



## AWARENESS OF DIABETIC PATIENTS REGARDING DIABETES COMPLICATIONS IN SAUDI ARABIA: SYSTEMATIC REVIEW

Amer Ahmed Balla Ahmed<sup>1\*</sup>, Mathayil Nazal Alruwaili<sup>2</sup>, Jalal Farhan Alanazi<sup>2</sup>, Dalal Farhan Alanazi<sup>2</sup>, Ahlam Sultan Alanazi<sup>2</sup>

1. Department of Endocrinology, King Abdulaziz Specialist Hospital, Al Jouf, Saudi Arabia.
2. Faculty of Medicine, Northern Border University, Arar, Saudi Arabia.

### ARTICLE INFO

#### Received:

19 Jul 2022

#### Received in revised form:

14 Oct 2022

#### Accepted:

15 Oct 2022

#### Available online:

28 Oct 2022

**Keywords:** Knowledge, Awareness, Diabetes mellitus, Complications, Diabetic patients, Saudi Arabia

### ABSTRACT

Diabetes is the furthestmost widespread illness in Saudi Arabia consuming huge health and financial inferences. If not controlled, diabetes can cause serious complications which can impair or end the patient life. Hence, to stop and regulate the sickness, every effort should be made. Diabetes cosequences are less common when people are more knowledgeable and aware of the disease and its consequences. We aimed to asses the awareness level of the diabetes mellitus complications among diabetic patients in Saudi Arabia. We searched PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane library. Utilizing Rayyan QCRI, study papers were already screened by title and abstract before a full-text analysis was done. More than half of respondents in this article's eight research, which comprised individuals of both sexes and different ages, were men. In all included studies we included diabetic patients in Saudi Arabia and we evaluated their awareness level about diabetic complications. The general level of awareness of Saudi diabetic patients was relatively good, and the highest awareness levels were obtained in the educated individuals. Likewise, to quantify greater people's awareness level, hospital-based practitioners could step up their efforts to educate diabetic patients and family members on the significance of managing their diabetes and preventing its consequences.

*This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-Share Alike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non commercially, as long as the author is credited and the new creations are licensed under the identical terms.*

**To Cite This Article:** Ahmed AAB, Alruwaili MN, Alanazi JF, Alanazi DF, Alanazi AS. Awareness of Diabetic Patients Regarding Diabetes Complications in Saudi Arabia: Systematic Review. *Pharmacophore*. 2022;13(5):58-63. <https://doi.org/10.51847/UQQWem7NOV>

### Introduction

Diabetes mellitus is a metabolic disorder caused by disturbances in insulin secretion, insulin movement, or both, and is diagnosed by the presence of hyperglycemia [1]. It is associated with improper carbohydrate, protein, and fat metabolism [2]. Diabetes is can be devided into three main types: type 1 (T1DM), type 2 (T2DM), and gestational diabetes. Type 1 diabetes is caused by the autoimmune destruction of beta cells within the islets of Langerhans, resulting in decreased insulin secretion. Type 2 diabetes is caused by a decrease in insulin motion as a result of insulin resistance through the use of frame tissues, which leads to disrupted glucose access to frame cells.

Kind 2 diabetes is the most common type of diabetes [3]. Type 2 diabetes affects around 90%-95% of diabetic patients. The global occurrence of diabetes mellitus in 2014 was estimated to be 9% in men and 7.9% in women, nearly double the 1980 figures of 4.3% and 5% in women and men, respectively [4], reflecting an increase in risk elements such as weight problems and unhealthy lifestyle choices. This can have an effect on patients' overall well-being as well as their quality of life [5]. It is also linked to morbidity and death. Diabetes mellitus was responsible for 1.5 million fatalities worldwide in 2012, making it the eighth leading cause of mortality [6]. Diabetes is regarded as a major global concern due to its high morbidity and mortality [7].

Middle Eastern and North African (MENA) countries have a higher prevalence of diabetes than other parts of the world; the superiority charge became 9.6% in 2017, and the charge is expected to rise to 12.1% by 2045 [8]. The high prevalence of diabetes within the MENA region is ascribed to the urbanisation process, high obesity rates, and the expanding elderly population in those countries [9]. This fashion is linked to the present economic boom in Saudi Arabia, which has brought

**Corresponding Author:** Amer Ahmed Balla Ahmed; Department of Endocrinology, King Abdulaziz Specialist Hospital, Al Jouf, Saudi Arabia. E-mail: aahmed108@moh.gov.sa.

about major lifestyle changes, with unsafe consuming behaviour and a lack of exercise becoming the norm. As a result, diabetes mellitus has risen to prominence, with 23.9% of the Saudi population suffering from it [10].

Poorly managed diabetes can cause a variety of headaches ranging from microvascular to macrovascular, including coronary artery disease, renal failure, blindness, stroke, skin ulcers, particularly within the foot, and so on, all of which can result in significant morbidity and mortality [11]. Diabetes is the most serious hazard to the progression and development of DM complications. As a result, diabetic problems associated with a long length of sickness become a top priority in healthcare. Public health interventions must consider how to change Saudi society's behaviour in order to better prevent and manage diabetes, which is the country's most frequent general ailment and has a high financial cost. Diabetes patients' quality of life may improve if the disease's signs are detected early. As a result, educating the person is critical [12].

### *Objectives*

This systematic review aims to examine the literature to determine the level of interest in the consequences of diabetes mellitus among diabetic patients in Saudi Arabia. The literature was reviewed using the PubMed database between 2017 and 2021 for this review.

### **Materials and Methods**

This systematic review was carried out according to the guidelines outlined (PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-analyses).

### *Study Design*

This was a meta-analysis and systematic review.

### *Study Condition*

This review looks at newly and previously published literature on the level of awareness of Saudi diabetic patients about the various complications of diabetes mellitus.

### *Search Strategy*

A systematic search of five major databases, including PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane library, was done to incorporate the eligible literature. Our search was restricted to English and tailored to each database as needed. The following keywords were converted into Mesh terms in PubMed to find suitable studies: "knowledge, awareness, diabetes mellitus, complications, diabetic patients, Saudi Arabia." The relevant keywords were combined with the "OR" and "AND" Boolean operators. The search results included full-text publications in English, freely available articles, and human trials.

### *Selection Criteria*

Our review included the studies with the following criteria:

- Cohort studies and study designs, primarily retrospective cohort provided qualitative or quantitative data on the perception of diabetic complications in people with diabetes in Saudi Arabia.

The following were among the exclusion criteria:

- Studies that are not done in English.
- No free access to studies.

### *Data Extraction*

Rayyan (QCRI) [9] was utilised to discover duplicate features of the search strategy results. The researchers determined the adequacy of the titles and abstracts by assessing the pooled search results against a set of inclusion/exclusion criteria. The reviewers evaluated the whole texts of the papers that met the inclusion criteria. To resolve any disputes, the writers held a conversation. A data extraction form was built to contain the eligible study. The writers gathered information on the research titles, authors, study design, population survey, participant number, aims, complications mentioned, study year, and significant findings.

### *Assessment of the Risk of Bias*

To assess the incorporated research quality, the ROBINS-I technique for non-randomized studies [13] was utilized for qualitative data synthesis. The reviewers identified and corrected any anomalies in the quality evaluation.

### *Data Synthesis Strategy*

Summary tables with the gathered details from the relevant studies were produced to offer a qualitative overview of the included study components and result data. Following the completion of the data extraction in this systematic review,

judgments were taken on how to best utilize the available data from the included study articles. Studies that satisfied the full-text inclusion criteria but did not offer data on the level of awareness were eliminated.

**Results and Discussion**

*Search Results*

The systematic search yielded 220 study papers, after which 53 duplicates were deleted. Twenty studies were removed after being subjected to title and abstract screening. A total of 122 reports were requested for retrieval, with just 30 items not being found. Finally, 92 articles were screened for full-text evaluation; 20 were excluded due to incorrect research outcomes, 38 were excluded due to insufficient data on the current topic, and 42 were excluded due to the incorrect population type. This systematic review contained eight eligible study papers.

*Characteristics of the Studies Included*

This review covered a total of eight papers. The major theme of most of this research ranged from the degree of awareness of Saudi diabetic patients on the various diabetes complications. The sex studies were cross-sectional [14-19], Two of them were longitudinal [13, 20]. The studies' sample sizes ranged from 519 to 259 people. The elderly, adults, and teenagers were among the age groups evaluated. All of the research listed were conducted in Saudi Arabia.

In the **Table 1** we included the summary of the included previous studies with their main objectives, key findings, and the year of publication.

**Table 1.** Summary of characteristics of the included studies

Study	Study design	Location	Sample Size	Type of complication	Awareness level	Study Objective	Key findings
El Sheikh, <i>et al.</i> , 2021 [14]	Cross-sectional study	Alahsa, Saudi Arabia	379	cardiovascular complications		To assess type 2 diabetes patients' knowledge, attitude, and practise about DM cardiovascular headaches in Alahsa, Saudi Arabia.	In our latest survey, more than half of the participants had a thorough awareness of diabetes and its consequences. Age, gender, educational level, and personal family history of DM have all been found to be important predictors of DM headache awareness. However, due to the rising rates of diabetes incidence and prevalence in Saudi Arabia, interest and understanding are necessary.
Basharheel <i>et al.</i> , 2020 [15]	Cross-sectional study	Saudi Arabia	259	diabetic neuropathy		to determine the level of awareness of diabetic Neuropathy among diabetic patients in Saudi Arabia.	The level of knowledge of the Saudi population about diabetic neuropathy symptoms was found unsatisfactory. More research is needed to determine the relationships between the occurrence of diabetic neuropathy and patients' degree of knowledge regarding diabetic neuropathy...
Al Bshabsheet <i>et al.</i> , 2020 [16]	A descriptive cross-sectional	southwestern Saudi Arabia	287	All complications		Every outpatient division of a diabetes care centre in a tertian care medical facility in southern Saudi Arabia was evaluated to measure diabetes care practises and related awareness among patients with type 2 diabetes.	This study demonstrates that the exploration population, particularly educated young patients who stick to regular therapy follow-up, is well informed of diabetic problems. The doctor is an essential source of information for the patient....
Alharbi <i>et al.</i> , 2020. [13]	A Review of the Literature	Saudi Arabia	---	Diabetic Retinopathy		to educate diabetic patients about the prevalence of DR in Saudi Arabia, to identify the major interconnected risk factors, and to improve disease cognition in diabetic patients	In Saudi Arabia, the prevalence of DR has risen dramatically in recent decades. Important risk factors associated with DR include advanced age, long-term diabetes, poor glycemic management, and hypertension. Diabetes education and awareness are linked to improved outcomes and fewer complications.
Alhomayani, <i>et al.</i> , 2020 [20]	Systematic review	Saudi Arabia	---	All complications		To examine the literature to assess the level of knowledge and attitude toward diabetes complications in Saudi Arabia.	The evidence on diabetes complications knowledge is contradictory. Further large, multicenter studies should be considered to provide an accurate estimate of diabetes complications knowledge and practises.

Fatani, <i>et al.</i> , 2018 [17]	descriptive cross-sectional study	Makkah, Saudi Arabia	299	All complications	to assess Makkah population understanding and recognition of diabetes complications signs and symptoms, and to quantify the incidence of diabetic complications occurrence	To broaden powerful patient education and improve sufferers' diabetic control and very own headaches, academic techniques are required. They will assist diabetic sufferers to enhance their self-knowledge and popularity of early symptoms and signs of DM headaches, which will save you similarly deterioration, in order to enhance existence fine and boom existence expectancy for those sufferers. Diabetes, awareness, and headaches are all keywords.
Algshanen, <i>et al.</i> , 2017 [18]	cross-sectional study	Saudi Arabia	519	Diabetic Foot	to appraise the lore, teaching, attitudes and rehearse of diabetic foot in patients owing to diabetes across Saudi Arabia.	diabetic feet in Saudi Arabia exist, even amputation and different diabetic foot convulsion are donative. Diabetics have commonsense knowledge and attitude towards diabetic feet. There are many weaknesses in the education along with exercise of legs for people with diabetes.
Alasiri, <i>et al.</i> , 2016 [19]	A hospital-based, cross-sectional study	Jeddah Saudi Arabia	357	Diabetic Retinopathy	Diabetic retinopathy consciousness evaluation in Saudi diabetic patients	Although the majority of diabetics in Saudi Arabia are aware that diabetes might harm their eyes, little or no information is accessible on its risk factors and prevention. As a result, raising awareness is critical in order to minimise the number of instances of blindness caused by DR in Saudi Arabia.

Diabetes mellitus is a chronic condition that entails ongoing monitoring and management. Diabetes management issues can lead to a variety of life-threatening consequences [21]. One of the primary reasons of poor diabetes management is patients', caregivers', and physicians' lack of knowledge and behaviour regarding the impacts of diabetes and the importance of adequate blood glucose control [22]. The present systematic study examined the scientific literature to determine the extent to which Saudi diabetes patients were aware of the risks. In this study, we assessed that diabetic patients have a high degree of knowledge of diabetes complications, particularly among young educated patients who follow up regularly.

In Al Bshabshe *et al.* [16], a good awareness level was estimated from a male and female mixed sample of 287 examine subjects made up of diabetic patients attending the Diabetes Clinic at Aseer Central Hospital [16], approximately 50.5% of the contributors recorded a high level of consciousness about DM and its complications, whereas only 9.8% had negative consciousness. They also stated that 45.6% of diabetic patients were aware of renal complications, 42.9% were aware of cardiac complications, 41.8% were aware of renal headaches, 39.7% were aware of stroke, and 36.9% were aware of dermatological complications.

These results were similar to Fatani's *et al.* [17], reported a good awareness level about diabetes complications in Makkah City. Nearly (80%) of their participants were aware of complications of diabetes mellitus. Another study that was done previously reported lesser results. It showed the level of knowledge of the complications of diabetes mellitus and the majority did not have knowledge about diabetes complications (60.0 %), and only (13.1 %) had adequate knowledge [23].

The following complications were identified by participants in Fatani *et al.* [17]: eye disease (72.9%), diabetic foot (71.2%), renal disease (56.2%), peripheral neuropathy (53.8%), sexual impairment (42.5%), heart disease (40.1%), high blood pressure (33.1%), sudden death (20.4%), and cerebrovascular disease (18.7%). Another study by Algshanen *et al.* [18] found that diabetic individuals had strong knowledge and attitude about diabetic foot as a frequent consequence of diabetes, with the majority of participants (55.1%) scoring 7-8 out of 8 items in Knowledge. Female gender and educational level were crucial factors in raising knowledge of a diabetic foot, with better educated individuals receiving higher evaluation scores.

According to Alasiri *et al.* [19], only 218 (61%) of 357 participants were aware of Diabetic Retinopathy (DR) as a diabetic consequence. Type 1 diabetes patients were much more aware of DR than type 2 diabetic patients (63.8% versus 36.2%, respectively). These findings are lower than the level of awareness about eye complications obtained by Fatani *et al.* [17].

According to Alasiri *et al.* [19], despite the fact that 218 (61%) patients were aware of diabetic retinopathy and 82 (22.9%) patients were aware it could result in blindness, only 179 (50%) of all respondents went for eye checkups and only 71 (19.8%) of patients were compliant on annual eye examination.

On the other hand, the level of knowledge of the Saudi population about diabetic neuropathy symptoms was found unsatisfactory in Basharheel *et al.* [15]. The study revealed that the average knowledge score for the whole cohort was  $3.83 \pm 2.893$ . The maximum knowledge score was 11, whereas the minimum score was zero. Alhashim *et al.* [24] performed a retrospective cross-sectional study, which reported that the mean score of the level of awareness was  $7.1 \pm 3.4$ . However, the number of individuals who know that DM can cause diabetic neuropathy was 56.4%. Furthermore, 27.5% did not understand why this condition occurs with DM. Besides, 20.4% of the individuals had no idea about DN [24]. Also, Shaikh *et al.* [25] performed a cross-sectional study to determine patients' awareness level regarding DN. When patients were assessed regarding their awareness of DN, only 30% of patients knew about the complications of DM; only 10% of patients knew about DN [25]. Basharheel *et al.* [15] did not detect a statistically significant difference in knowledge among both genders. However, there was a significantly different among different age groups (<0.001) and educational levels (0.008). An excellent academic level

was found to be highly effective in the awareness level in Eman El Sheikh *et al.* [14] as well. They included a total of 379 participants with diabetes.

Diabetes was most usually associated with hypertension. Her 54.6% of patients have a basic understanding of diabetes and its complexities. The most common DM complications identified by participants were: heart disease (6.1%), diabetic foot disease (5.5%), and cerebrovascular disease (1.8%). This is a higher level of awareness about these diseases as complications to diabetes than obtained by Ensaf Mohammad Fatani *et al.* [17].

Awareness about the positive effect of lifestyle modification in controlling diabetes and prevention of diabetic complications is a significant point to consider.

According to previous research [26], regular exercise improves fasting blood glucose, plasma insulin levels, glycemic control, and insulin resistance. Badedi *et al.* [27], Al-Aboudi *et al.* [28], and Ismail *et al.* [29] investigated diabetes knowledge and behaviour in three different contexts.

In three studies [13, 15, 18], patients' understanding of the importance of controlling blood sugar levels and making lifestyle changes to reduce the incidence of diabetes complexity was painfully low. Patients' levels of education may influence the specificity of diabetic complications they may experience [27-29].

The Saudi people, in general, were aware of the dangers. Bani *et al.* uncovered diabetes complexity variables in a large community-based study [30, 31]. They enlisted 2,023 people from the general public and estimated their chance of developing diabetes. They state that the most often identified risk factors include a higher BMI, a family history of diabetes, physical inactivity, and advanced age.

## Conclusion

In conclusion, we found that the awareness level of Saudi diabetic patients is relatively good, however; more effort should be done to patient education about such a vital subject. Although self-follow-up is common in diabetes because of its chronic nature, the patient should be aware of how to follow up and control his diabetes, and he must be aware of diabetes complications and how to avoid or deal with them.

Diabetes advertence and Education Are interconnected with Improved consequence along with lesser complicacy.

**Acknowledgments:** Many thanks to Dr. Amer Ahmed Balla Ahmed Consultant of Endocrinology, King Abdulaziz Specialist Hospital, Al Jouf, Saudi Arabia, for his continuous help, support and encouragement to complete this work.

**Conflict of interest:** None

**Financial support:** None

**Ethics statement:** None

## References

1. Mohieldein AH, Alzohairy MA, Hasan M. Awareness of diabetes mellitus among Saudi non-diabetic population in Al-Qassim region, Saudi Arabia. *J Diabetes Endocrinol.* 2011;2(2):14-9.
2. Sami W, Ansari T, Butt NS, Ab Hamid MR. Effect of diet on type 2 diabetes mellitus: a review. *Int J Health Sci.* 2017;11(2):65.
3. Almeahadi AH, Alzaid G, Quqandi S, Almalki G, Bannan A, AlHindi A, et al. Awareness of the Effect of Diabetes on Oral Health among a Population in Jeddah, Saudi Arabia. *Oral Health Prev Dent.* 2020;18(1):27-34. doi:10.3290/j.ohpd.a44115
4. Robert AA, Al Dawish MA. The Worrying Trend of Diabetes Mellitus in Saudi Arabia: An Urgent Call to Action. *Curr Diabetes Rev.* 2020;16(3):204-10. doi:10.2174/1573399815666190531093735
5. Alwin Robert A, Al Dawish MA. Microvascular complications among patients with diabetes: An emerging health problem in Saudi Arabia. *Diab Vasc Dis Res.* 2019;16(3):227-35. doi:10.1177/1479164118820714
6. El-Kebbi IM, Bidikian NH, Hneiny L, Nasrallah MP. Epidemiology of type 2 diabetes in the Middle East and North Africa: Challenges and call for action. *World J Diabetes.* 2021;12(9):1401-25. doi:10.4239/wjd.v12.i9.1401
7. Nganabashaka JP, Ntawuyirushintege S, Niyibizi JB, Umwali G, Bavuma CM, Byiringiro JC, et al. Population-Level Interventions Targeting Risk Factors for Hypertension and Diabetes in Rwanda: A Situational Analysis. *Front Public Health.* 2022;10:882033. doi:10.3389/fpubh.2022.882033
8. International Diabetes Federation. IDF diabetes atlas - 2017 Atlas. [Update 2017; cited 2018 February 19]. Available from: <http://www.diabetesatlas.org/resources/2017-atlas.html>.
9. Branigan GL, Torrandell-Haro G, Vitali F, Brinton RD, Rodgers K. Age and sex differences on anti-hyperglycemic medication exposure and risk of newly diagnosed multiple sclerosis in propensity score matched type 2 diabetics. *Heliyon.* 2022;8(10):e11196. doi:10.1016/j.heliyon.2022.e11196

10. Alomari A, Al Hisnah S. Prevalence of Prediabetes and Associated Risk Factor Assessment Among Adults Attending Primary Healthcare Centers in Al Bahah, Saudi Arabia: A Cross-Sectional Study. *Cureus*. 2022;14(9):e29465. doi:10.7759/cureus.29465
11. Elafros MA, Callaghan BC, Skolarus LE, Vileikyte L, Lawrenson JG, Feldman EL. Patient and health care provider knowledge of diabetes and diabetic microvascular complications: a comprehensive literature review. *Rev Endocr Metab Disord*. 2022. doi:10.1007/s11154-022-09754-5
12. Alanazi FK, Alotaibi JS, Paliadelis P, Alqarawi N, Alsharari A, Albagawi B. Knowledge and awareness of diabetes mellitus and its risk factors in Saudi Arabia. *Saudi Med J*. 2018;39(10):981-9. doi:10.15537/smj.2018.10.22938
13. Alharbi AMD, Alhazmi AMS. Prevalence, Risk Factors, and Patient Awareness of Diabetic Retinopathy in Saudi Arabia: A Review of the Literature. *Cureus*. 2020;12(12):e11991. doi:10.7759/cureus.11991
14. El Sheikh E, Alkhars JA, Alsaad AM, Albattat FS, Al-Omran ZM, Alradhi HK et al. Knowledge, attitude, and practice of type 2 diabetic patients toward Diabetes Mellitus and its cardiovascular complications in Alpha. *Int J Med Deve Ctries*. 2021;5(2):494-502. doi:10.24911/IJMDC.51-160769175
15. Basharheel AS, Khawaji ST, Mawkili AA, Alddarb YA, Moafa AA, Majrabi AQ. Awareness of diabetic patients regarding diabetic neuropathy in Saudi Arabia. *Int J Med Dev Ctries*. 2020;4(11):1715-20. doi:10.24911/IJMDC.51-1577358615
16. Al Bshabshe A, Ahmad MT, Assiri OAA, Assery AA, Aljadhaa GA, Al Aslai SA, et al. Diabetes-care practices and related awareness amongst type-2 diabetes patients attending diabetes OPD at a tertiary care hospital in southwestern Saudi Arabia. *J Family Med Prim Care*. 2020;9(4):2085-91. doi:10.4103/jfmpc.jfmpc\_1120\_19
17. Fatani EM, Gari LN, Alharbi AH, Alzaharani JA, Almasoudi AS, Bablghaith ES. Awareness of Diabetic Complications, Perceived knowledge, Compliance to Medications and Control of Diabetes Among Diabetic Population of Makkah City, Kingdome Saudi Arabia: Cross-Sectional Study. *Egypt J Hosp Med*. 2018;70(7):1190-5.
18. Algshanan MA, Almuhanma MF, Almuhanma AM, Alghobaish FF, Bari OS, Alajji NA, et al. Diabetic Foot Awareness among Diabetic Patients in Saudi Arabia. *Egypt J Hosp Med*. 2017;68(2):1289-90.
19. Alasiri RA, Bafaraj AG. Awareness of Diabetic Retinopathy among Diabetic Patients in King Abdulaziz University Hospital, Jeddah, Saudi Arabia. *Ann Int Med Dent Res*. 2016;2(6).
20. Alhomayani FKH, Alotibi YZM, NasserAlharbi AA, Alsuwat HAM, Altowairqi MHA, Alotaibi HAA. Knowledge and attitude toward diabetes mellitus complications in Saudi Arabia; a systematic review. *IJMDC*. 2020;4(2):498-503. doi:10.24911/IJMDC.51-1575931871
21. Gillani SW, Ansari IA, Zaghloul HA, Sulaiman SAS, Rathore HA, Baig MR, et al. Predictors of Health-Related Quality of Life Among Patients with Type II Diabetes Mellitus Who Are Insulin Users: A Multidimensional Model. *Curr Ther Res Clin Exp*. 2019;90:53-60. doi:10.1016/j.curtheres.2019.04.001
22. Bour C, Ahne A, Aguayo G, Fischer A, Marcic D, Kayser P, et al. Global diabetes burden: analysis of regional differences to improve diabetes care. *BMJ Open Diabetes Res Care*. 2022;10(5):e003040. doi:10.1136/bmjdr-2022-003040
23. Nkoka O, Ntenda PAM, Phiri YVA, Mabuza GN, Dlamini SA. Knowledge of diabetes among Gambian adults: evidence from a nation-wide survey. *BMC Cardiovasc Disord*. 2022;22(1):145. doi:10.1186/s12872-022-02591-z
24. Alhashim BN, Zaher A, Albujaays DS, Alhashim JN, Ali SI. Study of the level of awareness of diabetic neuropathy among diabetic patients in Al-Ahsa Region, Kingdom of Saudi Arabia: a cross-sectional study. *Int J Sci Study*. 2018;5(1):1-6.
25. Shaikh MN, Memon ZH, Ajmal MI. Awareness of diabetic patients regarding diabetic neuropathy. *Med Forum Mon*. 2017; 28(5):191-4.
26. World Health Organization (WHO). Physical activity and adults. [accessed]. Available from: <https://www.who.int/teams/health-promotion/physical-activity/physical-activity-and-adults>
27. Dey S, Mukherjee A, Pati MK, Kar A, Ramanaik S, Pujar A, et al. Socio-demographic, behavioural and clinical factors influencing control of diabetes and hypertension in urban Mysore, South India: a mixed-method study conducted in 2018. *Arch Public Health*. 2022;80(1):234. doi:10.1186/s13690-022-00996-y
28. Mansy W, Wajid S, Alwhaibi A, Alghadeer SM, Alhossan A, Babelghaith S, et al. Assessing Outpatients' Knowledge, Attitude, and Practice Toward Managing Diabetes in Saudi Arabia. *Inquiry*. 2022;59:469580221082781. doi:10.1177/00469580221082781
29. Ibrahim Abougambou SS, AbaAlkhalil H, Abougambou AS. The knowledge, attitude and practice among diabetic patient in central region of Saudi Arabia. *Diabetes Metab Syndr*. 2019;13(5):2975-81. doi:10.1016/j.dsx.2019.07.049
30. Mahzari MA, Oraibi OH, Shami AM, Shami MO, Thobab TY, Awlaqi AA, et al. Knowledge, Attitude, and Practice Regarding Diabetes Mellitus Among Type 2 Diabetic Patients Attending Primary Health Care Centers in the Jazan Region of Saudi Arabia. *Cureus*. 2022;14(9):e28704. doi:10.7759/cureus.28704
31. Moradpour F, Rezaei S, Piroozi B, Moradi G, Moradi Y, Piri N, et al. Prevalence of prediabetes, diabetes, diabetes awareness, treatment, and its socioeconomic inequality in west of Iran. *Sci Rep*. 2022;12(1):17892. doi:10.1038/s41598-022-22779-9