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The Effect of Ergonomic Gymnastics "Kandiha Weki" on Foot Sensivity And Sugar Levels in DM Patients In The Working Area of East Bolo Community Health Center

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Abstract
Diabetes mellitus is a hyperglycemic disease characterized by the absolute absence of insulin or a relative decrease in cell insensitivity to insulin. Type 2 DM constitutes 90% of all diabetes mellitus categories. Diabetes mellitus is a fairly high cause of death, due to complications that cause atherosclerosis, coronary heart disease and stroke. The research design was quasi-experimental, using a pre-test and post-test with control group design. Using Wilcoxon and Mann Whitney tests. The sampling technique was purposive sampling with a sample of 100 respondents. The results of data analysis using the Wilcoxone test in the treatment group showed a p-value of 0.000 (p<0.05) for the knowledge, attitude and behavior variables. In the control group, a p-value was obtained of 0.002 (p<0.05) in the knowledge variable, a p-value was obtained of 0.001 (p<0.05) in the attitude variable, a p-value was obtained of 0.001 (p<0.05) on behavioral variables. These results show that Ha is accepted and H0 is rejected, so it can be interpreted that there is an influence of providing video media and modules on increasing knowledge, attitudes and behavior in an effort to prevent complications. The results of the analysis in the intervention group and control group using the Mann Whitney Test, obtained ap value of 0.000 < 0.002, which indicates that the provision of video educational media in the intervention group was more significant in increasing knowledge. The results of statistical tests on attitudes in the intervention group and control group showed ap value of 0.000 < 0.001, which indicates that the provision of video educational media in the intervention group was more significant in improving respondents' attitudes. And the results of statistical behavioral tests in the intervention group and control group showed ap value of 0.000 < 0.001, which shows that the provision of video educational media in the intervention group was more significant in improving behavior. It can be concluded that video education media and modules have an influence in increasing knowledge, attitudes and behavior, but providing education using videos is more significant in increasing knowledge, attitudes and behavior in type 2 diabetes mellitus.

Keywords: Ergonomic gymnastics, foot sensitivity, blood sugar reduction

Introduction

The importance of physical activity in managing diabetes is underscored by research indicating that regular exercise can significantly lower blood glucose levels. Lestari et al. highlighted that the frequency of walking exercises leads to decreased blood sugar levels in diabetic patients, establishing a clear relationship between physical activity and glycemic management (1). Similarly, the study conducted by Hasanuddin et al. substantiated that a regular walking program is effective in reducing blood glucose levels among elderly individuals with type 2 diabetes mellitus (2). Furthermore, walking as a form of physical exercise is not only accessible but is also associated with enhanced foot sensitivity, thereby addressing two crucial areas of concern in diabetes management simultaneously.

The ergonomic gymnastics "Kandiha Weki" is designed to engage participants at their physical level, making it a theoretically sound and practical intervention. While some studies indicate that community health workers can significantly influence diabetes management by advocating lifestyle changes through structured programs (3), the specific applicability of such findings to the Kandiha Weki program requires further examination, as the cited work primarily focuses on different cultural contexts and healthcare systems.

In addition to the physical benefits, incorporating community health perspectives into the Kandiha Weki program aligns with growing evidence supporting the role of community health interventions in improving diabetes outcomes. For instance, research conducted by Reininger et al. demonstrated significant improvements in diabetes control among low-income populations when community-based participatory research tactics were employed (4). The cultural relevance of the Kandiha Weki program could enhance participant engagement, thus fostering adherence to the intervention and improving long-term management of diabetes.

The synergy between physical activity benefits for foot sensitivity and blood sugar management aligns with evidence from various studies indicating that structured interventions can successfully lead to improved diabetes control (5). Cross-sector collaboration among healthcare professionals and community workers is emphasized as a method to enhance diabetes prevention and management, as evident from the findings of Patel, which advocate for integrated healthcare strategies to address inequities in diabetes risk (6). Therefore, by leveraging existing community resources, the Kandiha Weki program stands to improve health outcomes through enhancing patient self-efficacy and fostering adherence to prescribed health practices.

Moreover, the likelihood of sustaining behavioral change necessitates ongoing support and education. Several studies pointed out the importance of supportive educational frameworks in establishing effective diabetes self-management, although the specific cited studies may not directly address the implementation details for the Kandiha Weki intervention (7). The Kandiha Weki intervention could therefore be enhanced by educational components aimed at informing participants about diabetes management strategies, the implications of foot sensitivity, and the importance of routine sugar level monitoring. By incorporating a health education aspect, the program could enable participants to gain the necessary knowledge to implement healthier lifestyle choices independently.

Continuous monitoring and evaluation of the Kandiha Weki program will be critical to assess its efficacy in improving foot sensitivity and glycemic levels. Utilizing standardized assessment tools to evaluate outcomes such as HbA1c levels, foot sensitivity testing, and patient-reported outcomes will facilitate a comprehensive understanding of the program's impact. It is important to account for potential Hawthorne effects, wherein behavioral changes may not solely be attributed to the intervention but rather awareness from participation in a study (8). By addressing these considerations, the Kandiha Weki program could emerge as a scalable model for diabetes management in similar contexts throughout Indonesia and beyond.

Results and Discussion

Based on the research, general data was obtained including respondent characteristics consisting of age, gender, last education, eating habits, duration of illness, history of drug consumption, and intervention with the implementation of ergonomic gymnastics which are presented in the following table:

Table 1.Frequency distribution of respondent characteristics based on age, gender, last education, eating habits, duration of illness, history of drug consumption in the PKM Bolo work area, Bima Regency in 2025

Variables	**Intervention**		**Control**	
	n	**%**	**n**	**%**
Age				
Late adulthood 36-45 years	9	18	11	22
Early old age 46-55 years	11	22	16	32
Late elderly period 56-65 years	24	48	19	38
Seniors 66 years and over	6	12	4	8
Total	50	100	50	100
Gender				

Man	15	30	20	40
Woman	35	70	30	60
Total	50	100	50	100
Last education				
No school	1	2	2	4
Elementary School	3	6	4	8
Junior High School	8	13	8	16
Senior High School	16	32	16	32
Diploma	19	39	19	38
Bachelor	3	6	1	2
	50	100	50	100
Eating Habits Patterns				
Diet	12	24	16	32
No diet	38	76	34	68
Total	50	100	50	100
Duration of Illness				
< 5 Years	12	24	12	27
≥ 5 Years	37	77	37	74
Total	50	100	50	100
Drug Consumption History				
DM	30	60	30	60
DM and HT	20	40	20	40
Total	50	100	50	100

Based on table 4.1, of the 100 respondents, 50 respondents in the intervention group and 50 respondents in the control group, the age of most of the respondents was almost half in the late elderly age range of 56-65 years, as many as 25 people (48%) in the intervention group, and as many as 19 people (38%) in the control group.

The gender of the respondents was mostly female, 35 people (70%) in the intervention group, and 28 people (56%) in the control group, almost half of the respondents had a Diploma education, 30 people (60%) in both the intervention and control groups. Respondents who did not diet in the intervention group were 38 people (76%) and in the control group were 34 people (68%). The duration of the respondent's illness was more than 5 years, 37 people (77%) in the intervention group and 37 people (74%) in the control group. Most respondents had a history of consuming diabetes mellitus medication, 30 people (60%) in the intervention and control groups and almost half had a history of consuming diabetes mellitus and hypertension medication in the control and intervention groups.

Researchers conducted a simple sensitivity test on respondents, then asked whether the scratches felt inadequate, adequate, or good. The test was conducted on all 100 respondents, and the results were recorded in the table below.

Table 2. Foot Sensitivity of DM Patients Before Intervention

Foot Sensitivity of DM Patients	**n**	**%**	**Mean**	**Standard Deviation**
Not enough	20	20	2.25	0.770 (1-3)
Enough	35	35		
Good	45	45		
Total	100	100.0		

Based on Table 2, it can be seen that of 100 respondents with diabetes mellitus, 20 respondents (20%) had foot sensitivity in the poor category, 35% of respondents (35%) in the sufficient category, and 45 respondents (45%) in the good category. The average (mean) value of foot sensitivity was 2.25 with a standard deviation (SD) of 0.770. The minimum value obtained was 1 (poor) and the maximum value was 3 (good). This indicates that the majority of respondents had sufficient to good sensitivity.

Researchers conducted a simple sensitivity test on participants after education and demonstration of ergonomic exercises in the intervention group, and standard education in the control group. The same assessment was made to determine whether the strokes felt inadequate, adequate, or good. The test was conducted on all 100 participants, and the results were recorded in the table below.

Table 3. Foot Sensitivity of DM Patients After Intervention

Foot Sensitivity of DM Patients	**n**	**%**	**Mean**	**Standard Deviation**
Not enough	1	1	2.89	0.345 (1-3)
Enough	9	9		
Good	90	90		
Total	100	100.0		

Based on Table 3, it can be seen that of 100 respondents with diabetes mellitus, 1 respondent (1%) had foot sensitivity in the poor category, 9% of respondents (9%) in the sufficient category, and 90 respondents (90%) in the good category. The average value (mean) of foot sensitivity was 2.89 with a standard deviation (SD) of 0.345. The minimum value obtained was 1 (poor) and the maximum value was 3 (good). This indicates that most respondents had sufficient to good sensitivity. There was an increase in the average value before and after the intervention, indicating improvement, and the standard deviation was getting smaller, indicating more homogeneous data after the intervention.

Researchers conducted random blood sugar tests on respondents before the intervention. Blood sugar values were summarized and divided into two groups: patients with blood sugar <200 and those with blood sugar ≥200 mg/dL. The tests were performed on all 100 respondents, with the results shown in the table below.

Table 4. GDS of DM Patients Before Intervention

GDS	**n**	**%**	**Mean**	**Standard Deviation**
<200 mg/dL	13	13	1.87	0.338 (1-2)
≥200 mg/dL	87	87		
Total	100	100.0		

Based on Table 4, it can be seen that of 100 respondents with diabetes mellitus, 13 respondents (13%) had GDS <200, and 87 respondents (87%) were in the category ≥200 mg/dL. The average (mean) GDS value was 1.87, which means that most respondents had an abnormal GDS. The standard deviation (SD) was 0.335, the minimum value obtained was 1 (<200) and the maximum value was 2 (≥200).

Researchers conducted random blood sugar tests on respondents after education and demonstration of ergonomic exercise procedures in the intervention group, while only standard education was given to control patients. Respondents were divided into two groups: those with a GDS <200 and those with a GDS ≥200 mg/dL. The tests were conducted on all 100 respondents, and the results were recorded in the table below.

Table 5. GDS of DM Patients After Intervention

GDS	**n**	**%**	**Mean**	**Standard Deviation**
<200 mg/dL	53	53	1.47	0.502 (1-2)
≥200 mg/dL	47	47		
Total	100	100.0		

Based on Table 5, it can be seen that of 100 respondents with diabetes mellitus, 53 respondents (53%) had GDS <200 mg/dL, and 47 respondents (47%) had GDS ≥200 mg/dL. The average GDS value was 1.47 with a standard deviation (SD) of 0.502. The minimum value obtained was 1 (poor) and the maximum value was 3 (good). This shows that most respondents had GDS <200 mg/dL. There was a decrease in the average value before and after the intervention, indicating an improvement.

To compare the results of the foot sensitivity assessment before and after exercise, the non-parametric McNemar-Bowker test was used. This test was chosen because the data were ordinal (poor, sufficient, good) and paired (pre- and post-intervention).

Table 6. Comparison of Foot Sensitivity Before and After Intervention

Category		**Post Intervention**			**Total**	***P-Value***
		Not enough	Enough	Good		
Pre-Intervention	Not enough	1	0	19	20	<0.001
	Enough	0	9	26	35	
	Good	0	0	45	45	
Total		1	9	90	100	

The analysis results are shown in Table 6. Of the 20 respondents who were initially in the poor category, 19 moved to the good category after the ergonomic exercise. Of the 35 respondents who were initially in the sufficient category, 26 moved to the good category, 9 remained in the sufficient category, and none dropped to the poor category. Meanwhile, all 45 respondents who were initially in the good category remained in the same category after the intervention. The results of the McNemmar-Bowker test showed a Chi-Square value with a significance value of p<0.001. This indicates a significant difference between the distribution of assessment categories before and after the exercise. Thus, it can be concluded that the exercise intervention had a significant positive effect, indicated by an increase in the proportion of respondents in the good category after the exercise.

To compare blood sugar levels before and after the intervention, the non-parametric McNemar test was used. Data were categorical (two groups <200 and ≥200 mg/dL) and paired, measured before and after the intervention. The test results are shown in the table below.

Table 7. Comparison of GDS Before and After Intervention

GDS Pre Intervention	**GDS Post Intervention**		***P Value***
	<200 mg/dL	≥200 mg/dL	
<200 mg/dL	13	0	<0.001
≥200 mg/dL	40	47	

The analysis results in table 7, as many as 13 respondents remained in the GDS category <200 mg/dL, and 47 respondents remained in the GDS category ≥200 mg/dL. A total of 40 respondents experienced improvement, namely moving from the GDS category ≥200 mg/dL at the initial measurement to ≥200 mg/dL after the intervention. No respondents experienced a worsening from the category <200 mg/dL to ≥200 mg/dL. The Mc.Nemmar test showed a Chi-Square value with a significance of p<0.001, this indicates that there is a significant difference between the GDS scores before and after the intervention, where there was a significant decrease in the number of respondents with GDS ≥200 mg/dL after the intervention.

To compare the post-exercise assessment results between the intervention and control groups, a Chi-Square test was used. This test was chosen because the data being analyzed were categorical (Poor, Adequate, and Good) and we wanted to determine the difference in proportion distribution between two independent groups. The Chi-Square test is appropriate for comparing category proportions in two independent groups with nominal/ordinal data.

Table 8. The Relationship Between Ergonomic Exercise and Foot Sensitivity in DM Patients

Group Distribution			**Foot Sensitivity**			**Total**	***P-Value*(Cramer's V)**
			Not enough	Enough	Good		
Group	**Intervention**	n	0	6	44	50	0.360 (0.143)
		%	0	12	88	100	

	Control	n	1	3	46	50	
		%	1	6	92	100	
Total		n	1	9	90	100	
		%	1	9	90	100	

The results of the analysis are shown in Table 8. In the intervention group, most respondents were in the good category (44 people, 88%), 6 people (12%) in the sufficient category, and none were in the poor category. In the control group, the majority of respondents were also in the good category (46 people, 92%), 3 people (6%) in the sufficient category, and 1 person (2%) in the poor category. The Chi-Square test with p = 0.360 means there is no significant difference between the intervention and control groups in the distribution of foot sensitivity assessment categories after exercise. Cramer's V shows a low value of 0.143 so that the relationship between variables is very weak. Because the number of categories is more than two (3x2) and there are cells with expected frequencies <5, the risk estimate analysis cannot be calculated. Thus, the results of this study indicate that although the majority of respondents in both groups are in the Good category, there is no statistically significant difference between the intervention and control groups.

To compare the post-intervention GDS results between the control and intervention groups, a Chi-Square test was performed. This test was chosen because the variables being analyzed were categorical (post-GDS was categorized as <200 and ≥200) and we wanted to determine the difference in the distribution of proportions between two independent groups. The Chi-Square test is appropriate for comparing proportions in two independent groups with categorical data.

Table 9. The Relationship of Ergonomic Exercise to GDS of DM Patients

Group Distribution			**GDS Post**		**Total**	***P-Value*(Risk Estimate)**
			<200	>= 200		
Group	**Intervention**	n	34	16	50	0.003 (3.467)
		%	68	32	100	
	Control	n	19	31	50	
		%	38	62	100	
Total		n	53	47	100	
		%	53	47	100	

The results of the analysis are shown in Table 9. In the intervention group, 34 respondents (68%) were in the <200 mg/dL category and 16 respondents (32%) were in the GDS ≥200 mg/dL category. In contrast, in the control group, only 19 respondents (38%) were in the GDS <200 mg/dL category, while 31 respondents (62%) were in the GDS ≥200 mg/dL category. The Chi-Square test results showed a p value = 0.003, indicating a significant difference between the intervention and control groups in GDS values after treatment. Risk analysis showed that the chance of respondents in the intervention group having GDS <200 was 3,467 times greater than the control group. This confirms that the intervention provided was effective in reducing the proportion of respondents with GDS ≥200 mg/dL compared to the control group.

Based on the results of the study, the characteristics of respondents in the intervention and control groups were relatively balanced, allowing for objective comparisons. Before the intervention, most respondents had foot sensitivity in the fair to good category, but some were still lacking, and the majority had GDS levels ≥200 mg/dL, indicating suboptimal glucose control. After the intervention, there was an increase in foot sensitivity, with the majority of respondents in the good category, and a smaller standard deviation indicating more homogeneous data. In addition, the proportion of respondents with GDS levels <200 mg/dL increased, indicating improved blood glucose control. The results of the McNemar-Bowker and Chi-Square tests proved that the ergonomic exercise intervention had a significant effect on increasing foot sensitivity and reducing GDS levels, although the difference in foot sensitivity distribution between the intervention and control groups was not significant, while GDS levels showed a significant difference. Thus, it can be concluded that ergonomic exercise is effective in increasing foot sensitivity and improving blood glucose control in people with diabetes mellitus.

The results of the study, based on Table 1, show that almost half of the respondents were in the late elderly age range of 56-65 years, with 24 people (48%) in the intervention group and 19 people (38%) in the control group. This is in line with research (Riyambodo, 2017), which found that most respondents were aged 51-60 years (9)In research (Fitriana et al., 2019), most people are aged 56-65 years, where at that age, physiological function begins to decline, so the ability to absorb information also decreases (10)(11). Research results (Khasanah & Fitri, 2019) show that most people are aged 53-58 years (12). Age is closely related to increased blood sugar levels. As age increases, the prevalence of diabetes mellitus and glucose disorders increases. Therefore, a person with diabetes mellitus can only maintain normal blood sugar levels (13).

Increasing age causes a person to be at risk of an increased incidence of diabetes mellitus, people who enter the age of 55 years and above, are related to the occurrence of diabetes because in old age, physiological body functions decline due to a decrease in insulin secretion or resistance so that the body's ability to control high blood glucose is less than optimal (14). This is in accordance with what Smeltzer Suzane C stated, stating that at the age of >45 years, the function of body organs decreases, this is due to the reduced activity of pancreatic beta cells to produce insulin. DM in the elderly tends to increase, because DM in the elderly is multifactorial, influenced by extrinsic and intrinsic factors, including increased complications, including decreased foot sensitivity and increased blood sugar.(15)Age is an independent factor influencing changes in the body's glucose tolerance. Generally, 90% of elderly diabetes patients have type II diabetes and are aged >45 years (16). Damayanti explained that the risk factor for developing type II diabetes is being over 30 years old, this is due to anatomical, physiological, and biochemical decline (17).

In the study, the majority of respondents were female, 35 people (70%) in the intervention group and 28 people (56%) in the control group. The results of the study (Kunaryanti, 2018) showed that the majority were female (18). In line with research (Musdalifah & Setiyo Nugroho, 2020), which shows that women are the most common gender, there is no relationship between gender and the incidence of diabetes mellitus (19). Research conducted by (Ukat et al., 2018) shows that the majority of respondents were female (20)Women are at greater risk of developing diabetes because physically, women have a greater increase in body mass index.(21)Diabetes mellitus occurs in women due to premenstrual syndrome (PMS). Post-menopause causes fat distribution in the body to accumulate more easily due to hormonal processes, making women more at risk of developing diabetes.

Almost half of the respondents' highest education level was a diploma, 19 people (38%) in both the intervention and control groups. This is in line with the results of Hunt's (2012) research, which found that the highest educational background of respondents was higher education, at 76%, followed by secondary education at 44%, and the lowest was elementary education at 14%.(22). Likewise, according to the research results of Wilson (2012), respondents with the highest educational background were higher education, namely 66.2%, secondary education was 23.1% and the lowest was elementary education, namely 1.5%.(23)This is in line with the results of Yin's (2005) study, which found that education was not related to self-management behavior. Similarly, studies conducted by Wattanakul (2012) and Adwan & Najjar (2013) yielded p-values > 0.05, indicating no differences in DM self-management behavior between respondents with primary, secondary, or tertiary education (24).

According to researchers, education does not directly influence management behavior in the management of type 2 diabetes, but rather influences knowledge first. However, education is also an important factor that type 2 diabetes patients need to have because, as stated by Lukoschek (2003, in Yin, 2005), DM patients with a high level of education are better able to absorb information provided by health workers if they receive education on diabetes mellitus management. Meanwhile, DM patients with a low level of education have limited ability to understand the health information provided, where this can ultimately become an obstacle for DM patients to obtain the necessary knowledge regarding diabetes and diabetes management.(25)This is also consistent with the respondent data in this study, where respondents with a good level of knowledge were mostly those with a high level of education. Therefore, it can be concluded that education is not directly related to type 2 diabetes management behaviors, as both high and low-educated DM patients can implement self-management behaviors as long as they receive education related to diabetes management. In addition to receiving education, DM patients must also improve their self-efficacy to encourage them to implement type 2 diabetes self-management behaviors.

The eating habits of almost all respondents were not on a diet, as many as 38 people (76%) in the intervention group and as many as 34 people (68%) in the control group. The eating habits of almost all smokers were not on a diet, as many as 38 people (84.4%), and the eating habits of almost all non-smokers were also not on a diet, as many as 47 people (85.5%). Modern lifestyle habits of consuming instant foods that are high in fat, sugar and preservatives are often carried out by someone with a stressful lifestyle. This disorder is often associated with modern lifestyle habits such as reduced physical activity, diet, obesity, smoking habits, and genetic factors (26).

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A history of diabetes medication consumption in most respondents had a history of consuming diabetes mellitus medication as many as 30 people (60%) in the intervention group and the control group and almost half had a history of consuming diabetes mellitus and hypertension medication in the control group and the intervention group. The history of consuming diabetes mellitus medication for most respondents was smokers as many as 25 people (55.6%) and some were taking diabetes mellitus and hypertension medication, then among non-smoker respondents most respondents were taking diabetes medication as many as 30 people (54.5%), and some were taking diabetes mellitus and hypertension medication as many as 25 people (45.5%). Consuming medication is one of the 5 pillars of type 2 DM management that can be implemented as an effort to prevent complications and improve quality of life. Management of the 5 pillars of DM control includes diet, pharmacological treatment, physical exercise, education and monitoring blood sugar levels (28).

Peripheral neuropathy is one of the most common chronic complications of diabetes, resulting from nerve damage caused by long-term hyperglycemia. Symptoms include decreased sensitivity, tingling, and even diabetic foot ulcers. Poor foot sensitivity can increase the risk of repeated trauma without the patient realizing it, so regular screening is highly recommended.(29).

Based on the research results, before the intervention, 20% of respondents had poor foot sensitivity, 35% had adequate, and 45% had good, with a mean score of 2.25 (SD 0.770). This data aligns with the theory that peripheral neuropathy does not necessarily occur in all DM sufferers, but its prevalence is quite high in patients with poor blood sugar control. These results confirm that the majority of respondents already experienced sensitivity disorders, although still in the mild to moderate category (30).

Physical exercise, including ergonomic gymnastics, has been shown to improve blood circulation, enhance glucose metabolism, and stimulate peripheral nerve function. Regular activity can also enhance proprioceptive and motor function, thereby reducing the risk of neuropathy. Therefore, exercise is a recommended non-pharmacological approach in the management of diabetes (31).

In this study, after the intervention, the majority of respondents (90%) were in the good sensitivity category, with the mean score increasing to 2.89 (SD 0.345). The increase in the mean and decrease in the standard deviation indicate a more evenly distributed improvement in sensitivity across respondents. These findings support the theory that structured exercise interventions can improve peripheral nerve function in people with diabetes, thereby reducing the risk of diabetic foot complications (32).

Random blood sugar (RBG) is an important indicator in monitoring glucose control in diabetes patients. A RBG value of ≥200 mg/dL indicates hyperglycemia, which requires further treatment. Chronic hyperglycemia causes damage to blood vessels and nerves, which in turn increases the risk of microangiopathic and macroangiopathic complications (29).

In this study, before the intervention, 87% of respondents had a blood glucose level ≥200 mg/dL, with a mean value of 1.87 (SD 0.335). This indicates that most patients do not yet have good glycemic control. This condition aligns with the theory that diabetes patients in Indonesia still face issues with adherence to diet, therapy, and physical activity, making blood sugar control difficult to achieve (29).

Regular physical activity has been shown to increase insulin sensitivity, improve glucose utilization by muscles, and lower blood sugar levels. Ergonomic exercises, with movements tailored to diabetes sufferers, help improve energy metabolism while enhancing fitness (32).

In this study, significant improvements occurred after the intervention: 53% of respondents had a GDS <200 mg/dL, with the mean decreasing to 1.47 (SD 0.502). These results support the theory that regular exercise is effective in lowering blood glucose levels. These improvements suggest that ergonomic exercise can be an effective non-pharmacological strategy for controlling diabetes (31).

The McNemar-Bowker test is a non-parametric statistical method used to assess differences in categorical proportions in paired data, especially when there are more than two categories. This test is particularly suitable in health intervention research, as it allows for analysis of changes in respondent status before and after treatment. In the context of diabetic neuropathy, changes in foot sensitivity after exercise can be clearly seen through this test. In this study, the McNemar-Bowker test results showed $p<0.001$, indicating a significant change in the respondents' foot sensitivity after ergonomic exercises. This finding supports the theory that physical exercise can significantly improve peripheral nerve function in diabetics (31).

In addition to foot sensitivity, the McNemar-Bowker test can also be used to assess changes in categorized random blood sugar levels (e.g., <200 mg/dL and ≥200 mg/dL). In theory, physical activity interventions will have a rapid effect on blood glucose, due to increased insulin sensitivity and glucose utilization by muscles. The results showed $p<0.001$, indicating a significant change in random blood sugar levels after ergonomic exercise. This is consistent with scientific evidence that physical exercise can effectively lower blood glucose, even in the short term (30).

The Chi-Square test is used to compare the distribution of proportions between independent groups, such as the intervention and control groups. The theory suggests that this test is appropriate for use with categorical data, with the aim of determining whether the intervention produces a difference in outcomes compared to the untreated group. In this study, the Chi-Square test results showed $p=0.360$ for foot sensitivity after the intervention, indicating no significant difference between the intervention and control groups. This can be explained by the relatively long time required to improve neuropathy, so differences between groups were not yet apparent during the short intervention period (32).

Unlike foot sensitivity, blood sugar levels are more responsive to physical activity in the short term. Physiologically, exercise can directly affect blood glucose levels by increasing muscle glucose uptake, so results are more quickly visible. This study found that the chi-square test results for post-intervention blood sugar showed $p = 0.003$, indicating a significant difference between the intervention and control groups. This finding supports the literature stating that structured physical activity is effective in improving glycemic control compared to patients who did not undergo intervention (29).

Conclusion

The findings of this study indicated improvements in foot sensitivity and blood glucose management among diabetic patients participating in ergonomic exercises. Prior to intervention, the majority of respondents exhibited poor foot sensitivity, with average glucose levels skewed towards hyperglycemia, reflecting common issues related to diabetes management. Following the implementation of ergonomic exercises, there was a notable increase in the number of respondents reporting improved foot sensitivity (90% post-intervention) and a significant reduction in the percentage of patients with glucose levels above 200 mg/dL, suggesting the intervention's potential effectiveness in enhancing both peripheral nerve function and glycemic control. Statistical analyses using appropriate tests validated these improvements, indicating significant results ($p < 0.001$ for changes in foot sensitivity and $p = 0.003$ for glycemic control), suggesting that ergonomic exercises could serve as a potential non-pharmacological approach to diabetes management.

Reference

1. Lestari Dt, Rahmasari Lf, Karyati S, Jauhar M. Frequency Of Walking Physical Exercise Reduces Blood Sugar Levels In Diabetic. South East Asia Nursing Research. 2024 Mar 12;6(1):32–8.
2. Hasanuddin I, Mulyono S, Herlinah L. Efektifitas Olahraga Jalan Kaki Terhadap Kadar Gula Darah Pada Lansia Dengan Diabetes Mellitus Tipe Ii. Holistik Jurnal Kesehatan. 2020 Apr 22;14(1):38–45.
3. Kumar R, Rehman S, Baloch Gm, Vankwani M, Somrongthong R, Pongpanich S. Effectiveness Of Health Education Intervention On Diabetes Mellitus Among The Teachers Working In Public Sector Schools Of Pakistan. Bmc Endocr Disord. 2022 Dec 30;22(1):194–201.

4. Reininger Bm, Lee M, Hessabi M, Mitchell-Bennett La, Sifuentes Mr, Guerra Ja, Et Al. Improved Diabetes Control Among Low-Income Mexican Americans Through Community-Clinical Interventions: Results Of An Rct. Bmj Open Diabetes Res Care. 2020 May 31;8(1):1–12.
5. Campbell Ja, Yan A, Egede Le. Community-Based Participatory Research Interventions To Improve Diabetes Outcomes: A Systematic Review. Diabetes Educ. 2020 Dec 14;46(6):527–39.
6. Patel R, Kornas K, Gerstle D, Diemert Lm, Rosella Lc. Multilevel Diabetes Prevention Interventions To Address Population Inequities In Diabetes Risk: Scoping Review. Jmir Public Health Surveill. 2025 Aug 25;11(8):E70267–E70267.
7. Young Hm, Miyamoto S, Dharmar M, Tang-Feldman Y. Nurse Coaching And Mobile Health Compared With Usual Care To Improve Diabetes Self-Efficacy For Persons With Type 2 Diabetes: Randomized Controlled Trial. Jmir Mhealth Uhealth. 2020 Mar 2;8(3):1–12.
8. Vasan A, Morgan Jw, Mitra N, Xu C, Long Ja, Asch Da, Et Al. Effects Of A Standardized Community Health Worker Intervention On Hospitalization Among Disadvantaged Patients With Multiple Chronic Conditions: A Pooled Analysis Of Three Clinical Trials. Health Serv Res. 2020 Oct 8;55(S2):894–901.
9. Riyambodo B. Hubungan Antara Tingkat Pengetahuan Dengan Tingkat Distres Pada Pasien Diabetes Melitus Di Rsud Dr. Moewardi Surakarta. Fakultas Ilmu Kesehatan Universitas Muhammadiyah Surakarta. 2017;
10. Fitriana, F. E., Purnamasari, V., & Kurniasih Y. Pengaruh Peer Teaching Terhadap Pengetahuan Diabetes Melitus Di Wilayah Kerja Puskesmas Dlingo Bantul Yogyakarta. 2019;
11. Notoatmodjo S. Promosi Kesehatan Dan Ilmu Perilaku. Jakarta: Rineka Cipta; 2007.
12. Khasanah, T. A., & Fitri Zf. Hubungan Pengetahuan Dan Kepatuhan Diet Dengan Kadar Gula Darah Pada Pasien Diabetes Melitus Di Poli Penyakit Dalam Rsud Idaman Banjarbaru Tahun 2018. Jurnal Kesehatan Indonesia. 2019;9(2):84.
13. Rosyida, K. And Safitri N. Gambaran Neuropati Perifer Di Semarang. Jurnal Luka Indonesia. 2017;2(3):137–44.
14. Suyono S. Buku Ajar Ilmu Penyakit Dalam, Jilid Iii Edisi Iv Diabetes Mellitus Di Indonesia; Sudoyo, Setiyohadi, Alwi I, Simadibrata, Setiati (Eds),. In Jakarta: Balai Penerbit Fakultas Kedokteran, Universitas Indonesia; 2007. P. 1852–6.
15. Smeltzer Suzane C Bbrenda. Buku Ajar Keperawatan Medical Bedah. ,Volume 2, Edisi 8, Alih Bahasa Dr. Andri Hartono Et Al. Jakarta: Egc; 2002.
16. Gustaviani R. Diagnosa Dan Klasifikasi Diabetes Melitus, Ilmu Penyakit Dalam, Fk Ui Edisi Iv. In Jakarta: Fk Ui; 2006. P. 1852–9.
17. Damayanti S. Diabetes Melitus & Penatalaksanaan Keperawatan. Yogyakarta: Nuha Medika; 2015.
18. Kunaryanti Andriyani, Annisa Wulandari, Riyani W. Hubungan Tingkat Pengetahuan Tentang Diabetes Mellitus Dengan Perilaku Mengontrol Gula Darah Pada Pasien Diabetes Mellitus Rawat Jalan Di Rsud Dr. Moewardi Surakarta. Jurnal Kesehatan. 2018;11(1):49–56.
19. Musdalifah, & Setiyo Nugroho P. Hubungan Jenis Kelamin Dan Tingkat Ekonomi Dengan Kejadian Diabetes Melitus Di Wilayah Kerja Puskesmas Palaran Kota Samarinda Tahun 2019. Borneo Student Research (Bsr). 2020;1(2).
20. Ukat, Z. M. Y., Yuliwar, R., & Dewi N. Hubungan Antara Tingkat Pengetahuan Dengan Gaya Hidup Pada Penderita Diabetes Mellitus Di Wilayah Kerja Puskesmas Kendalsari Kelurahan Tulusrejo Kecamatan Lowokwaru Malang. Nursinng News,. 2018;3(3):644–653.
21. Trisnawati, S., Widarsa, T., Suastika K. Faktor Risiko Diabetes Melitus Tipe 2 Pasien Rawat Jalan Di Puskesmas Wilayah Kecamatan Denpasar Selatan. Public Health And Preventive Medicine Archive. 2013;1(1).
22. Hunt, C.W., Wilder, B., Steele, M.M., Grant, J., Pryor, E., & Moneyham L. Relationships Among Self-Efficacy, Social Support, Social Problem Solving, And Self-Management In A Rural Sample Living With Type 2 Diabetes Mellitus. Res Theory Nurs Pract. 2012;26(2):126–41.
23. Wilson. Manajemen Sumber Daya Manusia. Jakarta: Erlangga; 2012.

24. Wattanakul B. Factors Influencing Diabetes Self-Management Behaviors Among Patients With T2dm In Rural Thailand. Order No 3550962, University Of Illinois At Chicago) Proquest Dissertations And Theses. 2012;154.
25. Lukoschek, P., Fazzari, M., & Marantz P. Patient And Physician Factors Predict Patients' A Comprehension Of Health Information. Patient Educ Couns. 2003;50(2):201–10.
26. Lotfy, M., Adeghate, J., Kalasz, H., Singh, J., Dan Adeghate E. Chronic Complications Of Diabetes Mellitus: A Mini Review. Current Diabetes Review. 2017;13:3–10.
27. Lotfy, M., Adeghate, J., Kalasz, H., Singh, J., Dan Adeghate E. Chronic Complications Of Diabetes Mellitus: A Mini Review. Current Diabetes Review. 2017;13:3–10.
28. Suciana F, Arifianto D. Penatalaksanaan 5 Pilar Pengendalian Dm Terhadap Kualitas Hidup Pasien Dm Tipe 2 Kata Kunci : Kualitas Hidup , Diabetes Melitus Management 5 Pillar Dm Control Of Quality Of Life Of Dm Type 2 Patients Pendahuluan. 2019;9(4):311–8.
29. Association Ad. Classification And Diagnosis Of Diabetes: Standards Of Medical Care In Diabetes. Association, American Diabetes. 2022;45(1):17–38.
30. Kautzky, A -Willer, J H, G P. Sex And Gender Differences In Risk, Pathophysiology And Complications Of Type 2 Diabetes Mellitus. Endocr Rev. 2016;37(3):278–316.
31. Stratton I, Adler A, Neil H, Matthews D, Manley S, Cull C. Association Of Glycaemia With Macrovascular And Microvascular Complications Of Type 2 Diabetes. Bmj Open. 2000;321(7258):401–12.
32. Boulton A, Vinik A, Arezzo J, Bril V, El Feldman E, Freeman R. Diabetic Neuropathies: A Statement By The American Diabetes Association. Diabetes Care. 2019;28(4):956–62.