Multidisciplinary Surgical Research Annals
https://msrajournal.com/index.php/Journal/issue/view/15
Volume 3, Issue 3 (2025)

Online ISSN 3007-1941
Print ISSN 3007-1933

Case Study of a Patient with Decompensated Type 2 Diabetes Mellitus and Multiple Comorbidities: Implications for Personalised Care and Disease Modulation

Muhammad Ahmad Afzal[1*], Maryam Noor[2], Dr. Neelum Shahzadi[3], Dr. Sana Saadat[1,4], Rida Chaudhry[5], Muhammad Naeem Zafar[6]

Article Details

ABSTRACT

Keywords

Diabetes, medical nutrition therapy, physical activity, nutrition education

Muhammad Ahmad Afzal
Department of Human Nutrition and Dietetics, Faculty of Medical Sciences, Government College University Faisalabad,Pakistan
ahmadansarians17@gmail.com
https://orcid.org/0009-0006-7359-1296

Maryam Noor
Bachelor of Science in Nursing, College of Nursing, District Headquarters Hospital, Rajanpur, University of Health Sciences Lahore, Pakistan

Dr. Neelum Shahzadi
Assistant Professor, Faculty of Eastern Medicine, Hamdard University Islamabad Campus,Pakistan,
neelum.shahzadi@hamdard.edu.pk

Dr. Sana Saadat
Department of Human Nutrition and Dietetics, Faculty of Medical Sciences, Government College University Faisalabad, Pakistan

Rida Chaudhry
Institute of Home Sciences, Faculty of Food, Nutrition and Home Sciences, University of Agriculture Faisalabad, Pakistan

Muhammad Naeem Zafar
Incharge Patient Diet/Nutrition Services Department, Lahore General Hospital, Pakistan

Type 2 diabetes mellitus (T2DM) is a chronic condition characterised by persistently high levels of blood glucose resulting from the body cells' resistance to insulin. Nutrition education and awareness regarding diabetes play a crucial role in counselling patients. A personalised nutrition care plan helps in managing the complex symptoms of T2DM. In this case report, we studied a complex case of T2DM, with the patient showing symptoms of high blood pressure, sweating, nocturia and increased hunger. Nutrition assessment comprising diet, medical, social, anthropometric and laboratory data was recorded. The patient was diagnosed with various comorbidities: hyperglycaemia, hypertension and hyperlipidaemia, and each one was addressed by implementing medical nutrition therapy (MNT). A tailored diet plan and medicine regimen were designed to treat the complications. Counselling was provided throughout the session on every new approach. Patient, family and healthcare team active participation ensured the success of the programme.

INTRODUCTION

Type 2 diabetes (T2D) affects the utilisation of glucose in the body by preventing the action of insulin on the cells. This disease, if left untreated, can lead to high levels of blood sugar. T2D is accompanied by various comorbidities like neuropathy, nephropathy and retinopathy. Dietary management in T2D can not only prevent further complications but also prevent its onset in people predisposed to diabetes (ElSayed et al., 2023). Overweight, sedentary lifestyle and genetics are some of the key factors that are responsible for developing diabetes. Early diagnosis helps in managing T2DM more effectively, and the best way to detect it is regular blood check-ups with a healthcare professional (Li et al., 2022).

Nutritional awareness, along with self-management, is very crucial in any disease prevention or treatment (ElSayed et al., 2023). The patient's healthcare team is responsible for providing specialised care and nutritional education to patients with diabetes. Registered dietitian nutritionist (RDN), patient food services supervisor, advanced practice registered nurse (APRN) and nutrition consultant all work together to ensure the success of the MNT. Nurses played a pivotal role in educating the patient about self-management. They are the only ones who are available to the patient all the time during the care process and communicate directly with the patient. Health services consumers show a high level of satisfaction with the care provided by nurses (Guo et al., 2023). The patient-healthcare team relationship is very important. It enhances the effective transfer and implication of self-care education and management at various stages of the care plan. Nutrition education alone cannot do much good. Gaining knowledge and not implementing it is a big issue. The healthcare team ensures the effective implementation of both education and management to ensure the improvement of the patient (Salvia & Quatromoni, 2023).

Adjusting medications in the patients' dietary regimen is of utmost importance and requires a thorough understanding of drug-drug or drug-nutrient interactions. T2D is often accompanied by a series of comorbidities, which require a skilled and extensive nutrition care plan.

The following case study shows a complex interplay of T2D with various associated conditions. Lack of awareness and education was another major hurdle in treating the problems. Focused counselling and personalised treatment approaches helped in managing the symptoms. Team holistically addresses the patient's needs and observes the primary role of him in the maintenance and improvement of his own health. In the assessment portion of the MNT, medical history, family history, social history, laboratory data and anthropometric measurements are noted, followed by relevant diagnoses. An

appropriate treatment plan is devised keeping in view the previous record, which is followed by the patient's follow-up monitoring and evaluation (M&E) (Lu et al., 2023).

Clinical Case

Nutrition Assessment

Medical History

Mr. Z is a 67-year-old man who has been suffering for 4 years from T2D. He had faced repeated episodes of hyperglycaemia in the past. His blood glucose values were indicative of borderline diabetes, having fasting blood glucose levels of 120-128 mg/dl. He also remembered recurring episodes of nocturia related to large carbohydrate meals. He was advised by his dietitian at that time to lose 5 kg, but no further action was taken by him. He had gained more weight over the period and is now being diagnosed with suboptimal glycemic control and foot pain. He has been making lifestyle modifications for the last three months, like switching to a calorie-deficient diet and increasing physical activity, but no success has been achieved so far.

He was also taking glibenclamide (Daonil®) 5mg every morning, but had ceased to take it because of dizziness followed by headache and sweating. He has also been suffering from hypercholesterolemia for the past year and was taking atorvastatin (Lipitor®) 10 mg daily without experiencing any side effects. For the past four months, he had started to take chromium picolinate 250 mcg daily with a meal, *Gymnema sylvestre* herbal tea and pancreatin 1,000 mg one tablet daily with meal to improve lipid and glycemic control, but stopped taking these supplements as he didn't notice any results. He does not monitor his blood sugar levels at home and is unsure whether this approach would help him or not. "How on earth would this technique help me, merely by knowing the values?" he questions. "The doctor already knows that my blood sugar levels are high."

Medical record shows that his glycated haemoglobin (HbA1C) levels have never been down to 7.5%. The report shows that his blood pressure fluctuated tremendously on separate occasions, recorded at 155/70, 147/93 and 165/88 mmHg. The doctor told him that his blood pressure was not normal, but due to a lack of awareness, he was confused about why and how to manage it for cardiovascular risks. He never paid much attention to his foot pain and disregarded it as a normal pain. Medical records show that Mr. Z had never been hospitalised in his life, nor had any surgeries. His immunisation records are clear and up to date. The record shows that before his diabetes diagnosis, he had been spending a lively life without any health worries.

Family History

Mr. Z lives with his 63-year-old wife and two children. He has retired from his government job and is now receiving a pension. Both his parents had T2D, and he knew very little about diabetes and how to manage it. He was unaware that he was diabetes pre-disposed, and was unable to understand why he got diabetes. He confidently states that "I never eat table sugar in my life." His wife googled remedies on treating diabetes at home in the past, and encouraged her husband to take weight-loss supplements and herbal medicines to manage diabetes.

Social History

He had gained 10 kg in the past years, despite the fact that he has been more active ever since his retirement. He occasionally went for a walk and had some light home exercises, but he did not manage to lose more than 1-2 pounds per month. He said that he used to do more exercise in the winters than in the summers because of the sweltering heat and sweating. In-depth discussion on exercise made the patient realise that he often skipped physical activity for a week or more. He admitted that he often faced a lack of commitment and consistency in following his health routine. He spent his summer mostly in the air conditioner, leading to a sedentary lifestyle. He went for a walk rarely, 4-6 times a month in summer. In winters, although he had walked and exercised, but that was compensated because of his consumption of energy-dense foods, such as up to five servings of milk, three servings of dry nuts and traditional sweets of winter. He had never been to a proper healthcare facility and had no clue about self-monitoring of blood glucose (SMBG).

Diet History

Mr. Z's diet history shows excessive intake of carbohydrates in the form of bread, rice and chapati. His normal lunch and dinner consist of 2-3 chapatis with any salan. He usually likes more oil in his curry. Breakfast usually consists of up to four slices of bread, accompanied by butter, jam or eggs. He is also habituated to taking three cups of full-fat milk tea a day. He eats huge bowls of fruit at least twice a day as snacks, and considers this behaviour healthy. He is averse to mutton and beef, and has only chicken and fish, which are mostly deep-fried. He doesn't like grilled, smoked or baked chicken. He likes chicken gravy at weekends with two naan breads. He also does not like ultra-processed food items, but has the habit of drinking one cup of high-sugar soda daily, late at night. He used to smoke in the past, but quit because of the escalation in cigarette prices.

Physical Examination

Mr. Z uses corrective eyeglasses, however, his PERRLA (pupils equal, round, and reactive to light and accommodation) eye exam is quite satisfactory. Funduscopy shows no signs of retinopathy and arteriovenous (AV) nicking. He has a nonpalpable thyroid, and lungs are clear to auscultation. Heart rate and rhythm are also regular, without any murmurs or gallops. Vascular assessment shows no signs of carotid artery stenosis, and no carotid bruits are noted. Femoral, popliteal, and dorsalis pedis pulses show slightly diminished pulse force of 2+ bilaterally. Neurological testing shows weaker neurological sensation in the forefoot. Semmes-Weinstein 5.07 monofilament testing shows that sensation is only perceived above the ankle, and no ankle reflexes are observed. Other measurable physical findings are stated in Table 1.

Physical Parameters	Result
Weight	96 kg
Height	5'4"
Body mass index (BMI)	36.3 kg/m^2
Fasting capillary glucose (FCG)	152 mg/dl
Blood pressure (lying, right arm)	152/94 mmHg
Blood pressure (sitting, right arm)	140/90 mmHg
Respiration rate	20 beats per minute
Pulse rate	87 bpm

Table 1. Measurable physical findings

Laboratory Results

The list of lab tests performed on Mr. Z is shown in Table 2.

Test	Normal Range	Unit	Result
Glucose (fasting)	70-100	mg/dl	182
HbA1c	<5.7	%	8.3

Creatinine	Male: 0.7-1.3 Female: 0.6-1.1	mg/dl	0.9
Blood urea nitrogen	6-24	mg/dl	21
Sodium	135-145	mmol/L	142
Potassium	3.5-5.2	mmol/L	4.2
AST	0-40	IU/L	16
ALT	4-36	IU/L	22
ALP	30-120	IU/L	57
Urine microalbumin	<30	mg	47

Table 2. Results of laboratory analysis

Lipid analysis of the patient is shown in Table 3.

Table 3. Lipid panel

Nutrition Diagnosis

Test	**Normal Range**	**Unit**	**Result**
Total cholesterol	<200	mg/dl	170
HDL cholesterol	≥40	mg/dl	42
LDL cholesterol	<100	mg/dl	82
Triglycerides	<150	mg/dl	179
Cholesterol-to-HDL ratio	<5.0	N/A	3.9

Keeping in view the patient's assessment, medical history, diet history, physical examination and laboratory results, the following diagnoses are made:

- Decompensated type 2 diabetes (A1C >7%)
- Obesity (36.3 kg/m2)
- Hyperlipidaemia (triglycerides >150 mg/dl, treated with atorvastatin)
- Peripheral neuropathy (distal and symmetrical)
- Hypertension (≥140/90 mmHg)
- Nephropathy (Urine microalbumin >30 mg)

- Poor nutritional awareness
- Lack of self-care management
- Excessive carbohydrate intake
- Lack of physical activity

Medical Treatment

A medication regimen for treating the insulin resistance and improving the glycemic control had to be developed, keeping in view that this regimen would not contribute to weight gain.

The doctor prescribed metformin, 500 mg twice a day with meals, to reduce possible gastrointestinal tract (GIT) symptoms. Atorvastatin (Lipitor®) 10 mg daily was administered as per the previous schedule for the management of hyperlipidaemia, as the patient was not experiencing any side effects. Antihypertensive medicine, angiotensin-converting enzyme (ACE) inhibitors, such as enalapril (Renitec®), were recommended, but Mr. Z was hesitant that he might find it difficult to carry on with these many medicines. His wife said that he would prefer a natural solution rather than medication, which gave valuable insight into the patient's health belief system. Although it was necessary to start a hypertensive medicine, but on the will of the patient, it was delayed for two weeks. However, an antihypertensive diet plan was incorporated into the treatment plan. The nurse wrote down the medication schedule, a date and time for telephone contact, and handed it over to the patient.

Nutrition Intervention

Mr. Z has uncontrolled T2D, along with other comorbidities. The healthcare team prioritised the most pressing medical conditions to address first: hyperglycaemia and hypertension. Weight loss was also another step in reducing blood pressure. He acknowledged his lack of awareness regarding diabetes and wanted to lose weight under the supervision of a dietitian. He was well aware that his hyperglycaemia was because of his excessive intake of high-carbohydrate foods and was willing to change his dietary habits.

The dietitian requested Mr. Z to record his food intake in a food diary regarding everything he ate in meals and snacks, and also guided him to note portion sizes, timing of meals, and minutes spent eating. He was also advised to note the duration and type of his physical activity. Although he had increased his physical activity ever since his retirement, it was occasional and mostly dependent on cool weather. After a counselling session with the nutrition consultant, Mr. Z's wife suggested that both of them could have a morning walk before breakfast. To ensure the continuation of exercise in the hot summer,

a treadmill at home was suggested to get sufficient exercise. The consultant told them about the positive effects of exercise on regulating blood sugar levels, and the couple agreed to walk every morning for at least 30 minutes between 7:00 and 8:00 a.m. The consultant told him to have regular physical exercise, as irregularity while consuming oral agents could lead to hypoglycaemia (Kanaley et al., 2022).

RDN discussed glycemic goals with the couple and helped them in making decisions regarding initial short-term goals for weight loss, physical activity and medication. He also gave him a list of foods high in glycemic index (GI) and educated him on making informed choices about possible combinations of high and low GI foods. Advanced dietary recommendations would be made based on the patients' dietary recall assessed from the food diary. Meal frequency was reduced to three meals and three snacks a day. He was also advised to have no more than one fruit serving per snack. A consistent fashion of carbohydrate intake was made (2 carbohydrate servings per meal) to avoid troublesome symptoms. Initially, a 500kcal reduction per day was made in the overall caloric intake to treat obesity. Energy intake from fat was restricted to 25% of the total calorie intake in the tailored diet plan, and trans fats were kept to a minimum. Protein 0.8 g/kg per day of body weight was given, leaving 55% of calories from carbohydrates.

Mr. Z was counselled on the use of basic carbohydrate counting and the exchange system. A healthy food choices chart was shown to the couple to increase their understanding of wise choices. RDN modulated the diet according to the diabetes plate (1/2 non-starchy vegetables, 1/4 protein, 1/4 carbohydrate). After consultation with Mr. Z and his wife, it was decided to shift him primarily from refined white flour to multi-grain flour. Two servings of lean meat, three of fat-free milk and six of non-starchy vegetables were added to the diet plan. Two teaspoons of guar gum and pectin powder were also incorporated in the morning meal. Mr. Z's wife was educated in detail regarding low-oil cooking methods, and that pan-seared chicken would be better instead of deep-fried. She was also guided on the incorporation of monounsaturated fatty acids in the meals. Mr. Z insisted that not taking soda at night might make him feel anxious and burdened. As an initial intervention, the quantity was reduced to 1/2 cup, and the drink was switched to Diet Coke. Mr. Z was not well aware of treating hypertension. The sodium intake was restricted to less than 1500 mg per day in the diet plan, and fluid intake was estimated at 3500 ml or 14 cups of water per day.

Nutrition Education

The dietitian explained to Mr. and Mrs. Z how to use a glucometer and convinced them to use it twice per day in the first week, while the metformin was being titrated, preferably at breakfast and dinner. Mr. Z understood the need for checking glucose, as explained by the dietitian, that it would help in determining the medication course and dose, and evaluating the effects of dietary changes. However, Mr. Z showed concern about whether he would be able to keep this practice persistent.

The total available glucose (TAG) concept was saved for the follow-up session next week, hence not to overburden them with strategies which would confuse them in implementing the plan. With the consent of Mr. Z and his wife, both were enrolled in a self-support type 2 diabetes group. Blood glucose and HbA1c graphs were provided to the patient for self-filling, which would help him in staying committed.

An exercise tolerance test (ETT) was performed, and RDN performed pre-exercise screening to ensure the patient's safety and protection. Peripheral neuropathy was demonstrated to the patient by showing him his inability to assess monofilament sensation. Mr. Z was also advised to look for any possible signs of foot discomfort, like skin lesions.

Nutrition Monitoring

Nutrition M&E was set to be performed every week.

Follow-up

Important follow-up diagnostic and other test results performed one month after the treatment plan are shown in Table 4.

Table 4. Follow-up test results

Test	Normal Range	Unit	Result	Previous Result	Status
Blood Pressure	<120/80	mm Hg	124/86	140/90	Improved
Glucose (fasting)	70-100	mg/dl	92	182	Improved
HbA1c	<5.7	%	7.8	8.3	Improved

Urine microalbumin	<30	mg	36	47	Improved
Triglycerides	<150	mg/dl	110	179	Improved

Mr. Z's adherence to the interventions was assessed by his apparent weight reduction of 2.5 kg in the first month. Improved follow-up test results indicated that the patient was strictly adhering to the prescribed treatment. He did not feel any ill effects regarding the therapy, indicating that the treatment was well tolerated. His wife played a significant role in keeping him consistent with the plan. No adverse and unanticipated events were noted, except periods of low motivation, which were eventually revived by her wife. Overall, Mr. Z was satisfied with the prescribed plan.

Discussion

This case summarises a complex interplay of diabetes and various diseases associated with it. The patient showed exceptional improvement in just one month. The reason for this improvement was a tailored prescription plan, which was designed by mutual discussion between the patient and the healthcare team (Farrokhi et al., 2023).

Thiazolidinediones (TZDs), such as pioglitazone (Piozer®), have been proved to be effective in treating T2D by improving insulin sensitivity (Al Neyadi et al., 2024). But this medication has a strong potential for causing weight gain (Hurren & Dunham, 2021). Sulfonylureas like repaglinide (NovoNorm®) are seen to reduce elevated postprandial blood glucose levels after a high glycemic load (GL) meal, but this medicine is also associated with weight gain (SIVAKUMAR et al., 2021). These medications can also cause hypoglycaemia if not taken in the prescribed amount (Susilawati et al., 2023). Hypoglycaemia was seen in the patient when he was taking glibenclamide. Alpha-glucosidase inhibitors (AGIs) such as acarbose (Glucobay®) inhibit the activity of enzymes involved in the breakdown of carbohydrates in the small intestine, which helps in dealing with postprandial hyperglycaemia (Miller & Joubert, 2022).

Slow drug titration is required to have the maximum benefit of acarbose without causing adverse effects; however, it can cause GIT discomfort (Helvaci et al., 2025). Acarbose is seen to reduce HbA1c by merely 0.5 to 0.8% (Fisher, 2022). Elevated A1c levels of Mr. Z would not be fully addressed by acarbose, hence it might be considered a second-line therapy. Metformin (Glucophage®) reduces the production of liver glucose and increases insulin sensitivity. It does not cause hypoglycaemia and can

also cause a reduction of 0.9 to 2% in A1c results (Guo et al., 2021). There are chances of GIT discomfort with this medicine as well, but that was reduced by slow titration (Nabrdalik et al., 2022). The patient's consumption of high-carbohydrate foods, soft drinks and sodium intake was successfully managed. Follow-up test results were also improved. A calorie deficit of 500 kcal is a well-established scientific protocol in managing healthy weight loss, which is easy to achieve (Nicholas et al., 2021). Nutrition education proved to be successful in changing behaviour. It promoted commitment and dedication regarding the treatment course (Kim & Hur, 2021).

Conclusion

The healthcare team together played an important part in the education, nutrition and medical management of the patient. Clinical skills, along with teaching and counselling, ensured the successful delivery of the care plan. This case highlights a complex affair of type 2 diabetes with multiple comorbidities. Medicines were selected by carefully considering their effects and benefits, and personalised drug doses and dosages were set. Individualised care and a tailored diet plan were designed to address the patient's conditions. The patient was ready to take action, but was unsure about how to proceed. Adequate nutritional education led to informed choices and better management of diabetes. Including family members in every stage of devising the treatment plan was found to be very effective in ensuring the success of the plan. Counselling and mutual discussion paved the way for a convenient and effective care plan.

Funding

This case study did not receive any financial or material support.

Authors' Contributions

All authors read and approved the final manuscript.

Conflict of interest

The authors report no conflicts of interest.

References

1. ElSayed, N. A., Aleppo, G., Aroda, V. R., Bannuru, R. R., Brown, F. M., Bruemmer, D., ... & Gabbay, R. A. (2023). Introduction and methodology: standards of care in diabetes—2023. *Diabetes care*, *46*(Supplement_1), S1-S4.

2. Li, Y., Zhong, Q., Zhu, S., Cheng, H., Huang, W., Wang, H. H., & Li, Y. T. (2022). Frequency of follow-up attendance and blood glucose monitoring in type 2 diabetic patients at moderate to high cardiovascular risk: a cross-sectional study in primary care. *International Journal of Environmental Research and Public Health*, *19*(21), 14175.
3. ElSayed, N. A., Aleppo, G., Aroda, V. R., Bannuru, R. R., Brown, F. M., Bruemmer, D., ... & Gabbay, R. A. (2023). Summary of revisions: standards of care in diabetes—2023. *Diabetes Care*, *46*(Supplement_1), S5-S9.
4. Guo, S., Chang, Y., Chang, H., He, X., Zhang, Q., Song, B., & Liu, Y. (2023). Patient satisfaction with nurses' care is positively related to the nurse–patient relationship in Chinese hospitals: A multicentre study. *Frontiers in Public Health*, *10*, 1109313.
5. Salvia, M. G., & Quatromoni, P. A. (2023). Behavioral approaches to nutrition and eating patterns for managing type 2 diabetes: a review. *American Journal of Medicine Open*, *9*, 100034.
6. Lu, M., Pilla, S. J., & Oh, S. H. (2023). Diabetes mellitus: Dietary management. In *Encyclopedia of Human Nutrition: Volume 1-4, Fourth Edition* (pp. 234-251). Elsevier.
7. Kanaley, J. A., Colberg, S. R., Corcoran, M. H., Malin, S. K., Rodriguez, N. R., Crespo, C. J., ... & Zierath, J. R. (2022). Exercise/physical activity in individuals with type 2 diabetes: a consensus statement from the American College of Sports Medicine. *Medicine and science in sports and exercise*, *54*(2), 353.
8. Farrokhi, M., Taheri, F., Khouzani, P. J., Rahmani, E., Tavakoli, R., Fard, A. M., ... & Sadoughi, K. (2023). Role of precision medicine and personalized medicine in the treatment of diseases. *Kindle*, *3*(1), 1-164.
9. Al Neyadi, S. S., Adem, A., Amir, N., Ghattas, M. A., Abdou, I. M., & Salem, A. A. (2024). Novel thiazolidinedione and rhodanine derivatives regulate glucose metabolism, improve insulin sensitivity, and activate the peroxisome proliferator-activated γ receptor. *ACS omega*, *9*(5), 5463-5484.
10. Hurren, K. M., & Dunham, M. W. (2021). Are thiazolidinediones a preferred drug treatment for type 2 diabetes?. *Expert opinion on pharmacotherapy*, *22*(2), 131-133.
11. SIVAKUMAR, H., JEGANATH, D. S., & BALAMURUGAN, D. G. (2021). Effect of sulfonylurea in patients with type 2 diabetes mellitus. *International Journal of Pharmacy Research & Technology (IJPRT)*, *11*(2), 57-67.
12. Susilawati, E., Levita, J., Susilawati, Y., & Sumiwi, S. A. (2023). Review of the case reports on

metformin, sulfonylurea, and thiazolidinedione therapies in type 2 diabetes mellitus patients. *Medical Sciences*, *11*(3), 50.

13. Miller, N., & Joubert, E. (2022). Critical assessment of in vitro screening of α-glucosidase inhibitors from plants with acarbose as a reference standard. *Planta Medica*, *88*(12), 1078-1091.
14. Helvaci, M. R., Halici, H., Erdogan, K., Sevinc, A., Camci, C., Abyad, A., & Pocock, L. (2025). Acarbose in the treatment of chronic obstructive pulmonary.
15. Fisher, M. (2022). Acarbose and alpha glucosidase inhibitors. *Diabetes Drug Notes*, 229-238.
16. Guo, L. X., Liu, G. E., Chen, L., Wang, H. F., Guo, J., Zheng, X. L., ... & Lei, M. X. (2021). Comparison of clinical efficacy and safety of metformin sustained-release tablet (II)(Dulening) and metformin tablet (Glucophage) in treatment of type 2 diabetes mellitus. *Frontiers in Endocrinology*, *12*, 712200.
17. Nabrdalik, K., Skonieczna-Żydecka, K., Irlik, K., Hendel, M., Kwiendacz, H., Łoniewski, I., ... & Lip, G. Y. (2022). Gastrointestinal adverse events of metformin treatment in patients with type 2 diabetes mellitus: A systematic review, meta-analysis and meta-regression of randomized controlled trials. *Frontiers in endocrinology*, *13*, 975912.
18. Nicholas, A. P., Soto-Mota, A., Lambert, H., & Collins, A. L. (2021). Restricting carbohydrates and calories in the treatment of type 2 diabetes: a systematic review of the effectiveness of 'low-carbohydrate'interventions with differing energy levels. *Journal of nutritional science*, *10*, e76.
19. Kim, J., & Hur, M. H. (2021). The effects of dietary education interventions on individuals with type 2 diabetes: a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, *18*(16), 8439.