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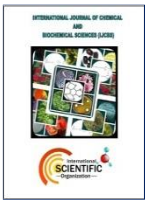

Quality of combined effect of nutrition and exercise on biochemical indicators in Type 2 diabetes in young adults: A Systematic Review

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Abstract

Chronic illnesses like diabetes mellitus (DM) are challenging to manage. Chronic illness patients endure difficulties. The nutrition intervention that has a focus on encouraging healthy eating has been found to be crucial to the management of diabetes mellitus because it improves lipid profiles and glycemic control. For the management developing metabolic issues including avoiding the development of type 2 diabetes, a crucial alternative treatment strategy is often suggested. This systematic review's goal is to assess how food and exercise, either alone or in tandem, affect lipid profiles and glucose levels persons with type 2 diabetes, in their blood. Using the descriptors, researchers searched the PubMed/Medline database for relevant studies. The articles were searched by following inclusion and exclusion criteria. The articles published in English are considered. The journals which are peer reviewed are considered and included to manage the trustworthiness of the evidence. The articles published in the last 10 Years were considered. Out of 270 articles total 8 articles finalized. The findings demonstrated that a greater intake of whole grains, vegetables, legumes, fruits, or saturated fatty acids, together with eating foods that have an excessive glycaemic directory, a decreased calorie intake to probiotics, along with vitamin D supplementation, or lectures about diabetes all improve patients' glucose levels in their blood and lipid profiles.

Keywords: Diabetes, BMI, obesity, glucose, HbA1c.

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1. Introduction

Chronic illnesses like diabetes mellitus (DM) are challenging to manage. Chronic illness patients confront obstacles such as inadequate understanding, difficulty maintaining lifestyle changes, and limited access to professionals for prompt counsel. A metabolic condition called diabetes mellitus is characterized by persistent hyperglycemia and alterations in how sugar, proteins, and lipids are broken down [1-7]. A number of macrovascular and microvascular issues negatively affect quality living as a consequence of insufficient pancreatic cell synthesis of insulin and/or insulin activity [8-13]. Obesity and inactivity are closely linked to a high incidence of type 2 diabetes. In Western nations, diabetes of the type 2 variety is the greatest cause of mortality for adults, contributing to kidney failure, heart disease, blindness, and lower limb amputation [14-26]. Since diabetes accounts for over 10 percent of all healthcare expenditure, for example, across the USA, Canada, etc Europe, it significantly strains national healthcare systems financially [27]. Diabetes type 2 is a condition that is predictable and treatable. Along with medication, lifestyle modifications that increase nutrition and physical exercise may successfully delay or stop a type 2 diabetes diagnosis or diagnosis of diabetes [24]. Fasting insulin (FI), fasting glucose (FG), systolic blood pressure (SBP), body mass index (BMI), and high density lipoprotein (HDL) since they have all been they are often used in simulations that assess the risk of diabetes since they are linked to an elevated risk. [17]. Accurate diabetes risk forecasts and successful diabetes preventive programs may both benefit from reliable assessments of adverse response to lifestyle changes [14].
Type 2 diabetes appears to be developing quickly in terms of certain disease types' clinical manifestations. Between 90 and 95 of all diabetes mellitus cases globally are caused by it. Between 90 and 95 of all diabetes mellitus cases globally are caused by it [10]. Its incidence rises with advancing age and is inversely correlated with unhealthy eating patterns, visceral and abdominal obesity, and sedentary lifestyles. Cardiovascular disease is as many as four times more inclined to occur in diabetics than in non-diabetics [19].

The nutrition intervention that has a focus on encouraging healthy eating has been found to be crucial to the management of diabetes mellitus because it improves lipid profiles and glycemic control. Better glycemic control or lipid profiles in diabetic patients have been linked to diets high in entirely grains, fruits, fruits and vegetables, nuts, with moderate amount of consumption of alcohol and and a reduced amount of red meat, dealt with sugary sweets, dairy items with high fat, and beverages with sugar [15]. A balanced and nutritious diet is crucial for both type 2 diabetes prevention and self-management. It fosters normal development and growth, which is evident in the patterns of acquired illnesses. In simple terms, it significantly affects a person's health from a social, physical, & mental standpoint. To achieve this, individuals must follow the dietary recommendations, especially with regard to the number and quality of meals [11]. The effects of food and exercise and diabetes risk variables have been extensively studied, albeit the projected impact sizes differ from research to study. To assess and integrate treatment effects across trials and reach agreement on the treatment effect size as a whole, meta-analyses are often utilized. However, if the individual research and datasets are significantly different, conclusions obtained from integrating data may be deceptive. Therefore, when doing meta-analyses, it is crucial to estimate and explain the between-study variability and impact magnitude variation [16]. By assuming that the studies represent an arbitrary number of the complete population of research, random-effect meta-analyses enable generalizations beyond the studies that were actually included. Additionally, random-effect meta-analyses enable quantification and investigation of heterogeneity [6]. International organizations suggest choosing a combination of 150 minutes of modest aerobic either two full days of inactivity, 75 minutes of strenuous activity, or no activity at all. Since muscle is utilized in every bodily motion, physical activity consumes more energy than being at rest does.]8]. It is often acknowledged as a crucial non-pharmacological therapy approach for the management and prevention of metabolic issues related to type 2 diabetes.

1.1. Aim

The objective of this systematic review is evaluating the effectiveness of the implementation of independently or combined nutrition pattern and physical activity programs on the blood glucose values and lipid profile in patients with type 2 diabetes.

2. Methods

2.1. Search strategy

Clinical outcomes data over the previous 10 years from commercially accessible mobile medical applications for DM have been published in peer-reviewed publications. A search of two commercially accessible platforms—the Android and Apple app stores—was used to find mobile medical applications. PubMed/Medline using the phrases "Diabetes AND ((food habits) OR BMI OR obesity OR (physical activity) OR activity OR glucose OR HbA1c OR (total cholesterol) OR HDL OR LDL OR VLDL OR fats OR apoA OR apoB OR apoC OR apoD OR apoE)". Were searched the databases that were most suitable for the review were searched.

2.2. Inclusion and exclusion criteria

The publications were searched using both inclusion as well as exclusion criteria. The articles published in English are considered. The journals which are peer reviewed are considered and included to manage the trustworthiness of the evidence. The articles published in the last 10 Years were considered.

2.3. Study selection, selection criteria and quality assessment

Two authors independently reviewed all papers that were found through database searches using key words. Discrepancies were settled. The entire texts of the studies chosen in level one were obtained, and the same two writers independently assessed each one to determine its eligibility. The grounds for exclusion were meticulously classified and recorded.

2.4. Data extraction

The study design, Time period, participant characteristics, description and limitations were all gathered using a standard proforma. Inclusion and exclusion criteria were applied. The duplicate articles were removed. Total 270 articles were extracted. After applying the filters, the remaining articles were screened by the titles and full text. The remaining articles were fully read and additional articles were fully retrieved. The final 8 articles were extracted and charted as follows. Yuan et al performed an RCT in which the intervention group's patients got a 3-month intervention that included self-management instruction for diabetes mellitus for 8 weeks and practice for the recommendations for another 4 weeks. The control group's patients got typical medical nutrition treatment guidance. Prior to and subsequent to the three-month intervention, the patients in both groups received their metabolic metrics, radially intima-media thickness, and carotid carotid arterial stiffness assessed. In the treatment group, HbA1c levels were higher, but they were lower in the control group. ($p = 0.039/0.102$), while fasting glucose and TG levels also demonstrated equivalent results ($p = 0.238/0.427$ and $p = 0.626/0.850$). LDL and TC levels dropped in each group ($p = 0.005/0.001$ & $0.034/0.001$, respectively).

In the treatment group, HDL cholesterol rose whereas it fell in the group that received the control group ($p = 0.160/0.303$). Type-2 diabetes, increased C-reactive protein (CRP) levels, with a greater risk of heart attacks have all been linked, according to Swift et al. Despite the fact physical activity has been found to reduce CRP, further research is needed to determine how people with type-2 diabetes respond to various fitness modalities, including aerobic, resistance, and mixed training. The findings of an RCT revealed a correlation between baseline CRP and the amount of fat, the circumference of the waist, BMI, especially VO2 peak (p0.05). When compared to controls (0.35 mgL-1, 95% CI: 1.0, 1.7), CRP was not decreased after aerobic training (0.16 mgL-1, 95% CI: 1.0, 1.3), resistance training (0.03 mgL-1, 95% CI: 1.1, 1.0), or combined training (0.49 mgL-1, 95% CI: 1.5 to 0.6). CRP reductions were linked to changes in increasing blood glucose ($r=0.20$, $p=0.009$), hemoglobin that is glycated (HbA1C), or fat mass ($r=0.21$, $p=0.005$) but not to changes overall fitness or weight ($p > 0.05$). CRP levels decreased in the tertials with reduced body fat & HbA1C levels ($p=0.009$ & $p=0.040$, respectively). When Swift and Co. Investigators Mohatari Tabari et al. published an RCT. Type 2 diabetics women were divided either training ($n = 27$) along with control ($n = 26$) groups in this randomized experiment. The workout regimen called for 10 meters of seated stretching and flexibility exercises as a warm-up phase 30 meters of walking with an optimal heart-rate increase of 60%, and 10 meters of walking. For eight weeks, this had to be performed three times each week. The Homeostasis Model Assessment on Insulin Resistance (HOMA-IR) was used to measure insulin resistance. After 8 weeks, there was still a discernible difference in insulin resistance, overnight blood sugar, nor insulin levels in the plasma between the two groups. There were no observable variations between both groups over time in terms of insulin resistance, insulin sensitivity, or BMI for waist and pelvic size. The variations in FBS, blood the hormone insulin, waist/hip circumference, and insulin resistance across the groups were also strongly correlated with time. The present workout program has decreased blood sugar levels ($p = 0.05$), insulin resistance ($p = 0.02$), and sensitivity to insulin ($p = 0.000$). The efficiency of medications used to treat type 2 diabetes mellitus seems to be enhanced by aerobic exercise training.[18] Balducci et al. examined the effects of light to moderate physical exercise (LI) and intermediate to high intensity (HI) on varying cardiovascular risk factors as assessed by exercise volume. People in LI and HI exercised in comparable amounts under supervision and unsupervised. In contrast to other risk variables or CHD risk scores, only triglycerides (0.12 mmol/l [0.34,0.10], total cholesterol (0.24 mmol/l [0.46, 0.01], and HbA1c (mean difference 0.17% [95% CI 0.44,0.10], P = 0.03) exhibited statistically significant improvements between HI and LI training. However, based just on intensity, no decline in each of these qualities could be predicted. The incidence of negative occurrences was the same for individuals in HI and LI [4]. Balducci et al. Italian Diabetes Exercise Study (IDES) examined the impact of under-monitored exercise on traditional or novel cardiovascular risk variables in type 2 diabetics who were insulin-dependent, overweight, or obese. Over the course of a year, 73 insulin-treated people were randomly assigned to either physical counseling alone (CON) or physical counseling combined with twice-weekly controlled resistance along with cardiovascular exercise (EXE).

At the start and conclusion of the experiment, analytical or clinical parameters were evaluated. Compared with the CON group, the EXE group exercised much more. Hemoglobin A1c, circumference of the waist, body mass index (BMI), high levels of C-reactive protein (C-reactive protein), just the members of the EXE group had substantially reduced high LDL cholesterol and the total coronary cardiovascular risk score. No discernible negative effects were seen [4]. Twenty adult T2DM patients got supervised exercise training (SET) in a hospital setting in one of two groups that were randomly assigned. The control group was the other one. Vinetti et al. looked at the impact of SET on cardiometabolic risk, pulmonary health, and oxidative state in T2DM patients. SET comprises supervised obstructions, flexibility, or aerobic training over a span of a year. Additionally, 10 healthy men were chosen as a reference group for baseline testing alone. Oxidative stress markers (1-palmitoyl-2-[5-oxovaleroyl]-sn-glycero-3-phosphorylcholine [POVPC] & 1-palmitoyl-2-glutaroyl-sn-glycero-3-phosphorylcholine [PGPC]) were assessed in plasma and peripheral blood mononuclear cells. All trials were completed at the baseline or one year thereafter. V'O2max (114.4%), methane return threshold (123.4%), hip circumference (21.4%), total cholesterol level (214.6%), LDL fat (220.2%), rapid insulinemia (248.5%), HOMA-IR (252.5%), blood POVPC (227.9%), and PGPC (231.6%) were all significantly affected by SET (p 0.05). After a year, the control group's changes in gas sensitivities and V'O2max were much fewer than that of the one receiving therapy group. Healthy subjects' blood POVC & PGPC levels were significantly altered before to the therapy but not after it [23]. Strobel et al. looked assessed the outcomes of a six-month vitamin D therapy in individuals without the condition who didn't need insulin. A 86-person, double-blind, placebo-controlled, assigned at random experiment was completed. Patients received either Vigantol oil or a placebo twice each week for the first six months, followed by another six months of monitoring. Tests were run for 25OHD, PTH, weight, HbA1c, insulin, C-peptide at the beginning and then every 30 days after that. The main result was a shift in the morning insulin and blood sugar levels. After six months of therapy, the median 25OHD within the verum group rose to 35 ng/ml, surpassing the median 25OHD in the comparison group (median 20 ng/ml, p=106). PTH levels were generally lower in the verum group (25.5 pg/ml vs. 35.0 pg/ml, p=0.08).

At the conclusion of the 6-month therapy period, all of thirty-one patients (78%) displayed an 25OHD level higher than 20 ng/ml. Their HbA1c was significantly reduced at the start of therapy (p=0.008) and after treatment (p=0.009) compared to those with 25OHD 20 ng/ml. Fasting insulin levels in both groups demonstrated a favorable link with 25OHD levels after six months of therapy; however, within the verum team, C-peptide, glucose, or HOMA-index didn't change substantially. Regular vitamin D consumption of 1904 IU showed no discernible effect on the metabolic indicators of type 2 diabetes. However, the correlative findings of this study do indicate a relationship between each condition's energy expenditure and 25OHD status. More research should be done to determine if higher vitamin D supplementation doses might improve glucose metabolism [22]. Asemi et al. examined the effects of consuming synbiotic meals on the hs-CRP levels, oxidative stress markers, and metabolic profiles of diabetic patients. The 62 diabetes patients in this double-blind cross-over random clinical research ranged in age from 35 to 70. A two-week "run-in" phase was followed by randomly assigning participants to a symbiotic lunch (n = 62) or a conventional diet (n = 62). After a 3-week recuperation period, subjects were switched to the next drug arm for another 6 weeks of treatment. The symbiotic breakfast included 0.04 g of prebiotic HPX inulin, 0.107 CFU of heat-resistant, active Lactobacillus sporogeneses, and 0.38 g of isomaltose, sorbitol, or sucrose as sweeteners per 1 g. The control diet included similar 9-gram packets but were deficient in prebiotic inulin and beneficial microorganisms. Three meals a day, including the conventional and symbiotic meals, were required for the patients. Blood samples obtained while fasting were taken twice: once at baseline and once six weeks after the intervention in order to measure antioxidant biomarkers, hs-CRP, and metabolic profiles. Blood insulin levels considerably dropped after a symbiotic meal as compared to the untreated condition (changes from baseline: 1.75 0.60 vs. +0.95 1.09 IU/mL, P = 0.03). However, compared to the effects on total- and LDL-cholesterol levels and HOMA-IR, the effects of FPG (22.3 vs. 4.2 mg/dL, P = 0.09), serum triglycerides (45.9 vs. 20.6 mg/dL, P = 0.08), and HDL cholesterol (3.1 vs. 2 mg/dL) are less likely to be statistically significant. In comparison to individuals who were a part of the untreated sample, blood hs-CRP levels considerably dropped after ingesting symbiotic meals (1057.86 283.74 vs. 95.40 385.38 ng/mL, P = 0.01). Consuming the symbiotic meal raised blood levels of uric acid (+0.7 vs. 0.1 mg/dL, P = 0.04) and total Gss (319.98 vs. 19.73 mol/L, P 0.001) in comparison to the control diet. Plasma TAC levels were not noticeably affected by the symbiotic supper [3].

3. Discussion

According to the review, diabetic individuals who consumed symbiotic food for six weeks had substantial changes in their levels of plasma total GSH, hs-CRP, uric acid, and serum insulin compared to those who consumed control food. To our knowledge, this research is the first to look at how symbiotic meals affect diabetes patients' metabolic health. In terms of exercise style, it was shown that combined exercise [22] Compared to independent aerobic or resistance training, provides superior advantages for diabetics. Since mild to moderate cardiovascular activity has no impact on TG levels, the intensity of exercise has an impact on the lipid profile. Exercises that increase aerobic resistance and flexibility have been demonstrated to lower HDL cholesterol. In one trial, the arterial glucose level rose [23]. In conclusion, it has been shown that exercise causes changes in HbA1c, blood sugar, insulin levels, TG, TC, LDL cholesterol level, Apo B 48, decreased insulin resistance, and a rise in HDL cholesterol across the various continents where the research have been done. According to research done by several writers [12] [9] where it was also learned that managing type 2 diabetes by controlling metabolism requires physical exercise. Three of the studies evaluated addressed the implementation of instructional sessions which tackle the habits of engaging in physical exercise and eating healthily. It is evident that classes that emphasize the value of exercise and a balanced diet in managing diabetes, together with moderate-intensity aerobic exercise, are associated with decreased levels of HbA1c, glucose, An rise in TG, low-density lipoprotein cholesterol, HDL cholesterol, and LDL cholesterol [6]. Similar findings were found in Steinsbekk et al.'s comprehensive review and meta-analysis, which showed that self-management education encourages greater oversight of type 2 diabetes [20].

Depending on its intensity and duration, exercise may have an impact on both the generation of reactive oxygen molecules or the use of antioxidant mechanisms. The equilibrium between free-radical production and antioxidant activity controls oxidative stress. Similar findings revealed that high-intensity workouts raised 8-OHdG plasma concentrations and malondialdehyde-modified lower-density lipoprotein cholesterol serum concentrations, both of which are indicators of oxidative stress, in young, healthy males. The research, however, also revealed a tendency for moderate-intensity exercise training to lower these oxidative stress indicators' levels. Therefore, these results suggested that the impact of exercise on cellular oxidative stress may vary depending on the intensity of the activity. Most individuals with type 2 diabetes should train for moderate-intensity exercise to improve their metabolic health [2].

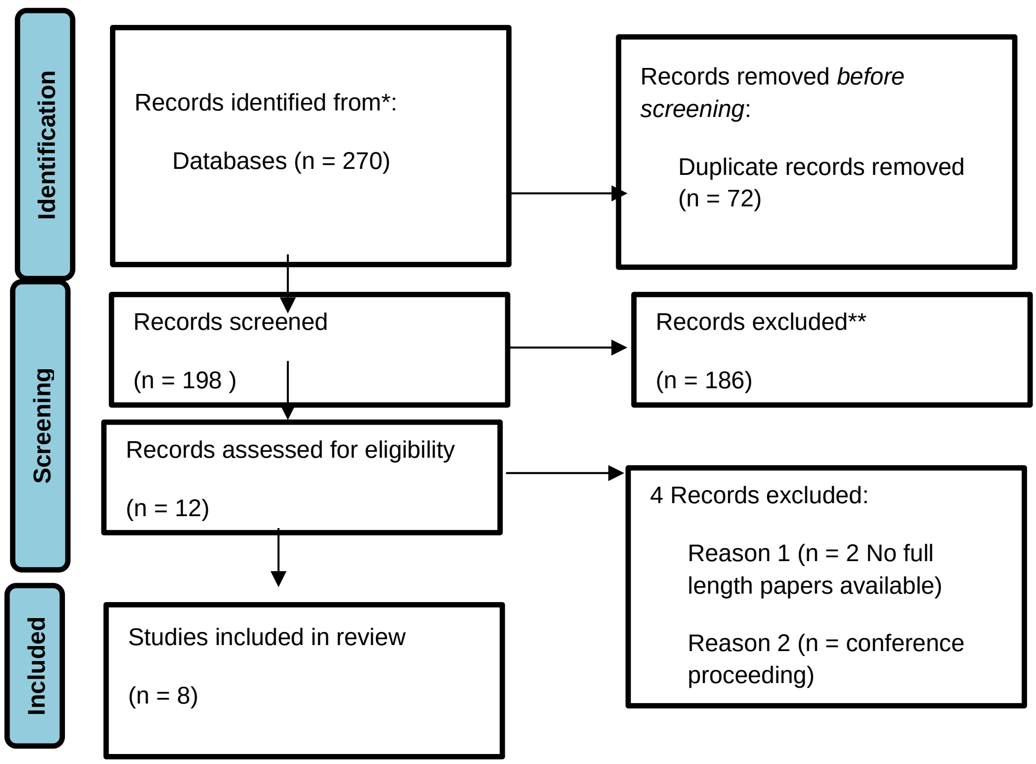

Figure 1: Prisma flowchart

Table 1: Findings of previous studies

Author	Design	Sample Size	Key findings
Yuan et al (Yuan *et al.*, 2014)	**RCT**	**88**	Given p values of 0.039 or 0.102, HbA1c in the insulin-treated group, levels are lower compared to the comparable control group, respectively. Additionally, the untreated group's fasting glucose and TG levels were higher, whereas those in the one receiving therapy group were lower (p = 0.626/0.850 & 0.238/0.427, respectively). LDL and TC levels dropped in both groups (p = 0.005/0.001 & 0.034/0.001, respectively). In the treatment group, HDL cholesterol rose while falling in the placebo arm (p = 0.160/0.303).
Swift et al (Swift *et al.*, 2012)	**RCT**	**204**	In comparison to the original group (+0.24%), HbA1c reduced in the intensive fitness group (0.34%, p 0.05). The group has a decline in both resistance and aerobic exercise (0.15/0.16%, p > 0.05). Fasting insulin levels dropped (Resistance exercise: 1.89 pmol/l; mixed exercise: 2.05 pmol/l; control exercise: 1.53 pmol/l) and blood pressure increased (Control: 7.54 mg/dl, p > 0.05; aerobic physical activity: 2.96 mg/dl; resistance: 4.76 mg/dl; put together: 0.46 mg/dl;). All four groups had increased fasting glucose levels.
Motahari Tabari et al (Motahari-Tabari *et al.*, 2015)	**RCT**	**53**	P = 0.06 shows the amount of fasting glucose level rose it the classroom group's scores rose, but the corresponding control group's scores dropped. These differences weren't significant across groups with a p value of 0.06, nevertheless. Both groups' levels of insulin in their plasma dropped during the course of the study (p = 0.002). With a significance level of 0.007, these differences were found to be significantly difference across groups. In comparison to the control group, the exercise group had lower insulin resistance. These improvements were significant across groups as well as during the whole study, as shown by the P value of 0.004/0.007.
Balducci et al (Balducci, Zanuso, Cardelli, Salvi, *et al.*, 2012)	**RCT**	**303**	In both the LI group and the HI group, the HbA1c, rising blood sugar levels, blood insulin, and insulin resistance levels were all reduced (p = 0.005, 0.030, and 0.009). The TG & HDL cholesterol values in the LI group rose (p = 0.010/0.001), nevertheless, neither the levels of TC nor LDL cholesterol did (p = 0.001). The TG, TC, & LDL cholesterol decreased while the HDL cholesterol rose in the HI group (p = 0.51/0.001/0.001/0.001).
Balducci L et al (Balducci, Zanuso, Cardelli, Salerno, *et al.*, 2012)	**RCT**	**73**	HbA1c, TC, & LDL in general, cholesterol levels were all decreased. fitness group (p 0.001/=0.20/=0.04). (p = 0.80/0.25) The levels of TG & HDL cholesterol both rose. HbA1c, TC, HDL, and LDL cholesterol all reduced in the uncontrolled group (p = 0.16, 0.74, 0.18, and 0.75, respectively), while TG rose (p = 0.035).
Vinetti et al (Vinetti *et al.*, 2015)	**RCT**	**20**	The median nocturnal blood-glucose level decreased in both both the intervention as well as control groups (p = 0.32/0.26). HbA1c increased in the placebo group whereas it declined in the experiment group. (p = 0.08 and 0.25, respectively). These variations across the groups, however, were not substantially different (p = 0.75/0.05). Similar findings were made regarding the resistance to insulin (p = 0.02/p 0.05), levels of fasting insulin (p = 0.01/0.42, mathematically significant differences among groups, p = 0.02), TC (p = 0.03/0.52, lines among the two groups were more pronounced, p = 0.05), LDL cholesterol levels (p = 0.04/>0.05), or TG (p = 0.11/0.33). P = 0.06 demonstrates the statistically significant nature of these changes across groups. HDL cholesterol decreased in both groups (p = 0.79/0.20). It was discovered that Regarding this decline, there wasn't no statistically significant distinction between the groups (p = 0.29).
Strobel et al (Strobel *et al.*, 2014)	**RCT**	**86**	HbA1c reduced in the vitamin D supplementation condition whereas it rose in the matched group (p = 0.16). In comparison to diabetics who baseline HbA1c values from 8 and 8.9% (+0.3, p = 0.90) and those having baseline HbA1c values between 7 and 7.9% (+0.1%, p = 0.50), those having baseline HbA1c > 9% (1.4%, p = 0.013) had the highest decrease in HbA1c.
Asemi et al (Asemi *et al.*, 2014)	**RCT**	**62**	The amount of insulin is the blood decreased after probiotic administration as compared to the untreated control (p = 0.03). Furthermore, overnight plasma glucose within the probiotic sample decreased compared to the control group's increase. Diabetes and insulin resistance have the same characteristics. LDL cholesterol and TG levels increased in two of the groups. In the probiotic-consuming group, HDL cholesterol rose whereas it fell in the control group. None of those modifications were statistically significant because p > 0.05.

4. Limitations

When interpreting the findings, a number of constraints should be taken into account, such as how the sample of people studied in the different publications was different and how the level and form of exercise along with different eating patterns may affect the result. Exercise, routine physical activity, but dietary behaviors may be overestimated; there is insufficient follow-up of patients following programs to assess the durability of any long-term advantages; the possibility of bias in the studies the fact were taken into account is questionable. Another drawback is that little consideration is given to pharmacological diabetic therapy or the use of nutritional supplements or other therapies, notably for weight loss. Due to all of this, comparing research and their findings is challenging.

5. Conclusion

It is essential to change behaviors pattern in daily living activities and promote a more active and healthier lifestyle throughout every phase one's life given the significant prevalence of this illness of the second kind in people of all ages, especially among seniors, and the reality that it tends to get worse with age. Physical exercise, dietary pattern, and wellness seminars are offered as supplementary therapy strategies for the management of type 2 diabetes's biochemistry and therapy. These strategies highlight the effective requirement of modifying lifestyles in accordance with knowledge that has been scientifically verified. Low-carbohydrate, low-GI, Mediterranean Seas, etc., diets high in protein may help patients with diabetes lower multiple indicators of cardiovascular risk and may be more crucial in the treatment of diabetes, according to an examination of the data on different diets. Due to the enormous range of dietary preferences and practices, it is often more feasible to tailor dietary pattern to each individual's unique needs rather than adopt a one-size-fits-all philosophy. The quality of diets examined in this research suggest that individuals with T2D may have access to a variety of nutrient-rich food alternatives.

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