

Review Paper

Evaluation of Non-pharmacological Interventions in the Control and Treatment of Type 2 Diabetes: A Systematic Review



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Citation Ghardashi F, Akbarzadeh R, Zardosht R, Hossein Zadeh Hesari M. Evaluation of Non-pharmacological Interventions in the Control and Treatment of Type 2 Diabetes: A Systematic Review. *Journal of Research & Health*. 2023; 13(6):391-406. <http://dx.doi.org/10.32598/JRH.13.6.2219>

 <http://dx.doi.org/10.32598/JRH.13.6.2219>



ABSTRACT

Background: The prevalence of type 2 diabetes is a global health challenge that requires continuous care. Non-pharmaceutical interventions in controlling and treating type 2 diabetes can be less costly and have fewer complications. Accordingly, this study identifies non-pharmaceutical interventions in controlling and treating type 2 diabetes through systematic review.

Methods: This study is a systematic review of the papers published in non-pharmaceutical interventions to control and treat type 2 diabetes. The authors have used the standard guideline of systematic review (PRISMA). A total of 41 papers were selected from 529 full-text articles published between 2014 and 2020. The search included the electronic data banks, including Medline, Science Direct, Embase, Scopus, Cochrane Library, and the Google Scholar search engine.

Results: Non-pharmaceutical interventions were classified into four categories: Lifestyle, treatment devices, traditional treatment, and education. The results showed that lifestyle modification is the most effective non-pharmaceutical intervention for treating type 2 diabetes.

Conclusion: Study findings show that applying non-pharmaceutical interventions effectively controls and prevents type-2 diabetes complications. Education is a part that needs to be given more attention.

Keywords: Type 2 diabetes, Education, Lifestyle, Health

Article info:

Received: 31 Jan 2023

Accepted: 03 Jun 2023

Publish: 01 Nov 2023

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1. Introduction

Diabetes is one of the most critical health challenges worldwide. During the past three decades, the number of diabetic cases has increased more than twofold [1, 2]. The prevalence of vulnerability to diabetes is growing rapidly and will reach approximately 625 million people in all quarters of the globe by 2045 [3]. According to the estimations by the international diabetes federation in the year 2015, about 75% of adult diabetics are living in low-income countries [4]. Some risk factors of vulnerability to type 2 diabetes are unchanging, such as age and family background; however, other risk factors, such as weight gain, blood sugar, and triglyceride, change dramatically with lifestyle correction [5]. Monitoring the metabolic indicators, such as blood pressure, body weight, blood sugar, HbA1c, and lipid, is imperative for managing diabetics [6]. Studies have shown that pharmaceutical interventions and lifestyle modification can effectively control Hyperglycemia [7]. Correcting the lifestyle and mood factors, self-confidence, and social support can save pre-diabetics from the risk of vulnerability to this illness [8, 9]. About 50% to 80% of the people with diabetes have no adequate skills and knowledge of self-care and illness management [10]. Numerous studies have demonstrated that healthcare strategies engaging the diabetics' family members cause higher awareness and self-efficacy concerning self-care in patients with diabetes [11]. In recent years, the US and UK diabetes associations have confirmed the effect of a low carbohydrate diet in lowering weight and improving blood glucose and lipid regulation in mellitus diabetics [12, 13]. Combinatorial diet programs and physical activity promotion plans may hinder and delay the progress of type 2 diabetes [14-17]. Disease management programs have introduced particular instructions as the best strategy for diabetes prevention in which the increase in physical activity [18, 19], decrease of consumable calories, and training of patients together with the support by peer groups are among the most crucial disease management programs [20-26]. Despite the variety and frequency of the interventions to control and treat type 2 diabetes in different countries, the knowledge and awareness of the methods and the relevant consequences are crucial for the science community. They can be counted as a decisive step toward promoting this science. A systematic review is a comprehensive study based on a predetermined and accurate protocol. Many studies do not have good interpretive power for various reasons; however,

the systematic review and meta-analysis that often follows will combine studies to reach a larger sample size; therefore, they can be examined with greater power and ultimately provide better conclusions. Accordingly, this study aims to determine effective non-pharmacological interventions in controlling and treating type 2 diabetes by systematic review method. This study has been conducted to find answers to the following questions:

- 1) What are the types of non-pharmacological interventions used in intervention studies to control or treat type 2 diabetes?
- 2) Which non-pharmacological intervention is primarily recommended in controlling or treating type 2 diabetes in intervention studies?
- 3) What have been the outcomes of non-pharmacological interventions in controlling or treating type 2 diabetes?

2. Methods

This study is a systematic review of the papers published on the non-pharmaceutical intervention arrangements in controlling and treating patients with type 2 diabetes. The authors have used the standard systematic review guideline (PRISMA), including 27 items [27].

The search included the electronic data banks, including [Medline](#), [Science Direct](#), [Embase](#), [Scopus](#), [Cochrane Library](#), and the [Google Scholar](#) search engine. The main selected keywords were as follows: "Clinical trial," "treatment," "type-2 diabetes," and "control." Their equivalents were also searched in MeSH: "NIDDM" and "diabetes mellitus." The words "AND" and "OR" were used to combine the keywords. Searching was restricted to all relevant English papers published and indexed from June 2014 to the end of 2020.

Inclusion criteria

The inclusion criteria of selected papers were from scientific research journals, the language of the paper was in English, and the documents were full-text papers. The criteria for selecting articles were as follows: Type of participants=type 2 diabetes, type of interventions=non-pharmaceutical interventions, type of comparator=intervention performed, type of outcome=control or treatment, study type=clinical trial or empirical.

Exclusion criteria

The exclusion criteria of papers were inaccessibility to the full text, letters to the editors, and exclusively descriptive and review papers.

Data extraction, variables, and data analysis

A researcher-made data extraction form based on the study objective was used to analyze the papers. This form included parts of the article details, including the authors' names, publication year, paper's objective, study design, study methodology, information relevant to type 2 diabetes, and final results and outputs. Two researchers were involved in the selection work and data extraction activities. The main features of the studies and their results have been summarized considering the following variables:

Type of study: The papers from clinical trials or empirical studies were selected.

Target population: The patients with type 2 diabetes and gestational diabetes (GDM).

Types of interventions

Types of interventions in this study were classified into four categories, namely "lifestyle," "education," "traditional treatment," and "Treatment devices," based on the [World Health Organization \(WHO\)](#) interventions category guidelines [28], and the study objectives that embraced only the non-pharmaceutical interventions.

Two reviewers worked independently to determine whether a study met the inclusion criteria. They collected information to assess each study's methodological validity (degree of protection against confounding and bias). They also extracted data from the included studies using structured and standardized data extraction forms. The reviewers resolved discrepancies by jointly reviewing any study in question. A third reviewer would enter as an external peer reviewer if no consensus were reached. The third author was unaware of the other reviewers' determinations and functioned as an arbitrator.

3. Results

Searching of the data sources was performed for two months based on the keywords and searching strategies, and a total of 41 papers were selected from 529 articles after three selection steps. The authors systematically considered the title and abstract of all papers in the in-

cludes in the first step based on the relevancy to the study subject in addition to the inclusion and exclusion criteria. Accordingly, a total of 198 articles were entered into the study. Meanwhile, 35 articles were excluded from the study due to inaccessibility to the full text or duplication (indexed in different sites). An expert panel thoroughly analyzed the remaining articles (n=163) with two expert reviewers (after a full-text reading of the articles). Eventually, 68 articles with more comprehensive and relevant information were selected. The full text of the above 68 papers was then handed to two independent expert authors, and finally, 36 articles were selected. Then, 5 articles were added from among the articles' references, and 41 papers were selected. The flow chart of article selection is presented in [Figure 1](#).

[Table 1](#) represents the main features of the selected articles in addition to their aims and results.

The result indicated that the above 41 selected articles were from the outcome of studies performed in 21 different countries. Most of the randomized controlled trial (RCT) studies (82.9%) and interventions were related to lifestyle (61%). Meanwhile, most studies (53.7%) represented an improvement in the patient's status and a decrease in HbA1c, while the reduction of HbA1c accompanied the outcome of most diet intervention studies (88.9%). The percentage and frequency of the under-study variables in terms of the type of study, type of intervention, the comparison group, and the interventions' outcomes are shown in [Table 2](#). In response to the first question of the study:

1) What are the types of non-pharmacological interventions used in intervention studies to control or treat type 2 diabetes?

In the present study, it was determined that the researchers had used the interventions, such as "changing the lifestyle (diet, physical activity, and social support)," "treatment devices," "treatment-other," "traditional treatment," and other interventions (education).

In response to the second and third questions of the study:

2) In intervention studies, which non-pharmacological intervention is most recommended in controlling or treating type 2 diabetes?

3) What have been the outcomes of non-pharmacological interventions in controlling or treating type 2 diabetes?

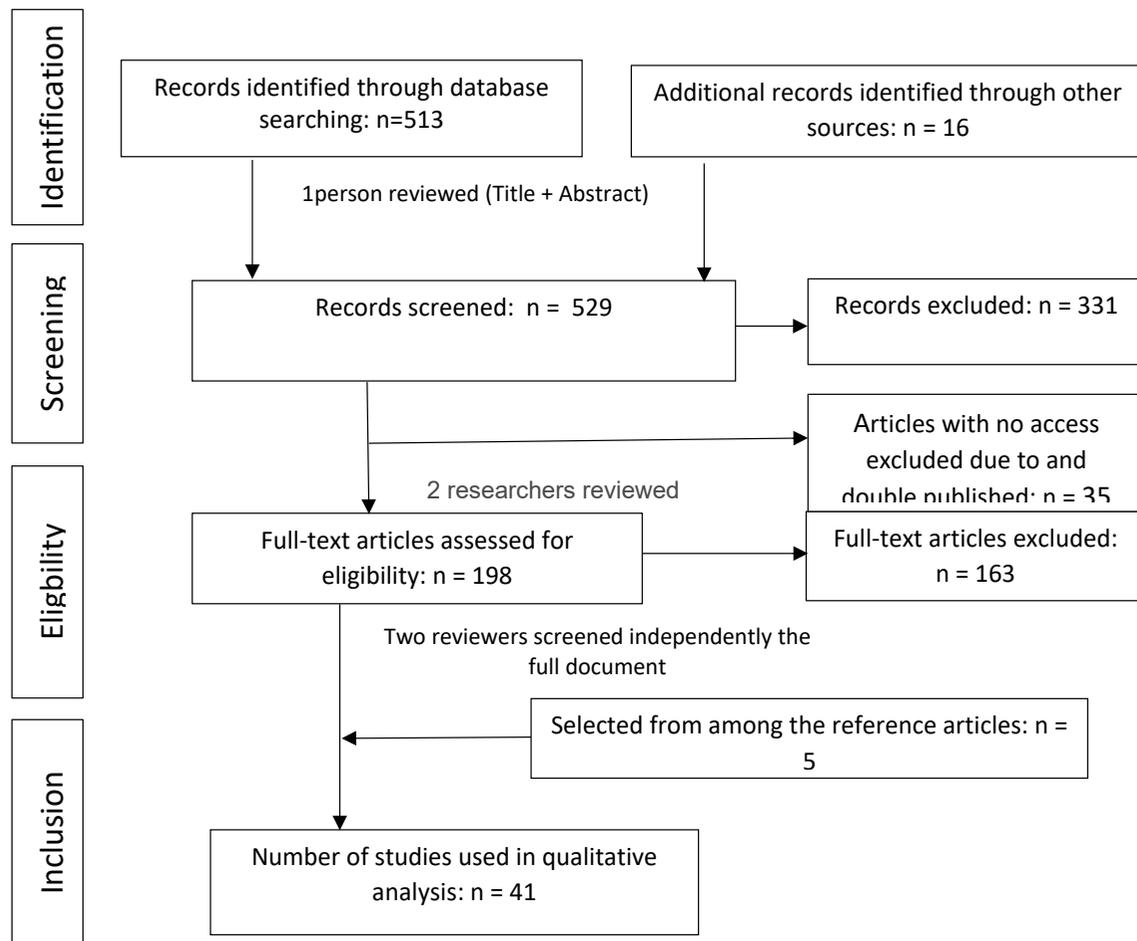


Figure 1. PRISMA flow diagram for the literature review and study selection

Most non-pharmacological intervention to control and improve type 2 diabetes was related to lifestyle (60.9%), although only 4.9% of the studies had investigated all lifestyle elements. Among the lifestyle variables, the highest frequency was diet and nutritional supplements (19.5%). Subsequently, physical activity (26.8%) and social support (7.3%) had the highest frequencies, respectively.

About 65.9% of interventions resulted in controlling and improving blood sugar and decreasing HbA1c. Meanwhile, 7.3% of the studies represented satisfaction and increased patients' quality of life; only 26.8% showed no significant statistical result. The study's results also demonstrated that all diet-related interventions produced the outcome of better control and improvement of blood sugar and decreased HbA1c, which indicates the importance of diet as an essential factor in controlling and preventing type 2 diabetes.

4. Discussion

Articles related to diabetes have dramatically increased worldwide in recent years. The [Medline](#) website contains more than 60 thousand papers published in the past seven years on this subject, hence confirming the importance of the issue and the concerns felt by all countries regarding the prevalence of diabetes and their serious attempt to find ways to prevent and control this disease. Using non-pharmaceutical interventions to treat and control diabetes while avoiding expenses for the patient and society prevents drug side effects. Hence, the use of non-pharmaceutical interventions is preferable to pharmaceutical ones.

WHO has classified the intervention types into 12 classes as follows: Behavior, diagnosis, early detection, lifestyle, placebo, prevention, rehabilitation, treatment devices, treatment-drugs, treatment-surgery, and treatment-other and other. The results of this study were classified into four categories: 1) Lifestyle, 2) Treatment-devices, 3) Treatment-other (traditional treatment), and 4) Other (education).

Table 1. Characteristics of selected articles

Row	Study Details (Authors/Date)	Study, Location, Number of Subject, Duration	Study Objectives	Interventions Category	Results/Conclusions
1	Sato et al. 2017 [37]	RCT, Japan, (n=66), 6 m	Comparing the effectiveness and safety of a low-carbohydrate diet with calorie-restricted diet	Lifestyle/diet	Low-carbohydrate diet is a potentially helpful nutrition therapy for Japanese patients who cannot adhere to a calorie-restricted diet.
2	Kitalong et al. 2017 [39]	RCT, Palau, (n=68), 12 w	Effects of traditional drink as adjuvant therapy when diabetes control is insufficient	Lifestyle/diet	Poorly controlled diabetic patients improved the control of diabetes within 12 weeks when drinking traditional drinks for at least 6 weeks.
3	Gomes et al. 2017 [63]	RCT, Brazil, (n=164), 2 y	Evaluating the contribution of family social support to the clinical/metabolic control of people with type 2 diabetes mellitus	Lifestyle/social support	The results showed a greater reduction in blood pressure and glycated hemoglobin in the intervention group than in the control group.
4	Nakayama et al. 2017 [40]	RCT, Tokyo, Japan, (n=18), 8 w	Evaluating the effect of glutinous brown rice intake for 8 weeks on glycemic control in outpatients with diabetes mellitus	Lifestyle/diet	Glutinous brown rice was well tolerated for 8 weeks and improved glycemic control in patients with type 2.
5	Sato et al. 2016 [38]	RCT, Tokyo, Japan, (n=34), 8 m	Assessing the effects of treatment guidance based on data from a continuous glucose monitoring device on glycemic control and patient satisfaction in patients with type 2 diabetes mellitus	Treatment-devices	The study did not demonstrate that treatment guidance using retrospective continuous glucose monitoring data effectively improved glycemic control and therapeutic satisfaction in Japanese patients with type 2 diabetes mellitus.
6	Sönnichsen et al. 2010 [26]	RCT, Austria, (n=337), 24 m	Testing the effectiveness of peer support in additionally to disease management programs for type 2 diabetes patients	Lifestyle/social support	Peer support intervention as an additional disease management programmed component showed no significant impact on HbA1c and secondary outcome measures.
7	Asemi et al. 2016 [41]	RCT, Iran, (n=102), 6 w	Determining the beneficial effects of β -carotene fortified symbiotic food intake on metabolic status in patients with type 2 diabetes mellitus	Lifestyle/diet	β -carotene fortified symbiotic food intake in patients with type 2 diabetes mellitus for 6 weeks had favorable effects on insulin.
8	Fountoulakis et al. 2015 [49]	RCT, Greece, (n=115), 1 y	Comparing the effects of telemonitoring on HbA1c, body mass index, frequency of hyper- and hypoglycemia, and cost of insufficiently controlled insulin-treated diabetes mellitus patients versus usual outpatient care alone	Treatment-devices	Telemonitoring can result in the reduction of HbA1c and frequency of hypo- and hyperglycemia.
9	Sato et al. 2016 [38]	RCT, Japan, (n=24), 1 y	Comparing HbA1c and body mass index between the low- low-carbohydrate diet and calorie-restricted diet groups at 1 year after the end of the 6-month RCT	Lifestyle/diet	Well-constructed nutrition therapy programs, both a restricted diet and low-carbohydrate diet, were equally effective in improving HbA1c for at least 1 year.
10	Li et al. 2014 [42]	RCT, China, (n=71), 12 w	Examining the effect of a low glycemic index multi-nutrient supplement, consumed in place of breakfast, on glycemic control in patients with type 2 diabetes mellitus	Lifestyle/diet/nutritional supplements	Breakfast replacement with a low glycemic index multi-nutrient supplement can improve glycemic and weight control in type 2 diabetes mellitus.
11	Yuan et al. 2014 [81]	Experimental, Hong Kong, (n=76), 3 m	Evaluating the effect of a short-term diabetes self-management education on metabolic markers and atherosclerotic parameters in patients with type 2 diabetes	Education	Diabetes self-management education can improve HbA1c and body weight in patients with type 2 diabetes.
12	Kirilmaz et al. 2015 [29]	Experimental, Turkey, (n=83), 3 m	Evaluating the effect of lifestyle modifications and glycemic control on the efficiency of sildenafil citrate in patients with type-2 diabetes and erectile dysfunction	Lifestyle	Glycemic control and lifestyle changes are not solely adequate for better sexual function in erectile dysfunction due to diabetes, and sildenafil citrate should be used additionally.

Row	Study Details (Authors/Date)	Study, Location, Number of Subject, Duration	Study Objectives	Interventions Category	Results/Conclusions
13	Wang et al. 2018 [43]	RCT, China, (n=56), 3 m	Evaluating low-fat diet to improve blood glucose levels in patients with type 2 diabetes mellitus	Lifestyle/Diet	A low-carbohydrate diet can improve blood glucose more than a low-fat diet in Chinese patients with type 2 diabetes mellitus.
14	Huhmann et al. 2018 [44]	RCT, USA, (n=12), 2 m	Evaluating an enteral nutrition formula containing a very high concentration of protein and low concentration of carbohydrate provides better control of postprandial blood glucose relative to a high-protein/higher carbohydrate formula	Lifestyle/Diet	An enteral nutrition formula containing high-protein and low-carbohydrate loads can significantly improve glucose control in subjects with type 2 diabetes.
15	Rasekaba et al. 2018 [70]	RCT, Australia, (n=95), 10 w	Exploring the effects of telemedicine-supported gestational diabetes mellitus care on a range of health service utilization and maternal and fetal outcomes	Treatment-devices	Telemedicine was a significant predictor of better glycemic control.
16	Gholaman et al. 2018 [49]	RCT, Iran, (n=40), 8 w	Investigating the effects of training along with fenugreek seed supplement on lipid profile, body composition, insulin resistance, and VO ₂ max in obese women with type 2 diabetes	Traditional treatment	Fenugreek consumption increases the endurance training-induced adaptations in obese women with type 2 diabetes.
17	Sajatovic et al. 2017 [79]	RCT, Japan, (n=200), 60 w	Assessing the effects of targeted training in illness management vs usual treatment	Lifestyle/Physical activity	Targeted training in illness management was associated with improved psychiatric symptoms, functioning, and diabetes knowledge compared with treatment as usual.
18	O'Dea et al. 2015 [30]	RCT, Ireland, (n=50), 12 w	Evaluating a group-based lifestyle intervention program for women with prediabetes following gestational diabetes	Lifestyle	Prevention programmers must tackle the barriers to participation faced by this population; home-based interventions should be investigated.
19	Skleppe Kocic et al. 2018 [51]	RCT, Croatia, (n=38), 6 weeks	Investigating the impact of a structured exercise program on the parameters of glycemic control and other health-related outcomes in pregnant women diagnosed with gestational diabetes mellitus	Lifestyle/Physical activity	The structured exercise program had a beneficial effect on postprandial glucose levels at the end of pregnancy.
20	Draffin et al. 2017 [83]	RCT, UK, (n=150), 1 y	Evaluating the impact of an innovative patient-centered educational DVD on anxiety and glycemic control in women newly diagnosed with gestational diabetes mellitus	Education	The results did not highlight differences between the intervention and those who received usual care.
21	Davoudi et al. 2016 [48]	Quasi-experimental, Iran, (n=10)	Investigating the effect of different intensities of acute aerobic exercise on plasma resistance levels in men with type 2 diabetes	Lifestyle/Physical activity	Acute exercise with different intensities does not affect resistance action in individuals with diabetes.
22	Ghoreishi et al. 2016 [78]	RTC, Iran, (n=60), 2 m	Evaluating the effect of consuming sesame seeds on some biochemical factors in type 2 diabetic patients	Traditional treatment	The sesame seeds suggested that this plant is probably useful as a complementary therapy for treating and preventing diabetes disorders.
23	Mirfeizi et al. 2014 [76]	RCT, Iran, n=75), 2 y	Evaluating the effect of oral supplementation of cinnamon on glucose control index and lipid profile in type 2 diabetic patients	Traditional treatment	The oral supplementation of cinnamon to adjust the weight of diabetic patients with conventional therapy is recommended.
24	Samadi et al. 2017 [77]	RCT, Iran, (n=57), 12 w	Assessing bee propolis supplementation on insulin resistance indices in patients with type 2 diabetes	Traditional treatment	The daily intake of 900 mg of bee propolis supplement for 12 weeks improves glycemic and some serum lipid levels in patients with type 2 diabetes.

Row	Study Details (Authors/Date)	Study, Location, Number of Subject, Duration	Study Objectives	Interventions Category	Results/Conclusions
25	Ji et al. 2019 [90]	Pilot study, RCT, China, (n=100), 3 & 6 m	Investigate whether simulation education and case management had any effect on glycemic control in type 2 diabetes patients	Education	After 6 months, HbA1c, fasting plasma glucose, and postprandial blood glucose level improvements were superior in the experimental group compared with the control group.
26	Madsen et al. 2015 [58]	RCT, Denmark, (n=33), 8 w	Investigating glycemic control, pancreatic function, and total fat mass before and after 8 weeks of low volume high-intensity interval training on a cycle ergometer in type 2 diabetes patients and matched healthy control individuals	Lifestyle/Physical activity	These results demonstrate that high-intensity interval training improves overall glycemic control and pancreatic β cell function in type 2 diabetes patients.
27	Gupta et al. 2020 [84]	RCT, (n=81), 3 m	Investigating the effectiveness of a video-based lifestyle education program in improving glycemic control in people with type 2 diabetes mellitus compared with usual care	Education	A significant reduction ([0.6%-95% CI (0.1, 1.1)], P=0.013) in HbA1c was seen in the video-based lifestyle education program group compared to usual care was observed.
28	Yuan et al, 2014 [81]	RCT, Hong Kong, (n=76), 3 m	Comprehensively evaluating the effect of short-term diabetes self-management education on metabolic markers and atherosclerotic parameters in patients with type 2 diabetes	Education	Diabetes self-management education can improve HbA1c and body weight in patients with type 2 diabetes.
29	Xu et al. 2018 [89]	RCT, China, (n=300)	Evaluating the intervention effects of peer support education mode for type 2 diabetes control in rural residents	Education	Peer support for education intervention seemed beneficial for diabetic control. The combination of education and effect evaluation was important for assessing diabetes prevention and control.
30	Abdulah et al. 2018 [82]	Iraq, double-arm post-test interventional clinical trial, (n=87), 15-69 y	Investigating the impact of 3 months of diabetes self-management intervention on glycemic control in patients with non-complicated type 2 diabetes	Education	The current study showed a substantial statistically higher participation of patients in the experimental arm in walking, higher consumption of some healthy foods, and a statistically considerably lower consumption of some unhealthy foods following a three-month self-management intervention.
31	Zaidi et al. 2018 [59]	RCT, Norway, (n=137), 41-81 years, 12 months	Investigating whether exercise training would reduce the levels of circulating IL-18, as well as gene expression of IL-18, Caspase-1, and NLRP3 in circulating leukocytes and AT in patients with coronary artery diseases and type 2 diabetes mellitus	Lifestyle/Physical activity	Long-term exercise training had no significant effects on the inflammasome-related mediators in our patients with combined coronary artery disease and type 2 diabetes mellitus.
32	Gaffney et al. 2018 [45]	RCT, New Zealand; (n=24 men), 10 weeks, 40-65 years,	Determining if pretraining whey protein supplementation combined with mixed-mode interval training can improve glycemic control	Lifestyle/Diet/Nutritional supplements	Consumption of 20 g of whey protein before and after high-intensity mixed-mode interval training for 10 weeks, compared with iso caloric non-protein control, did not clearly enhance glycemic control in middle-aged men with type 2 diabetes.
33	Tokmakidis et al. 2014 [50]	Clinical trials, Greece, n=13 (postmenopausal women), 21 m	Investigating the effects of training, detraining, and retraining, using a combined strength and aerobic exercise program on glycemic control in women with type 2 diabetes	Lifestyle/Physical activity	The cessation of exercise brings about negative alterations while retraining restores all beneficial adaptations and improves them even more.
34	Hermanns et al. 2017 [86]	RCT, Germany, (n=182), 6 m	Comparing the effects of MEDIAS 2 BSC with an established education program acted as a control group in a randomized, multi-center trial	Education	MEDIAS 2 BSC was more effective in lowering HbA1c than the control condition.

Row	Study Details (Authors/Date)	Study, Location, Number of Subject, Duration	Study Objectives	Interventions Category	Results/Conclusions
35	Andersen et al. 2014 [62]	RCT, Germany; (n=21) middle-aged men, 24 w	Evaluating the effects of 24 weeks of recreational football training on glycemic control, muscular adaptations, body composition, and maximal oxygen uptake in middle-aged male subjects with type 2 diabetes mellitus	Lifestyle/Physical activity	24 weeks of recreational football training improved VO ₂ peak and lowered total body and android fat mass in middle-aged men with type 2 diabetes mellitus.
36	Kuniss et al. 2018 [80]	RCT (prospective, longitudinal trial), Germany, (n=33), 12 m	Assessing the efficacy of a patient education programs for the optimization of conventional insulin therapy in patients with type 2 diabetes in an in- and outpatient setting	Education	Participation in an out- or inpatient DTPP improved substantially HbA1c levels in people with type 2 diabetes on conventional insulin treatment.
37	Deng et al. 2016 [64]	RCT, China, (n=200), 40-70 y, 7 m	Observing the effects of a peer support program on the outcomes of patients with type 2 diabetes who received community-based insulin therapy in rural communities of central China	Lifestyle/Social support	This study indicates that 4-month peer support training achieved a satisfactory effect on diabetic behavior, knowledge related to diabetes, and self-management of patients with diabetes in rural communities of central China.
38	Park et al. 2014 [61]	RCT, Korea, (n=37), 12 w	Investigating the effect of circuit exercise training and detraining in type 2 diabetic patients	Lifestyle/Physical activity	Neither group had a significant improvement in BMI and blood lipid profile.
39	Karstoft et al. 2017 [60]	RCT, Denmark, (n=14), 8 w	Evaluating the effects of oxygen consumption-matched short-term interval walking training vs continuous walking training on glycemic control, including glycemic variability in individuals with type 2 diabetes	Lifestyle/Physical activity	In contrast to continuous walking training, short-term interval walking training improves CGM-derived measures of glycemic control independent of changes in physical fitness and body composition in individuals with type 2 diabetes.
40	Karstoft et al. 2014 [57]	RCT, Japan, (n=20), 4 m	Elucidating the underlying mechanisms behind the advantageous effects of interval training compared with continuous training on glycemic control in individuals with type 2 diabetes	Lifestyle/Physical activity	These results suggest that training with alternating intensity, not just training volume and mean intensity, is a key determinant of changes in whole body glucose disposal in individuals with type 2 diabetes.
41	Delevatti et al. 2015 [51]	RCT, Brazil, (n=34), 12 w	Comparing the effects of two aerobic training methods in water and on dry-land on glycemic, lipid, inflammatory, hormonal, cardiorespiratory, and functional outcomes in patients with type 2 diabetes	Lifestyle/physical activity	Aerobic training in an aquatic environment provides effects similar to aerobic training in a dry-land environment in patients with type 2 diabetes.

RCT: Randomized controlled trial.



Lifestyle

US Diabetes Association considers lifestyle management a principal aspect of preventing and controlling type 2 diabetes [29]. Although lifestyle interventions are the major element of care in type 2 diabetes cases [30] and lifestyle can prevent the micro- and macro-vascular complications accompanied by type 2 diabetes [31], due to the complexity and time-consuming nature of complete intervention in lifestyle, a minimal number of studies are often conducted. Most studies consider only one of the elements involved in the lifestyle as an individual variable. This is while numerous factors, including smoking, alcohol consumption, physical activities,

diet, social support and spiritual dimensions, and stress in lifestyle are also involved [32-34]. Based on the findings of this study, among the lifestyle components, most of the components, including physical activity, nutrition, and social support, have been studied.

Diet

Most of the articles reviewed in this study have investigated the diet component as an essential factor in lifestyle. Low carbohydrates, low-calorie diet [35-36], traditional beverages [37], brown rice [38], β carotene-enriched foods [39], nutritional supplements containing several low-glucose nutrients with breakfast [40], low-

Table 2. Percentage and frequency of studied variables by the type of intervention (n=41)

Variables		Intervention Categories							No. (%)
		Education	Treatment-devices	Traditional Treatment	Lifestyle				
					Lifestyle	Social Support	Physical Activity	Diet	
Study design	RCT	8	4	4	0	2	8	9	34(82.9)
	Experimental	1	0	0	2	1	3	0	7(17.1)
Comparison	Placebo	0	0	4		0	0	1	5(12.2)
	Other interventions	1	1	0		0	1	4	10(24.4)
	Crossover	0	0	0	0	0	0	2	2(4.9)
	Usual care	8	2	0	2	2	8	2	24(58.5)
Outcome	Satisfaction	1	1	0		1	0	0	3(7.3)
	Control	1	0	1	0	1	2	0	5(12.2)
	Improve	5	1	2	0	1	5	8	22(53.7)
	None	2	1	1	1	1	4	1	11(26.8)

RCT: Randomized controlled trial.



fat diet [41], and prepared food with high protein and low glucose concentration in enteral nutrition [42] have been effective in better blood sugar control and reduction of HbA1c level in type 2 diabetes patients. However, whey protein supplementation was not effective [43]. Vitamin D supplementation did not affect type 2 diabetes incidence or insulin resistance [44].

Accordingly, the results of this study are indicative of the essential role of diet in controlling the blood sugar of people with type 2 diabetes; therefore, it is recommended that considering the native and local nutritional cultures of each country and ease of access to foodstuffs, the necessary education is given to this type of diabetics. The latest guidelines for type 2 diabetes in China also introduce medical nutrition therapy as an essential component of the control and treatment of these patients [45].

Physical activity

In this study, it was confirmed that acute exercise with various intensities is ineffective in controlling the blood sugar of type 2 diabetes patients [46]; however, the use of vegetable supplements, such as fenugreek seed with physical activity, in addition to the reduction of blood sugar, would significantly decrease the body fat percentage [47]. The results of studies also indicate the effect of following a regular and uninterrupted exercise program

throughout life on controlling glucose metabolism [48] and programmed structured exercise on the blood sugar level after delivery in the GDM [49].

Physical activity affects lipids, blood sugar, cardiovascular incidents, and life quality and is additionally considered an essential element in predicting and controlling type 2 diabetes. Physical activity with moderate weight loss can decrease the vulnerability risk of type 2 diabetes by up to 58% in high-risk populations [50]. Aerobic exercise, on land and in water, may improve blood sugar and nerve function in type 2 diabetes [51, 52]. Ghanbarzadeh (2017) also demonstrated that a balanced and low-fat diet maintained with (aerobic or anaerobic) exercise can be effective in decreasing the blood sugar of diabetics [53]. In some studies, the intensity of physical exercise is known as the main determinant of metabolic improvement and is also effective on blood sugar [54, 55].

According to the contradictory results of studies [56-60], the effective role of physical activity in decreasing weight and physical health is not unknown. Still, due to a lack of knowledge on the type of activity, intensity, and frequency of exercises that could be effective on the blood sugar of type 2 diabetes patients, the whole issue needs further investigation.

Social support

This study determined that the family's social support, especially with their participation in the health care program of type 2 diabetes patients, results in blood sugar control [61]. Peer social support had a satisfactory effect on diabetic behavior, diabetes-related knowledge, and self-management of diabetic patients in rural China []; however, peer-supportive interventions were ineffective in controlling blood sugar and side effects [56].

The results of other studies are in line with the results of this study that community-based social support will be associated with better health [63] and is effective on the HbA1c level and lifestyle as well as self-efficacy [64-66].

Lifestyle

The study results indicate the effects of the lifestyle interventions on better sexual performance of the patients and their satisfaction [67]. Also, better stress control has been accompanied by diet self-efficacy and higher life quality, although with no evident changes in the biochemical variables [68].

Treatment-devices

Continuous glucose monitor (CGM) devices were effective in the patients' blood sugar control and satisfaction [38]. Although telemonitoring was effective in controlling the blood sugar and improving the HbA1c level of type 2 diabetes patients, this effectiveness was weakened six months after the termination of such monitoring [69]. In GDM, telemedicine can be associated with better diabetes control and maternal and neonatal outcomes [70].

The diabetes monitoring device may include sensors to supervise one or more of the following items: Blood sugar level, physical activity, energy consumption, and insulin dose [71]. Although numerous interventions have reported the significance and effect of telemedicine and telemonitoring interventions on controlling and preventing diabetes complications [72-74], telemedicine services must facilitate infrastructure, including continuous support services and service guideline training, to be effective. Therefore, the capacity of telemedicine providers will be far more critical than the competence of their recipients in the success of telemedicine services [75].

Traditional treatment

Although the result of this study is indicative of the ineffectiveness of using cinnamon nutritional supplements [76] in reducing the blood sugar of type 2 diabetes patients, the consumption of bee propolis [77] and sesame seeds [78] achieved the fetal bovine serum reduction outcome besides reducing the HbA1c level.

Education

Targeted training in diabetes management (TTIM) improved psychiatric symptoms and heightened the knowledge level of diabetes [79, 80]. Diabetes self-management and education can, in addition to decreasing body weight, improve the HbA1c level [81, 82]. Although the training DVD was not effective in controlling blood sugar in type 2 diabetics, the video-based lifestyle education program was effective in improving glycemic control in patients with type 2 diabetes [83, 84].

Diabetes self-management and education support facilitate the knowledge, skill, and ability required for self-care in diabetics [85, 86]. Based on the results reported by numerous studies, education currently represents one of the most essential elements in preventing and controlling diabetes [87, 88]. Peer support for educational intervention and simulation education in diabetes control will be useful [89, 90]. However, assessing educational needs is necessary for the success of every educational program [91]. The self-management education must be appropriate to the specific population considering the ethnic, social, cognitive, literacy, and cultural factors. There is a need to improve access to and absorption of diabetes self-management programs across the globe [92], and comprehensive research should be conducted on the manner, period, and method of interaction with the trainer. It is recommended that in every educational group, first, the preliminary educational needs assessment is performed. Then, based on the literacy level, cultural and ethnic factors, and the groups' educational needs, the content and tools suitable to the training are selected, and the educational planning is executed.

5. Conclusion

Study findings show that applying non-pharmaceutical interventions effectively controls and prevents type 2 diabetes complications. The interventions, such as lifestyle correction, suitable diet, social support, application of treatment devices, traditional treatment, and education, all have a role in treating type-2 diabetes. However, depending on the patient's condition, these interventions

may need to be accompanied by medication. Most studies are in line with a low-carbohydrate diet. Still, this study demonstrated that in addition to the low glucose and high protein diet, consuming some foodstuffs, including brown rice, DAK beverages, β -carotene contained foods, and low-fat diets could decrease HbA1c levels. Structured physical activity, family support through their participation in the care programs, application of telemonitoring devices, and diabetes self-management education are all effective methods in controlling diabetes and preventing its complications. However, some of these components need further investigation to confirm a rigorous and consistent program. In addition, it seems that the most important issue is education because using all of the above methods requires patient education, so proper patient education should not be neglected.

Study limitations

We attempted to minimize the limitations of this study. We used several strategies to identify studies to limit publication bias's possible effect. The Inclusion criteria were chosen to increase the possibility that high-quality studies would be selected. However, there are many limitations. Firstly, a literature search was conducted in major electronic databases, [Medline](#), [Science Direct](#), [Embase](#), [Scopus](#), [Cochrane Library](#), and the [Google Scholar](#) search engine. Still, no other databases were searched (gray literature). Therefore, some relevant studies are probably missing. Secondly, based on the search strategy in the study, we included all studies with available full text in English and Persian languages that investigated the non-pharmacological interventions in the control and treatment of type 2 diabetes with “clinical trial,” “treatment,” “type-2 diabetes,” “control,” and its equivalents in MeSH, namely “NIDDM” and “diabetes mellitus.” However, other interventions for treating this disease can be investigated in other studies, but due to the small number of them, they were not included in this study, and only the main interventions were used. Third, we excluded articles published in preprint databases due to a lack of peer review.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of [Sabzevar University of Medical Sciences](#) (Code: IR.MEDSAB.REC.1399.145) and informed consent was obtained from every participant.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Writing—review and editing: Fatemeh Ghardashi and Roghayeh Zardosht; Data collection and writing—original draft: All authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

The authors would like to thank [Sabzevar University of Medical Sciences](#) for their support.

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