# Effect of Tertiary Preventive Behavior on HbA1c Level, Quality of Life, and Complication Risk in Diabetes Mellitus Patients

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| ABSTRACT |
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**Background:** Type 2 diabetes mellitus (DM) is a non-communicable disease which is a source of additional severity for other diseases. This study aims to determine the effect of tertiary preventive behavior on hba1c level, quality of life (QoL), and complication risk in diabetes mellitus patients.

**Subjects and Method:** This was a cross-sectional study conducted in Sukoharjo, Central Java, Indonesia, from October to November 2023. A total sample of 200 patients with type 2 diabetes mellitus (DM), registered in the Prolanis program, was selected through multistage random sampling. The independent variables were HbA1c levels, risk of complications, and QoL. The independent variable was tertiary preventive behavior. HbA1c levels were measured using spectrophotometer. QoL was measured using the WHOQOL questionnaire, and risk of complications using a questionnaire. Data were analyzed using the SEM model.

**Results:** Tertiary prevention behavior significantly increased HbA1c level (b= 0.31; CI 95%= -0.45 to 0.15; p<0.001) and quality of life (b= 0.15; 95% CI= -0.15 to 0.38; p<0.001). Tertiary prevention behavior significantly reduced the risk of complications (b= -0.22; CI 95%= -0.42 to 0.02; p= 0.026). The goodness-of-fit values suggest that the structural equation model (SEM) is acceptable (p= 0.188; RMSEA=0.04; CFI=0.97, TLI=0.95; SRMR=0.05; CD= 0.07).

**Conclusion:** Tertiary prevention behavior significantly increased HbA1c level and quality of life. Tertiary prevention behavior reduces the risk of complications in type 2 DM patients.

**Keywords:** Diabetes mellitus, HbA1c, complications, quality of life

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## BACKGROUND

Diabetes mellitus is a non-communicable disease that is an additional source of severity for other diseases. Diabetes mellitus or often called diabetes is the cause of premature death in the world (Kemenkes RI, 2020). This disease is divided into two types, namely diabetes mellitus types 1 and 2. Around 90% of people with diabetes fall into type 2 diabetes mellitus. The cause of T2DM

is that insulin does not work according to its system which is balanced by increasing glucose so that more insulin is released. Initially, this type was dominated by the elderly but as lifestyle patterns develop, the number of cases increases at younger ages (IDF, 2023).

The prevalence of diabetes mellitus in the world is increasing from year to year. Around 537 million adults have a history of Diabetes Mellitus in 2021 and this is estimated to increase to around 643 million in 2030. West Pacific countries contribute the largest incidence of Diabetes Mellitus compared to other states, with around 206 million in 2021. This incidence will increase by 27% until 2045 (IDF, 2021). Based on Global Burden Disease data, DM is in 3rd place out of 369 diseases aged over 50 years (Vos, 2020). Meanwhile, Indonesia entered the 7th highest DM ranking in 2019 in the world at 10.4% of cases (Kemenkes RI, 2020). Another study found that COVID-19 patients who had comorbid T2DM had a 1.93 times greater risk of dying than those who did not have comorbidities (Kurniawati et al., 2020).

The increase cases of diabetes mellitus can be reduced with prevention efforts. Disease prevention is done before illness occurs, but there is prevention when one is already sick. Prevention before illness is called primary prevention, namely reducing the risk posed to someone susceptible to disease. Apart from that, there is secondary prevention which is a follow-up to find out clinically whether a person has a disease (Kisling, 2023). Tertiary prevention of diabetes mellitus is carried out to prevent complications. Classic macrovascular complications of DM include coronary heart disease, stroke, and peripheral vascular disease. Assessment of glycated hemoglobin is an effective measure and can prevent the problem of variability in glucose values at any

time. HbA1c accuracy ≥6.5% is sufficient to diagnose diabetes (Chaudhary and Tyagi, 2018).

Diabetes mellitus in Central Java is the second highest number of non-communicable disease cases at 10.7% after hypertension. Based on the health profile of Central Java Province (DinkesProv Jateng, 2021) as many as 17,910 patients in Sukoharjo suffer from diabetes mellitus, and around 17,349 (96.8%) patients receive health services according to standards. This supports the achievement of chronic disease management programs aimed at improving the quality of life of diabetes patients. Based on a preliminary survey, Sukoharjo experienced a decrease in diabetes mellitus cases from (2021) 17,910, (2022) 14,010 and March (2023) amounting to 8,409 cases. This study aims to research the influence of tertiary prevention on HbA1c blood glucose regulation, quality of life, and risk of complications in type 2 diabetes mellitus patients in Sukoharjo.

## SUBJECTS AND METHOD

### 1. Study Design
This research was conducted using a cross-sectional research design. Implemented from October to November 2023 at Community Health Centers throughout Sukoharjo Regency which implement the Prolanis program in their working areas.

### 2. Population and Sample
The population in this study was 8,279 type 2 diabetes mellitus patients in Sukoharjo Regency. The sample was 200 patients with type 2 diabetes mellitus. The number of samples taken using multistage random sampling.

### 3. Study Variables
The dependent variable is tertiary preventive behavior with independent variables including HbA1c levels, quality of life and risk of complications.

## 4. Conceptual Definition

**Tertiary preventive behavior:** tertiary prevention efforts such as diet, smoking habits, exercise, and compliance with taking medication carried out after participating in the Prolanis program which consists of several chronic disease management activities carried out by BPJS health centers.

**HbA1c level:** glycated hemoglobin level measured a maximum of 3 months after joining the Prolanis program.

**Quality of life:** the quality of life a patient has when diagnosed with type 2 diabetes mellitus and undergoing tertiary prevention. Measured from five dimensions including diabetes control, anxiety, social burden, social function, energy, and mobility.

**Risk of complications:** risk of other comorbidities during diabetes mellitus treatment such as hypertension, stroke, coronary heart disease, tuberculosis or others.

## 5. Study Instruments

The research instrument used is a questionnaire to determine whether type 2 diabetes mellitus patients carry out tertiary preventive behavior, the risk of complications experienced. On the variables of quality of life using the WHOQOL questionnaire and HbA1c levels obtained from looking at the results of the spectrophotometer.

## 6. Data Analysis

Research analysis uses univariate to see the descriptive characteristics of each respondent. Meanwhile, the influence analysis test uses a multivariate SEM model.

## 7. Research Ethics

This study used human subjects to determine the exposure to health impacts of Prolanis tertiary prevention efforts on HbA1c, quality of life, and risk of complications in patients with type 2 diabetes mellitus. Therefore, it is necessary to carry out a feasibility test with the following requirements. Letter of ethical suitability from the Research Ethics Commission of Dr Moewardi Hospital Surakarta with number: 1.794/X/HREC/2023. Consent from research subjects to questionnaires given is very necessary. Confidentiality of research subjects is the responsibility throughout the research process until publication.

## RESULTS

### 1. Univariate Analysis

Table 1 shows that of the 200 diabetes mellitus patients who took part in this study the minimum age was 40 years and the maximum age was 85 years with an average of 62 years. Based on the distribution of HbA1c levels, the average is 7.92% with a minimum of 4.7% and a maximum of 15.2%. Meanwhile, the total score on the quality of life (QoL) questionnaire obtained an average of 78.21 with a minimum of 56 and a maximum of 103.

Table 2 explains the univariate analysis of categorical data. The results showed that of the 200 diabetes mellitus patients who took part in this research, 128 people (64%) were dominated by women and 69 people had a high school education (34.5%). The complication risk variable shows that the majority of diabetes mellitus patients do not have complications, 115 people (57.5%). However, there were patients who had the greatest risk of complications, namely hypertension, with 44 people (22%). Diabetes mellitus patients in Sukoharjo were dominated by 125 people (62.5%) taking part in Prolanis activities and 135 people (67.5%) taking tertiary preventive measures such as diet, 126 people (63%) exercising, 192 people (96%) not smoking. and compliance with taking medication was 170 people (85%). Apart from that, in latent tertiary prevention, the majority carried out 4 preventions with a total of 87 people (43.5%).

**Table 1. Numerical characteristics of research respondents (N=200)**

| Classification | Mean | SD | Min | Max |
|---|---|---|---|---|
| Age | 62.15 | 9.04 | 40 | 85 |
| Level of HbA1c | 7.92 | 2.30 | 4.7 | 15.2 |
| Score of QoL | 78.21 | 15.65 | 56 | 103 |

**Table 2. Categorical characteristics of research respondents (N=200)**

| Characteristics | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Gender | Male | 72 | 36.0 |
| | Female | 128 | 64.0 |
| Education | > no formal education | 4 | 2.0 |
| | PS | 45 | 22.5 |
| | JHS | 33 | 16.5 |
| | SHS | 69 | 34.5 |
| | Diploma 3 | 6 | 3.0 |
| | Bachelor Degree | 42 | 21.0 |
| | Master's Program | 1 | 0.5 |
| Risk of Complications | Do not have | 115 | 57.5 |
| | Hypertension | 44 | 22.0 |
| | Cholesterol | 20 | 10.0 |
| | Asthma | 4 | 2.0 |
| | Heart problems | 7 | 3.5 |
| | Visual impairment | 5 | 2.5 |
| | Hearing disorders | 1 | 0.5 |
| | Gout | 2 | 1.0 |
| | Others | 2 | 1.0 |
| Prolanis | No | 75 | 37.5 |
| | Yes | 125 | 62.5 |
| Diet | No | 65 | 32.5 |
| | Yes | 135 | 67.5 |
| Exercise | No | 74 | 37.0 |
| | Yes | 126 | 63.0 |
| Smoking | No | 192 | 96.0 |
| | Yes | 8 | 4.0 |
| Compliance with taking medication | No | 30 | 15.0 |
| | Yes | 170 | 85.0 |
| Latent tertiary prevention | Take 1 precaution | 3 | 1.5 |
| | Take 2 precautions | 46 | 23.0 |
| | Take 3 precautions | 62 | 31.0 |
| | Take 4 precautions | 87 | 43.5 |
| | Do not do | 2 | 1.0 |

**2. Bivariate Analysis**

Table 3 shows tertiary preventive behavior has a significant influence on HbA1c levels. The results can be interpreted that by carrying out tertiary prevention, diabetes mellitus patients can reduce HbA1c levels by 0.12 units compared to those who do not carry out tertiary prevention regularly (b=-0.12, 95% CI= -0.17 to -0.07, p<0.001).

Table 3 shows that tertiary preventive behavior can significantly influence the quality of life of diabetes mellitus patients with an increase of 0.03 units compared to those who do not (b=0.03, 95% CI= 0.02 to 0.04, p<0.001). while the risk of complications variable shows a significant influence. This means that diabetes mellitus type 2 patients who carry out tertiary preventive behavior have a low risk of complications

0.45 units (b=-0.45, 95% CI= -0.68 to -0.22, p<0.001). Multivariate analysis of dependent variable with several independent variables uses multiple linear regression tests as follows.

**Table 3. Simple linear regression analysis of tertiary prevention on HbA1C levels, quality of life and risk of complications**

| Independent Variables | b | CI (95%) | | p |
| --- | --- | --- | --- | --- |
| | | Lower Limit | Upper Limit | |
| Level of HbA1C | -0.12 | -0.17 | -0.07 | <0.001 |
| Quality of life | 0.03 | 0.02 | 0.04 | <0.001 |
| Risk of complications | -0.45 | -0.68 | -0.22 | <0.001 |
| n observation=200 | | | | |

### 3. Multivariate Analysis

Based on Table 4, shows that there is a significant influence between tertiary preventive behavior which can influence the health impact of patients with type 2 diabetes mellitus. The HbA1c level variable can be significantly influenced by tertiary preventive behavior with a decrease of 0.65 units compared to those who do not carry out tertiary preventive action (b=-0.65, CI 95%= -0.11 to -0.01, p<0.001). This is supported by the significant influence of tertiary preventive behavior on increasing quality of life by 0.03 units (b=0.03, 95% CI= 0.21 to 0.33, p<0.001).

Table 4 shows the negative influence of tertiary preventive behavior on the risk of complications. Type 2 diabetes mellitus patients who carry out tertiary prevention can reduce the risk of complications by 0.12 units compared to those who do not (b=-0.12; 95%CI= -0.35 to -0.11; p<0.001).

**Table 4. The result of multiple linear regression analysis**

| Independent Variables | b | CI (95%) | | p |
| --- | --- | --- | --- | --- |
| | | Lower Limit | Upper Limit | |
| Level of HbA1C | -0.65 | -0.11 | -0.01 | 0.012 |
| Life quality | 0.03 | 0.21 | 0.33 | <0.001 |
| Complication risk | -0.12 | -0.35 | -0.11 | 0.293 |
| n observation=200 | | | | |
| Adj R²= 33% | | | | |
| p<0.001 | | | | |

### 4. Structural Equation Model Analysis

The image in Figure 1 shows the Structural Equation Model (SEM) output model. This model presents two components of SEM, namely the Confirmatory Factor Analysis (CFA) measurement component; structural components, and measurements.

Table 5 shows that tertiary preventive behavior directly and significantly decreased HbA1c levels (b= -0.30; 95% CI= -0.45 to -0.15; p <0.001). Age directly decreased HbA1c (b= -0.23; 95% CI= -0.36 to -0.11; p <0.001).

Tertiary preventive behavior directly and significantly improved QoL (b= 0.97; 95% CI= 0.72 to 1.23; p<0.001). It indirectly affected QoL trough complication. Complication was positively associated with QoL, but it was statistically non-sinificant (b= 0.15; 95% CI= -0.08 to 0.39; p= 0.194).

The risk of complication was directly and negatively affected by tertiary preventive behavior (b= -0.22; 95% CI= -0.42 to -0.03; p= 0.026) and age (b= -0.85; 95% CI= 0.20 to 0.33; p= 0.157). Age directly

increased the risk of complication (b= 0.43; 95% CI= 0.30 to 0.56; p<0.001).

Tertiary prevention behavior was affected by education (b= 0.04; 95% CI= -0.11 to 0.18 p= 0.632) and age (b= 0.38; 95% CI= -0.11 to 0.19; p= 0.618).

Tertiary prevention behavior comprised several indicators (manifest), including diet (loading factor= 0.56; p <0.001), exercise (loading factor= 0.46; p <0.001),

smoking behavior (loading factor= -0.10; 95% CI= 0.05 to 0.25; p= 0.197), and medication adherence (loading factor= 0.14; p= 0.075).

The results of the analysis show that the SEM model is in accordance with the data sample, which is indicated by several suitability indicators (p= 0.188; RMSEA= 0.04; CFI= 0.97; TLI= 0.95; SRMR= 0.05; CD= 0.07).
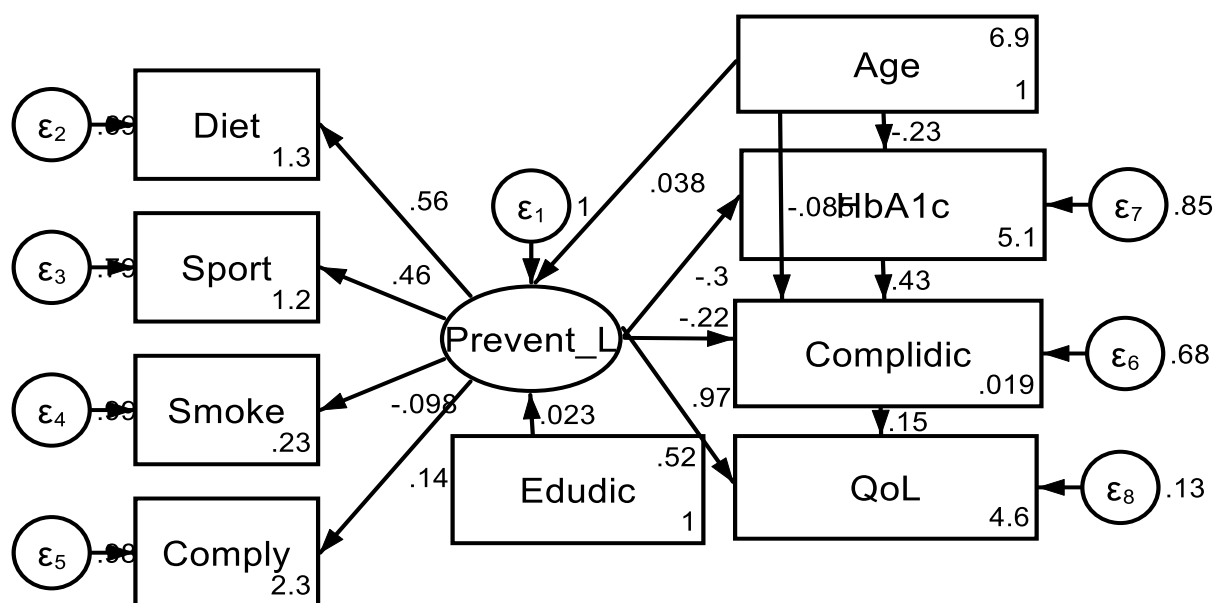


**Figure 1. Model of Structural Equation Model**

**Table 5. Structural Equation Model (SEM) Results**

| Dependent Variable | Independent Variable | Coeff (b) | CI 95% | | p |
|---|---|---|---|---|---|
| | | | Lower Limit | Upper Limit | |
| **Structural** | | | | | |
| HbA1c | ← Tertiary preventive | -0.30 | -0.45 | -0.15 | <0.001 |
| | ← Age | -0.23 | -0.36 | -0.11 | <0.001 |
| Quality of life | ← Tertiary preventive | 0.97 | 0.72 | 1.23 | <0.001 |
| | ← Complication risk | 0.15 | -0.08 | 0.39 | 0.194 |
| Complication risks | ← Tertiary preventive | -0.22 | -0.42 | -0.03 | 0.026 |
| | ← HbA1c | 0.43 | 0.30 | 0.56 | <0.001 |
| | ← Age | -0.85 | -0.20 | 0.33 | 0.157 |
| Tertiary preventive | ← Education | 0.04 | -0.11 | 0.18 | 0.632 |
| | ← Age | 0.38 | -0.11 | 0.19 | 0.618 |
| **Measurement** | | | | | |
| Tertiary preventive | ← Diet | 0.56 | 0.42 | 0.70 | <0.001 |
| | ← Exercise | 0.46 | 0.33 | 0.60 | <0.001 |
| | ← Smoking | -0.10 | -0.25 | 0.05 | <0.001 |

| Dependent Variable | Independent Variable | Coeff (b) | CI 95% | | p |
|---|---|---|---|---|---|
| | | | Lower Limit | Upper Limit | |
| ← Adherent to medication | | 0.14 | -0.01 | 0.29 | <0.001 |

p= 0.188
RMSEA= 0.036
CFI= 0.97; TLI= 0.95
SRMR= 0.050; CD= 0.072

## DISCUSSION

### a. Tertiary preventive behavior indicators

The results of the study showed that there was a direct influence of diet as a tertiary preventive factor in patients with type 2 diabetes mellitus (b= 0.56; 95% CI= 0.42 to 0.70; p <0.001). The diet is carried out by limiting the patient's food consumption patterns according to recommendations after being diagnosed with diabetes mellitus. Diet is said to be one of the most effective forms of preventive behavior for changing metabolic conditions for the better. Based on other studies, regular low-calorie intake can reduce the cardiovascular risk of obese diabetes patients (Umphonsathien et al., 2022).

Sport has an influence as a form of tertiary preventive behavior (b= 0.46; 95% CI= 0.33 to 0.60; p <0.001). Patients with type 2 diabetes mellitus can do exercise or physical activity to maintain a balanced body condition during treatment. Lack of physical activity in productive age becomes a bad habit for a person so that it can accumulate in old age and cause diabetes. Physical exercise on both the lower and upper extremities provided benefits in a controlled trial of patients with type 2 diabetes mellitus and aerobic fitness increased by 10% after testing (Hwang et al., 2019).

There was an influence on the smoking behavior of diabetes mellitus patients as a form of tertiary prevention (b= -0.10; 95% CI= -0.25 to 0.05; p <0.001). Smoking habits can increase the risk of diabetic nephropathy due to diabetes.

The content of cigarettes which has a bad effect on a person's health has led to recommendations to stop smoking. Another study shows that someone who habitually smokes is more susceptible to insomnia, anxiety, and irritability compared to those who take smoking cessation treatment in diabetes mellitus patients (Russo et al., 2022).

Adherence to taking medication is one of the factors that shape the tertiary preventive behavior of type 2 diabetes mellitus patients (b= 0.14; 95% CI= -0.01 to 0.29; p <0.001). This is related to the pharmacological treatment of other diseases. A person who receives a diagnosis of a disease must maintain a regular pattern of taking medication as recommended. In connection with improving the metabolic condition of patients with type 2 diabetes mellitus, thereby preventing the complications that arise (Nathan et al., 2022).

### b. The structural effect of tertiary prevention on HbA1c levels in T2DM patients

This research shows that there is a significant effect of tertiary preventive efforts on HbA1c levels (b= -0.30; 95% CI= -0.45 to -0.15; p <0.001). HbA1c levels are measured through the Prolanis program which is carried out twice a year. HbA1c is evidence of an accurate measurement of someone experiencing prediabetes or diabetes. Prolanis supports someone to make sustainable prevention efforts so that the next time the

HbA1c is measured, the results change. It has been proven in this study that carrying out a series of preventive measures frequently can reduce HbA1c levels in patients with type 2 diabetes mellitus.

A meta-analysis study on 9 RCT articles revealed that adjusting dietary consumption patterns can reduce HbA1c levels by 0.49 units higher compared to diabetes mellitus patients who do not diet (Kusumaningrum et al., 2022). Another study showed that with a trial of a low-carbohydrate diet for 6 months, diabetes patients experienced changes in decreasing HbA1c (Dorans et al., 2022). Apart from that, increased consumption of herbal plants such as curcuma longa rhizome extract can reduce HbA1c levels by 0.40 units in 11 other RCT study articles (Fatony et al., 2021).

Tertiary preventive studies such as regular exercise or physical activity have an effect of 0.81 units in reducing HbA1c levels compared to those who do not (Kusumaningrum et al., 2022). Regular physical activity is carried out to increase insulin sensitivity, and metabolism and control the body's glycemia so that HbA1c is reduced. In this study, health workers in Sukoharjo monitored and reminded diabetes mellitus patients registered with the Prolanis program to carry out tertiary prevention. Prolanis routinely exercises once every 2 weeks at the Puskesmas in each region. So that patients who are not used to doing physical activity can be motivated to take Prolanis.

**c. The structural influence of tertiary prevention on the quality of life of T2DM patients**

This research shows that there is a significant effect of tertiary preventive efforts on quality of life (b= 0.97; 95% CI= 0.72 to 1.23; p<0.001). Type 2 diabetes mellitus patients who undertake more tertiary preventive measures can improve their quality of life. A sense of comfort and a more meaningful meaning in life is felt after carrying out tertiary preventive efforts. Quality of life is measured by the WHOQoL component which consists of what one feels about oneself, one's abilities, and the support of people around the patient when undergoing treatment for type 2 DM.

A meta-analysis study on 7 similar articles shows that good family support for diabetes patients increases self-care by 2.22 times compared to those who do not receive support (Islami et al., 2021). Family support is important for diabetes mellitus patients. Lifestyle changes such as going on a diet and taking regular medication every day must always be supported by the family and people around you. Not only does family monitoring improve the quality of life of diabetes patients, but telemonitoring by health workers is very influential. Another meta-analysis proved that diabetes mellitus patients who were monitored by healthcare had a 0.16 times better quality of life than those who were not monitored (Sholihah et al., 2021).

**d. The structural influence of tertiary prevention on the risk of complications in T2DM patients**

This research shows that there is a significant effect of tertiary preventive efforts on the risk of complications (b= -0.22; 95% CI= -0.42 to -0.03; p= 0.026). Preventive efforts carried out frequently can reduce the risk of complications that occur in patients with type 2 diabetes mellitus. The results show that patients who carry out various preventive measures have fewer complications in their bodies. Lifestyle changes can update the pattern of diabetes mellitus so that the complications caused are reduced. According to other research, type 2 diabetes mellitus results in an accelerated increase in atherosclerosis resulting in the severity of peripheral vascular disease (Galicia-Garcia, et al., 2020).

The risk of complications is indicated by the pain that occurs when undergoing diabetes treatment. The presence of complications such as peripheral arterial disease, and hypertension in diabetes mellitus patients can increase the risk of leg amputation. A meta-analysis study of 9 cohort articles found that diabetes patients who had peripheral artery disease had a 2.46 times risk of lower limb amputation compared to those who had no complications (Septiani et al., 2020). The influence of other diseases causes many complications that occur in diabetes mellitus patients. Another study showed that there was an effect of two intervention groups on changes in body conditions such as complications of kidney diabetes and cholesterol in type 2 diabetes mellitus patients (Ueki et al., 2021).

Lifestyle change interventions have the effect of reducing the risk of complications. Diabetes mellitus patients are provided with education, regular monitoring of diet, increasing physical activity, and experiencing an influence on the risk of complications of diabetic peripheral neuropathy in a randomized clinical trial (Ghavami et al., 2018). The trial was carried out for 12 weeks and obtained different results between before the intervention and after the intervention.

This research uses a cross-sectional study model to briefly analyze the influence of efforts made by diabetes mellitus patients on changes in their health. The results of the differences in influence obtained can be applied directly by patients or general knowledge that this study has proven. Apart from that, the respondents obtained were not only elderly but pre-elderly. So it can be used as a reference for early prevention and early detection efforts. The limitation of this research is that the sample taken was only limited to 200 respondents with the hope that future research can take a larger number of respondents to represent the existing population. In addition, the interview process was very limited so it did not delve into the actual condition of diabetes mellitus patients on quality of life variables, thereby allowing research bias to occur.

## CONFLICT OF INTEREST
There is no conflict of interest in this study.

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