Effectiveness of Interventional Studies on Type 2 Diabetes: A Decade Systematic Review

Ameneh Pooresmaeil Dorosteh [ID][1], Mohtasham Ghaffari [ID][1] and Sakineh Rakhshanderou [ID][1, *]

[1]School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[*]*Corresponding author*: School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Email: s_rakhshanderou@yahoo.com

Abstract

Context: Educational interventions on type 2 diabetes can have life-saving effects. A closer analysis of studies in this area contributes to well-designed interventions.

Objectives: We surveyed the effectiveness of interventional studies on type 2 diabetes in the last decade.

Data Sources: The research papers were obtained from PubMed, Science Direct, Scopus, Web of Science, Google Scholar, SID, and Magiran for Persian and English language studies between 2010 and 2019. The PRISMA checklist was used to select the studies for systematic reviews.

Study Selection: The criteria for article selection were experimental studies, quasi-experimental studies, clinical trials, and pre-treatment and post-treatment observations. Also, the exclusion criteria were case studies, short articles, cross-sectional studies, descriptive and analytic studies, letters to the editor, and systematic review papers. Finally, 24 studies (out of 1,374) were entered in our study.

Data Extraction: An interventional study checklist was used to report the standard of studies: (1) consolidated standards of reporting trials with 25 items; (2) checklist for experimental design with nine items; (3) checklist for quasi-experimental studies with nine items; and (4) transparent reporting of evaluations with non-randomized designs with 22 items.

Results: Twenty-four research papers entered the final analysis. Most studies were clinical trials with the intervention period ranging from one to 12 months. Patients were usually selected as the participants. The education interventions in most studies were lectures, questions/answers, group discussions, brainstorming, photo/film/slide display, group teaching, individual training, individual counseling, and group counseling. The main focus of the interventions was on physical activity and diet, with positive effects.

Conclusions: Most interventions made on type 2 diabetes variables had positive effects. Therefore, it is recommended that in addition to diet and physical activity, other factors of type 2 diabetes be considered in educational interventions. Also, the most effective and appropriate teaching methods should be considered to prevent and control this disease.

Keywords: Effectiveness, Survey, Educational Interventions, Diabetes Mellitus, Systematic Review

1. Context

The type 2 diabetes pandemic and its complications are a worldwide threat to all people's health. The International Federation of Diabetes has estimated that one out of 11 adults between the ages of 20 and 79 (i.e., 415 million adults) had diabetes worldwide in 2015. It is predicted that this figure will rise to 642 million by 2040. Currently, Asia is the epicenter of the type 2 diabetes pandemic, which is increasing on an unprecedented scale, particularly in China and India (1).

According to the IDF report, 30.3 million (9.4%) people had type 2 diabetes in the US in 2017 (2). In the eastern Mediterranean region, Kuwait (19.4%) and Yemen (3.9%) recorded the highest and lowest rates in the development of type 2 diabetes in the 20 - 79 age group in 2019, with Iran

somewhere in the midpoint with a 9.4% rate (2). According to the World Health Organization (WHO), nearly five million people aged between 20 and 79 died of diabetes in 2015. This figure is tantamount to one death every six seconds, making diabetes the seventh leading cause of death worldwide in 2016. Fatal cases of diabetes among Iranian adults have increased to 37,075 (10.8%), ranking third in the Middle East, following Pakistan (86,365 cases) and Egypt (78,184 cases) (3).

Several factors can contribute to type 2 diabetes, including overweight, hypertension, high triglycerides, age of 45 or older, stress, genetics, inactivity, gestational diabetes, race, poor economic and social conditions, policies and social norms, environmental factors, inadequate health care, public and social media, changing food con-

sumption patterns, culture, urbanization, society, smoking, alcohol consumption, vitamins D and K deficiency, and insufficient sleep (less than five hours or more than eight hours) (3). Type 2 diabetes can increase the likelihood of many health issues. These health complications include heart attack, stroke, kidney failure, amputation, injuries, and nervous breakdown (4). Disability, low-quality life, and untimely death can be some of the consequences of diabetes (5). Thirst, polyuria, blurred vision, and weight loss might also be related to diabetes (6).

The WHO has a strategic plan to prevent this disease by providing training and education aiming at changing the lifestyle, reaching and retaining the right weight (physical fitness), physical activity (at least 30-min regular and vigorous exercise on most days), a healthy and balanced diet, cutting down sugar and fat, and quitting smoking (7). In order to prevent the high cost of treatment, it is imperative to train and raise people's awareness of diabetes. As a result, "education and prevention" was the slogan used by the International Federation of Diabetes from 2009 to 2013 (8).

2. Objectives

This study aimed to survey the effectiveness of interventional studies on type 2 diabetes from one decade ago in Iran and the world to highlight its significance to policymakers. A structured review of documents and their syntheses can illuminate all dimensions of this epidemic in Iran and the world. In addition, this research study can help decision-makers adopt appropriate strategies and training in their interventions to prevent type 2 diabetes.

3. Methods

3.1. Study Question

What is the impact of interventional studies on controlling, managing, and preventing type 2 diabetes?

This research was a systematic review that followed these procedures.

3.2. Search Strategies

This study aimed to identify and explore the factors related to the effectiveness of health education and promotion interventions for type 2 diabetes. For this purpose, an electronic search was systematically carried out on Persian databases of SID and Magiran and English databases of PubMed, Science Direct, Scopus, Web of Science, and Google Scholar between 2010 and 2019 (January - December). The search focused on type 2 diabetes interventions in Iran and the world. At first, all related keywords (MeSH and non-MeSH) were identified. Then, the keywords were combined using the operators AND and OR and were applied to the search database. The search strategy is shown in Table 1. Also, additional articles were obtained by evaluating the references of the selected articles. There was no limitation regarding the kind of intervention, length of intervention, type of participants, and the location of the research study (Appendix 1 in Supplementary File).

3.3. Inclusion Criteria

The study was designed based on the PICOS format (9), as listed in Table 1. We included interventional studies, such as experimental studies, quasi-experimental studies, clinical trials, pre-treatment and post-treatment observations, and research papers in Persian and English published in prestigious journals between 2010 and 2019, with access to their full texts.

3.4. Exclusion Criteria

The exclusion criteria were case studies, short articles, cross-sectional studies, descriptive and analytic studies, letters to the editor, and systematic reviews.

3.5. Study Selection

The paper selection followed this procedure. First, an initial search by the two researchers (S. R. and A. P.) was done individually. Second, similar papers were removed. Third, a narrower search was done by omitting irrelevant matters. Next, having studied each paper's title and abstract for relevance and suitability, we selected the potential research papers. In order to reach a consensus, the papers were read, analyzed, and discussed by both researchers (S. R. and A. P.). Finally, the articles were reviewed and evaluated by the third author (M.GH) (Figure 1).

3.6. Evaluation of Quality of Papers

In order to report the standard of studies, an interventional study checklist was used, including consolidated standards of reporting trials with 25 items (10), checklist for experimental design with nine items (11), checklist for quasi-experimental studies with nine items (12), and Transparent reporting of evaluations with non-randomized designs with 22 items (10).

Depending on the checklists and the acquired scores, papers meeting the requirements for entry in the study were classified as high-quality papers. Twenty-four appropriate research papers entered the final analysis, all having full texts (Appendix 2 in Supplementary File).

3.7. Data Extraction

The specific features of the studies were introduced in a form including the researchers' names, year of publication, the location of study, the year of study, study type, participants, the sample size, intervention description, theoretical framework with the model, and significant findings (Appendix 2 in Supplementary File).

Table 1. PICOS and Criteria for Study Inclusion

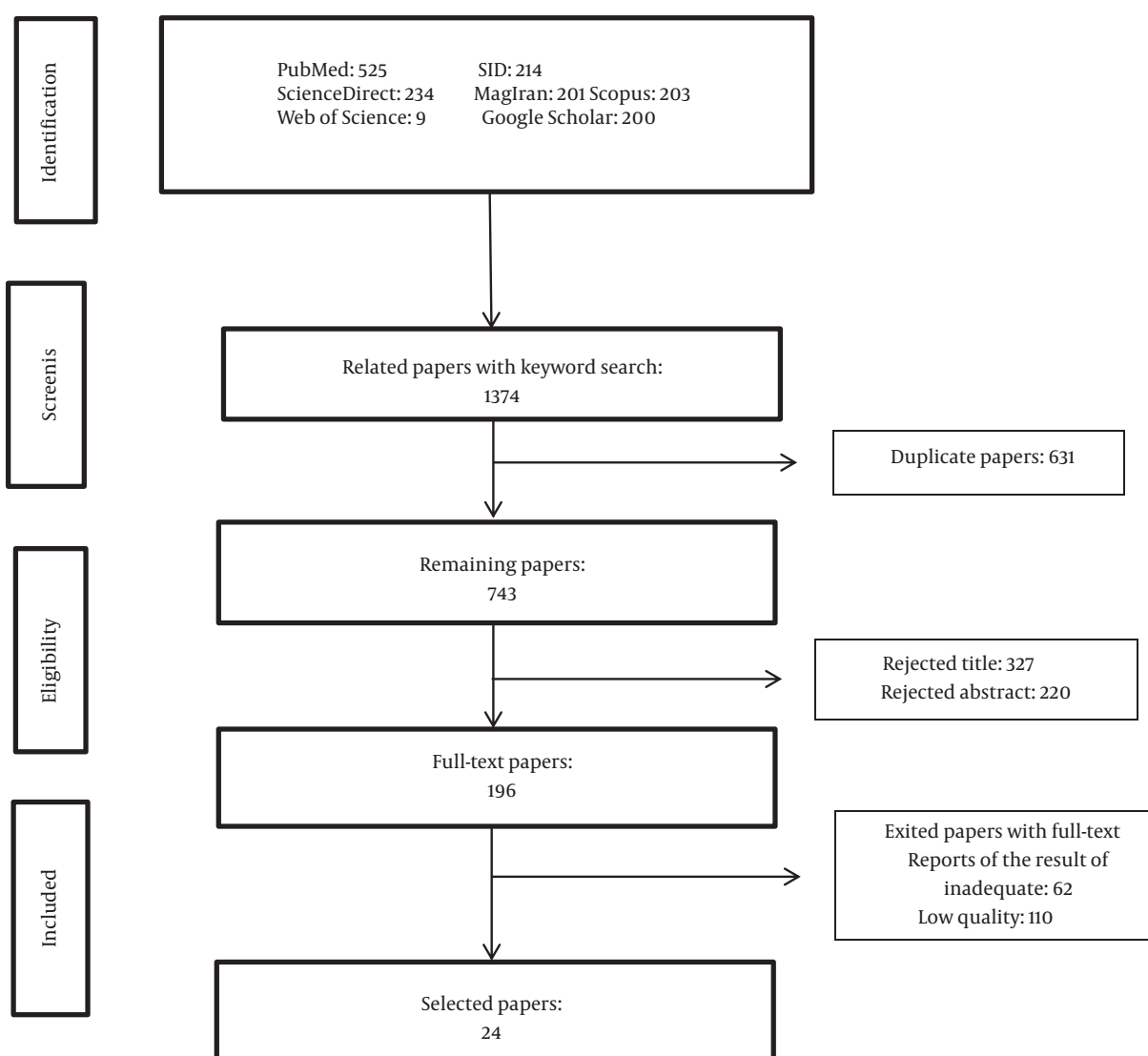| Criteria	Definition
Population	Patients, high-risk groups, and healthy people
Intervention	Interventions aimed at controlling, managing, and reducing complications of type 2 diabetes, reducing type 2 diabetes incidence, risk behaviors, changing type 2 diabetes attitudes, and increasing type 2 diabetes knowledge
Comparison	Comparison between intervention and control groups
Outcome	Incidence of type 2 diabetes, control, management, complications, knowledge, attitude, and high-risk behaviors
Study Design	Pre- and post-intervention, RCT, quasi-experimental

Figure 1. PRISMA flow diagram

4. Results

In the initial search, 1,374 papers were obtained. Similar papers (631 ones) were omitted in the second stage, and 743 papers remained. Next, 327 papers were omitted after reading their titles, and 220 were removed after closely studying their abstracts. The remaining 196 papers were reassessed through the checklist, and finally, 24 research papers were selected. Figure 1 illustrates the research papers' selection process.

From our pool of studies (24 papers), 11 papers were randomized clinical trials, seven were quasi-experimental studies, and six were experimental studies. The location of the studies was as follows: 11 in Iran, seven in the USA, two in Germany, and one in each of the countries Malaysia, Japan, Columbia, and New Zealand. Most RCT papers focused on therapeutic interventions, while experimental and quasi-experimental studies focused on blood pressure, BMI, dietary intakes, physical activity, TG, HbA1C, FBS, and 2-h glucose. Out of these 24 studies, seven interventional studies were conducted based on theories and models: Three studies following the BASNEF model, one study based on the Theory of Planned Behavior (TPB), one study with the PRECEDE-PROCEED model, one study based on the ability, information, motivation (AIM) model, and one study following planned approach to community health (PATCH) model.

Six studies primarily employed lecturing, question and answer, group discussion, brainstorming, practical demonstrations, DVD playing, photo/film/slide presentations, and pamphlets (13-18). In two studies, the education intervention was only done through lectures (19, 20), and in one study, education centered on websites (21). In another study, the workshop was the medium of education (22). In the other studies (23-30), education largely depended on group training, individual training, individual counseling, group counseling, and counseling by phone. All the papers were published between 2010 and 2019, most of which were from 2015 onwards (Appendix 2 in Supplementary File). According to Appendix 3 in Supplementary File, the mean scores of all study structures based on theories and models increased significantly in the intervention group after the educational intervention. However, changes were insignificant in studies that did not work with theories and models. The health education programs designed based on theories and models effectively promote the preventive behaviors of type 2 diabetes and enhance the treatment of diabetic patients and lifestyle changes.

5. Discussion

This systematic study investigated 24 intervention research papers regarding type 2 diabetes. The study showed that the interventions positively influenced biomarkers, improved the performance of the sufferers and high-risk people, and played a preventive role in type 2 diabetes. The studies on type 2 diabetes are open to discussion from different dimensions.

5.1. The Design of Interventions

Most studies under investigation were randomized clinical trials (16, 24-28, 30-34) and the others were quasi-experimental (13-15, 17-19, 23) and experimental studies (18, 20-22, 35, 36). The length of the interventions was between one and 12 months. Only one study had an 18-month intervention. The result of the previous study indicates that for an intervention to be effective, a longer period is required. In addition, even though short-term studies are more feasible, long-term follow-ups and investigations are needed to explore the stability and consistency of research findings. Another finding of this research study was that in most interventions made for type 2 diabetes on either patients or high-risk groups, only diet, and physical activities had been the focus of studies (13, 15, 16, 20, 21, 29, 31-33) and other contributory factors to diabetes such as smoking, alcohol consumption, vitamins D and K deficiency, inadequate sleep and stress, and depression were ignored. Therefore, it is recommended that a constellation of factors (biological, sociocultural, geographical, and local) should be considered in the design of educational interventions.

5.2. Participants

In general, 19 interventional studies had been made on patients; another five had been made on high-risk groups and only one on teenagers. The results showed that the majority of interventions focused on patients (13, 16-19, 22-28, 31, 37) and a few (18, 20, 23, 30) had a high-risk group as participants, and only one study (21) made a preventive intervention on teenagers. As type 2 diabetes is an acute disease, its complications can lead to disability, low life quality, and premature death (5). Furthermore, this disease can take a heavy economic toll, a serious obstacle to sustainable economic development (38). The abovementioned studies have disregarded teenagers and young adults, who comprise the most vulnerable age groups. Thus, it is suggested that effective and timely measures be taken to design and implement improved preventive actions.

5.3. Interventions Description

A review of the studies showed that most educational interventions in Iran have been in the form of lectures, question and answer, group discussion, brainstorming, photo/film/slide displays, pamphlets, and websites (13, 15, 17, 37). However, the studies conducted in other countries heavily relied on group training, individual training, individual counseling, group counseling, counseling

by phone, and practical demonstrations ([16], [18], [23-25], [27], [28], [30], [31], [39]). In these studies, less emphasis has been placed on modern communication devices such as computer programs, mobile phones, and the internet despite their potential and accessibility to many people. Several options are available to be employed effectively: Innovative teaching methods such as virtual and digital teaching and applications with reminders, group training to improve lifestyle, consciousness-raising, changing people's attitude and performance, particularly people at risk of type 2 diabetes, and preventing high-risk behaviors. Future studies must pay special attention to factors such as the target group's culture and age to improve the training's efficacy.

Since health education and promotion strategies are not limited to a specific health problem or a specific set of behaviors, educational interventions can use health education strategies to prevent type 2 diabetes by creating healthy public policy, creating supportive environments, strengthening community action, enhancing individual skills, reorienting health services.

5.4. The Application of Theories and Models

Most studies had an approach without a theory. However, a few were based on theories (one study based on TPB ([21]), three studies following the BASNEF model, one study with the PRECEDE-PROCEED model, one study based on the AIM model, and one study following the PATCH model) ([13], [15], [17], [20], [22], [37]). Out of these 24 studies, only one was performed on adolescents with first-level approach prevention, while fear-based theories such as HBM were not used ([21]). It is argued that the efficacy of health education dramatically depends on the appropriate use of theories and frameworks. Theories and frameworks offer a systematic view of the events and present a regular procedure to evaluate the successes and failures ([40]). Besides, maximizing the efficacy of the plans requires an understanding of the behavior and its contributing factors to change or accommodate the current behavior or replace it with a new one ([41]). It also calls for a theory-driven procedure based on theories of behavior change and learning ([42]). Theory-driven interventions have facilitated the health-behavior changes through increasing the understanding of behavior-change processes and individual and environmental features affecting the behavior. All these factors can contribute to the efficacy of the education offered ([39]). Therefore, it is apt to mention that reforming the lifestyle requires consideration of people's lifestyles, beliefs, and attitudes within the health education programs. As there is insufficient evidence to prescribe the optimal education theory for future interventions, the decisions regarding the appropriate theory and model for every intervention should be based on the performance of models and theories, the purpose of the study, and the intended factors.

5.5. Limitations

This study has some limitations that must be mentioned. Although searches were performed on many databases, the overall search strategy may have been biased towards public health. Another limitation of this study is that while the review included any paper published in any language, our search was conducted only using Persian and English keywords (language bias). Also, the small sample owning to a limited number of included studies with a small sample size for all included studies was another limitation of this study. Moreover, a wide range of the intervention period, from one to 12 months, and follow-up duration (from three to 12 months) could limit the research. The last limitation is reporting bias.

5.6. Practical Implications

Considering the findings of studies and the global prevalence of type 2 diabetes, and the impact of health education and promotion interventions on preventing chronic diseases such as type 2 diabetes, implementers should use new educational strategies that are appropriate concerning culture and age factors. Also, all risk factors for type 2 diabetes should be considered, and efforts to encourage and persuade people to adopt a healthy lifestyle should be augmented.

6. Conclusions

Considering the findings, an overwhelming majority of the interventions regarding type 2 diabetes had these common themes: (1) a positive effect on the reduction of factors under study (2-h post glucose, FBS, HbA1C, BMI, blood pressure, and TG); (2) a raised awareness; and (3) a positive change in attitude and mindset in the sample; also, the target group was primarily patients assessed for diet and physical activity. Educational interventions, other crucial factors leading to type 2 diabetes, and the most effective and appropriate teaching methods with the target group of healthy people should be considered to prevent this disease.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

References

1. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nat Rev Endocrinol*. 2018;**14**(2):88–98. [PubMed ID: 29219149]. https://doi.org/10.1038/nrendo.2017.151.

2. International Diabetes Federation. *IDF diabetes atlas*. Brussels, Belgium: International Diabetes Federation; 2019, [cited 2021]. Available from: https://www.diabetesatlas.org/data/upload/download/mena_factsheet_en.pdf.

3. Centers for Disease Control and Prevention. *Diabetes Risk Factors*. Georgia, USA: Centers for Disease Control and Prevention; 2022, [cited 25th Jul 2017]. Available from: https://www.cdc.gov/diabetes/basics/risk-factors.html.

4. World Health Organization. *Global report on diabetes*. Geneva, Switzerland: World Health Organization; 2016.

5. International Diabetes Federation. *Middle East and North Africa news*. Brussels, Belgium: International Diabetes Federation; 2019, [cited 2021]. Available from: https://www.idf.org/our-network/regions-members/middle-east-and-north-africa/middle-east-and-north-africa-news.html.

6. Centers for Disease Control and Prevention. *National Diabetes Statistics Report*. Georgia, USA: Centers for Disease Control and Prevention; 2022, [cited 2019]. Available from: https://www.cdc.gov/diabetes/data/statistics-report/index.html.

7. World Health Organization. *Diabetes*. Geneva, Switzerland: World Health Organization; 2021, [cited 4th Jun 2019]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes.

8. SlideShare. *C14 idf diabetes in childhood and adolescence guidelines 2011*. India: SlideShare; 2011, [cited 27th Mar 2017]. Available from: https://www.slideshare.net/Diabetesforall/c14-idf-diabetes-in-childhood-and-adolescence-guidelines-2011.

9. Centre for Reviews and Dissemination. *Systematic Reviews: CRD's Guidance for Undertaking Reviews in Health Care*. Heslington, England: CRD, University of York; 2009.

10. Dwan K, Li T, Altman DG, Elbourne D. CONSORT 2010 statement: extension to randomised crossover trials. *BMJ*. 2019;**366**:l4378. [PubMed ID: 31366597]. [PubMed Central ID: PMC6667942]. https://doi.org/10.1136/bmj.l4378.

11. O'Leary Z. *Checklist for Experimental Design*. California, USA: SAGE Publications; 2020, [cited 2021]. Available from: https://study.sagepub.com/oleary3e/student-resources/choosing-and-practising-appropriate-methods/checklist-for-experimental.

12. Joanna Briggs Institute. *Checklist for Quasi-Experimental Studies*. Adelaide, South Australia: Joanna Briggs Institute; 2020, [cited 2021]. Available from: https://jbi.global/sites/default/files/2019-05/JBI_Quasi-Experimental_Appraisal_Tool2017_0.pdf.

13. Akbari Abdiabadi M, Mohebbi B, Sadeghi R, Tol A, Mahmoudi Majdabadi M. [The Effect of educational intervention on barriers of living with diabetes in awareness and belief, lifestyle, adaptation, and support dimensions among patients with type 2 diabetes mellitus: Application of the basnef model]. *Iran J Diabetes Metab*. 2017;**16**(1):49–62. Persian.

14. Razavi NS, Majlessi F, Mohebbi B, Tol A, Azam K. [Assessing the effect of educational intervention on treatment adherence based on AIM model among patients with type 2 diabetes]. *Iran J Diabetes Metab*. 2017;**16**(3):173–82. Persian.

15. Khani Jeihooni A, Kashfi SM, Hazavehei SMM. Effects of the BASNEF Model-Based Educational Programs on Blood Sugar Control, (Type 2 Diabetes). *J Educ Health Promot*. 2013;**1**(1):33–49.

16. Buhse S, Muhlhauser I, Heller T, Kuniss N, Muller UA, Kasper J, et al. Informed shared decision-making programme on the prevention of myocardial infarction in type 2 diabetes: a randomised controlled trial. *BMJ Open*. 2015;**5**(11). e009116. [PubMed ID: 26567256]. [PubMed Central ID: PMC4654390]. https://doi.org/10.1136/bmjopen-2015-009116.

17. Hazavehei MM, Khani Jyhouni A, Hasanzadeh AKBAR, Rashidi MONIREH. [The effect of educational program based on BASNEF model on diabetic (Type II) eyes care in Kazemi's clinic, (Shiraz)]. *Iran J Endocrinol Metab*. 2008;**10**(2):145–54. Persian.

18. Blanks SH, Treadwell H, Bazzell A, Graves W, Osaji O, Dean J, et al. Community Engaged Lifestyle Modification Research: Engaging Diabetic and Prediabetic African American Women in Community-Based Interventions. *J Obes*. 2016;**2016**:3609289. [PubMed ID: 27493797]. [PubMed Central ID: PMC4963564]. https://doi.org/10.1155/2016/3609289.

19. Archuleta M, Vanleeuwen D, Halderson K, Jackson K, Bock MA, Eastman W, et al. Cooking schools improve nutrient intake patterns of people with type 2 diabetes. *J Nutr Educ Behav*. 2012;**44**(4):319–25. [PubMed ID: 22572403]. https://doi.org/10.1016/j.jneb.2011.10.006.

20. Yazdanpanah B, Safari M, Yazdanpanah S, Angha P, Karami M, Emadi M, et al. The effect of participatory community-based diabetes cares on the control of diabetes and its risk factors in western suburb of Yasouj, Iran. *Health Educ Res*. 2012;**27**(5):794–803. [PubMed ID: 22907534]. https://doi.org/10.1093/her/cys079.

21. Muzaffar H, Chapman-Novakofski K, Castelli DM, Scherer JA. The HOT (Healthy Outcome for Teens) project. Using a web-based medium to influence attitude, subjective norm, perceived behavioral control and intention for obesity and type 2 diabetes prevention. *Appetite*. 2014;**72**:82–9. [PubMed ID: 24099704]. https://doi.org/10.1016/j.appet.2013.09.024.

22. Nejhaddadgar N, Darabi F, Rohban A, Solhi M, Kheire M. The effectiveness of self-management program for people with type 2 diabetes mellitus based on PRECEDE-PROCEDE model. *Diabetes Metab Syndr*. 2019;**13**(1):440–3. [PubMed ID: 30641740]. https://doi.org/10.1016/j.dsx.2018.08.016.

23. Ibrahim N, Ming Moy F, Awalludin IA, Mohd Ali Z, Ismail IS. Effects of a Community-Based Healthy Lifestyle Intervention Program (Co-HELP) among Adults with Prediabetes in a Developing Country: A Quasi-Experimental Study. *PLoS One*. 2016;**11**(12). e0167123. [PubMed ID: 27935988]. [PubMed Central ID: PMC5147835]. https://doi.org/10.1371/journal.pone.0167123.

24. Trief PM, Fisher L, Sandberg J, Cibula DA, Dimmock J, Hessler DM, et al. Health and Psychosocial Outcomes of a Telephonic Couples Behavior Change Intervention in Patients With Poorly Controlled Type 2 Diabetes: A Randomized Clinical Trial. *Diabetes Care*. 2016;**39**(12):2165–73. [PubMed ID: 27456837]. [PubMed Central ID: PMC5127234]. https://doi.org/10.2337/dc16-0035.

25. Slentz CA, Bateman LA, Willis LH, Granville EO, Piner LW, Samsa GP, et al. Effects of exercise training alone vs a combined exercise and nutritional lifestyle intervention on glucose homeostasis in prediabetic individuals: a randomised controlled trial. *Diabetologia*. 2016;**59**(10):2088–98. [PubMed ID: 27421729]. [PubMed Central ID: PMC5026926]. https://doi.org/10.1007/s00125-016-4051-z.

26. Hermanns N, Schmitt A, Gahr A, Herder C, Nowotny B, Roden M, et al. The effect of a Diabetes-Specific Cognitive Behavioral Treatment Program (DIAMOS) for patients with diabetes and subclinical depression: results of a randomized controlled trial. *Diabetes Care*. 2015;**38**(4):551–60. [PubMed ID: 25605812]. https://doi.org/10.2337/dc14-1416.

27. Ferrara A, Hedderson MM, Albright CL, Ehrlich SF, Quesenberry CP, Peng T, et al. A pregnancy and postpartum lifestyle intervention in women with gestational diabetes mellitus reduces diabetes risk factors: a feasibility randomized control trial. *Diabetes Care*. 2011;**34**(7):1519–25. [PubMed ID: 21540430]. [PubMed Central ID: PMC3120183]. https://doi.org/10.2337/dc10-2221.

28. Coppell KJ, Kataoka M, Williams SM, Chisholm AW, Vorgers SM, Mann JI. Nutritional intervention in patients with type 2 diabetes who are hyperglycaemic despite optimised drug treatment–Lifestyle Over and Above Drugs in Diabetes (LOADD) study: randomised controlled trial. *BMJ*. 2010;**341**:c3337. [PubMed ID: 20647285]. [PubMed Central ID: PMC2907481]. https://doi.org/10.1136/bmj.c3337.

29. Zakerimoghadam M, Bassampour SH, Faghihzadeh S, Nesari M. [Effect of Nurse-led Telephone Follow ups (Tele-Nursing) on Diet Adherence among Type 2 Diabetic Patients]. *Hayat*. 2008;**14**(2). Persian.

30. Sorkin DH, Rook KS, Campos B, Marquez B, Solares J, Mukamel DB, et al. Rationale and study protocol for Unidas por la Vida (United for Life): A dyadic weight-loss intervention for high-risk Latina mothers and their adult daughters. *Contemp Clin Trials*. 2018;**69**:10–20. [PubMed ID: 29597006]. [PubMed Central ID: PMC5964027]. https://doi.org/10.1016/j.cct.2018.03.013.

31. Matsuhashi T, Sano M, Fukuda K, Kohsaka S, Suzuki Y. Sitagliptin counteracts seasonal fluctuation of glycemic control. *World J Diabetes*. 2012;**3**(6):118–22. [PubMed ID: 22737282]. [PubMed Central ID: PMC3382708]. https://doi.org/10.4239/wjd.v3.i6.118.

32. Engebretson SP, Hyman LG, Michalowicz BS, Schoenfeld ER, Gelato MC, Hou W, et al. The effect of nonsurgical periodontal therapy on hemoglobin A1c levels in persons with type 2 diabetes and chronic periodontitis: a randomized clinical trial. *JAMA*. 2013;**310**(23):2523–32. [PubMed ID: 24346989]. [PubMed Central ID: PMC4089989].

https://doi.org/10.1001/jama.2013.282431.

33. Milajerdi A, Akhonzadeh S, Jazayeri S, Shirzadi E, Hashemzadeh N, Derakhshan Z, et al. [The effect of saffron (Crocus sativus L.) hydroalcoholic extract on mild to moderate mixed depression-anxiety treatment in type 2 diabetes: a triple-blind randomized placebo-controlled clinical trial]. *Iran J Nutr Sci Food Technol*. 2016;**11**(3):11–20. Persian.

34. Talaei B, Mozaffari-Khosravi H, Jalali BA, Mahammadi M, Najarzadeh A, Fallahzadeh H. [The effect of ginger on blood glucose, lipid and lipoproteins in patients with type 2 diabetes: a double-blind randomized clinical controlled trial]. *J Shahid Sadoughi Univ Med Sci*. 2012;**20**(3):383–95. Persian.

35. Kashfi SM, Khani Jeyhouni A, Bahadori Khalili R, Hatami M. [Evaluation of the effects of educating about nutrition and jogging on the blood sugar of type II diabetic patients of a clinic in Shiraz, Iran]. *Hakim Res J*. 2009;**12**(3):54–60. Persian.

36. Tavakoli Z, Kazemi- Zahran H. [Effect of mindfulness-based stress reduction intervention on distress problems and self-regulation in patients with type 2 diabetes]. *Iran J Nurs Res*. 2018;**13**(2):41–9. Persian.

37. Razaz JM, Rahmani J, Varkaneh HK, Thompson J, Clark C, Abdulazeem HM. The health effects of medical nutrition therapy by dietitians in patients with diabetes: A systematic review and meta-analysis: Nutrition therapy and diabetes. *Prim Care Diabetes*. 2019;**13**(5):399–408. [PubMed ID: 31186171]. https://doi.org/10.1016/j.pcd.2019.05.001.

38. Davari M, Boroumand Z, Amini M, Aslani A, Hosseini M. The Direct Medical Costs of Outpatient Cares of Type 2 Diabetes in Iran: A Retrospective Study. *Int J Prev Med*. 2016;**7**:72. [PubMed ID: 27217937]. [PubMed Central ID: PMC4872475]. https://doi.org/10.4103/2008-7802.181758.

39. Hardeman W, Sutton S, Griffin S, Johnston M, White A, Wareham NJ, et al. A causal modelling approach to the development of theory-based behaviour change programmes for trial evaluation. *Health Educ Res*. 2005;**20**(6):676–87. [PubMed ID: 15781446]. https://doi.org/10.1093/her/cyh022.

40. Glanz K, Rimer BK, Viswanath K. *Health behavior and health education: theory, research, and practice*. New Jersey, USA: John Wiley & Sons; 2008.

41. Centers for Disease Control Prevention. Evolution of HIV/AIDS prevention programs–United States, 1981-2006. *MMWR Morb Mortal Wkly Rep*. 2006;**55**(21):597–603. [PubMed ID: 16741496].

42. Lundy KS, Janes S. *Community health nursing: Caring for the public's health*. Massachusetts, USA: Jones & Bartlett Learning; 2009.