

THE RELATIONSHIP AMONG PHYSICAL ACTIVITY AND PERIPHERAL NEUROPATHY IN DIABETIC PATIENTS IN 2022 AMONG THE ELDERLY IN SAUDI ARABIA AND HEALTH-RELATED QUALITY OF LIFE

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Abstract:

Background

The most prevalent long-term complication of diabetes is diabetic neuropathy, which often manifests as agonizing diabetic peripheral neuropathy (DPN). This condition has the potential to greatly diminish the quality of life (QOL) of affected patients. Diabetic peripheral neuropathy (DPN) is a significant risk factor for skin disintegration, amputation, and decreased physical mobility (e.g., difficulty ascending stairs and walking). It affects over 50% of individuals with diabetes. While numerous studies have established the positive effects of exercise for individuals with diabetes, there is a scarcity of research investigating whether exercise offers similar advantages for individuals with DPN. DPN was previously regarded as an indication against walking or any weight-bearing exercise due to the risk of injuring an individual's insensitive feet. However, subsequent to research findings that weight-bearing activities do not elevate the risk of foot ulcers in individuals with DPN but not severe foot deformity, these recommendations were recently modified. **Objective:** to examine the correlation between physical activity and peripheral neuropathy in diabetic patients in 2022; assess the relationship between physical activity and health-related quality of life among the elderly residing in Saudi Arabia. **Method:** The research

design employed in this descriptive cross-sectional study was older individuals diagnosed with type 2 diabetes who presented with peripheral neuropathy at primary healthcare centers in Saudi Arabia in 2022. This commentary examines the prevalence of type 2 diabetes among the elderly in the context of peripheral neuropathy, physical activity, and overall health. There were 300 participants in total. **Results:** The findings indicate that the majority of the participants (33.3%) belonged to the age group of 60-70 years. In terms of gender, the majority of the participants (72.0%) identified as male. With respect to nationality, the majority of the participants were Saudi (83.3%). In terms of educational attainment, the majority of the participants (34.0%) had completed primary school or lower. Lastly, the majority of the participants (34.0%) were married. **Conclusion:** To conclude, In Saudi Arabia, painful peripheral neuropathy is prevalent among type 2 diabetic patients and has significant physical and mental implications for the afflicted individuals' quality of life.

Keywords: Physical activity life, Saudi Arabia, Diabetic, Peripheral Neuropathy, health-related quality.

Introduction

Peripheral neuropathy, a frequent consequence of diabetes mellitus, is usually described as a symmetrical degradation of peripheral nerves in the distal regions and hindered nerve regeneration. Diabetic peripheral neuropathy (DPN) may lead to deficits in tactile sensibility, vibration sensation, lower limb proprioception, as well as kinesthesia (1). Neuropathy-induced loss of feeling is believed to lead to compromised balance, changed walking habits, and heightened likelihood of falling. The occurrence of DPN in elderly individuals is significantly linked to reduced activity levels, as shown by the number of steps taken each day (2,3). The sensory deficits and rapid vascular disease enhance the vulnerability of the lower limbs to injury and infection, leading to diabetic amputations.

Peripheral Neuropathy has been associated with the growing prevalence of type 2 diabetes, a global health challenge that has been difficult to manage for several years. Diabetes mellitus is a clinical disorder defined by impaired glucose metabolism and hyper-glycaemia owing to absolute or relative insulin insufficiency, insulin resistance or both. Over time, recommendations have stressed the need of physical activity and exercise training in managing type 2 diabetes, particularly in senior individuals with chronic conditions including coronary artery disease and musculoskeletal problems (4,5).

The study on physical exercise and overall wellness in older individuals with type 2 diabetes and peripheral neuropathy might provide crucial therapeutic insights into the non-pharmacological treatment of type 2 diabetes (6). The physical inactivity rate among older individuals in Saudi Arabia is currently 80.5% due to various factors such as time constraints, heavy traffic, air pollution, limited exercise facilities, and lack of social support, cultural barriers, and environmental factors. Prior studies have shown the efficacy of home-based exercise regimens (7). Considering the obstacles to physical activity in Saudi Arabia, a home-based exercise program

might be an effective alternative for older individuals with Type 2 Diabetes and Peripheral Neuropathy (8).

The current diabetic epidemic has led governments in heavily impacted nations to implement strict preventative measures on their populations. These led to harmful practices that negatively impacted public health (9). Additionally, limitations on physical activities (10). Prior to the onset of diabetes, a sedentary lifestyle was already recognized as a significant public health issue, as over 25% of elderly individuals with Type 2 Diabetes could not reach the necessary physical activity levels for optimal health (11). Nevertheless, recent statistics revealed throughout the Diabetic suggested low levels of physical activity (10). Adopting a healthy lifestyle, including physical exercise, is known to prevent complications, enhance insulin action, and improve glycaemic control in older individuals. This includes monitoring glycated hemoglobin, fasting plasma glucose, dietary patterns, exercise routines, and body composition (12-15). Most of these research studies primarily examined socio-behavioral changes using descriptive data in a cross-sectional method. No qualitative study has been released to investigate the full effect of the global outbreak on the lifestyle of older individuals with T2DM, which might potentially impair illness management and overall health (16).

Literature Review

Solomou et al (2020) discovered that diabetes significantly affected physical exercise, overall health, and quality of life in older individuals with Type 2 Diabetes as well as the general populace (17). Satici et al (2021) suggested that the rise in Type 2 Diabetes cases among older individuals could be attributed to various factors experienced throughout the diabetic condition, including fear of high mortality rates, medical consequences post-recovery, financial instability, joblessness, lack of social support, and excessive exposure to media, particularly problematic social media. (18). Bawazeer et al. (2021) stated that the Saudi Arabian cuisine has grown increasingly Westernized, leading to a higher consumption of fats, free sugars, salt, and cholesterol in regular meals (19).

Cheikh et al. (2020) found a decreased amount of spare period physical exercise between Saudi individuals. An rise in the prevalence of Type 2 Diabetes Mellitus (T2DM) over the same era is linked to significant lifestyle modifications, genetic susceptibility of Saudi individuals to diabetes, and a high rate of consanguineous marriages (20). The American College of Sports Medicine and the ADA suggest engaging in large-muscle-group resistance exercise 2 or 3 days per week. The training regimen must consist of at least one set of five or more resistance-training exercises. Flexibility exercises should be added to target joint range-of-motion restrictions, especially in the ankle, hip, as well as shoulder (21). A comprehensive musculoskeletal assessment by a physical therapist may pinpoint specific requirements that need attention to optimize joint alignment and reduce the risk of movement-related injuries (22).

In 2016, Gadkari and colleagues found that insulin treatment was a distinct risk variable for PDPN. This likely indicates the seriousness of the illness and inadequate management of blood sugar levels. Other researchers have also noted that females are more susceptible to PDPN, which may be due to their sedentary lifestyle and greater BMI in comparison to men. In a different research, both the physical and mental component ratings of Quality of Life were shown to be

poorer in diabetic individuals with Painful Diabetic Peripheral Neuropathy (PDPN) (23). Similar findings have been reported in research conducted in France, Spain, Greece, Belgium, and USA using the same instrument as in the current study (HRQoL-SF12) (24). The decline in both physical and mental components of Quality of Life (QOL) is mostly caused by the negative impacts of the illness on patients, including restricted daily tasks, erectile disorder, pain perception, and low sleep quality. Hence, it is necessary to consistently assess the Health-Related Quality of Life (HRQoL) of diabetes patients suffering from peripheral neuropathy (25).

Several meta-analysis studies suggest a notably higher risk of developing type 2 diabetes and a metabolic disorder in those with a sedentary lifestyle (23). Physical exercise can postpone or avoid the development of Type 2 Diabetes Mellitus by enhancing insulin sensitivity or influencing BMI (24). In addition to its good influence on the progression of T2DM, consistent physical exercise is linked to various additional advantages for people with diabetes. It is recommended as the first approach to managing blood sugar levels in persons with T2DM (23). The American College of Sports Medicine and American Diabetes Organization, in a joint position assertion, along with the American Heart Association exercise regulations, suggest exercising at least every forty-eight hours to help control blood glucose levels and insulin resistance in individuals with Type 2 Diabetes Mellitus (24,25). Exercising's impact on insulin resistance diminishes within 48 to 72 hours, but brief and intense exercise has been demonstrated to enhance insulin sensitivity in diabetic individuals (26,27).

In clinical investigations conducted in Saudi Arabia, it was shown that both Saudi patients and doctors at primary care centers had inadequate understanding of diabetes as well as peripheral neuropathy (28,29). In Saudi Arabia, 66% of adult males and 71 percent of adult women are overweight or obese. Alshayban et al. (30) revealed the incidence of diabetes in Saudi Arabia. Alsomali et al. (2019) additionally discovered this in their research. The significant increase in socioeconomic development over recent decades likely led to poor eating habits in Saudi Arabia. High-calorie conventional foods like dates and high-calorie, fat-based meals such as fast food are often consumed in Saudi Arabia (31).

Rationale

Many elderly individuals with Type 2 Diabetes and Peripheral Neuropathy lack understanding of the significance of physical activity. Individuals noted modifications to their illness maintenance following the onset of Peripheral Neuropathy. The significant increase in socioeconomic development in Saudi Arabia during the last few centuries likely led to harmful food practices. In Saudi Arabia, excessive intake of high-calorie conventional foods like dates, as well as high-calorie and fat-based diets such as fast food, is prevalent. Furthermore, the treatment of diabetes and related associated risks continues to be not at an ideal level. Physical exercise ought to be the preferred method to help people identified with type 2 diabetes or those susceptible for diabetes achieve their wellness objectives.

Aim of the study:

Assessing the relationship among exercise and health-related aspects of life in elderly individuals residing in Saudi Arabia, and examining the connection among physical exercise and peripheral neuropathy in patients with diabetes in 2022.

Objective:

To assess the relationship among exercise and health-related aspects of life in elderly individuals residing in Saudi Arabia, and examining the connection among physical exercise and peripheral neuropathy in patients with diabetes in 2022.

Methodology:**Study design:**

This descriptive cross-sectional research was undertaken amongst 300 older individuals with Type 2 Diabetes and Peripheral Neuropathy who were visiting main medical centers.

Study Area

The research was conducted in Saudi Arabia under the auspices of the Ministry of Health, employing a randomized number generator algorithm tool. The research was carried out amongst patients visiting basic healthcare institutions in Saudi Arabia. From August to December 2022, the population profile is diverse, with a significant number coming from rural backgrounds and others from metropolitan areas. These variations result in biological, social, and behavioral variances among individuals. The respondents were chosen by the systematic random selection method.

Study Population

A research was done to assess the relationship between physical exercise and health-related aspects of life in older individuals residing in Saudi Arabia.

Selection criteria:**Inclusion criteria**

- Patients suffering from the Type 2 Diabetes Epidemic
- Type 2 diabetes diagnosis.
- Visiting a main health care facility.
- The identification of Peripheral Neuropathy.
- Strong cognitive skills • Individuals of all ethnicities
- Both genders.

Exclusion criteria :

- Children receiving medical treatment.
- Individuals with serious cognitive deficits like dementia or delirium.
- Patients who refuse to provide written permission to attend.

Sample size

Assess the relationship among physical exercise and health-related quality of life in elderly individuals residing in Saudi Arabia, as well as the relationship among physical exercise and peripheral neuropathy in patients with diabetes. 2022 The sample size was determined using the Raosoft sample size calculator with a margin of error of five percent, a level of confidence of 95 percent, and assuming a response range of twenty percent. The sample size includes 300

individuals diagnosed with type 2 diabetes and peripheral neuropathy, visiting a traditional medical center in Saudi Arabia in 2022. Both male and female patients are included. An additional 10 participants were included to reduce the margin of error following formal discussion with the main health care center. The minimum computed sample size is 300 after including five percent oversampling. The research participants were selected using a computer-generated basic random selection procedure.

Sampling technique:

Systematic random-selection approach is used. Following that, a random number generator was used to use a basic random selection procedure in order to choose the participant. The research will use convenience sampling to choose individuals. A systematic method randomly divides the total number of older people with Type 2 Diabetes and Peripheral Neuropathy patients into the needed sample size of 300.

Data collection tool

Researchers created a survey based on a study of the relevant literature to gather the data. The text was translated into basic Arabic to accommodate the comprehension level of all research participants. A self-administered questionnaire was employed. The questionnaire has four components. First section: includes demographic information such as gender, marital status, age, and employment. The second half has questions to evaluate the prognosis of Pre diabetes, Diabetes, and Peripheral Neuropathy. The third portion focused on risk factors and complications associated with Type 2 Diabetes.

Data collection technique:

The researcher has been conducting visits to the Primary Health Care center in Saudi Arabia in 2022. The city is organized into seven categories of Primary Health Care (PHC), consisting of three core sectors and four outside sectors. Each sector comprises a cluster of Primary Health Care Centers. After receiving clearance from the ministries of health, the academic is focusing on one specific aspect of primary healthcare. The examiner has acquired consent from respondents. Once the participants have arrived, the goal of the research is conveyed to all attendees.

Data entry and analysis:

The data was coded and imported into the Statistical Package for the Social Sciences (SPSS), version 24. The data were processed to provide the results using inferential and descriptive statistics. The descriptive statistics provide percentages and frequencies for variables that are categorical, whereas standard deviations summarize numerical data. Statistically significant relationships were found among demographic and historical variables at a level of significance of less than 0.05.

Pilot study:

A pilot study has been conducted in the same sector due to the similarity to the target group using the same questionnaire to test the methodology of the study. As a feedback, the questionnaire has been clear and no defect has been detected in the methodology

Ethical considerations:

A pilot research was carried out in the same industry to assess the technique of the study, since it closely resembled the target population, using the same questionnaire. The survey has been straightforward and no defects have been found in the approach. Ethical considerations: Verbal agreement from all participants in the questionnaire was acquired with permission from the health directorate. All input was private, and the findings would be sent to the division as feedback. The researcher explained the study's goals and objectives to the inhabitants. Anonymity was maintained to ensure data confidentiality, and all knowledge remains secret only for the purposes of this research.

Budget: Self-funded.

RESULT

Table 1: Distribution of Socio-demographic characteristics of participants among older People with Type 2 Diabetes of participant in the study (n=300)

	N	%
Age (year)		
<50	93	31
50-60	63	21
60-70	99	33
>70	45	15
Gender		
Male	216	72
Female	84	28
Nationality		
Saudi	249	83
Non-Saudi	51	17
Educational level		
Primary school/below	102	34
Intermediate school	63	21
High school	60	20
University	45	15
Postgraduate	30	10
Marital status		
Single	81	27
Married	102	34
Divorced	60	20
Widowed	57	19
Monthly family income (SR)		
<5000	84	28
5000-10000	114	38
>10000	102	34

Table 1 indicates that the majority of the respondents (33.0%) were in the 60-70 age range, followed by 31.0% in the age group over 50 years. The majority of participants were male (72.0%) and Saudi (83.0%). In terms of education, most of them had elementary school or lower schooling (34.0%) followed by intermediate school education (21.0%). The bulk of participants are married (34.0%) while single participants make up 27.0%. The majority of participants had a monthly household income between 5000-10000 SR (38.0%), followed by above 10000 SR (34.0%).

Table 2 displays the distribution of risk variables amongst older individuals with Type 2 Diabetes who participated in the research.

Risk factor	No	%
Duration of diabetes, years		
<5 years	159	53
5-14 Y	66	22
>15 y	75	25
Chronic disease		
No co-morbidity	111	37
1–2 co-morbidities	126	42
>3 co-morbidities	63	21
Of which		
Ischaemic heart/ artery disease or cardiac failure	102	34
Asthma or COPD	69	23
Diabetic complication	129	43
Diabetes treatment		
Lifestyle advise only	81	27
Oral antihyperglycaemic therapy only	93	31
Insulin ± oral antihyperglycaemic therapy	126	42
Complications from diabetes		
Yes	132	44
No	168	56
Physical activities or exercise		
Yes	123	41
No	177	59
Peripheral Neuropathy complaints		
Yes	165	55
No	66	22
I don't know	69	23

The table displays the distribution of risk variables among older individuals with Type 2 Diabetes throughout the COVID-19 pandemic based on the duration of diabetes. Participants with diabetes for less than 5 years accounted for 49.0%, those with diabetes for more than 15 years accounted for 29.0%, and those with diabetes for 5-14 years accounted for 22.0%. Regarding chronic diseases, 66.0% of participants had more than 3 co-morbidities, 52.0% had no co-

morbidities, and 38.0% had 1-2 co-morbidities. Among them, 43.0% of participants had diabetic complications. Participants with Ischaemic heart/ artery disease or cardiac failure accounted for 34.0%, while those with Asthma or COPD made up 23.0%. In terms of Diabetes treatment, 42.0% of participants were on Insulin \pm oral anti-hyperglycemic therapy, 31.0% were on Oral anti-hyperglycemic therapy only, and 27.0% received Lifestyle advice only. Regarding complications from diabetes, 56.0% of participants answered "No" and 44.0% answered "Yes." In terms of physical activity or exercise, the majority of participants said... 56.0% answered No and 41.0% answered Yes about physical activities or exercise. Most participants answered Yes (55.0%) whereas 22.0% answered No and 23.0% were unsure.

Table 3 displays the distribution of diagnoses of pre-diabetes and diabetes among older individuals with type 2 diabetes who participated in the research.

	Normal		Pre diabetes		Diabetes		Chi-square	
	N	%	N	%	N	%	X ²	P-value
Fasting plasma glucose, mg/dL	81	27	87	29	132	44	47.715	<0.001*
2-h plasma glucose after 75-g OGTT, mg/dL	39	13	81	27	180	60		
Random plasma glucose, mg/dL	81	27	93	31	126	42		
Glycated hemoglobin, %	57	19	57	19	186	62		

Abbreviation: OGTT, oral glucose tolerance test

Table (3) in the study shows a significant relationship with a P-value of 0.001 and X² of 47.715. In terms of Fasting plasma glucose (mg/dL), the majority of participants with Diabetes were 44.0%, Pre-diabetes were 29.0%, and Normal were 27.0%. For 2-h plasma glucose after 75-g OGTT (mg/dL), the majority of participants with Diabetes were 60.0%, Pre-diabetes were 27.0%, and Normal were 13.0%. As for Random plasma glucose (mg/dL), the majority of participants with Diabetes were 42.0% and Pre-diabetes were 31.0%. Among participants, 62.0% of those with diabetes had a high level of Glycated hemoglobin, compared to 19.0% of those with normal levels and 19.0% with pre-diabetes.

Figure 1 displays the frequency of diagnoses of pre-diabetes and diabetes among older individuals with type 2 diabetes who participated in the research.

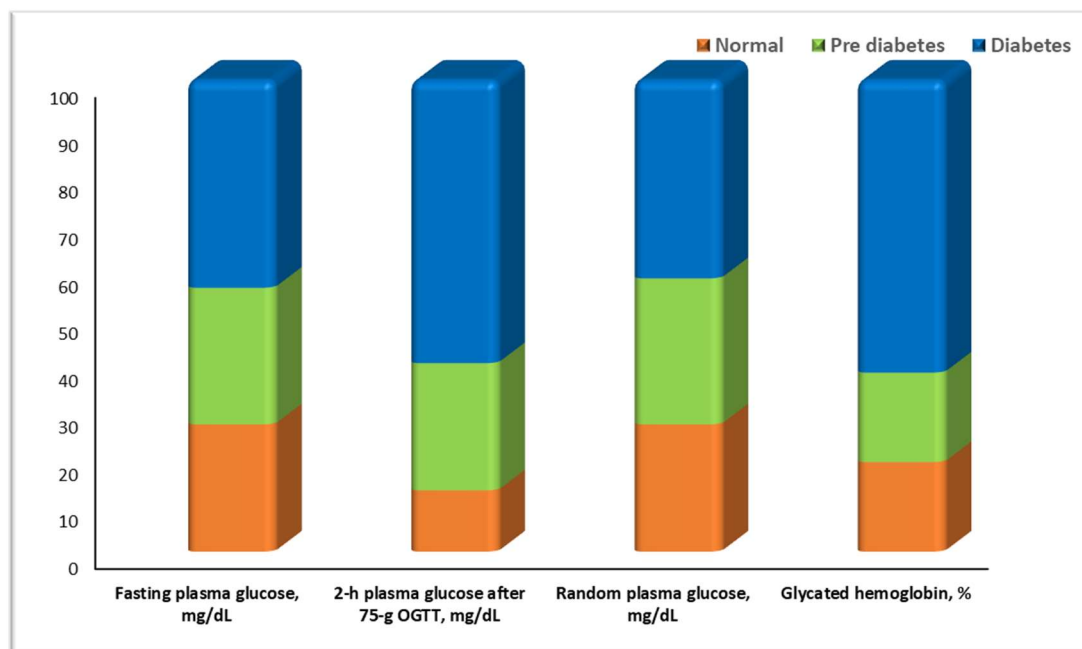


Table 4 Distribution of complications from diabetes of participant in the study

		Complications from diabetes					
		Yes		No		Total	
		N	%	N	%	N	%
Physical activities or exercise	Yes	37	28.03	86	51.19	123	41
	No	95	71.97	82	48.81	177	59
	Total	132	100.00	168	100.00	300	100
Chi-square	X ²	15.448					
	P-value	<0.001*					

Table 4 displays a significant relationship among problems from diabetes and physical activities or exercise in the study participants, with a P-value of 0.001 and X² value of 15.448. In the group that reported engaging in physical activities or exercise, 51.19% answered No and 28.3% answered Yes, totaling 41.0%. In the group that did not engage in physical activities or exercise, 71.97% answered Yes and 48.81% answered No, totaling 59.0%.

Figure 2 displays the distribution of diabetes-related complications across study participants.

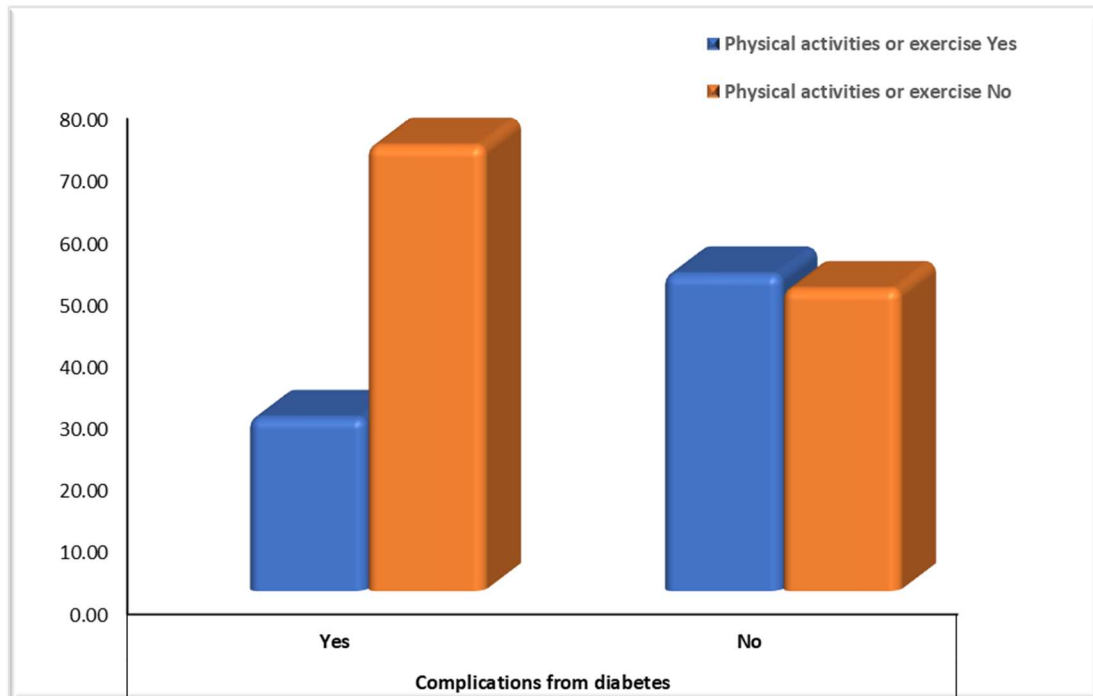
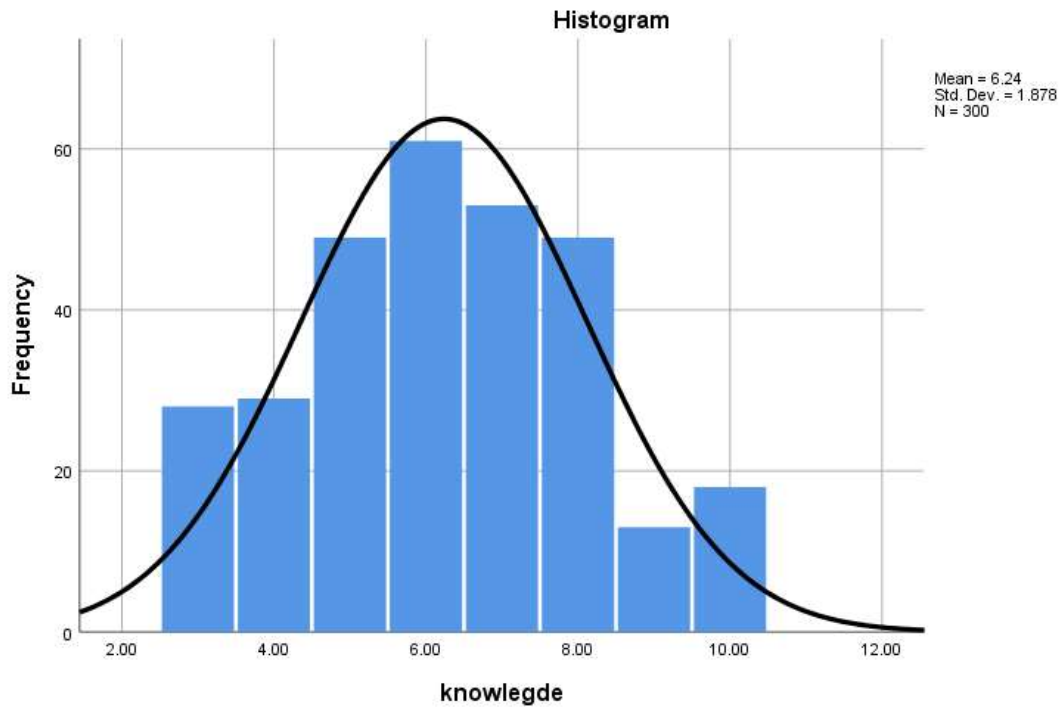


Table (5) showing the distribution of knowledge of physical exercise among individuals with diabetes and diabetic retinopathy scores..

Knowledge			Score	
	N	%	Range	Mean+SD
Weak	66	22.00	3-10.	6.241+1.878
Average	125	41.67		
High	109	36.33		
Total	300	100.00		
Chi-square	X ²	18.62		
	P-value	<0.001*		

Table 5 displays the respondents' understanding levels on DM and DR. The findings indicate that 41.67% had average understanding, 22.0% had inadequate understanding, and 36.33% had excellent knowledge. The data ranged from 3 to 10 with a mean of 6.241 and a standard deviation of 1.878, showing a statistically significant relationship. The Chi-square value is 18.62 with a corresponding P-value of 0.001.

Figure (3) Distribution of the Knowledge about Physical activity of DM and DR Score .



Discussion

The present evaluation examined 300 participants to analyze the relationship between exercise and health-related quality of life in older individuals residing in Saudi Arabia. An investigation of the relationship among exercise and peripheral neuropathy in patients with diabetes in a primary health care facility in Saudi Arabia in 2022. The importance of understanding physical exercise and overall wellness between elderly individuals with type 2 diabetes throughout peripheral neuropathy in Saudi Arabia, particularly among those attending primary healthcare centers, is significant. However, the prevalence of diabetes mellitus is high among people, frequently due to poor physical exercise, overall health between older individuals with type 2 diabetes, and unhealthy lifestyles (32). There can be a knowledge gap about the possibility of a Type 2 Diabetes Pandemic among elderly people visiting Primary Health Care facilities, despite its high incidence. The prevalence of Type 2 Diabetes Mellitus in Saudi Arabia, as shown by cross-sectional research, varies between 10 and 30 percent (33).

The survey revealed that the majority of participants (33.0%) were aged between 60-70 years, followed by 31.0% in the age group over 50 years. The bulk of participants were male (72.0%) and Saudi (83.0%). 17.0% of participants were non-Saudi. The majority of participants, 34.0%, had a primary school education or lower, while 21.0% had an intermediate school education. The bulk of participants are married (34.0%), while single participants make up 27.0%. The majority of participants had a monthly family income between 5000-10000 SR (38.0%), followed by those with an income more than 10000 SR (34.0%). Refer to Table 1

Peripheral Neuropathy has caused substantial changes and consequences for almost everyone's life. The impact on disadvantaged populations in daily life may have been particularly

noticeable. This research detailed the firsthand experiences of elderly individuals with T2DM as they navigated Peripheral Neuropathy, with a specific focus on the impact of physical activity. The results were condensed into five themes: modified social interactions and relationships; shifts in habits and mindset towards physical activity; increased importance of activities at home; effects on health and how to manage them; and considerations about life after being diagnosed with diabetes. Studies indicate that socialization and physical exercise were prevalent and significant for health and well-being before the onset of diabetes (24). The participants altered their daily habits and increased their time spent at home owing to the epidemic (25).

There are both non-modifiable and adaptable risk factors for the emergence of type 2 diabetes in elderly people with Peripheral Neuropathy. These variables are outlined in Table 2. Non-modifiable risk factors for diabetes encompass gender, socioeconomic status, age, ethnic background, a familial background of diabetes during pregnancy, as well as low weight at birth (33). In European research, males had a greater risk of diabetes than women, but this pattern is not regularly shown in the United States.

In the United States, people living in lower economic roles, characterized by lower levels of education, profession, and income, had a greater chance of getting type 2 diabetes (34). American Indians/Alaska Natives possess the highest rate of diabetes, subsequent to non-Hispanic blacks and Hispanics. African Americans have a higher propensity to get diabetes compared to white and Asian folks (35). American Indians have varying rates of diagnosed diabetes, ranging from 5.5% to 33.5% across various tribes and demographic groupings (22). While hereditary factors contribute, key risk factors seem to be non-genetic (30). Analysis of the study data revealed a significant correlation between problems from diabetes and physical activity or exercise, with a P-value of 0.001 and X2 value of 15.448. Among participants who engaged in physical activities or exercise, 51.19% answered No and 28.3% answered Yes, totaling 41.0%. For participants who did not engage in physical activities or exercise, 71.97% answered Yes and 48.81% answered No, totaling 59.0%. Refer to table 4.

Conclusion

The primary patterns discovered from the experiences of older individuals with T2DM during the pandemic include changes in social life, schedules, exercise behavior, significance of older-related actions, effects on well-being and health, and ideas regarding the period following the pandemic. Approximately 9 months into the pandemic, elderly individuals with Type 2 Diabetes Mellitus remained secluded, fearful of getting the virus, and had a shortage of physical activity. Due to the health hazards linked to an unhealthy lifestyle and the mental health issues and illness management challenges mentioned by participants, there is an increasing need for an integrated strategy to address the issue. Government policy should focus on addressing the needs of elderly individuals with Type 2 Diabetes Mellitus, including managing psychological concerns, promoting healthier habits, and achieving disease management.

References

1. Elafros, M. A., Andersen, H., Bennett, D. L., Savelieff, M. G., Viswanathan, V., Callaghan, B. C., & Feldman, E. L. (2022). Towards prevention of diabetic peripheral neuropathy: clinical presentation, pathogenesis, and new treatments. *The Lancet Neurology*, *21*(10), 922-936.
2. Yang, K., Wang, Y., Li, Y. W., Chen, Y. G., Xing, N., Lin, H. B., ... & Yu, X. P. (2022). Progress in the treatment of diabetic peripheral neuropathy. *Biomedicine & Pharmacotherapy*, *148*, 112717.
3. BHATT, U., MEHTA, M., & KUMAR, G. P. (2022). Postural Control in Diabetic Peripheral Neuropathy: A Narrative Review. *Journal of Clinical & Diagnostic Research*, *16*(4).
4. Ray, J., Sahoo, C. K., Mohanty, R., Sahoo, R., & Dalai, R. (2021). A review on diabetic peripheral neuropathy. *Journal of Drug Delivery and Therapeutics*, *11*(2-S), 121-125.
5. Akbari, N. J., & Naimi, S. S. (2022). The effect of exercise therapy on balance in patients with diabetic peripheral neuropathy: a systematic review. *Journal of Diabetes & Metabolic Disorders*, *21*(2), 1861-1871.
6. Alzubaidi, H., Hafidh, K., Saidawi, W., Othman, A. M., Khakpour, M. M., Zoghbor, M. M., ... & Shaw, J. E. (2022). Behavioral, psychological, and clinical outcomes of Arabic-speaking people with type 2 diabetes during COVID-19 pandemic. *Primary Care Diabetes*, *16*(3), 355-360.
7. Peimani, M., Bandarian, F., Namazi, N., & Nasli-Esfahani, E. (2022). COVID-19-specific worries among people with type 2 diabetes following the continuation of the pandemic and occurrence of multiple waves of COVID-19 in Iran. *Journal of Diabetes & Metabolic Disorders*, *21*(1), 61-68.
8. Task Force for the management of COVID-19 of the European Society of Cardiology, Baigent, C., Windecker, S., Andreini, D., Arbelo, E., Barbato, E., ... & Williams, B. (2022). European Society of Cardiology guidance for the diagnosis and management of cardiovascular disease during the COVID-19 pandemic: part 1—epidemiology, pathophysiology, and diagnosis. *Cardiovascular Research*, *118*(6), 1385-1412.
9. Rey-Reñones, C., Martínez-Torres, S., Martín-Luján, F. M., Pericas, C., Redondo, A., Vilaplana-Carnerero, C., ... & Grau, M. (2022). Type 2 diabetes mellitus and COVID-19: A narrative review. *Biomedicines*, *10*(9), 2089.
10. Flaxman, S. R., Bourne, R. R., Resnikoff, S., Ackland, P., Braithwaite, T., Cicinelli, M. V., ... & Zheng, Y. (2017). Global causes of blindness and distance vision impairment 1990–2020: a systematic review and meta-analysis. *The Lancet Global Health*, *5*(12), e1221-e1234.
11. Williams, R., Karuranga, S., Malanda, B., Saedi, P., Basit, A., Besançon, S., ... & Colagiuri, S. (2020). Global and regional estimates and projections of diabetes-related health expenditure: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice*, *162*, 108072.

12. Al Zarea, B. K. (2016). Knowledge, attitude and practice of diabetic retinopathy amongst the diabetic patients of AlJouf and Hail Province of Saudi Arabia. *Journal of clinical and diagnostic research: JCDR*, 10(5), NC05.
13. Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. E. (2014). Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes research and clinical practice*, 103(2), 137-149.
14. Bakkar, M. M., Haddad, M. F., & Gammoh, Y. S. (2017). Awareness of diabetic retinopathy among patients with type 2 diabetes mellitus in Jordan. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 10, 435.
15. Voigt, M., Schmidt, S., Lehmann, T., Köhler, B., Kloos, C., Voigt, U. A., ... & Müller, N. (2018). Prevalence and progression rate of diabetic retinopathy in type 2 diabetes patients in correlation with the duration of diabetes. *Experimental and Clinical Endocrinology & Diabetes*, 126(09), 570-576.
16. Naous, E., Boulos, M., Sleilaty, G., Achkar, A. A., & Gannagé-Yared, M. H. (2022). Quality of life and other patient-reported outcomes in adult Lebanese patients with type 2 diabetes during COVID-19 pandemic. *Journal of endocrinological investigation*, 1-10.
17. Solomou, I., & Constantinidou, F. (2020). Prevalence and predictors of anxiety and depression symptoms during the COVID-19 pandemic and compliance with precautionary measures: age and sex matter. *International journal of environmental research and public health*, 17(14), 4924.
18. Satici, B., Gocet-Tekin, E., Deniz, M. E., & Satici, S. A. (2021). Adaptation of the Fear of COVID-19 Scale: Its association with psychological distress and life satisfaction in Turkey. *International journal of mental health and addiction*, 19, 1980-1988.
19. Bawazeer, N. M., Al-Qahtani, S. J., & Alzaben, A. S. (2021). The Association Between Dietary Patterns and Socio-Demographic and Lifestyle Characteristics: A Sample of Saudi Arabia. *Current Research in Nutrition and Food Science Journal*, 9(3), 1046-1057
20. Cheikh Ismail, L., Osaili, T. M., Mohamad, M. N., Al Marzouqi, A., Jarrar, A. H., Abu Jamous, D. O., ... & Al Dhaheri, A. S. (2020). Eating habits and lifestyle during COVID-19 lockdown in the United Arab Emirates: a cross-sectional study. *Nutrients*, 12(11), 3314.
21. Ostman, C., Smart, N. A., Morcos, D., Duller, A., Ridley, W., & Jewiss, D. (2017). The effect of exercise training on clinical outcomes in patients with the metabolic syndrome: a systematic review and meta-analysis. *Cardiovascular diabetology*, 16(1), 1-11.
22. Sasongko, M. B., Widyaputri, F., Agni, A. N., Wardhana, F. S., Kotha, S., Gupta, P., ... & Wang, J. J. (2017). Prevalence of diabetic retinopathy and blindness in Indonesian adults with type 2 diabetes. *American journal of ophthalmology*, 181, 79-87.
23. Gadkari SS, Maskati QB, Nayak BK. Prevalence of diabetic retinopathy in India: The all India ophthalmological society diabetic retinopathy eye screening study 2014. *Indian journal of ophthalmology*. 2016 Jan;64(1):38

24. Janssen, J. A. (2021). Hyperinsulinemia and its pivotal role in aging, obesity, type 2 diabetes, cardiovascular disease and cancer. *International Journal of Molecular Sciences*, 22(15), 7797.
25. Ruth, K. S., Day, F. R., Tyrrell, J., Thompson, D. J., Wood, A. R., Mahajan, A., ... & Perry, J. R. (2020). Using human genetics to understand the disease impacts of testosterone in men and women. *Nature medicine*, 26(2), 252-258.
26. Moser, O., Riddell, M. C., Eckstein, M. L., Adolfsson, P., Rabasa-Lhoret, R., van den Boom, L., ... & Mader, J. K. (2020). Glucose management for exercise using continuous glucose monitoring (CGM) and intermittently scanned CGM (isCGM) systems in type 1 diabetes: position statement of the European Association for the Study of Diabetes (EASD) and of the International Society for Pediatric and Adolescent Diabetes (ISPAD) endorsed by JDRF and supported by the American Diabetes Association (ADA). *Diabetologia*, 63(12), 2501-2520.
27. Powers, M. A., Bardsley, J. K., Cypress, M., Funnell, M. M., Harms, D., Hess-Fischl, A., ... & Uelman, S. (2020). Diabetes self-management education and support in adults with type 2 diabetes: a consensus report of the American Diabetes Association, the Association of Diabetes Care & Education Specialists, the Academy of Nutrition and Dietetics, the American Academy of Family Physicians, the American Academy of PAs, the American Association of Nurse Practitioners, and the American Pharmacists Association. *Diabetes Care*, 43(7), 1636-1649.
28. Fleming, G. A., Petrie, J. R., Bergenstal, R. M., Holl, R. W., Peters, A. L., & Heinemann, L. (2020). Diabetes digital app technology: benefits, challenges, and recommendations. A consensus report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) Diabetes Technology Working Group. *Diabetes care*, 43(1), 250-260.
29. American Diabetes Association. (2020). 5. Facilitating behavior change and well-being to improve health outcomes: Standards of Medical Care in Diabetes—2020. *Diabetes Care*, 43(Supplement_1), S48-S65.
30. Alshayban, D., & Joseph, R. (2020). Health-related quality of life among patients with type 2 diabetes mellitus in Eastern Province, Saudi Arabia: A cross-sectional study. *PloS one*, 15(1), e0227573.
31. Alsomali, S. I. (2019). *An investigation of self-care practice and social support of patients with type 2 diabetes in Saudi Arabia*. University of Salford (United Kingdom).
32. Teufel, F., Geldsetzer, P., Sudharsanan, N., Subramanyam, M., Yapa, H. M., De Neve, J. W., ... & Bärnighausen, T. (2021). The effect of bearing and rearing a child on blood pressure: a nationally representative instrumental variable analysis of 444 611 mothers in India. *International journal of epidemiology*, 50(5), 1671-1683.
33. Meex, R. C., Blaak, E. E., & van Loon, L. J. (2019). Lipotoxicity plays a key role in the development of both insulin resistance and muscle atrophy in patients with type 2 diabetes. *Obesity Reviews*, 20(9), 1205-1217

34. Alkhlaif, A. A., Alsuraimi, A. K., & Bawazir, A. A. (2020). Epidemiological profile of end-stage renal diseases in Riyadh, Saudi Arabia. *Asian J Med Health*, 8, 16-27.
35. Piercy, K. L., & Troiano, R. P. (2018). Physical activity guidelines for Americans from the US department of health and human services: Cardiovascular benefits and recommendations. *Circulation: Cardiovascular Quality and Outcomes*, 11(11), e005263.