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Original Research Article

A Study on the Reduction of Type-2 Diabetes Incidence with Metformin and Lifestyle Modification

Shivaraj Gurupadappa Sajjanshetty

MD, General Medicine. Assistant Professor, Vedantaa Institute of Medical Sciences, Saswand, Dhundalwadi, Dahanu, Palghar, Maharashtra

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Corresponding Author: Dr. Shivaraj Gurupadappa Sajjanshetty
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Abstract:

Introduction: This study discusses how DM causes persistent hyperglycemia due to insulin resistance or decreased production. In 2015, there were 415 million cases of DM while by 2040, morethan 200 millions of DM patients will be added. Diabetes and hyperglycemia damage organs, raising coronary disease risk. The three primary kinds of DM are T1DM (autoimmune-driven insulin loss), T2DM (insulin resistance), and gestational DM. The main T2DM treatment is metformin.

Aim and Objectives: This study aims to assess the effectiveness of metformin and lifestyle modifications in lowering the incidence of Type-2 Diabetes.

Method: This prospective study was conducted with 120 participants. The study included adults aged 25+ with BMI ≥24 (≥22 for Asians) and high glucose, excluding severe diseases. Fasting glucose 95-125 mg/dL, post-glucose 140-199. At least 50% were minorities. The study formed 3 groups, namely, metformin, placebo and extreme lifestyle change. Starting at 850 mg, adjusted metformin. Goal: ≥7% weight loss, personalised plan, moderate exercise. Main focus: glucose testing for diabetes. Analysed diabetes evolution, lifestyle, and metformin effects utilising various prediabetes therapy.

Result: Table 1 shows the baseline characteristics of 120 placebo, metformin, and lifestyle subjects. The lifestyle group demonstrated stable weight and physical activity changes across 2-12 months (Figures 1 and 2). Medication adherence (%) differed by metformin and lifestyle group in Figure 3. Table 2 compares diabetes prevalence by age, gender, BMI, etc. across treatments. Figures 4 and 5 show glucose and glycosylated haemoglobin trends. In Table 3, metformin caused higher gastrointestinal symptoms.

Conclusion: In conclusion, lifestyle adjustments and metformin delay type 2 diabetes. Diabetes is prevented in 1 in 7 patients after three years, lowering social damage.

Keywords: Diabetes and hyperglycemia damage organs, glucose and glycosylated haemoglobin, treatments, gastrointestinal symptoms.

Introduction

Chronic metabolic Persistent hyperglycemia is a defining characteristic of the condition known as diabetes mellitus (DM). A gain in resistance to insulin, a decrease in insulin production, and possibly both may be to blame. In 2015, 415 million persons aged 20 to 79 were estimated to have diabetes mellitus by the International Diabetes Federation (IDF). Given that The number of those affected is predicted to rise by more than 200 million by 2040, DM is demonstrating that it has a negative impact on global public health. When paired with additional In patients with diabetes mellitus, metabolic issues and persistent hyperglycemia can impair numerous organ systems, which can have serious and sometimes deadly health repercussions. Together with macrovascular, and microvascular (retinopathy, nephropathy, and neuropathy) issues, which are the most common, both raise between and four times the likelihood of developing coronary artery disease [1].

Based on the aetiology DM may be loosely categorised into three types based on clinical symptoms: gestational diabetes, type 1 diabetes, and type 2 diabetes (GDM). Additionally, less frequent forms of diabetes exist, such as monogenic and secondary [1].

Diabetes Mellitus Type 1 (T1DM)

Within the pancreatic islets, insulin-producing beta cells experience autoimmune death the hallmark 5% to 10% of all instances of diabetes are T1DM cases, or type 1 diabetes mellitus. As a result, there is absolutely no insulin. Autoimmune illness is frequently connected to environmental triggers

including viruses, chemicals, or certain dietary ingredients as well as a genetic tendency. T1DM can affect people of any age, yet it most typically affects children young adults teenagers [1].

Diabetes Mellitus Type 2

The majority of T2DM, also known as type 2 diabetes, accounts for the majority of cases of diabetes (around 90%). The diminished insulin response with T2DM is referred to as insulin resistance. The body first generates more insulin and maintains glucose homeostasis although insulin is useless in this situation; however, as time passes, this production falls, which results in T2DM. The age group wherein T2DM is most frequently diagnosed is over 45. Nevertheless, it has grown more widespread among kids, teens, and adolescents due to rising obesity rates, inactivity, and calorie-dense foods [1,2].

The cornerstone for oral diabetes therapy is metformin. Current joint American & European guidelines recommend that metformin medication be started right away as type 2 diabetes mellitus (T2DM) is diagnosed, along with lifestyle changes. Metformin may preserve pancreatic islet cells in addition to its ability to decrease hepatic gluconeogenesis and increase glucose absorption. Metformin significantly reduces HbA1c, but it also has positive to neutral effects on lipid levels, and blood pressure, & doesn't significantly raise the probability of hypoglycemia or cause weight gain [3]. The most prevalent side effects of metformin are gastrointestinal problems. The majority of patients will undergo combination medication since T2DM deteriorates even with initially successful monotherapy. A doctor must consider the effectiveness of glycemic control, safety, and tolerability, as well as any potential side effects that might reduce the overall efficacy (such as effects on the body's weight, levels of cholesterol, or elevated blood pressure) when deciding which medications in co-administer with metformin. Regarding this, The characteristics of incretin-based medications make them particularly appropriate for metformin add-on treatment [3,4].

Cardiovascular disease and type 2 diabetes are relatively common worldwide. All ages are affected by diabetes mellitus, which is predicted to impact 451 million people globally in 2017 & 693 million people by the time period 2045. Treatment for pre-diabetes and diabetes was projected to cost $218 billion in 2007 [5].

A chronic condition called Insulin resistance and decreased insulin sensitivity are two hallmarks of type 2 diabetes mellitus production. More than 7% of people in the US are considered to have type 2 diabetes mellitus, which is more prevalent in elderly patients and several ethnic groups. Diabetes can have a multitude of long-term consequences, including as retinopathy, nephropathy, and a variety of other vascular abnormalities which might necessitate amputations, as well as placing a financial and personal burden on the patient. Additionally, the lifetime cardiovascular disease risk and stroke is increased two to four times in people a type 2 diabetes patients [5].

Weight loss is being found to be a successful strategy for avoiding Type 2 diabetes also called diabetes mellitus as studies have revealed that it increases insulin secretion and is advised as an intervention for diabetics who are overweight or obese. Information from a number of well-respected studies has backed the idea that losing weight lowers the chance of getting type 2 diabetes mellitus. For this intervention, individuals were put on a low-fat, calorie-reduced diet and required to engage in 150 minutes of moderate-intensity exercise each week exercise [6]. Over the course of the trial, individuals had 7% of their total body weight on average, which was linked to a 58% reduced incidence of diabetes compared to those who took a placebo. The DPP study showed that overweight or obese patients in America who have diabetes might significantly lower their chance of developing diabetes by losing weight, which was also observed in Asian populations. Participants in a study with reduced tolerance for glucose tests Japanese study that aimed to prevent type 2 diabetes by using lifestyle changes. Patients were randomly assigned to one of two groups: those who performed rigorous lifestyle modifications, such as eating well and exercising, in order to reach a BMI between 22 and 24; or those who did not [6,7].

Dietary modifications have been shown to assist in shedding pounds and preventing developing type 2 diabetes patients in addition to increasing physical activity (see below). Because they are linked to better glycemic control, dietary changes are a crucial part of diabetes prevention. Healthy eating practices can accelerate weight loss when combined with increased physical activity, which has been shown to be an effective strategy for diabetes prevention. Some diets do, however, make room for greater glycemic control than others. A comprehensive evaluation of 48 trials on Dietary changes for diabetes prevention showed that both the Mediterranean diet and Dietary Approaches for Prevention of Hypertension (DASH) diets significantly reduced the chance of getting diabetes [8].

A healthy diet includes four or more cups of fruits and vegetables each day, reduced-fat dairy products, a serving of whole grains each day, 7 ounces of fish altogether each week, less than 1,500 milligrammes of sodium each day, and less than 450 calories to sugar-sweetened drinks each week. the DASH diet. A meta-analysis of six trials that employed the DASH diet showed that the diet can

significantly reduce the risk of coronary heart disease and stroke. The chance of both disorders was found to be lowered by 21% and 21%, respectively [8].

Different kinds of vegetarian diets have been linked to lower diabetes prevalence. A portion Of the Adventist Health Study-2, which comprised almost 60,000 participants, revealed that vegetarians had a lower prevalence of diabetes than non-vegetarians. Even after adjusting for lifestyle factors and BMI, vegans and lacto-ovo vegetarians had a prevalence of diabetes that was nearly cut in half [8].

Method

Research Design

This prospective study was conducted in the concerned hospital during the period of one Year with 120 patients. The research primarily examined a cohort of individuals who were 25 years of age or older and had a body mass index (BMI) equal to or more than 24, as well as slightly higher levels of plasma glucose. The study incorporated fasting glucose levels ranging from 95-125 mg/dL, as well as post-glucose load readings ranging from 140-199 mg/dL. Exclusions encompass specific drugs or severe medical conditions. Approximately 50% of the participants were selected to reflect ethnic or racial minorities. The participants were assigned randomly to three distinct groups: one receiving conventional lifestyle advice together with metformin, another receiving standard lifestyle advice along with a placebo, and a third group participating in an intense lifestyle modification programme. The administration of metformin commenced with a daily dosage of 850 mg, with further increments based on individual tolerance. The primary objective of the intensive intervention was to achieve a minimum initial body weight loss of 7% through the implementation of a personalised nutrition plan and the incorporation of moderate activity. The main measure of interest in this study was the identification of diabetes, which was established based on the assessment of glucose tolerance and fasting glucose levels. The annual assessment included the evaluation of physical activity and nutritional consumption. The objective of this study was to assess therapies for prediabetes using predetermined criteria. Various methodologies and metrics were utilised to comprehensively examine the evolution of diabetes and assess the effects of lifestyle modifications and metformin utilisation.

Inclusion and Exclusion Criteria

Inclusion

- Individuals that are 25 years of age or older.
- Individuals with a body mass index (BMI) equal to or over 24 are considered to have a higher BMI.
- The fasting plasma glucose levels range from 95 to 125 mg/dL (5.3 to 6.9 mmol/L) or 140 to 199 mg/dL (7.8 to 11.0 mmol/L) when measured two hours following the administration of a 75-gram oral glucose load.
- The inclination to engage in a certain activity and offer informed permission.

Exclusion

- The utilisation of pharmaceutical agents that are recognised to have an impact on the body's ability to regulate glucose levels.
- The existence of serious illnesses is expected to have a significant effect on both life expectancy and involvement.
- Individuals who fall beyond the designated age range.
- Individuals with a body mass index (BMI) that falls below the established level.
- The lack of capacity or reluctance to give informed permission or comply with study protocols.

Statistical Analysis

Statistical significance was adjusted for repeated analyses. The trial design had 90% power to detect a 33% diabetes reduction. Life-table approaches assessed time-to-outcome and cumulative incidence using log-rank testing. Three-year cumulative incidence was used to calculate treatment numbers. Risk reduction, interactions, and variables were analysed using proportional hazard regression. Fixed-effects models compared group weight and glucose.

Ethical Approval: The study has been approved by the Ethical Committee of the concerned hospital.

Result

The baseline characteristics of the trial participants are presented in Table 1, with the participants categorised into three treatment groups: placebo (n=40), metformin (n=40), and lifestyle (n=40). The table presents various key characteristics, including age (49.6 ± 9.8, 49.8 ± 9.7, 49.5 ± 9.6), weight (93.2 ± 19.8, 92.5 ± 18.9, 93.3 ± 18.8), body-mass index (33.7 ± 7.6, 33.2 ± 6.5, 32.7 ± 6.6), waist circumference, waist-to-hip ratio, family history of diabetes, history of gestational diabetes, plasma glucose levels during fasting and two hours after an oral glucose load, glycosylated haemoglobin levels, and leisure physical activity. The aforementioned variables offer valuable insights into the demographic makeup of each treatment group at the outset of the trial.

Table 1: Baseline Characteristics of the Study participants

Characteristic	Placebo n=40	Metformin n=40	Lifestyle N=40
Age	49.6 ±9.8	49.8 ±9.7	49.5 ±9.6
Weight	93.2±19.8	92.5±18.9	93.3±18.8
Body-mass index	33.7±7.6	33.2±6.5	32.7±6.6
Waist circumference — cm	104.7±13.5	106.3±13.8	105.2±14.3
Waist-to-hip ratio	0.92±0.09	0.92±0.08	0.93±0.09
Family history of diabetes-— no. (%)	22	21	23
History of gestational diabetes — no. of women (%)	18	19	17
Plasma glucose — mg/dl§			
In the fasting state	105.8±7.9	105.8±7.9	105.5±8.2
Two hours after an oral glucose load	163.6±16.5	165.1±16.2	162.6±16.8
Glycosylated hemoglobin — %	5.89±0.49	5.88±0.49	5.90±0.49
Leisure physical activity — MET-hr/wk¶	16.0±28.1	17.1±28.2	16.5±28.1

Figure 1 depicts the alterations in weight seen within the control, metformin, and lifestyle intervention cohorts over a span of 2 to 12 months. The control group exhibited negligible variations, but both the metformin and lifestyle groups demonstrated diverse reductions in weight. It is worth noting that the lifestyle group consistently showed weight adjustments, suggesting that they may have effectively adhered to the lifestyle modification.

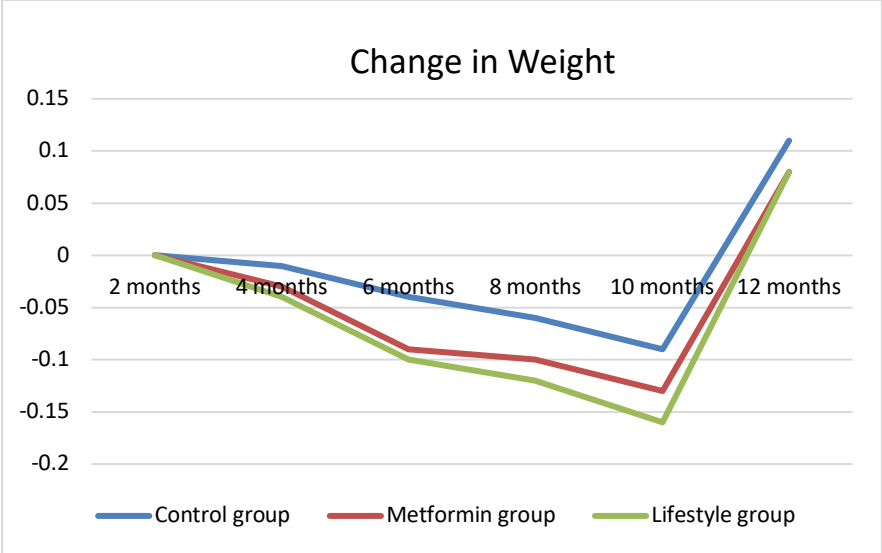

Figure 1: Change in Weight

Figure 2 depicts the variation in physical activity (measured in MET-hr/wk) among the control, metformin, and lifestyle groups across a period of 2 to 12 months. The control group demonstrated minor alterations, whereas both the metformin and lifestyle intervention groups displayed diverse declines in levels of physical activity. It is worth mentioning that the lifestyle group consistently exhibited modifications, which could indicate their adherence to the instructions provided by the intervention.

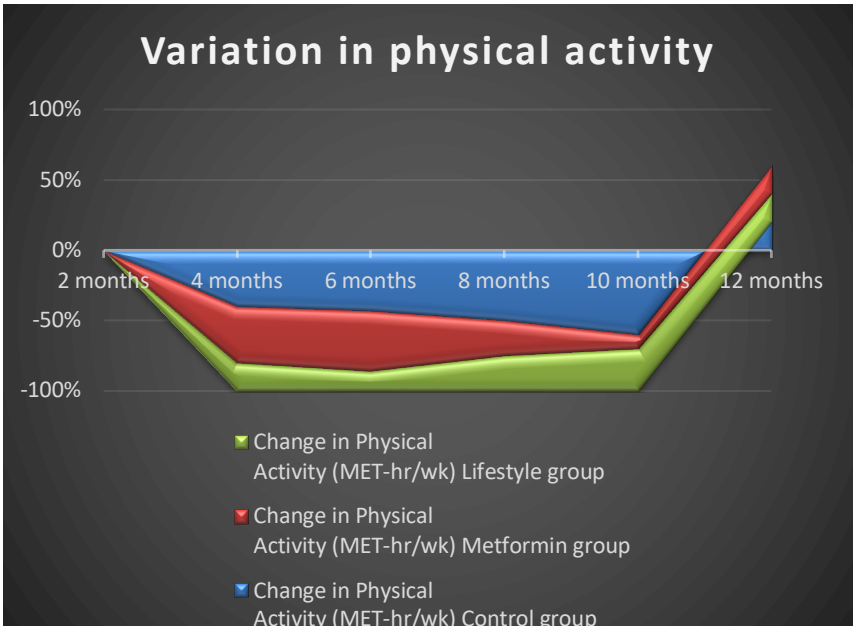

Figure 2: Variation in physical activity

Figure 3 illustrates the medication adherence rates (%) for the control, metformin, and lifestyle groups throughout a duration of 2 to 12 months. The control group exhibited a rather consistent level of adherence, whereas the metformin and lifestyle intervention groups exhibited diverse patterns of adherence. There was a modest decline in adherence levels observed in the metformin group, but the lifestyle group exhibited steady adherence throughout the study period.

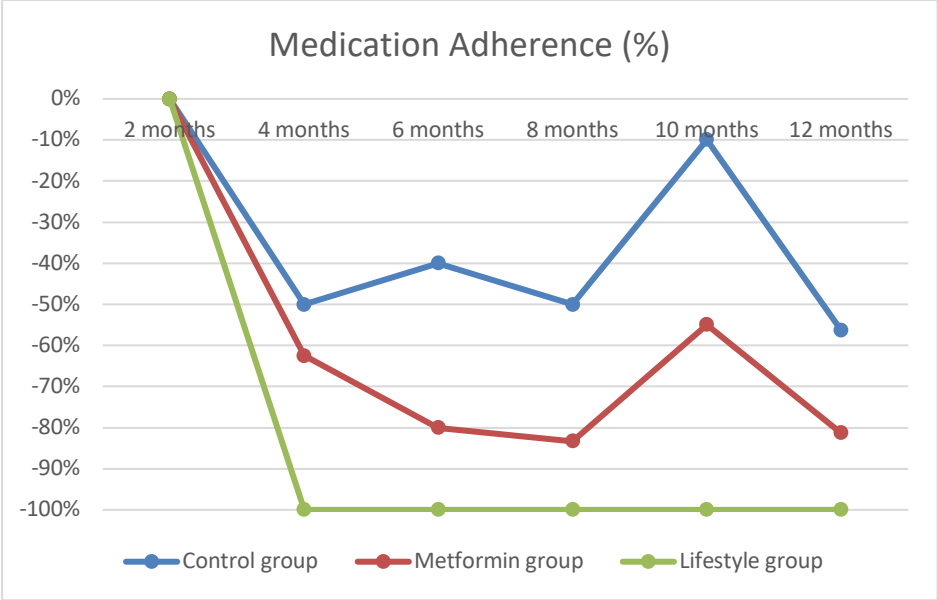

Figure 3: Medication adherence percentage

Table 2 provides an in-depth analysis of the prevalence of diabetes, focusing on comparisons of treatment outcomes across a number of different variables. The presented data comprises the number of participants, decreases in incidence along with confidence intervals (CIs) for 95%, and percentages for the lifestyle versus placebo group, the metformin against placebo group, and the lifestyle versus metformin group. In the analysis, age groups (25-44, 45-59, and >60), gender, race/ethnicity (White, African American, Hispanic, American Indian, and Asian), body mass index (BMI) categories (30, 30-35, and >35), and plasma glucose levels are all taken into consideration. Within the scope of the present investigation, this condensed presentation offers an examination of the patterns of diabetes incidence.

Table 2: Incidence of diabetes as found among the study partcipants

Variable	No. Of participants (%)	Reduction in incidence (95% ci)		
		Lifestyle Vs. Placebo	Metformin Vs. Placebo	Lifestyle Vs. Metformin
Overall	120 (100)	40 (48 to 66)	40 (17 to 43)	40 (24 to 51)
Age				
25–44 yr	80 (66.66)	28 (27 to 63)	56 (58 to 66)	12 (61 to 80)
45–59 yr	30 (25.00)	12 (44 to 70)	30 (51 to 75)	10 (65 to 85)
»60 yr	10 (8.33)	10 (51 to 83)	12 (49 to 66)	5 (66 to 79)
Sex				
Male	80 (66.66%)	35 (49 to 63)	12 (44 to 70)	12 (49 to 66)
Female	40 (33.33)	5 (51 to 84)	10 (51 to 83)	5 (66 to 79)
Body-mass index				
22 to <30	80 (66.66)	56 (58 to 66)	12 (44 to 70)	56 (58 to 66)
30 to <35	30 (25.00)	30 (51 to 75)	10 (51 to 83)	30 (51 to 75)
»35	10 (8.33)	12 (49 to 66)	5 (66 to 79)	12 (49 to 66)
Plasma glucose				
In the fasting state	70 (58.33)	12 (61 to 80)	56 (58 to 66)	12 (61 to 80)
95–109 mg/dl	40 (33.33)	10 (65 to 85)	30 (51 to 75)	10 (65 to 85)
110–125 mg/dl	10 (8.33)	5 (66 to 79)	12 (49 to 66)	5 (66 to 79)
Two hours after an oral load				
140–153 mg/dl	60 (50.00)	12 (61 to 80)	56 (58 to 66)	12 (61 to 80)
154–172 mg/dl	40 (33.33)	10 (65 to 85)	30 (51 to 75)	10 (65 to 85)
173–199 mg/d	20 (16.66)	5 (66 to 79)	12 (49 to 66)	5 (66 to 79)

Figure 4 displays the fasting plasma glucose levels (measured in mg/dL) for the control, metformin, and lifestyle groups across different time intervals ranging from 2 to 12 months. While the control group exhibited little changes, both the metformin and lifestyle groups had decreasing trends over time, indicating possible positive effects of these therapies on glycemic management.

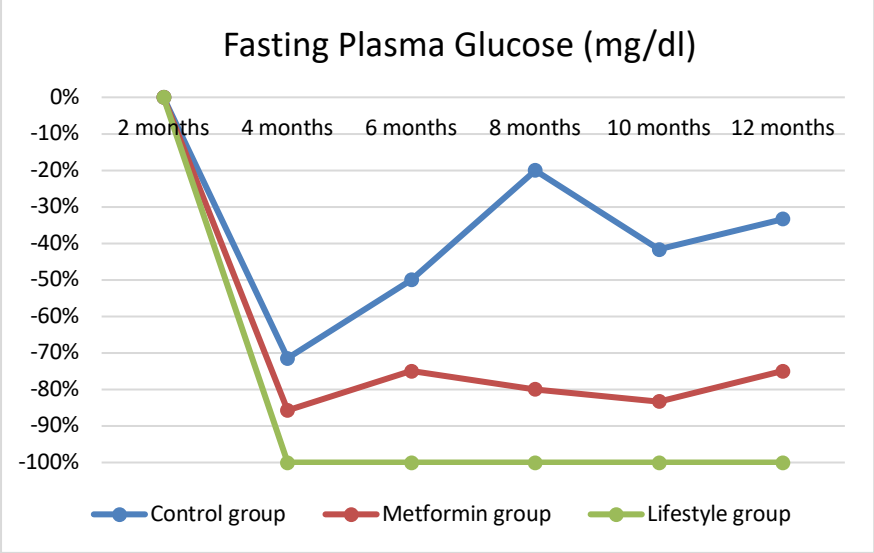

Figure 4: Fasting plasma glucose (mg/dl)

The diagram depicted in Figure 5 illustrates the study monitored the progression of glycosylated haemoglobin levels over a period of 2 to 12 months in three distinct groups: the control group, the metformin group, and the lifestyle group. The control group demonstrated consistent levels, whilst the metformin and lifestyle groups displayed marginal decreases in glycosylated haemoglobin percentages, suggesting possible favourable outcomes of both therapies in the management of diabetes.

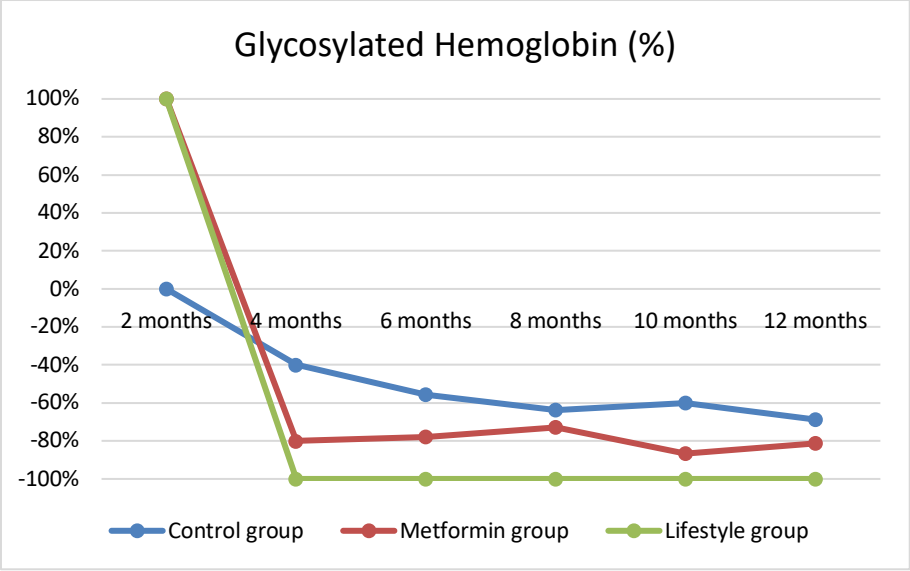

Figure 5: Glycosylated hemoglobin %

Table 3 compares the adverse effects of placebo, metformin, and lifestyle treatments. The metformin group (76.7%) had more gastrointestinal problems than the placebo group (39.8%) and the lifestyle group (12.8%). The musculoskeletal symptoms were consistent across groups. Hospitalisation rates for at least one admission were comparable across the three groups: 15.8% for placebo, 15.9% for metformin, and 16.3% for lifestyle. Hospitalisation per 100 individuals was similar, with the placebo group having 8.2, the metformin group 8.1, and the lifestyle group 7.9. The placebo and lifestyle groups had median hospital stays of 3 days. The metformin group had a median stay of 4 days. All groups had low death rates: placebo (0.15%), metformin (0.14%), and lifestyle intervention (0.13%). The table summarises adverse events and their incidence across trial treatment groups.

Table 3: Adverse Events noted during the follow-up

Event	Placebo	Metformin	Lifestyle
Gastrointestinal symptoms	39.8	76.7	12.8†
Musculoskeletal symptoms	20.8	19.8	25.1†
Hospitalization One or more admissions (% of participants)	15.8	15.9	16.3
Rate	8.2	8.1	7.9
Median stay (days)	3	4	3
Deaths	0.15	0.14	0.13

Discussion

About 8% of adults Type 2 diabetes is prevalent in the United States. Some risk factors, like being overweight, leading a sedentary lifestyle, as well as having elevated plasma glucose levels both when you're fasting and after taking in a lot of sugar, may be changeable. Our theory was that by modifying these factors through a dietary or lifestyle plan or by administering metformin, diabetes would be prevented or delayed from developing. A lifestyle modification programme with goals involving a minimum of a 7% weight loss along with at least 150 hours of vigorous exercise per week was given with the aid of a placebo, metformin (850 mg twice daily), or both to 3234 non-diabetic individuals who had elevated fasting and post-load plasma glucose concentrations. both of the latter two. The average BMI of the participants was 34.0, which is calculated by dividing every individual's body weight in kilogrammes by his or her height in metres squared. The participants' average age was 51 years. Among the participants, 68 per cent were women and 45 per cent belonged to underrepresented groups. Both modifying their behaviours and taking the medication metformin helped those who had an increased probability of getting diabetes. Metformin was less effective than changing one's lifestyle [9].

Chinese, Finnish, and American populations that are multiethnic, lifestyle changes can mostly prevent diabetes. We examined compared with the aforementioned populations, native Asian Indians with IGT had younger, slimmer, and more insulin-resistant bodies. in a prospective community-based trial to explore if interventions could reduce the development of diabetes. Native Asian Indians move from IGT to diabetes at a high rate. Combining LSM and MET did not provide any further advantages, however, they both markedly

decreased the incidence of type 2 diabetes among Asian Indians having IGT [10].

Serious microvascular (kidney and eye disease, for example) and macrovascular (stroke and ischemic heart disease) consequences are linked to diabetes mellitus. These problems can have serious long-term consequences, such as infirmity, blindness, and amputation, and they put a significant financial burden on society. This study examines Using data from the National Health Interview Survey (NHIS) of the CDC, this study examined changes in both the prevalence and incidence of self-reported diabetes in the United States between 1980 and 1994. The findings indicate that over this time, the frequency, as well as the incidence of diabetes, rose, and they suggest that the majority of this increase was brought on by causes other than the gradual ageing of the population of the United States [11].

However, there is no evidence that people with altered fasting glucose levels would experience similarly positive effects. Numerous lifestyle modifications can stop diabetes type 2 mellitus in persons with reduced glucose tolerance, according to earlier studies. We investigated the impact of lifestyle modifications on the development of diabetes of type 2 in those with low fasting glucose levels. Japanese people with impaired fasting glucose readings who are overweight can avoid type 2 diabetes by changing their lifestyle. Additionally, identifying people with more worsened glycemic status using the results of oral tolerance to glucose test of 75 grammes or, more specifically, by measuring haemoglobin A1c levels, could increase the effectiveness of lifestyle changes [12].

IGT patients have a higher chance of acquiring NIDDM than healthy individuals. In order to lower the incidence of NIDDM along with the impact of complications of diabetes like The higher mortality caused by comorbidities such as cardiovascular, renal, & retinal disease, the current investigation examined whether dietary and physical activity Interventions in IGT patients may prevent the onset of NIDDM. Over a 6-year period, diet or otherwise physical therapy dramatically decreased the emergence of diabetes in IGT patients [13].

The incidence of obesity and a sedentary lifestyle is increasing, which helps explain why More and more people are developing type 2 diabetes mellitus. It is unknown if those individuals who have a heightened chance of developing type 2 diabetes can prevent the disease by altering their lifestyles. To the intervention group, 522 overweight, middle-aged individuals with low glucose tolerance were randomised at random as well as the unaltered control group. These patients had a body mass index (BMI) aged 31 and a mean age of 55, with 172 men and 350 women. Each participant within the intervention group received Individualised advice geared at weight loss, lower consumption of total and saturated fats, higher intake of fibre, and increased physical activity. It took an annual oral tolerance test for glucose to identify the patient as having diabetes. The follow-up period was 3.2 years on average. By changing their lifestyles, high-risk individuals can lower their occurrence of type 2 diabetes [14].

Intensive blood-glucose management with insulin or sulphonylurea treatment for type 2 People with diabetes may delay the start of microvascular damage and lower the incidence of heart attacks. This study looked at any particular benefits or drawbacks of metformin-intensive glycemic management. Metformin might be used as the initial- line is the preferred pharmacological therapy for these patients because it appears to reduce the incidence of diabetes-related complications in overweight diabetics and is linked to a reduced risk of weight gain & fewer hypoglycemia episodes than insulin and sulphonylureas [15].

IGT patients have a higher chance of acquiring NIDDM than healthy individuals. In order to lower the risk of NIDDM along with the incidence of problems associated with diabetes such as retinal disease, renal disease, and cardiovascular disease, and to lower the elevated mortality resulting from such problems, the study examined whether dietary and physical activity interventions in individuals in IGT might delay the development of NIDDM. Over a 6-year period, diet as well as physical therapy dramatically decreased the development of diabetes in persons with IGT [16,17].

Conclusion

This study concluded that the results of this research indicate that the use of metformin medicine, in conjunction with adjustments to one's way of life, has shown significant promise in delaying or preventing the onset of type 2 diabetes. Over the course of three years, the lifestyle intervention proved to be rather effective, resulting in the avoidance of one new instance of diabetes for every seven people who were given therapy. This indicates the possibility of not only delaying difficulties connected with diabetes but also greatly minimising the individual and societal effects of the illness on the general well-being of society as a whole as a result of the condition.

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