

## **Assessment of the Role of Physical Therapists in Fighting Bad Life Style of the type 2 Diabetes Epidemic Patients Attending Primary Healthcare Centers in Makkah City, Saudi Arabia in 2022**

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### **Abstract:**

#### **Background**

Over the past decade the global prevalence of type 2 diabetes has increased markedly. People worldwide had diabetes 1 and by 2000 this figure increased to an estimated 171 million people worldwide. Furthermore, this upward trend is predicted to continue or even accelerate over the coming decades, with conservative estimates projecting that by 2030 the global prevalence of type 2 diabetes will exceed 350 million, and that it will be the seventh leading cause of death worldwide. Worldwide, 6% of the populations are affected by diabetes mellitus and the projection for the year 2030 is 438 million. With Saudi Arabia countries suffering the bulk of the total diabetes epidemic, the Kingdom of Saudi Arabia is among the countries with the highest prevalence of diabetes mellitus (23.1%). Medical Physical Therapists is an important aspect of diabetes care, there is an increasing awareness of Physical Therapists diabetes control also nutritional therapy breakfast skipping, late dinner and meal contents on diabetes control.

**Aim of the study:** To Assessment of the Role of Physical Therapists in Fighting bad life style of the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City, Saudi Arabia in 2022

**Methods:** cross-sectional descriptive study conducted at among the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City in 2022. This commentary, describes

the type 2 diabetes epidemic and the health impact of diabetes type 2 and diabetes-related complications, highlights the physical therapists, role fighting bad life style as frontline provider. Our total participants were (200 )

**Results:** the most of the participants (29.0%) were in the age group < 40 years, the gender the majority of them were male (67.0%) while Nationality the majority of participant are Saudi were(87.0%), also regarding level of education the majority of participant are Intermediate school were(34.0%), regarding Job the majority of participant are Professional worker were(32.0%), marital status the majority of participant are married were (55.0%).

**Conclusion** Patients with type 2 diabetes highlights the physical therapist's role as front-line provider, and provides recommendations for physical therapists in screening for diabetes risk factors and diabetes-related complications and considerations for patient management. We focus on type 2 diabetes.

**Keywords:** Type 2 Diabetes, Physical therapist, Fighting, bad, life style, PHC, Makkah City.

## **Introduction**

Type 2 diabetes mellitus (T2DM) is a metabolic disorder that is characterized by high blood sugar due to insulin resistance (reduced ability of insulin to stimulate utilization of glucose in the cells of the body system) and also relatively reduced secretion of insulin from the beta cells of pancreas. Obesity, unhealthy dietary habits, sedentary life style and genetic factors are considered as important risk factors in the development of T2DM[1]

Physical activity is an important component in the treatment of chronic diseases, including diabetes, reducing morbidity and mortality.[2] However, for patients with diabetes, physical activity programs must be carefully prescribed, such that they account for diabetes-associated pathophysiology and complications[3].

Worldwide, approximately 5.1 million people aged between 20 and 79 years died from diabetes , accounting for 8.4% of mortality among people in this age group [1]. In Kingdom of Saudi Arabia (KSA), the epidemiologic transition has been fast and complete. During the last 4 decades, rapid economic growth has led to a remarkable increase in living standards and adoption of a 'Westernized' lifestyle, characterized by decreased physical activity and unhealthy dietary patterns [4]. Increase in the risk of T2DM is attributed to the intake of dietary energy in excess of expenditure resulting in weight gain and obesity.[5]

Pathophysiology of Diabetes mellitus, Diabetes mellitus is a group of chronic metabolic conditions all characterized by elevated blood glucose levels resulting from the body's inability to produce

insulin, resistance to insulin action, or both [6]. This group of conditions consists of 4 clinically distinct types: (1) type 1 diabetes, which results from autoimmune beta-cell destruction in the pancreas and is characterized by a complete lack of insulin production; (2) type 2 diabetes, which develops when there is increased resistance to the action of insulin and the body cannot produce enough insulin to overcome the resistance; (3) gestational diabetes, which is a form of glucose intolerance that affects some women during pregnancy; and (4) a group of other types of diabetes caused by specific genetic defects of beta-cell function or insulin action, diseases of the pancreas, drugs, or chemical toxicity. We focus on type 2 diabetes in this commentary [7].

**Role of physical inactiveness in Type 2 Diabetes Mellitus** Regular physical activity has been shown to be associated with several beneficial physiological changes, key among them are its favorable effect on muscle and liver insulin sensitivity, muscle glucose uptake and utilization, and overall glycaemic control [8]. Physically active lifestyle leads to improvements in insulin action and glycaemic control. Physical activity could help in delaying the development of long-term diabetes complications, such as neuropathy, retinopathy, and nephropathy, and decrease the progression rate of existing complications [9]. Physical activity and resulting metabolic adaptations have been shown to improve glycaemic control for diabetic patients [10]. However, physical activity may lead to substantial blood glucose variation and management challenges for those who require insulin. In such cases, self-management training can reduce potential for excessive glucose variability related to exercise [11]. The global prevalence of diabetes has reached pandemic proportions with the 9th edition of the IDF reporting a prevalence of 9% (463 million adults) in 2019 [12]. The rising prevalence of diabetes has been attributed principally to the ageing of populations. However, decreasing mortality among those with diabetes due to improving medical care as well as increases in diabetes incidence in some countries resulting from increasing prevalence of diabetes risk factors, especially obesity, are also important drivers of higher prevalence. [13]

## **Literature Review**

Some meta-analysis studies indicate significantly greater risk for T2DM and metabolic syndrome in people having a sedentary lifestyle [14]. Physical activity contributes positively in delaying or preventing progression towards T2DM either by improving insulin sensitivity or affecting BMI [15]. Apart from its positive impact on the development of T2DM regular physical activity is associated with several other benefits for the individual with diabetes [16], and is suggested as the first step towards glycaemic control in individuals with T2DM. The American College of Sports Medicine and American Diabetes Association joint position statement [17], and the American Heart Association [18] exercise guidelines have recommended exercising no less than every 48 hours to

manage blood glucose levels and insulin resistance for people suffering with T2DM. The effects of exercising on insulin resistance may be lost after 48 to 72 hours [19], and short and vigorous bouts of exercise has been shown to improve insulin sensitivity in diabetic patients [20].

Some clinical studies from Saudi Arabia, it is reported that not only the Saudi patients have poor knowledge of diabetes [21], but the physicians at primary care centres also have suboptimal awareness of proper diabetes management [22]. 66% of adult men and 71% of adult women are either overweight or obese in Saudi Arabia . The prevalence of diabetes in Saudi Arabia as demonstrated by Alshayban et al. [23]

Sudharsanan, et al.(2018) report that countries with large populations such as China, India, Pakistan, and the USA contribute the most to the total number of people with diabetes. However, despite the WP having a larger total population, the greatest absolute growth in the number of people with diabetes over time is expected to take place in the SEA and MENA Regions. This reflects the variation in forecasted population changes in these regions in terms of greater mean age, overall population size and increasing proportions of people living in cities. [24]

Alsomali, et al.(2019) found in study Over the last few decades, the tremendous surge in socioeconomic growth probably contributed to unhealthy dietary habits in Saudi Arabia. In addition to the consumption of high-calorie traditional food (e.g. dates), excessive consumption of high calorie and fat based diets (e.g. fast food) is very common in Saudi Arabia [25].

The most of systematic review has shown that there is generally low Knowledge about the Risk of Type 2 Diabetes among Adults with Visiting the attending primary healthcare also about the risk factors and its complications among the Saudi population in particular .[26] Most diabetes mellitus patients had low to moderate knowledge scores in Riyadh, Jeddah, Al Hasa, Al-Khobar, and Mecca. Also unexpectedly, health professionals in Saudi Arabia also had low knowledge scores about diabetes mellitus especially type 2.[27]

Moreover, the management of diabetes and its risk factors is still suboptimal. Some clinical studies from Saudi Arabia, it is reported that not only the Saudi patients have poor knowledge of diabetes [28], but the physicians at primary care centres also have suboptimal awareness of proper diabetes management [29 ]

Demonstrated by Bawazeer et al.(2021)Due to westernization of the Saudi Arabian diet, the increased intake of high levels of fat, free sugars, sodium and cholesterol have become much more common in the daily dietary pattern [30]. Cheikh et al.(2020) reported a lower level of leisure time physical activity among the Saudis. An increase in the prevalence of T2DM is also observed during the same period, which is attributed to the dramatic changes in lifestyle, in addition to genetic predisposition of Saudi people to diabetes, and a high prevalence of consanguineous marriages [31].

## **Rationale**

Over the last few decades, the tremendous surge in socioeconomic growth probably contributed to unhealthy dietary habits in Saudi Arabia. In addition to the consumption of high-calorie traditional food (e.g. dates), excessive consumption of high calorie and fat based diets (e.g. fast food) is very common in Saudi Arabia. Moreover, the management of diabetes and its risk factors is still suboptimal. Physical therapists should be the provider of choice to assist patients who have been diagnosed with diabetes type 2 or who are at risk for diabetes in achieving their physical activity goals. Physical therapists' education provides both broad and in-depth content covering the pathophysiology of diabetes and associated comorbidities, screening for and treatment of diabetes complications, and prescription of physical activity for individuals with specific and important limitations of the human movement system that moderate physical activity tolerance.

## **Aim of the study:**

To Assessment of the Role of Physical Therapists in Fighting bad life style of the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City, Saudi Arabia in 2022.

## **Objective:**

Assessment of the Role of Physical Therapists in Fighting bad life style of the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City, Saudi Arabia in 2022

## **Methodology:**

### **Study design:**

This study is descriptive cross-sectional study was conducted among 200 of the Type 2 diabetes among role of physical therapists in fighting bad life style the Type 2 Diabetes Epidemic patients attending primary healthcare centers.

## **Study Area**

The study has been carried out in the city of Makkah Al-Mokarramah Makkah is the holiest spot on Earth. It is the birthplace of the Prophet Mohammad and the principal place of the pilgrims to perform Umrah and Hajj. It is located in the western area in Kingdom of Saudi Arabia and called the Holy Capital. Contains a population around 2 million. This study was conducted among the patients attending primary healthcare centers. in Makkah, Saudi Arabia. During the July to August 2022, and it reflects a diversified demographic profile with a considerable portion of the population

comes from rural descent, while others come from an urban one. This difference translates into biological, socioeconomic and lifestyle differences in the Makkah population.

### **Study Population**

The study has been conducted regarding Role of Physical Therapists in Fighting bad life style the Type 2 Diabetes Epidemic patients attending primary healthcare centers Makkah City, Saudi Arabia in 2022 During the April to June, 2022 the period of study in 2022..

#### **Selection criteria:**

#### **Inclusion criteria**

- Type 2 Diabetes Epidemic patients
- Diagnosis of Type 2 diabetes.
- Attending in primary health care center.
- Resident in Makkah province.
- Sound cognitive abilities
- All nationalities
- Both males and females.

#### **Exclusion criteria :**

- Pediatric patients.
- Patients with severe cognitive impairment such as dementia or delirium.
- Patients unwilling to give written consent to participate.

### **Sample size**

The type 2 diabetes among role of physical therapists in fighting bad life style the Type 2 Diabetes Epidemic patients attending primary healthcare centers Makkah City, Saudi Arabia in 2022. The sample size has been calculated by applying Raosoft sample size calculator based on (The margin of error: 5%, Confidence level: 95%, and the response distribution was considered to be 20%) accordingly the Sample size is (200) of the type 2 Diabetes Epidemic patients with attending in primary health care center Makkah City, Saudi Arabia in 2022 (male and female) after official communication with the primary health care center Makkah City, and adding 10 more to decrease margin of error. After adding 5% oversampling, the minimum calculated sample has been 200. Computer generated simple random sampling technique was used to select the study participants.

### **Sampling technique:**

Systematic random sampling technique is adopted. After that, by using random number generator, then simple random sampling technique has been applied to select the participant. Also, convenience sampling technique will be utilized to select the participants in the study. By using systematic sampling random as dividing the total Type 2 Diabetes Epidemic patients by the required sample size; (200 ).

### **Data collection tool**

The data was collected through a questionnaire that was developed by the researchers after reviewing the related literature. It was translated into simple Arabic language to suit the understanding level of the entire study subjects. Self-administrated questionnaire was used. The questionnaire contains four sections. First section: containing items related to demographic data as age, sex, marital status, and occupation. The second section questions to assess the diagnosis of Pre diabetes and Diabetes. The third section consisted of questions of risk factor and Complications from diabetes of Type 2 Diabetes.

### **Data collection technique:**

Researcher has been visiting the PHC Makkah City, Saudi Arabia in 2022. The city has seven sectors of PHC divided into three inners and four outers (Al-Zahir, Al-Adel, Al-Kakyeea, Al-Sharaee, Al-Jamom, Al-Kamel, and Kolese). Each sector consists of a group of Primary Health Care Centers. The researcher is concerned with one of the inner PHC of Al-kakyeea sector called " Al-Zahir PHCC". after getting the approval from the ministries of health . The researcher has been obtained permission from participants. After the arrival of the participants has been explained the purpose of the study to all participants attending

### **Data entry and analysis:**

The data were coded and introduced to the Statistical Package of Social Sciences (SPSS, version 24). The data were analyzed to present the findings in descriptive and inferential statistics. The descriptive statistics include frequencies and percentages for categorical variables and standard deviations were used to summarize numerical data. The significant associations between demographic and background variables were detected at  $< 0.05$  significance level.

### **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:**

Permission from the directorate of health , verbal consents from all participants in the questionnaire were obtained. All information was kept confidential, and results will be submitted to the department as feedback. The researcher described the aim and objectives of the study for the residents. No names were required to assure confidentiality of data, and all information was kept confidential only for this study's purposes.

**Budget:** Self-funded

### **RESULT**

**Table 1: Distribution of Socio-demographic characteristics of participant in the study about physical therapists in fighting the type 2 diabetes epidemic (n=200)**

	N	%
<b>Age (year)</b>		
<40	58	29
40-50	46	23
50-60	44	22
>60	52	26.00
<b>Gender</b>		
Male	134	67
Female	66	33
<b>Nationality</b>		
Saudi	174	87
Non-Saudi	26	13
<b>Educational level</b>		
Primary school/below	40	20
Intermediate school	68	34
High school	42	21
University	22	11
Postgraduate	28	14.00
<b>Job</b>		
Governmental employee	40	20



Private sector employee	38	19
Professional worker	64	32
House wife	22	11
Not working	36	18.00
<b>Marital status</b>		
Single	46	23
Married	110	55
Divorced	26	13
Widowed	18	9.00
<b>Monthly family income (SR)</b>		
<5000	56	28
5000-10000	76	38
>10000	68	34.00

Table 1 shows that most of the participants (29.0%) were in the age group < 40 years follow by the (26.0%) were in the age >60 years. Regarding the gender the majority of them were male (67.0%) while female(33.0%), also regarding Nationality the majority of participant are Saudi were(87.0%) non- Saudi were(13.0%), also regarding level of education the majority of participant are Intermediate school were(34.0%) High school education were(21.0%). regarding Job the majority of participant are Professional worker were(32.0%) while Governmental employee were(20.0%). Regarding Marital status the majority of participant are Married were (55.0%) while Single were(23.0%). Regarding the Monthly family income (SR) the majority of participant between 5000-10000 were(38.0%) follow by >10000 were(34.0%).

**Table 2 Distribution of diagnosis of Pre diabetes and Diabetes**

	Normal		Pre diabetes		Diabetes	
	N	%	N	%	N	%
<b>Fasting plasma glucose, mg/dL</b>	58	29	46	23	96	48
<b>2-h plasma glucose after 75-g OGTT, mg/dL</b>	22	11	42	21	136	68

<b>Random plasma glucose, mg/dL</b>	40	20	52	26	108	54
<b>Glycated hemoglobin, %</b>	46	23	32	16	122	61

Abbreviation: OGTT, oral glucose tolerance test

Table (2) shows the distribution of diagnosis of Pre diabetes and Diabetes. While regarding the Fasting plasma glucose, mg/dL, the most of participant from Diabetes were (48.0%) while Pre diabetes were (23.0%) while normal were (29.0%), while Regarding the 2-h plasma glucose after 75-g OGTT, mg/dL, the most of participant from Diabetes were (68.0%) while Pre diabetes were (21.0%) and Normal were (11.0%), regarding the Random plasma glucose, mg/dL, the most of participant from Diabetes were (54.0%), while Pre diabetes were (21.0%). while normal were (11.0%), regarding the Glycated hemoglobin, %, the most of participant from Diabetes were (61.0%) while Normal were (23.0%) while Pre diabetes were (16.0%)

**Table 3 Distribution of risk factors among patients with type 2 diabetes of participant in the study .**

<b>Risk factor</b>	No	%
<b>Duration of DM Group</b>		
<5 years	98	49
5-14 Y	44	22
>15 y	58	29.00
<b>Chronic disease</b>		
Asthma	104	52
High blood pressure	76	38
High fat and cholesterol	132	66
Heart diseases	90	45
Arthritis or other rheumatic diseases	46	23
<b>What type of treatment do you use for diabetes</b>		
Tablets	70	35
Tablets with insulin	66	33
Insulin	64	32.00
<b>Complications from diabetes</b>		
Yes	74	37

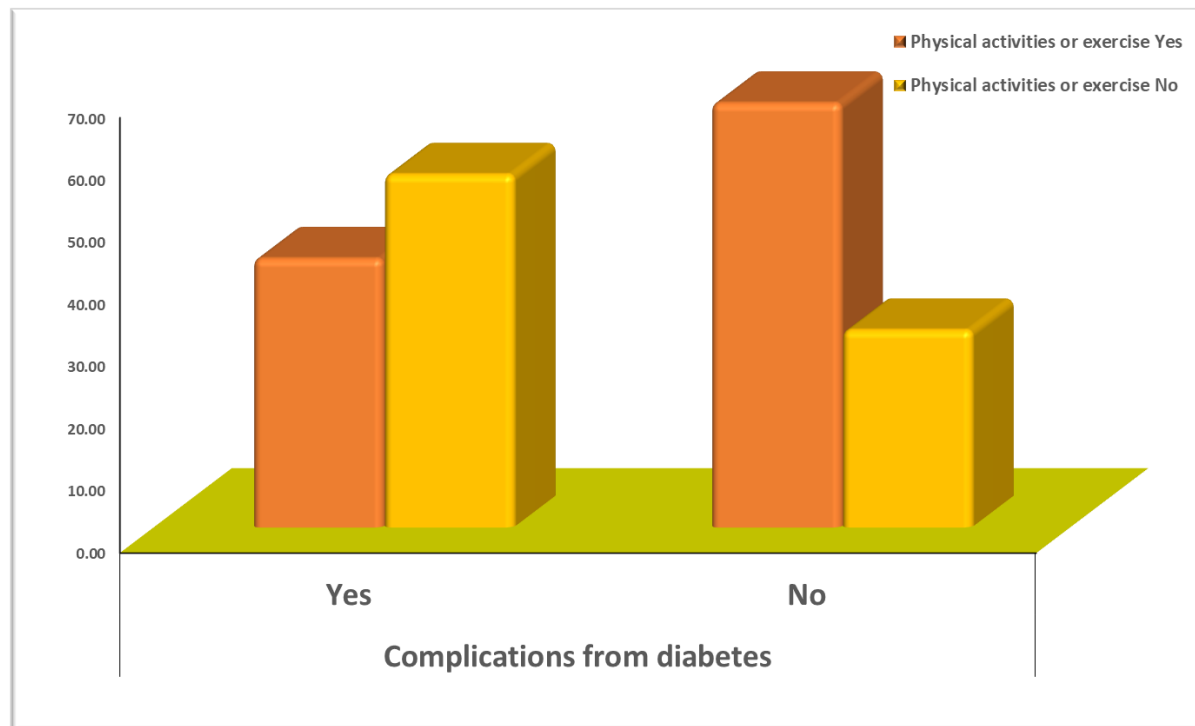
No	126	63.00
<b>Physical activities or exercise</b>		
Yes	118	59
No	82	41.00

Table (3) shows the risk factors among patients with type 2 diabetes of participant in the study, regarding the Duration of DM Group, the most of participant in <5 years were (49.0%) while 5-14 years were (22.0%) while >15 years were (29.0%). Regarding the Chronic disease the most of participant in High fat and cholesterol were (66.0%) while asthma were (52.0%), while heart diseases were (45.0%), regarding the what type of treatment do you use for diabetes, the most of participant in Tablets were (35.0%) while tablets with insulin were (33.0%). While regarding the Complications from diabetes the most of participant answer No were (63.0%) while Yes were (37.0%), regarding the physical activities or exercise the most of participant answer Yes were (59.0%) while No were (41.0%)

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

		<b>Complications from diabetes</b>					
		<b>Yes</b>		<b>No</b>		<b>Total</b>	
		<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
<b>Physical activities or exercise</b>	<b>Yes</b>	32	43.24	86	68.25	118	59.00
	<b>No</b>	42	56.76	40	31.75	82	41.00
	<b>Total</b>	74	100.00	126	100.00	200	100.00
<b>Chi-square</b>	<b>X<sup>2</sup></b>	11.044					
	<b>P-value</b>	0.0009					

Table 4 Regarding distribution of the patient's with of complications from diabetes of participant in the study show no significant relation between the Complications from diabetes and physical activities or exercise while P-value <0.0009 and X<sup>2</sup> 11.044, regarding the physical activities or exercise in YES the most of participant answer No were (68.25%) while Yes were (43.24%) while regarding Physical activities or exercise in NO the most of participant answer Yes were (56.76%) while No (31,75%).

**Figure (1) Distribution of complications from diabetes of participant in the study**

## Discussion

The current assessment surveyed a large number of participants, 200 participants to Assessment of the Role of Physical Therapists in Fighting bad life style of the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City, Saudi Arabia in 2022

Although the role of physical therapists in fighting the Type 2 Diabetes Epidemic patients and bad life style attending primary healthcare centers very important but the prevalence of diabetes mellitus (DM) is high among populations in Makkah City, patients often lack the role of physical therapists in fighting the Type 2 Diabetes Epidemic patients and bad life style [32]. There may be a gap between knowledge about the risk of Type 2 Diabetes among patients with Visiting the PHC, despite the high prevalence . Cross-sectional studies have suggested that the prevalence of T2DM in Saudi ranges from 10% to 30%[22].This is the first study to assessment role of physical therapists in fighting bad life style the Type 2 Diabetes Epidemic patients attending primary healthcare centers in Makkah City .

In the present study, shows the most of the participants (29.0%) were in the age group < 40 years follow by the (26.0%)were in the age >60 years. Regarding the gender the majority of them were male (67.0%) while female(33.0%), also regarding Nationality the majority of participant are Saudi were(87.0%) non- Saudi were(13.0%), also regarding level of education the majority of participant are Intermediate school were(34.0%) High school education were(21.0%(. regarding Job the majority of participant are Professional worker were(32.0%) while Governmental employee

were(20.0%). Regarding Marital status the majority of participant are Married were (55.0%) while Single were(23.0%(. Regarding the Monthly family income (SR) the majority of participant between 5000-10000 were(38.0%) follow by >10000 were(34.0%). . (See Table 1)

Another study from the western part of Saudi Arabia, indicates that the prevalence of the majority of Saudi patients entering dialysis are diabetic patients [33]. The burden of diabetes upon the Saudi society continues to be on the rise. Diabetes mellitus is a group of chronic metabolic conditions all characterized by high level of Fasting plasma glucose, mg/dL and show distribution of diagnosis of Pre diabetes and Diabetes of participant in the study (See Table 2)

There are no modifiable and modifiable risk factors for development of type 2 diabetes (Table 3). No modifiable risk factors include age, sex, socioeconomic position, race/ethnicity, genetic predisposition, history of gestational diabetes, and low birth weight.[31] While European studies show a higher risk of diabetes in men compared with women, this was not consistently observed in the United States.[34] similar in the United States, the risk of developing type 2 diabetes was higher among those in lower socioeconomic positions, including lower levels of education, occupation, and income. American Indians/Alaska Natives have the highest prevalence of diabetes, followed by non-Hispanic blacks and Hispanics. African Americans are more likely to develop diabetes than white and Asian individuals.[35] For American Indians, the rates of diagnosed diabetes range from 5.5% to 33.5% in different tribes and population groups.[22] Although genetic factors also play a role, primary risk factors appear to be those that are not genetic.[30]

Regarding distribution of the patient's with of complications from diabetes of participant in the study show no significant relation between the Complications from diabetes and physical activities or exercise while P-value <0.0009 and X<sup>2</sup> 11.044, regarding the physical activities or exercise in YES the most of participant answer No were (68.25%) while Yes were(43.24%) while regarding Physical activities or exercise in NO the most of participant answer Yes were (56.76%) while No (31,75%).(See table 4). Physical activity is an effective “medicine” for diabetes and other chronic diseases.[35]

## Conclusion

Physical therapists' education provides both broad and in-depth content covering the pathophysiology of diabetes and associated comorbidities, screening for and treatment of diabetes complications, and prescription of physical activity for individuals with specific and important limitations of the human movement system that moderate physical activity tolerance Patients may not be regularly referred to physical therapists for guidance on the development of physical activity programs for chronic conditions, such as diabetes type 2 Only low percentage of referrals to

physical therapy in the Saudi Arabia patients attending primary healthcare centers were for diabetes as the primary health condition to be treated. While it is true that the vast majority of patients seen in outpatient settings have diabetes or are at risk of diabetes.

## References

1. Wang, H., Lu, Y., Yan, Y., Tian, S., Zheng, D., Leng, D., ... & Bai, Y. (2020). Promising treatment for type 2 diabetes: fecal microbiota transplantation reverses insulin resistance and impaired islets. *Frontiers in Cellular and Infection Microbiology*, 9, 455.
2. Higuaita-Gutiérrez, L. F., Quiroz, W. D. J. M., & Cardona-Arias, J. A. (2020). Prevalence of metabolic syndrome and its association with sociodemographic characteristics in participants of a public chronic disease control program in Medellin, Colombia, in 2018. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 13, 1161.
3. Jayawardena, R., Ranasinghe, P., Chaturanga, T., Atapattu, P. M., & Misra, A. (2018). The benefits of yoga practice compared to physical exercise in the management of type 2 Diabetes Mellitus: A systematic review and meta-analysis. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 12(5), 795-805.
4. Alothman, S. A., Alghannam, A. F., Almasud, A. A., Altalhi, A. S., & Al-Hazzaa, H. M. (2021). Lifestyle behaviors trend and their relationship with fear level of COVID-19: Cross-sectional study in Saudi Arabia. *Plos one*, 16(10), e0257904.
5. Cheema, S., Maisonneuve, P., Abraham, A., Chaabna, K., Yousuf, W., Mushannen, T., ... & Mamtani, R. (2021). Dietary patterns and associated lifestyle factors among university students in Qatar. *Journal of American College Health*, 1-9.
6. Awuchi, C. G., Echeta, C. K., & Igwe, V. S. (2020). Diabetes and the nutrition and diets for its prevention and treatment: a systematic review and dietetic perspective. *Health Sciences Research*, 6(1), 5-19.
7. Poznyak, A., Grechko, A. V., Poggio, P., Myasoedova, V. A., Alfieri, V., & Orekhov, A. N. (2020). The diabetes mellitus–atherosclerosis connection: The role of lipid and glucose metabolism and chronic inflammation. *International journal of molecular sciences*, 21(5), 1835.
8. Karras, S. N., Koufakis, T., Tsekmekidou, X., Antonopoulou, V., Zebekakis, P., & Kotsa, K. (2020). Increased parathyroid hormone is associated with higher fasting glucose in individuals with normocalcemic primary hyperparathyroidism and prediabetes: a pilot study. *Diabetes Research and Clinical Practice*, 160, 107985.
9. Kaikini, A. A., Dhodi, D., Muke, S., Peshattiwari, V., Bagle, S., Korde, A., ... & Sathaye, S.

- (2020). Standardization of type 1 and type 2 diabetic nephropathy models in rats: Assessment and characterization of metabolic features and renal injury. *Journal of Pharmacy & Bioallied Sciences*, 12(3), 295.
10. Zhao, Q., Li, L., Zhu, Y., Hou, D., Li, Y., Guo, X., ... & Gong, K. (2020). Kukoamine B ameliorate insulin resistance, oxidative stress, inflammation and other metabolic abnormalities in high-fat/high-fructose-fed rats. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 13, 1843.
  11. Sarker, I. H., Faruque, M. F., Alqahtani, H., & Kalim, A. (2020). K-nearest neighbor learning based diabetes mellitus prediction and analysis for eHealth services. *EAI Endorsed Transactions on Scalable Information Systems*, 7(26), e4-e4.
  12. Smokovski, I. (2021). Burden of diabetes prevalence. In *Managing Diabetes in Low Income Countries* (pp. 1-12). Springer, Cham.
  13. Sun, Y., Ma, C., Sun, H., Wang, H., Peng, W., Zhou, Z., ... & He, X. (2020). Metabolism: a novel shared link between diabetes mellitus and Alzheimer's disease. *Journal of diabetes research*, 2020.
  14. 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.
  15. 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.
  16. 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.
  17. 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.
  18. 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.
19. 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.
  20. 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.
  21. Fareed, M., Salam, N., Khoja, A. T., Mahmoud, A. M., & Ahamed, M. (2017). Life style related risk factors of type 2 diabetes mellitus and its increased prevalence in Saudi Arabia: A brief review. *International Journal of Medical Research & Health Sciences*, 6(3), 125-132.
  22. Zafar, A., Stone, M. A., Davies, M. J., & Khunti, K. (2015). Acknowledging and allocating responsibility for clinical inertia in the management of type 2 diabetes in primary care: a qualitative study. *Diabetic Medicine*, 32(3), 407-413.
  23. 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.
  24. Sudharsanan, N., Bloom, D. E., & Sudharsanan, N. (2018, June). The demography of aging in low-and middle-income countries: chronological versus functional perspectives. In *Future directions for the demography of aging: Proceedings of a workshop* (pp. 309-338).
  25. 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).
  26. Alanazi, F. K., Alotaibi, J. S., Paliadelis, P., Alqarawi, N., Alsharari, A., & Albagawi, B. (2018). Knowledge and awareness of diabetes mellitus and its risk factors in Saudi Arabia. *Saudi medical journal*, 39(10), 981.
  27. Jalal, S. A. M., Alamri, R. I. A., & Albarakati, M. S. H. (2021). Diabetes Mellitus Knowledge and Awareness among Diabetic Secondary School Students at Makkah in Saudi Arabia 2021. *Annals of the Romanian Society for Cell Biology*, 25(7), 115-137



28. Robert, A. A., Al-Dawish, A., Mujammami, M., & Dawish, M. A. A. (2018). Type 1 diabetes mellitus in Saudi Arabia: a soaring epidemic. *International journal of pediatrics*, 2018.
29. Ellahham, S. (2020). Diabetes and its associated cardiovascular complications in the Arabian Gulf: challenges and opportunities. *J Clin Exp Cardiol*, 11, 1-5.
30. 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.
31. 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.
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. 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.
34. 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.
35. 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.