Effect of self-acupressure on fasting blood sugar (FBS) and insulin level in type 2 diabetes patients: a randomized clinical trial

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Abstract

Background: Uncontrolled symptoms of diabetes can lead to irreparable damage to vital organs. Despite the global trend towards the use of complementary alternative therapies, few studies have evaluated the effectiveness of self-acupressure in diabetes patients.

Objective: The aim of this study was to determine the effect of self-acupressure on FBS and insulin level in type 2 diabetes patients.

Methods: This randomized clinical trial was performed from September 2016 to February 2017. A total of 60 diabetic patients were selected from diabetes clinic in Rafsanjan in Iran, according to inclusion and exclusion criteria and then assigned to 2 groups (30 in acupressure and 30 in control) randomly by the minimization method. The intervention group received acupressure at ST-36, LIV-3, KD-3 and SP-6 points bilaterally for five minutes for each point in 10 seconds pressure and 2 seconds rest periods. Subjects in the control group received no intervention. The FBS and insulin levels were measured before and after the intervention for both groups. The data were analyzed by SPSS version 16 by the Chi-square test, independent-samples t-test, and paired-samples t-test. A level of 0.05 was considered significant for examining the hypotheses.

Results: There were no significant differences between the acupressure and control group regarding age, sex and level of education. The insulin level significantly increased after treatment in the acupressure group (p=0.001). There were no significant differences between the levels of insulin in study or control groups. Serum FBS level decreased significantly after intervention in the acupressure group compared to the control group (p=0.02).

Conclusion: Self-acupressure as a complementary alternative medicine can be a helpful complementary method in reducing FBS and increasing insulin levels in type 2 diabetic patients.

Trial registration: This trial was registered at the Iranian Registry of Clinical Trials with clinical trial registration number: IRCT2016122131459N1.

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Keywords: Acupressure, Complementary therapies, Type 2 Diabetes

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1. Introduction

Today, diabetes is considered as one of the main challenges of health systems around the world. Researchers believe that the prevalence of diabetes, mortality, and its associated health care costs are increasing worldwide. Results of a systematic review on 111 countries showed that in 2015 about 8.8% of the population within the age range of 20 to 29 years had diabetes, which is predicted to be increased by 10.4% by the year 2040 (1). Furthermore, according to the results of a previous study, the prevalence of type 2 diabetes in 2011 in the Iranian population was 9.3% and it is predicted to rise to 13.1% by the year 2030 (2). Uncontrolled chronic hyperglycemia caused by diabetes, is usually associated with long-term damage, deficit, or impairment in the function of various important organs, specifically eyes, kidneys, nerves, heart, and blood vessels (3). Different methods are available to control type 2 diabetes symptoms, such as changing lifestyle, exercising (4), maintaining a suitable diet (5), taking oral medicines (6), and injecting insulin (7). Maintaining each one of the mentioned methods is associated with its own difficulties attributed to their efficiency and the patient's safety. Therefore, there is a growing trend toward complementary and alternative medicines (CAM) among patients with diabetes mellitus in order to control the complications of this disease. In addition, complementary and alternative therapies have been considered for their high application in universities, industry and economics. The United States National Center for Complementary and Alternative Medicine (NCCAM) introduced CAM as: "a sort of medical and health care system with products, and practices that currently are not considered as a part of routine medical care" (8). CAM consists of a wide variety of practices such as massage therapy, music therapy, hypnotherapy, laughter therapy, acupuncture, and acupressure. (9). Acupressure is a Chinese traditional therapy with 5000 years history, and is a popular therapeutic method among Asian populations such as Chinese, Indians, Japanese, and Koreans, and today has found its way into European culture. According to Chinese traditional medicine, the physiological function of the human body is the result of balance between harmony and opposition, also called Yin and Yang. In acupressure therapy, the non-invasive pressure of fingers on meridian or acupressure points is used to release endorphins in the brain, cause relaxation in muscles, reduce pain, and emanate a feeling of comfort (10, 11). Also, the energy flow (qi) is increased in the body during acupressure; therefore, it can be effective in the management of diseases (12).

Researchers believe that diabetic patients tend to use alternative complementary therapies to control their symptoms. The results of a study showed that 63% of patients with diabetes within the previous 12 months had used complementary and alternative treatment, and 64% of CAM users stated that they had used CAM for managing their diabetic condition (13). In Iran, 88.4% of diabetic patients have used at least one complementary and alternative treatment in the past year. The most common treatment was medicinal plants, which were used by 84.9% of the participants. Sixty-nine percent of the patients were satisfied with using complementary and traditional treatments (13). A review on available literature revealed that few studies have been done on the therapeutic role of acupressure on FBS and insulin level in type 2 diabetes patients. The results of another study, have reported a positive effect of acupressure therapy in combination with some complementary treatments on the level of blood sugar in diabetes patients (14). Also, results of a pilot study indicated that acupressure significantly reduced the level of blood sugar in patients with diabetes, compared with a control group (10). Due to the small number of studies in this field and conflicting results of the conducted studies, scholars recommend further investigations to evaluate the effectiveness of this therapeutic method (15). Since we did not find any controlled clinical trial regarding the specific effect of self-acupressure on the level of fasting blood sugar and insulin in diabetes type 2 patients, the current study was designed with the aim of "determining the effect of self-acupressure on FBS and insulin levels in type 2 diabetes patients", in order to provide an easy to implement, cost-effective, and free of side effects therapeutic CAM to control diabetes symptoms and complications, and enhance the quality of life in such patients.

2. Material and Methods

2.1. Trial design
This randomized controlled clinical trial was performed from September 2016 to February 2017; aimed at determining the effect of acupressure on the level of FBS and insulin in patients with type 2 diabetes who attended the Diabetes Clinic in Rafsanjan in Kerman province, Iran.

2.2. Participants
Diabetes clinics in Iran, give patients the chance to meet medical experts who can check they are well, and give them highly specialized advice on how to look after their diabetes. Due to easy access to patients, sampling was done from this center. In Rafsanjan Diabetes Clinic, more than 5000 patients have registered and are receiving services. The research population was all diabetic patients who had health records in the Rafsanjan Diabetes Clinic in Kerman province, Iran.

2.3. Selection criteria
2.3.1. Inclusion criteria
The inclusion criteria of the study were: diagnosis of type 2 diabetes according to the medical records available in the clinic, lack of physical movement limitations, lack of physical disability or incapacitation for the study interventions, lack of abnormality at acupressure points, lack of insulin injection, lack of untreated hypertension, normal body mass index (BMI) within the range of 20 to 30 kg/m^2, willingness to cooperate with the study, lack of cognitive disorders to learn and maintain the intervention within the defined interval, lack of gestation, lack of using any narcotics and herbal medicines influencing the level of blood sugar, and lack of progressive neuropathy.
2.3.2. Exclusion criteria
The following were set as the exclusion criteria of the study: having infectious disease, receiving medicines that influence the level of blood sugar, having other disorders of the endocrine glands, discontinuation of anti-diabetics, inability to perform interventions within the determined interval, missing even one acupressure turn, emergence of topical problems at acupressure points, unwillingness to cooperate with the study, severe and sudden changes in the general conditions of the patient associated with blood sugar level, and failing to observe the study regulations.

2.4. Intervention
After approval of the project by the research council of Rafsanjan University of Medical Sciences and obtaining a license, one of the researchers attended with a presentation at the Diabetes Clinic. After studying the records of patients, samples were preliminary selected for some of the inclusion criteria that were documented in their records. Then they were invited by a clinic expert to present at the diabetes clinic via telephone call. Patients were evaluated again regarding the inclusion and exclusion criteria following an interview at the clinic. The study aims and objectives were explained to the eligible patients, and then they were asked to sign the written informed consent. Demographic data of the subjects including age, gender, and education level were collected using a researcher-designed questionnaire and face-to-face interview. It is noteworthy that the questionnaires were completed by the subjects if they had no limitations to read and write. Before intervention, a blood sample was taken from study subjects for determining FBS and the insulin levels by laboratory experts. Then, subjects in the control group received no intervention, except for routine clinical care (maintaining the diet, 1-hour/day walking, going to bed before 10 p.m., maintaining composure, and avoiding stress), and prescribed medication orders. The subjects in the acupressure group received self-acupressure in addition to the aforementioned orders. Intervention was performed bilaterally by the subjects at home. The intervention method was taught to patients by one of the researchers who was trained by a specialist. The acupressure points were marked on the body of the subjects; in addition, they were given an educational-pictured pamphlet for more guidance to ensure that patients learned the intervention protocol. The educational content includes the conditions that should be considered during the study period, the presentation of the acupressure as a complementary alternative medicine, pressure points, and the method of intervention and acupressure protocol. Typically, the duration of the training sessions lasted one hour.

The acupressure points selected in the current study were derived from Chinese traditional medicine tips recommended for acupuncture to treat diabetes (16, 17). The points were ST-36 (in the stomach meridian), LIV-3 (in the liver meridian), KD-3 (in the kidney meridian), and SP-6 (in the spleen meridian). The pressure was applied to the points in a way that the subjects felt some pressure, heat and pain at the place of points. The acupressure point Zusanli (ST-36) (Yang Ming foot hull meridian) was 3 cm under the patella and a finger toward the side of the tibial plateau. The spleen 6 (SP-6; spleen meridian) was 5 cm above the tibial internal angle (18). The LIV-3 (liver meridian), or third acupressure point, was at the level of the dorsal foot flexors between the first and second fingers at the point of bone junction (19). The KD-3 (Taixi), the third renal point at kidney meridian, was located between medial ankle and Achilles' tendon (17). Figure 1 shows the acupressure points. The total time of acupressure was 20 minutes (5 minutes at each point) in 10 seconds of pressure - and 2 seconds of rest periods (20, 21). Intervention was carried out every day at 10:00 a.m. for 3 weeks. To prevent forgetting, the program was reminded to the subjects by the researcher via telephone call. Then, on the last turn at the third week, a 4-mL blood sample was retaken from subjects in laboratory after 12 hours' fast between 8:00 and 9:00 a.m., to test FBS and insulin levels. The blood samples were immediately centrifuged for 10 minutes and sera were tested for FBS and insulin levels.

Figure 1. Acupressure points: A) KD-3 point, B) ST-36 Point, C) LIV-3 Point, D) SP-6 Point

2.5. Outcomes
The main outcomes were the FBS and insulin level of serum. FBS was measured in a medical laboratory using specific kits purchased from Pars Azmoon Co. (Iran), by the hexokinase method in a RA1000 apparatus based on mg/dL. The insulin level was also reported based on U/mL using Roche specific kits in an Elecsys apparatus by the electro Chemiluminescence technique. The internal and external variation coefficient at 37 °C for glucose kits was 41.1% and 74.1%, and for insulin 6.91 and 6.23, respectively, and the sensitivity of glucose and insulin kits was 5 mg/100 Ml and 1.76 micro units per milliliter.

2.6. Sample size
The sample size was estimated at 30 patients in each group. This sample size was calculated based on the previous studies (22) and using the formula [$n = 2(z_{1-\alpha/2} + z_{1-\beta})^2 \sigma^2 / d^2$] and considering the following indices: The confidence level of 95%, the power of 80%, the reported standard deviation for insulin level 8.1 and the effect size of 4.7.

2.7. Randomization and blindness
In this randomized clinical trial, on the whole, 60 patients were assigned randomly into the intervention and the control groups equally based on categories of age and sex, by using the minimization method. The categories were 40 years, 41 to 60 years and 61 years and older for the age variable and female and male for the sex variable. The samples were randomly assigned into the categories of the two groups, such that the total number of samples in each category was equal. Sampling continued until the required sample volume was reached.

2.8. Statistical methods

Data were analyzed by SPSS version 16 (SPSS Inc., Chicago, Illinois, USA), using descriptive statistics, the Kolmogorov-Smirnov, Chi-square, paired and independent-samples t-tests, p-value less than 0.05 was considered as level of significance. To evaluate the normal distribution of data, results of the Kolmogorov-Smirnov test showed normal distribution in the variables (p>0.05). Hence, parametric tests were used to analyze data.

2.9. Research ethics

The study was approved by the Research Council and Ethics Committee of Rafsanjan University of Medical Sciences under the registration and ethical codes (with Ethical code number: IR.RUMS.REC.1395.060). This trial is also registered at the Iranian Clinical Trial Registry (IRCT.IR) with the IRCT identification Code: IRCT2016122131459N1). In this study, all the participants were informed about the objectives and nature of the study. It was also explained to them that their participation was voluntary and did not play a role in obtaining clinical health services and they could be excluded at any time they wanted during the study process. All the participants provided a written consent form to participate before entering the study. In order to ensure that there was no harm in the routine treatment of participants in the study, all the therapies were respected and all conditions that could affect blood sugar levels were emphasized and monitored. The study did not result in any financial, spiritual or physical harm to the participants.

3. Results

In the current study, a total of 314 patients with diabetes were randomly selected out of 5,713 patients registered in the diabetes clinic. Of 107 patients that had primary inclusion criteria based on health cases information, 69 patients were enrolled in the study based on the inclusion and exclusion criteria; out of which, 9 patients were excluded because of exclusion criteria before post treatment test. Finally, the FBS and insulin levels were analyzed for 60 patients in 2 groups. The sampling details were explained in consort flow diagram (Figure 2).
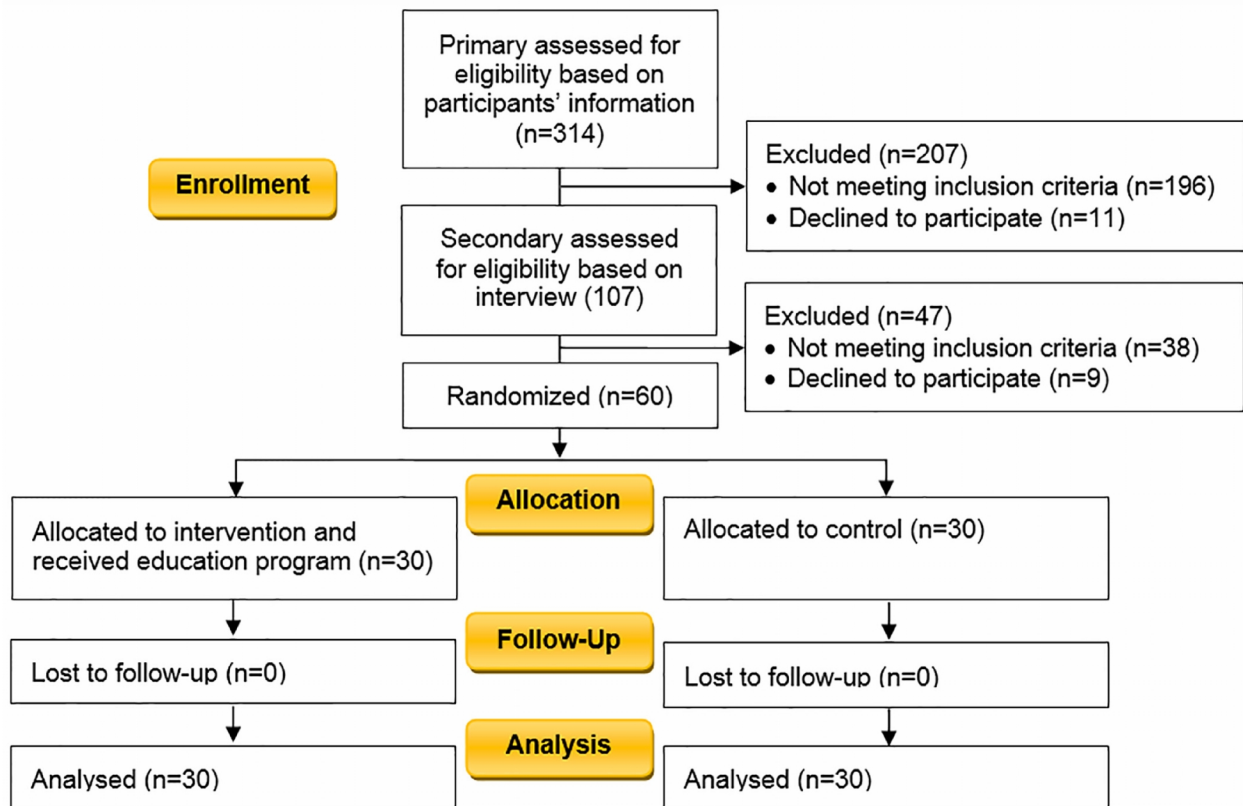
Figure 2. CONSORT 2010 Flow Diagram of the study

Most of the subjects (63.43%) were male. The educational level of most of the subjects was less than high school diploma (35%) and just 11.66% had academic education. The mean ± SD of sample's age was 53.65±8.08 years,

with minimum of 31 and the maximum of 73 years. Table 1 illustrates the patients' demographic characteristics. All subjects of the study were married and no statistically significant difference was observed between the groups regarding age, gender and educational level categories. In intra-group comparison of the FBS, the results showed that although the mean of FBS level in the intervention group was reduced after intervention phase, no significant difference between the before and after intervention was found in either group (p=0.10 and p=0.25 respectively) (Table 2). The mean ± SD of FBS level before intervention in the intervention group was 128.30±35.73 and in the control group was 139.63±36.72. There were no significant differences between the groups before the intervention phase (p=0.23); however, in comparing the FBS level between groups after intervention, results showed that the Mean ± SD of FBS in the intervention group was 122.23±30.93 and in the control group was 142.53±38.26. As shown in Table 2, the FBS level decreased significantly after the intervention phase in the intervention group (p=0.02). The results of intra-group comparison of insulin levels in the intervention group showed that the Mean ± SD of insulin was 11.25±7.58 before intervention and reached to 14.49±10.02 after intervention. Results of paired-samples t-test showed that this change in insulin level was statistically significant (p=0.001). However, this difference was not statistically significant in the control group (p=0.81). The mean and standard deviation of insulin before intervention in the control group was 13.24±7.26 and in the intervention group was 11.52±7.58, also, the Mean ± SD of insulin level after intervention in the control group was 13.44±7.38 and in the intervention group was 14.49±10.02. Results of independent-samples t-test indicated that the difference was not statistically significant between the groups before (p=0.37) and after the intervention phase (p=0.67) (Table 2).

Table 1. Demographic characteristics of participants

Variable		Intervention (n=30) n (%)	Control (n=30) n (%)	p-value
Sex	Male	20 (66.7)	18 (60)	0.592
	Female	10 (33.3)	12 (40)	
Education	Illiterate	5 (16.7)	11 (36.7)	0.102
	Less than high school diploma	9 (30)	12 (40)	
	High school diploma	11 (36.7)	5 (16.7)	
	Academic	5 (16.7)	2 (6.7)	
Age (year)	40-60	24 (80)	27 (90)	0.236
	>60	6 (20)	3 (10)	

Table 2. Comparison of serum FBS and serum insulin level within-group and between-groups

Variable	Groups	Intervention group (n=30); Mean± SD	Control group (n=30); Mean± SD	p-value **
Serum FBS level	Before Intervention	128.30±35.73	139.63±36.72	0.23
	After Intervention	122.23±30.93	142.53±38.26	0.02
	p-value *	0.10	0.25	
Serum insulin level	Before Intervention	11.52±7.58	13.24±7.26	0.37
	After Intervention	14.49±10.02	13.44±7.38	0.64
	p-value*	0.001	0.81	

*Paired-samples t-test; **independent-samples t-test; FBS: Fasting blood sugar

4. Discussion
Results of the current study showed that the self-acupressure at 4 points of LIV3, ST36 SP6, and KD3 under the controlled conditions, could increase serum insulin levels in the after intervention phase in the intervention group Also, in the comparison between the groups, the intervention could decrease the FBS in the intervention group in the after intervention phase. Reviewing the related literature, there are a small number of controlled clinical trials to evaluate the effects of acupressure on blood sugar and insulin levels in patients with diabetes. In most of such studies, the acupuncture was employed as intervention and the subjects were non-diabetics. In a literature review, researchers only had access to 2 human studies, and evaluated the effect of electro acupuncture on the level of blood glucose in non-diabetic subjects; hence their study mainly focused on animal studies (23). In one of the abovementioned human studies, stimulation of some acupressure points along with maintaining diet in females with obesity, could reduce blood sugar and serum insulin levels (22). Findings of this study were consistent with ours. But in contrast, in another aforementioned human study, the level of FBS did not show any changes in the subjects, but the level of insulin slightly increased immediately after the intervention and dropped after 30 minutes (24). Out

of 15 animal studies, 11 were conducted on diabetic and normal samples; these studies reported the effectiveness of acupuncture at ST-36 and CV-12 points on the reduction of FBS level in non-diabetic rats (23). It should be noted that in diabetic patients, conditions may be different and non-comparable with non-diabetic patients. So when we focused on similar studies on diabetic patients, the results of most of the studies confirmed our findings. Bay and Bay in a quasi-experimental design study in Iran, showed that a combined stimulation of spleen, liver, and lung points along with transcendental meditation and hypnotherapy on decreasing the level of blood sugar in patients with type 2 diabetes were positive (14). Therefore, they conducted that combined therapy; including acupressure, hypnotherapy, and TM reduced BS in type 2 diabetic patients and was more effective than placebo. Given that in this study, the sampling was done by convenience method, the control group was nonequivalent and the intervention was combined, so that the results cannot clearly be attributed to acupressure alone. Focusing on the role of acupressure alone in controlling blood glucose in diabetic patients, researchers in a pilot study in Indonesia introduced the acupressure at ST-36 points as an effective method to reduce blood sugar in patients with diabetes (10). Other similar studies that used the same mechanisms also indicated acupressure as a suitable method to control diabetes complications; for example, acupressure intervention on the auricular pellet could reduce the concentration of anti-oxidative enzymes in high-risk patients with diabetes (25).

All of the abovementioned studies showed short-term effects of acupressure on blood glucose control in diabetic and non-diabetic patients with different study design. Regarding the long-term effects of this intervention, the results showed that a 3-year acupressure intervention could significantly reduce the level of low-density lipoprotein-cholesterol (LDL-C), triglycerides (TG), and total cholesterol (T Chol) as well as increase the level of high-density lipoprotein-cholesterol (HDL-C). This longitudinal study indicated this method is suitable and effective for the prevention of hyperlipidemia and neuropathy in patients with type 2 diabetes; results of the study also showed this intervention is suitable for the improvement of kidney functions in such patients (26). However, results of a study, showed that bilateral acupressure at LI-4, HT-7, ST-36, ST-44, and SP-6 points could reduce the level of insulin in females with obesity (20).

Researchers believe that the effectiveness of acupuncture therapy, results from the secretion of neurotransmitters which regulate the function of glands and, consequently, different organs through the transmission of nerve messages or stimulation of the hypothalamic-pituitary-adrenal axis; in addition, it is believed that acupressure can affect the regulation of blood sugar through body relaxation and stress reduction (10). But it is not exactly clear that FBS decrease can be solely attributed to the increase of insulin level or FBS reduction, despite influencing by insulin, is driven by other independent mechanisms. Hence, it is not easy to comment on such interventions for patients with insulin-resistance. In addition, among the studies conducted in this regard, a large variety is observed on the employed methods (acupuncture or acupressure), intervention protocols, pressure points, and targeted populations, which can affect the results of the intervention. However, according to the results of the studies, acupressure, as a complementary medicine, could control complications and prevent symptoms of diabetes mellitus. Therefore, the intervention can be employed as a complementary treatment for patients with diabetes, to prevent diabetes in high-risk patients, control hyperglycemia of non-pancreatic origin such as stress-induced hyperglycemia, control blood sugar in patients who use drugs that increase blood glucose, and patients with adrenal dysfunction, and to treat morbid obesity.

5. Limitations
Despite the strengths of the self-acupressure method such as independence of patient in accomplishment of acupressure, time and cost saving and its adaptability, the study had some limitations. Firstly, the study subjects were selected according to inclusion criteria that included not receiving insulin injection; therefore, they may not be a representation of all diabetic patients. Secondly, there was limitation for considering insulin resistance situation, diabetic duration in matching study groups. So the generalization of results should be done with caution and also considering other future study results.

6. Conclusions
The Results of this study indicated that self-acupressure can be considered as an effective, suitable, and cost-effective complementary medicine to control the blood glucose level in patients with type 2 diabetes, and can be easily implemented by the patient without the need to refer to a health care center. Since different acupressure points were selected in the current study, the authors recommend further controlled clinical trials to compare the effectiveness of each point and the overall effect of the points on FBS and insulin level, considering the quality and quantity of acupressure protocol applied to the determined points. Furthermore, it is recommended to consider the

effect of such interventions on the level of glycosylated hemoglobin and FBS in patients with insulin-resistance, and also on the prevention of blood glucose increase under high-risk conditions, which predispose to hyperglycemia. The authors recommend more RCTs in controlled conditions due to the small size of the effect.

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