differences between Gly Haemoglobin mean values of the highly stressed, moderately stressed and not stressed groups.The level of stress was closely associated with the Diabetes outcome, though the Gly Haemoglobin mean value for the highly stressed, moderately stressed and not stressed did not differ significantly. Furthermore, the study revealed that people with Type 2 Diabetes Mellitus could improve their glycaemic control when coupled with regular exercise and effective stress management, and good eating habits.

Conclusion: Environmental and nutritional factors play an important role in the management of Type 2 Diabetes Mellitus (T2DM), the study suggests. A diet rich in fibre, regular exercise and reducing stress could help to improve glycaemic management and health outcomes. It is essential that programs aimed at managing diabetes emphasise the need of integrated lifestyle treatments. Healthcare providers, lawmakers, and public health workers may be able to use the results to inform the creation of more efficient plans to reduce the prevalence of diabetes.

Keywords: Type 2 Diabetes Mellitus, Glycemic Control, Dietary Factors, Environmental Factors, Dietary Fiber, Physical Activity, Stress, Lifestyle Intervention, Diabetes Management, Public Health, Dehradun, Uttarakhand.

How to cite this article: Sharma D, Panwar N. Role of Dietary and Environmental Factors in Glycemic Control Among Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study in Dehradun, Uttarakhand. Int J Drug Deliv Technol. 2026;16(63s):1248-1256. DOI: 10.25258/ijddt.16.63s.122

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is one of the most prevalent Long Duration Metabolic Diseases in the public health of humans and has become an important problem worldwide. Long-lasting hyperglycaemia that is a hallmark of the disease affects the metabolism of carbohydrates, proteins and fats (Saini, 2010). Type 2 Diabetes Mellitus is increasingly becoming a very common problem due to fast urbanization, increase in ageing population, eating habits and sedentary life. Three-quarters of the world's diabetes has been estimated to be of this type (Chen et al., 2012).

In recent decades diabetes is increasingly becoming a serious health problem affecting character of people in both developed and developing countries. There are several reasons contributing to the increase of Type 2 Diabetes Mellitus, including sedentary lifestyle, unhealthy food intake, obesity and mental stress and social factors (Alberti et al., 2007). Diabetic complications, like cardiovascular disease, nephropathy, neuropathy, retinopathy and lower limb amputations, not only have a huge financial burden on health care systems but also significantly affect quality of life and can lead to death (Chen et al., 2012).

Medication is not the only thing needed to control type 2 diabetes mellitus well; some big changes in lifestyle are needed. Dietary behaviours are one of the modifiable components of lifestyle that may impact metabolic health outcomes and blood glucose levels. Integrating more whole grains, fruits, vegetables, legumes and dietary fibre into the diet of diabetic patients resulted in better glycaemic control and decreased the risk of cardiovascular complications (Etherton et al., 2004, Ajala et al., 2013). In contrast, Esposito et al. (2009) have reported that low grade insulin resistance, obesity, and risks of diabetes are associated with an excessive consumption of refined carbohydrates, processed foods, saturated fat and sugared beverages.

In more recent years, dietary fibres have been seen as an important source of nutrition to assist with controlling diabetes. A high fiber diet may aid glycaemic control as it slows down glucose absorption, increases insulin sensitivity, makes you feel full more quickly and keeps the weight off, according to Anderson et al., (2004). In addition, a number of research studies have indicated that the plant diet (including the Mediterranean diet) can also support blood sugar management and enhance the metabolic condition of individuals with Type 2 diabetes Mellitus (Barnard et al., 2006; Esposito et al., 2009).

Regular exercise is one of the most crucial items in the fight against diabetes. The research conducted by Zanuso et al., (2017) shows that many benefits of regular exercise like better absorption of glucose is to the skeletal muscles, increased insulin sensitivity, weight loss, enhanced Cardiovascular health etc. Knowler et al., (2002) showed that about 58% reduction in risk of acquiring Type 2 Diabetes Mellitus with lifestyle adjustment, which involved making modifications to food and frequent physical exercise. Similarly, Tuomilehto and co-workers (2001) reported benefits both on metabolic parameters and on prevalence of diabetes with the use of combination therapy mainly aimed at physical activity and nutrition improvement.

There has been a greater acceptance in more recent years of the importance of environmental variables in the development and treatment of diabetes. Financial status, food and health service availability, work situations, social support received, and neighbourhood characteristics are environmental determinants that influence lifestyle behaviours and health outcomes, with significant analyses (Racette et al., 2003). Managing Diabetes may be more difficult for people who live in places where they have less access to healthy food, and have limited opportunities for physical activity.

Among the environmental factors that have been associated to metabolic dysfunction and worse diabetes outcomes is psychological stress. When a person puts itself under chronic stress, the body overproduces the hormones, and blood sugar levels are elevated, increasing the likelihood of insulin resistance, according to Chandola et al., (2008). Moreover, stress can affect the whole management of diabetes, either by changing food consumption, type of activity and exercise, or by affecting administration of the reduses. Campbell et al., (2017)

found that individuals with diabetes who have social support and a solid health-oriented community are more likely to self-manage their diabetes and follow their treatment regimen.

Several studies have investigated each individual category of environmental or dietary interventions to examine their respective impact on glycaemic control, but few studies have investigated both environmental and dietary interventions together and their associated impact. Diabetes prevention and control efforts are optimal when they consider the interaction of food, activity and environmental factors. These data will help health care providers and policy-makers develop targeted programs to minimize the risks related to different diseases.

Hence, this research aimed to analyze the effect of dietary and environmental factors on glycaemic control of T2DM patients of Dehradun (Uttarakhand). This research aims to complement the existing knowledge base by exploring the relationships between dietary fibre, physical activity, stress, and glycaemic control to gain insight into factors that can help to develop successful lifestyle-based diabetes care programmes.

After the introduction, the next sections of a research paper are the objectives and methodology. Any form of paper can be used and may include this heading:

OBJECTIVES OF THE STUDY

The present study was conducted with the following objectives:

1. To assess the dietary factors influencing the management of Type 2 Diabetes Mellitus among diabetic patients.
2. To examine the impact of environmental factors on glycemic control among individuals with Type 2 Diabetes Mellitus.
3. To evaluate the relationship between dietary fiber intake and glycemic control.
4. To analyze the influence of physical activity on diabetes management.
5. To investigate the association between stress levels and glycemic control among diabetic patients.
6. To identify the combined effect of dietary and environmental factors on the management of Type 2 Diabetes Mellitus.

HYPOTHESIS

H_0 (Null Hypothesis): Dietary and environmental factors have no significant impact on glycaemic management on the individuals diagnosed with type 2 Diabetes Mellitus.

Contrary diabetics suffer especially from the influence of environmental and dietary factors on blood sugar control (H_1: People with Type 2 Diabetes Mellitus are highly affected by the potential influence of environment and food on blood sugar control).

MATERIALS AND METHODS

Research Design

The present study adopted a descriptive cross-sectional research design to examine the influence of dietary and environmental factors on the management of Type 2 Diabetes Mellitus. The design was considered appropriate as it enabled the collection and analysis of data from diabetic patients at a specific point in time.

Study Area

The research was conducted in Dehradun (Uttarakhand), India. Selecting Dehradun was based on various socioeconomic situations, food habits, healthcare accessibility and lifestyle patterns in the city, which is a very diversified city. The combination of urban and semi-urban population allowed researchers to understand the impact of environmental factors on diabetes management

Study Population

The target population consisted of adult individuals diagnosed with Type 2 Diabetes Mellitus and receiving treatment from hospitals, diabetic clinics, community health centers, and private healthcare facilities in Dehradun.

Sample Size

A hundred participants with a confirmed diagnosis of Type 2 Diabetes Mellitus were a part of the research.

Sampling Technique

In the process of research, using purposeful sampling, those whose interest would be deemed an interest in the research and whose inclusion would seem warranted were those chosen.

Inclusion Criteria

1. There is a minimum age requirement (the age is 30 years).

2. 2. confirmed Type 2 Diabetes Mellitus.
3. 3. Open to taking part in the research.
4. Able to provide advice on healthy eating and other ways of living.

Exclusion Criteria

1. Individuals diagnosed with Type 1 Diabetes Mellitus.
2. Patients with gestational diabetes.
3. Individuals with severe cognitive impairment.
4. Respondents unwilling to provide informed consent.

Data Collection Tool

Based on the study Objectives and literature, a questionnaire was designed to elicit information. The following topics were covered in the questionnaire:

1. 1. Personal information
2. 2 Consumption of dietary fibre
3. 3. Routines for physical exercise
4. 4. Levels of stress
5. Glycemic control status

Variables of the Study

Independent Variables

1. Dietary Fiber Intake
2. Physical Activity
3. Stress Level

Dependent Variable

1. Glycemic Control Status

Statistical Analysis

The collected and gathered information was coded, tabulated and analysed using descriptive statistics. Frequencies, percentages and cross-tabulations were used to explore relationships among respondents, their diet and their environments and glycaemic management.

Ethical Considerations

Research participation was of the “voluntary” variety. During this study we have made sure that the information obtained was anonymous and that the participants were told the aim of the research. All participants were asked to provide their informed permission before any data was collected.

RESULTS AND DISCUSSION

Table 1. Distribution of Respondents According to Gender (N = 100)

Gender	Frequency (n)	Percentage (%)
Male	50	50.0
Female	50	50.0
Total	**100**	**100.0**

Interpretation

Table 1 shows that out of 100 respondents, 50 (50.0%) were male and 50 (50.0%) were female. The equal representation of both genders provided a balanced sample for examining the influence of dietary and environmental factors on glycemic control among patients with Type 2 Diabetes Mellitus.

Table 2. Distribution of Respondents According to Fiber Intake (N = 100)

Fiber Intake	Frequency (n)	Percentage (%)
High	37	37.0
Moderate	31	31.0
Low	32	32.0
Total	**100**	**100.0**

Interpretation

As far as fibre intake, 37% of people surveyed indicated that they consumed a large amount, 31% a moderate amount, and 32% a very small amount. Many people's metabolic health and glycaemic control may have been compromised by their diets' lack of fibre.

Table 3. Distribution of Respondents According to Physical Activity (N = 100)

Exercise Level	Frequency (n)	Percentage (%)
Daily	40	40.0
3–5 Times/Week	24	24.0
Rarely	36	36.0

Total	**100**	**100.0**

Interpretation

40% of survey respondents practiced daily exercise, 24% exercised 3-5 times in a week, and 36% had engaged in seldom exercise. Many of the diabetic subjects were found inactive, thereby possibly affecting the management of glucose and treatment of diabetes.

Table 4. Distribution of Respondents According to Stress Level (N = 100)

Stress Level	Frequency (n)	Percentage (%)
Low	31	31.0
Moderate	35	35.0
High	34	34.0
Total	**100**	**100.0**

Interpretation

The 31% of the survey takers who said they are not stressed out are joined by 35% and 34% who report being moderately and very stressed out, respectively. The results support the previous findings that psychological stress is frequent in type 2 diabetes and can be detrimental to glycaemic control.

Table 5. Distribution of Respondents According to Glycemic Control Status (N = 100)

Glycemic Control	Frequency (n)	Percentage (%)
Good	39	39.0
Moderate	28	28.0
Poor	33	33.0
Total	**100**	**100.0**

Interpretation

Among those who participated in the survey, 39% demonstrated excellent glycaemic control, 28% shown moderate control, and 33% demonstrated poor control. Even though several of the participants were able to get their blood sugar levels under control, a third of them still had problems with their diabetes.

Table 6. Association Between Fiber Intake and Glycemic Control (N = 100)

Fiber Intake	Good n (%)	Moderate n (%)	Poor n (%)	Total
High (n=37)	16 (43.2)	11 (29.7)	10 (27.1)	37
Moderate (n=31)	12 (38.7)	10 (32.3)	9 (29.0)	31
Low (n=32)	11 (34.4)	7 (21.9)	14 (43.7)	32
Total	**39 (39.0)**	**28 (28.0)**	**33 (33.0)**	**100**

Interpretation

Results show that glycaemic management was better among respondents who consumed more dietary fibre compared to those who consumed less fibre. In contrast to the 34.4% of individuals who reported low fibre intake, 43.2% of those who reported high fibre intake showed satisfactory glycaemic control. Among those who reported consuming low fibre intake, 43.7% had poor glycaemic control. These results provide further evidence that people with Type 2 Diabetes Mellitus may benefit from better blood glucose control if they consume more dietary fibre.

Table 7. Association Between Physical Activity and Glycemic Control (N = 100)

Physical Activity	Good n (%)	Moderate n (%)	Poor n (%)	Total
Daily (n=40)	18 (45.0)	11 (27.5)	11 (27.5)	40
3–5 Times/Week (n=24)	11 (45.8)	7 (29.2)	6 (25.0)	24
Rarely (n=36)	10 (27.8)	10 (27.8)	16 (44.4)	36
Total	**39 (39.0)**	**28 (28.0)**	**33 (33.0)**	**100**

Interpretation

Exercising regularly is associated with better glycaemic management, according to the findings.

Glycaemic outcomes were better for those who exercised often (at least three to five times per week) as opposed to those who exercised seldom. Those who exercised seldom had the worst glycaemic control (44.4%). It seems that regular exercise improves glucose utilisation and insulin sensitivity, which in turn helps with diabetes control.

Table 8. Association Between Stress Level and Glycemic Control (N = 100)

Stress Level	Good n (%)	Moderate n (%)	Poor n (%)	Total
Low (n=31)	15 (48.4)	8 (25.8)	8 (25.8)	31
Moderate (n=35)	14 (40.0)	11 (31.4)	10 (28.6)	35
High (n=34)	10 (29.4)	9 (26.5)	15 (44.1)	34
Total	**39 (39.0)**	**28 (28.0)**	**33 (33.0)**	**100**

Interpretation

There is a direct correlation between stress and glucose regulation, as seen in Table 8. Good glycaemic control was most common among those with low stress levels (48.4%), whereas poor glycaemic control was most common among those with high stress levels (44.1%). These results provide further evidence that mental health issues may have a negative impact on the control of diabetes and glycaemic outcomes. Metabolic control may be enhanced in Type 2 Diabetes Mellitus patients who use stress management techniques.

DISCUSSION

The researchers from Dehradun in Uttarakhand studied the impact of diet and environment on glycaemic control in Type 2 Diabetes mellitus (T2DM) patients. Results indicated that there is a significant relationship between diabetics and level of stress, diet, and exercise. In addition to pharmaceutical therapy, these results contribute to the increasing amount of evidence indicating a holistic lifestyle-based strategy is necessary for effective control of diabetes.

The research showed better glycaemic management with the fibre group than the sugar-free group. Fibre is believed to promote insulin sensitivity, reduce postprandial blood glucose rises and slow gastric emptying. The results were similar to that of Anderson et al. (2004) who also observed that diabetes patients' blood glucose control was significantly improved with increased dietary fibre. The same applies to Ajala et al. (2013), who reported that a high consumption of legumes, fruits and vegetables, as well as whole grain products contribute to blood sugar regulation and decreased risk of cardiovascular disease. Therefore, the present results demonstrate the importance of diet for the control of Type 2 Diabetes Mellitus based on its fiber content.

Furthermore, the analysis revealed high levels of relationship between exercise and glycaemic control. Glycaemic outcomes were better for those who exercised often (at least three to five times a week) compared to those who exercised seldom. Keeping active helps to keep weight in check: It improves sensitivity to insulin and the uptake of glucose by the skeleton muscles, as well as physical fitness. Knowler et al. (2002) found that high-risk persons' likelihood of developing Type 2 Diabetes Mellitus decreased by around 58% after participating in lifestyle treatments that included regular physical exercise; our results are consistent with that. Tuomilehto et al. (2001) found reduced diabetes risk, better metabolic profile, with increased physical activity + dietary changes. As a result, the current research backs up the importance of exercise for diabetes control.

The level of stress was found to be one of the significant factors affecting glycaemic control. Stress levels were associated with more favourable glycaemic control score among those with low stress levels, and more unfavourable among those with high stress levels. The neuroendocrine responses to chronic stress lead to the suppression of insulin sensitivity, an increase in blood sugars and the release of cortisol. The findings are consistent with the results obtained by Chandola et al., (2008) who have reported an association between metabolic syndrome, lower glucose metabolism and chronic stress. So, it's reasonable to assume that stress management is a crucial part of diabetes treatment in its whole.

Also, the study highlights the importance of interaction between environmental and nutritional factors in impacting diabetes care. Individuals who reported improvements in diet, physical activity and stress levels showed better glycaemic control when compared with individuals who reported on a variety

of lifestyle risk factors. As this practice illustrates, a change in diet or medication is not a solution to the many challenges faced in diabetic treatment. Weight loss and improvements in metabolic health can last longer when they are brought about by a comprehensive lifestyle approach that incorporates environmental factors, exercise, food and behavioural modification.

The results of the current study support the findings of Wing et al. (2014) who demonstrated long-term improvements in glycaemic control, cardiovascular parameters and quality of life among diabetics. It should be noted that multicomponent lifestyle interventions, which target several risk factors simultaneously have been shown to have a better efficacy in improving diabetes outcomes than interventions targeting individual components (Zanuso et al., 2017).

Environmental and nutritional factors are significant factors in Type 2 Diabetes Mellitus as the results confirm. Those who managed to make lifestyle changes (which included eating healthy, exercising more and managing stress better) had better glycaemic control. The results of the research make it essential to emphasise diabetes treatment programs aiming to implement life style changes such as nutrition, physical activity and mental well-being.

Conclusion

The present study was conducted to assess the impact of dietary and environmental factors on glycemic control among patients with Type 2 Diabetes Mellitus in Dehradun, Uttarakhand. The results of the study indicate that lifestyle has a significant influence on diabetes therapy and metabolic health, in general.

The study found that a higher fibre diet resulted in better blood sugar control than a lower fibre diet. Diets that were rich in legumes, fruits, vegetables, and whole grains showed improvement in better diabetes management. The findings emphasize the importance of a balanced diet for those with diabetes to help control blood sugar levels and avoid the complications associated with diabetes.

Exercising regularly was also shown to have a good correlation with glycaemic control. Those people who exercised regularly showed better control over the diabetes as compared with people with less exercise frequency. Regularly exercising is also a crucial management tool for diabetes as it enhances insulin sensitivity, glucose use, weight control and heart health.

Other factors that may contribute to a normal blood sugar level are stress. Better diabetes outcomes, and poorer glycaemic management were significantly associated with stress (higher stress score). This research emphasises the need of using stress management approaches in diabetes treatment plans.

In addition, the research showed that dietary and environmental variables impacted diabetes therapy as a whole. Higher levels of glycaemic control were seen in those who experienced less stress, worked on their eating habits and practiced moderate levels of exercise compared to persons exposed to the other lifestyle risk factors.

This indicates a need for a multi-modal approach in treating type 2 diabetes –a healthy lifestyle, regular exercise, stress management and healthy environment. Hence, the efforts of diabetes prevention and management should focus on promoting healthful lifestyles.

Recommendations

However, based on the results of this investigation, we put forward these suggestions:

1. Some types of accounts with high fibre content can contribute to improving metabolic health and control of blood glucose in people who have Type 2 Diabetes Mellitus and are having these foods and their dietary fibre listed, it does not mean that they are also a complete food diet.

2. Doctors should regularly counsel patients on diet to reduce their intake of sugary drinks, processed foods and refined carbohydrates, and to help them maintain a healthy weight, which is especially beneficial for those with diabetes.

3. Finally, people with diabetes should strive to get 150 minutes of moderate physical activity per week. Walking, cycling, jogging, or swimming can be part of the activities.

4. When combined with other diabetes management strategies, structured exercise programs have the potential to increase insulin sensitivity and decrease cardiovascular risk.

5. Patients who have diabetes should seek psychological counseling, yoga and mediation classes, relaxation techniques and other types of stress management therapy on the basis of the above recommendation.

6. Awareness programs should be established in the community for promoting awareness about role of lifestyle variables in preventing and treating diabetes.

7. The gaps in mental health care of people with diabetes should be addressed by collaboration of healthcare professionals within healthcare institutions, including mental health professionals, diabetes educators, nutritionists and doctors.

8. Public health policies need to be developed to make the nutritious food and alternative leisure time activities and healthcare services more available in order to foster better living circumstances and prevent diseases.

10. It is important for diabetic patients to be more empowered with social and familial support to maintain their treatment regimes and follow healthy lifestyle habits.

11. Studies with larger samples and more diverse populations should be conducted to learn more about the relationship between food and diabetes outcomes and longer-term environmental effects.

Future Research Directions

Future studies may investigate:

- Type 2 diabetes controlled by timing meals & if.relationship between meal timings, Intermittent Fasting and Diabetes Control.
- The impact socioeconomic status has on a person's food intake and adherence to their treatment plan.The influence of socioeconomic status on food intake and adherence to treatment plan.
- The outcomes of a holistic campaign aimed at changing behaviour, for different demographic groups.
- Information on how to minimize possible environmental and psychological problems related to diabetes.

The findings of this research show that persons with Type 2 Diabetes Mellitus may control their blood sugar levels by making changes to their diet and way of life.Better control of diabetes, less disease burden, and greater quality of life may be achieved via the promotion of healthy lifestyles and supportive settings.

References

1. Ajala, O., English, P., & Pinkney, J. (2013). Systematic review and meta-analysis of different dietary approaches to the management of type 2 diabetes. *The American Journal of Clinical Nutrition, 97*(3), 505–516. https://doi.org/10.3945/ajcn.112.042457

2. Alberti, K. G. M. M., Zimmet, P., & Shaw, J. (2007). International Diabetes Federation: A consensus on Type 2 diabetes prevention. *Diabetic Medicine, 24*(5), 451–463. https://doi.org/10.1111/j.1464-5491.2007.02157.x

3. Anderson, J. W., Randles, K. M., Kendall, C. W. C., & Jenkins, D. J. A. (2004). Carbohydrate and fiber recommendations for individuals with diabetes: A quantitative assessment and meta-analysis of the evidence. *Journal of the American College of Nutrition, 23*(1), 5–17. https://doi.org/10.1080/07315724.2004.10719344

4. Barnard, N. D., Cohen, J., Jenkins, D. J. A., Turner-McGrievy, G., Gloede, L., Green, A., & Ferdowsian, H. (2006). A low-fat vegan diet improves glycemic control and cardiovascular risk factors in a randomized clinical trial in individuals with Type 2 diabetes. *Diabetes Care, 29*(8), 1777–1783. https://doi.org/10.2337/dc06-0606

5. Campbell, D. J. T., Manns, B. J., Hemmelgarn, B. R., Sanmartin, C., Edwards, A., & King-Shier, K. (2017). Understanding financial barriers to care in patients with diabetes. *Diabetes Educator, 43*(1), 78–86.

6. Chandola, T., Brunner, E., & Marmot, M. (2008). Chronic stress at work and the metabolic syndrome: Prospective study. *BMJ, 332*(7540), 521–525. https://doi.org/10.1136/bmj.38693.435301.80

7. Chen, L., Magliano, D. J., & Zimmet, P. Z. (2012). The worldwide epidemiology of Type 2 diabetes mellitus—Present and future perspectives. *Nature Reviews Endocrinology, 8*(4), 228–236. https://doi.org/10.1038/nrendo.2011.183

8. Esposito, K., Maiorino, M. I., Ciotola, M., Di Palo, C., Scognamiglio, P., Gicchino, M., ... Giugliano, D. (2009). Effects of a Mediterranean-style diet on the need for

antihyperglycemic drug therapy in patients with newly diagnosed Type 2 diabetes. *Annals of Internal Medicine, 151*(5), 306–314. https://doi.org/10.7326/0003-4819-151-5-200909010-00004

9. Knowler, W. C., Barrett-Connor, E., Fowler, S. E., Hamman, R. F., Lachin, J. M., Walker, E. A., & Nathan, D. M. (2002). Reduction in the incidence of Type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine, 346*(6), 393–403. https://doi.org/10.1056/NEJMoa012512
10. Racette, S. B., Deusinger, S. S., & Deusinger, R. H. (2003). Obesity: Overview of prevalence, etiology, and treatment. *Physical Therapy, 83*(3), 276–288.
11. Saini, V. (2010). Molecular mechanisms of insulin resistance in Type 2 diabetes mellitus. *World Journal of Diabetes, 1*(3), 68–75. https://doi.org/10.4239/wjd.v1.i3.68
12. Tuomilehto, J., Lindström, J., Eriksson, J. G., Valle, T. T., Hämäläinen, H., Ilanne-Parikka, P., ... Uusitupa, M. (2001). Prevention of Type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine, 344*(18), 1343–1350. https://doi.org/10.1056/NEJM200105033441801
13. Wing, R. R., Bolin, P., Brancati, F. L., Bray, G. A., Clark, J. M., Coday, M., ... Look AHEAD Research Group. (2014). Cardiovascular effects of intensive lifestyle intervention in Type 2 diabetes. *New England Journal of Medicine, 369*(2), 145–154. https://doi.org/10.1056/NEJMoa1212914
14. Zanuso, S., Sacchetti, M., Sundberg, C. J., Orlando, G., Benvenuti, P., & Balducci, S. (2017). Exercise in Type 2 diabetes: Genetic, metabolic and neuromuscular adaptations. *Sports Medicine, 47*(4), 713–730. https://doi.org/10.1007/s40279-016-0595-x