Original Article

The prevalence of Alzheimer's disease among diabetic patients in Saudi Arabia

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ABSTRACT

الأهداف: تبحث هذه الدراسة في قياس توعية و معرفة مرض الزهايمر بين 228 من البالغين السعوديين و المصابين بالسكري، بهدف تقييم الوعي المعرفي من خلال استبيان مخصص لقياس التوعية بمرض الزهايمر. وتستكشف عوامل الخطر والأعراض واستراتيجيات الوقاية والمواقف تجاه هذا المرض.

المنهجية: أجرى إخصائيون التغذية وممارسوا التعليم و التوعيه لمرضى السكري بجمع الاستبيانات من 228 مشاركًا سعوديًا بالغًا مصابًا بالسكري بعد الموافقة الأخلاقية على هذا البحث و إقرار بموافقة المشاركين، مع التركيز على فهمهم لمرض الزهايمر عبر محاور مختلفة. استخدمت الدراسة أدوات معتمدة لجمع البيانات ودمجت الاستجابات مع التفاصيل الديموغرافية والطبية.

النتائج: من بين 228 مشاركًا، كانت الأعلى نسبة مشاركة نسبة من الإناث و التي بلغت ب 56.6%. كشفت النتائج عن مقياس التوعيه بثلاثة مجالات فرعية من مقياس معرفة مرض الزهايمر (ADKS) وهذه العوامل هي عامل الخطر، عامل الفعلي، و عامل التشخيص وكانت النسبة ب 75%. ومع ذلك، لوحظت معدلات إقرار أقل بقليل في باقي المحاور الفرعية من مقياس معرفة مرض الزهايمر (ADKS) وهي تأثير الحياة (71%)، الأعراض المرضية (71%)، الرعاية (72%)، و العلاج (69%). وأشار التحليل الإحصائي إلى وجود فروق كبيرة في المعرفة بناءً على مستويات التعليم ($p \leq 0.05$)، حيث أظهر الأفراد المتعلمون في الجامعة اتفاقًا أكبر عبر جميع المجالات الفرعية لـ ADKS.

الخلاصة: يسلط البحث الضوء على الحاجة إلى زيادة الوعي بمرض الزهايمر بين الأفراد السعوديين المصابين بالسكري. من خلال دمج الرعاية الصحية والتعليم والتدخلات الثقافية، تدعو الدراسة إلى التعليم المستهدف لتحسين فهم الصحة المعرفية واستراتيجيات الإدارة الفعالة في هذه التركيبة السكانية، مع التأكيد على دور الخلفية التعليمية في تشكيل التصورات.

Objectives: To investigate the knowledge of Alzheimer's disease (AD) among 228 Saudi adults with diabetes, aiming to assess cognitive awareness through a questionnaire. It explores risk factors, symptoms, prevention strategies, and attitudes towards dementia, while integrating demographic data to illuminate cognitive landscapes and correlations between diabetes and cognitive health.

Methods: Trained dietitians administered questionnaires to 228 adult Saudi diabetic participants, focusing on their understanding of AD across various domains. The study employed validated tools for data collection and amalgamated responses with demographic and medical details.

Results: Of the 228 participants, 56.6% were female. Findings revealed a high acknowledgment of 3 subdomains of the Alzheimer's disease knowledge scale (ADKS) - risk factors, course, and diagnosis - with 75% agreement. However, lower acknowledgment rates with agreements were observed in the domains of life impact (71%), symptoms (71%), caregiving (72%), and treatment management (69%). Statistical analysis indicated significant differences in knowledge based on education levels ($p \leq 0.05$), with university-educated individuals demonstrating greater agreement across all ADKS subdomains.

Conclusion: The research highlights the need for enhanced awareness of AD among Saudi diabetic individuals. By integrating healthcare, education, and culturally sensitive interventions, the study advocates for targeted education to improve understanding of cognitive health and effective management strategies in this demographic, emphasizing the role of educational background in shaping perceptions.

Keywords: Alzheimer disease, diabetes mellitus, awareness, knowledge

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Alzheimer's disease (AD) is a progressive neurodegenerative disorder that leads to cognitive decline, memory loss, and functional impairments. As the most prevalent form of dementia, it currently affects millions globally, and its incidence is projected to increase due to an aging population, creating considerable challenges for healthcare systems.[1] In Saudi Arabia, there is an increasing worry regarding the effects of AD, especially among those who also have comorbid conditions like diabetes.[2] Alzheimer's disease accounts for more than two-thirds of cases of progressive cognitive decline in the elderly population in Saudi Arabia, with an estimated total prevalence of approximately 130,000 individuals affected by the condition.[3] furthermore, AD is a specific type of dementia characterized by progressive memory loss, cognitive decline, and diabetes, which is a chronic metabolic disease characterized by high levels of blood glucose (or blood sugar), which over time leads to serious damage to the heart, blood vessels, eyes, kidneys and nerves.[4,5] Additionally, it is estimated that the prevalence of AD in the country is approximately 5%, with a noticeable rise in cases among individuals over the age of 65.[6] A country-specific report from the Global Burden of Disease revealed that, in 2010, chronic diseases were the leading cause of death in Saudi Arabia. Between 1990-2019, individuals aged 70 and older experienced rising mortality rates from AD and other dementias, lung cancer, diabetes, and chronic kidney disease.[7]

Despite the growing evidence regarding the epidemiological distribution and determinants of dementia worldwide, studies from the Arab region remain rare. Assessing the knowledge and awareness of AD among individuals with diabetes in Saudi Arabia is crucial for understanding the overall healthcare landscape in the region. Numerous studies have found that individuals with diabetes are at an increased risk for developing dementia.[8] Major risk factors of dementia included hypertension, low income, and low education, while the risk of developing dementia is increased by obesity, diabetes mellitus (DM), and cardiovascular risk factors.

The unique cultural context and healthcare infrastructure in Saudi Arabia further emphasize the importance of exploring the awareness levels and gaps in AD among individuals managing diabetes. This research examines AD awareness among Saudi diabetics at Prince Sultan Military Medical City in Riyadh, Saudi Arabia, revealing areas for educational improvement and addressing comorbidities in disease management. Ultimately, this study aims to enhance understanding of public health challenges and tailor interventions in Saudi Arabia. Given the rising rates of both diabetes and cognitive disorders worldwide, examining the intersection of these conditions in specific populations can reveal important challenges and opportunities for healthcare providers and policymakers. In addition, increased awareness, diagnosis, treatment strategies, and population-based studies are much needed to avert DM-induced dementia in high-risk populations.

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Methods. The study was carried out between March and August 2024 and encompassed all phases, including data collection, analysis, and manuscript preparation, aimed at exploring the understanding of AD knowledge among diabetic adults.

A total of 228 diabetic adults from Prince Sultan Military Medical City at Diabetic center, Riyadh, Saudi Arabia, took part in the study. Participants were aged 18 and above, diagnosed with type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), or prediabetes. The selection aimed for demographic diversity, including varied diabetes management and healthcare access levels, to reflect the center's diabetic population comprehensively and inclusively.

This work was carried out following the guidelines for ethical scientific research, Research Center at Prince Sultan Military Medical City in Riyadh, Saudi Arabia. Approval from the Prince Sultan Military Medical City (approval No.: E-2342) was obtained.

A structured questionnaire was developed to assess knowledge and awareness of AD, utilizing the validated Alzheimer's disease knowledge scale (ADKS).[9] This 30-items tool evaluates participant understanding across 7 critical domains: risk factors, symptoms, assessment and diagnosis, disease course, life impact, treatment and management, and caregiving. Each item can be answered as agree or disagree, with correct responses yielding a higher score indicative of better knowledge. The ADKS has demonstrated strong psychometric properties and is suitable for various respondents, including the general public, caregivers, and healthcare professionals. The questionnaire takes approximately 5-10 minutes to complete. Additionally, the ADKS show cases high test reliability, with a coefficient of 0.87 (p<0.001), reinforcing the reliability of the findings.[9] Demographic data were also collected from participants. This approach ensures a comprehensive assessment of knowledge regarding AD consistent with established research standards.

The study included adult patients who were diagnosed with T1DM, T2DM, and prediabetes at the diabetes center, using non-probability convenience sampling with 95% confidence level, the expected margin of error was 7%.

Participants who met the inclusion criteria were approached by the research team during their clinic visits or healthcare appointments. The study objectives were explained, and informed consent were secured for those interested in participating. Consequently, the study excluded the following cases during data collection, these cases were pediatric patients diagnosed with T1DM or T2DM, and patients with either type of diabetes who were followed up or diagnosed outside the diabetes center at Prince Sultan Military Medical City in Riyadh, Saudi Arabia. A trained dietitian administered the questionnaire privately, allowing participants ample time to complete it, addressing any questions they had.

Between May and July 2024, health practitioners collected confidential demographic, medical history, and questionnaire responses from participants, ensuring privacy.

The Scientific Research Center at Prince Sultan Military Medical City in Riyadh, Saudi Arabia, implemented quality control measures to ensure data accuracy and reliability during the data collection process. This included double-checking responses and verifying the completeness of questionnaires.

Statistical analysis. Statistical analysis was carried out using the Statistical Package for the Social Sciences for Windows, version 21.0 (IBM Corp., Armonk, NY, USA).[10] Categorical variables were represented as frequencies and percentages. Continuous variables were represented as mean and standard deviation (SD). For comparison, the Chi-square test, t-test, ANOVA, and MANOVA were used. Significant differences were indicated by *p*-values of <0.05.

Table 1 - Demographic data of study participants in Riyadh, Saudi Arabia (N=228).

Variables	n (%)
Gender	
Male	99 (43.4)
Female	129 (56.6)
Age (years), mean±SD	48.9±22.4
Educational level	
Below high school	94 (41.2)
College/university education	130 (57.0)
Graduate/postgraduate education	4 (1.8)
Family history of Alzheimer's disease	
Yes	39 (17.1)
No	136 (59.6)
Unknown	53 (23.3)
Type of diabetes	
T1DM	106 (46.5)
T2DM	115 (50.4)
Pre-diabetes	7 (3.1)
Duration of diabetes (year)	
<5 years	70 (30.7)
5-10	64 (28.1)
11-20	58 (25.4)
>20 years	36 (15.8)
Other comorbidity	
Cardiovascular disease	85 (29.8)
Blood pressure hypertension	100 (48.9)
Obesity	34 (15.3)
Other	9 (6.0)
Smoking habit*	
Smokers	23 (10.0)
Non-smokers	193 (85.0)
Occupation*	
Not working/retired	107 (46.9)
Housewife	32 (14.0)
Student	26 (11.4)
Administrator employee	30 (13.2)
Other	17 (7.4)
Source of Alzheimer's' knowledge	
Health practitioner	146 (64.0)
Family and friends	35 (15.4)
Social media	43 (18.9)
Other	4 (1.7)

Values are presented as numbers and percentages (%). *Missing data.
SD: standard deviation, T1DM: type 1 diabetes, T2DM: type 2 diabetes

Results. As shown in Table 1, a comprehensive overview of the participants' characteristics. A total of 228 participants who participated in this study. Among the participants, females represented 56.6% (n=129), while males comprised 43.4% (n=99), indicating a slightly higher participation rate among women. The mean age of the participants is 48.9 years, reflecting a diverse age range within the cohort. Educational attainment showed that a substantial majority (57%) have completed college or university education, while 41.2% have education levels below high school, and merely 1.8% hold graduate or postgraduate degrees. Regarding familial connections to AD, 17.1% (n=39) reported a family history of the condition, while 59.6% (n=136) did not, with 23.2% (n=53) indicating uncertainty regarding their family history. In terms of diabetes classification, The participants were predominantly diagnosed with T1DM (46.5%) and T2DM (50.4%), with a small fraction (3.1%) identified as pre-diabetic. The duration of diabetes varied among participants, with 30.7% diagnosed for less than 5 years, and 15.8% for more than 20 years, showcasing a wide range of diabetes management experiences. Additionally, comorbid conditions were prevalent,

with 48.9% having hypertension, 29.8% suffering from cardiovascular diseases, and 15.3% identified as obese, while 6% reported other comorbidities, other conditions such as allergic diseases, chronic headaches, iron deficiency, and vitamin D deficiency. The smoking habit category indicated that 10% of the participants were smokers, contrasting with a significant majority of 85% who did not smoke, revealing a general inclination towards healthier lifestyle choices. Occupation-wise, nearly half (46.9%) identified as not working or retired, while the rest were engaged in various roles, including housewives, students, and employees in administrative positions. Furthermore, participants predominantly acquired their knowledge of AD from health practitioners (64%), followed by social media (18.9%), and family and friends (15.4%), suggesting a reliance on professional sources for health information such as medical articles.

Table 2 presented a summary of the ADKS among diabetics, highlighting various questions within each subdomain. These subdomains included life impact, risk factors, course, assessment and diagnosis, treatment and management, symptoms, and caregiving. In the life impact subdomain, 72% of participants agreed that individuals with AD were particularly vulnerable to depression, emphasizing the emotional and psychological toll of the disease. However, there was a concerning belief that it was safe for people with AD to drive as long as they had a companion, suggesting a potential misunderstanding of the cognitive impairments associated with the disease. Additionally, while many individuals believed that most people with AD resided in nursing homes, this perspective may have overlooked the value of in-home care and support; approximately 25% (n=58) disagreed with this belief.

Table 2 - Public knowledge and awareness regarding Alzheimer's disease in Saudi Arabia, among diabetics (N=228).

Questions included in each subdomain	Agree	Disagree
Life impact		
People with AD are particularly prone to depression. It is safe for people with AD to drive as long as they have a companion in the car at all times. Most people with AD live in nursing homes.	165 (72.0)	63 (28.0)
Risk Factors		
Prescription drugs that prevent AD are available. It has been scientifically proven that mental exercises can prevent a person from getting AD. Genes can only partially account for the development of AD. Having high cholesterol may increase a person's risk of developing AD. Having high blood pressure may increase a person's risk of developing AD. People in their 30s can have AD.	170 (75.0)	58 (25.0)
Course		
Eventually, a person with AD will need 24-hour supervision. In rare cases, people have recovered from AD.	170 (75.0)	58 (25.0)
Assessment and diagnosis		
AD is one type of dementia. Symptoms of severe depression can be mistaken for symptoms of AD. When a person with AD becomes agitated, a medical examination might reveal other health problems that caused the agitation. If trouble with memory and confused thinking appears suddenly, it is likely due to AD.	170 (75.0)	58 (25.0)
Treatment and management		
Poor nutrition can make the symptoms of AD worse. AD cannot be cured.	158 (69.0)	70 (31.0)
Symptoms		
Trouble handling money or paying bills is a common early symptom of AD. A symptom that can occur with AD is believing that other people are stealing one's things. Most people with AD remember recent events better than things that happened in the past. Tremor or shaking of the hands or arms is a common symptom in people with AD	162 (71.0)	66 (29.0)
Caregiving		
Once people have AD, they are no longer capable of making informed decisions regarding their own care. When a person has AD, using reminder notes is a crutch that can contribute to the decline. When people with AD repeat the same question or story several times, it is helpful to remind them that they are repeating themselves. People with AD do best with simple instructions given one step at a time.	165 (72.0)	63 (28.0)

Values are presented as numbers and percentages (%). AD: Alzheimer disease

When exploring risk factors, a notable 75% concurred that prescription drugs aimed at preventing AD were not yet available, highlighting a gap in treatment options. Furthermore, the awareness of other risk factors, such as the roles of high cholesterol and blood pressure in increasing susceptibility to AD, was acknowledged or debated by the public, while 25% disagreed. Knowledge concerning the course of the disease indicated that 75% of respondents recognized that individuals with AD would eventually require 24-hour supervision, although the belief in the possibility of recovery remained rare.

Regarding assessment and diagnosis, many respondents understood that AD was a form of dementia and that severe symptoms of depression could mimic those of AD, which underscored the importance of accurate medical evaluation. The treatment and management subdomain reflected the public's understanding that, while there was no cure for AD, poor nutrition could exacerbate symptoms, emphasizing the significance of holistic care. In terms of symptoms, there was recognition that difficulties with finances might have signaled the onset of AD, alongside false beliefs that patients might have thought their possessions were being stolen.

Finally, the caregiving aspect revealed that a majority of 72% of respondents challenged the notion that individuals with AD could not make informed decisions regarding their care and emphasized the importance of clear and simple instructions for effective communication.

Table 3 displays participant responses on diet and AD (32% below high school, affirming dietary benefits, 14% skeptical, and 11% uncertain). In the college group, 23% agreed, 9% disagreed, and 9% were unsure. For postgraduates, only 1% agreed, none disagreed, and one was unsure. Overall, 57% believed in dietary benefits, 24% did not, and 20% were uncertain. Statistical analysis yielded a *p*-value of 0.049, suggesting a correlation between education levels and beliefs on diet's impact. Educational background significantly influenced perceptions of nutrition in AD management, emphasizing the need for targeted education on effective strategies.

Table 4 represented the demographic variables compared in each ADKS subdomain, the findings showed statistically significant differences among participants who answered the subdomain questions correctly, particularly with a higher rate for risk factors, course, assessment, and diagnosis at 75% (p=0.043, which is <0.05). In terms of gender, female participants constituted the majority across all ADKS subdomains compared to males, and these differences were statistically insignificant, regarding the *p*-value was bigger than 0.05 (p=0.052). The overall mean age did not show any statistically significant differences. Concerning the education levels of the respondents, the findings indicated strong statistical insignificance *p*-value of 0.051 (p>0.05), with those holding university degrees demonstrating higher agreement rates across the 7 subdomains of the ADKA questionnaire. Additionally, the sources of awareness regarding AD also displayed strong statistical significance (p<0.05), as health practitioners were recognized as the primary influencers of awareness among participants compared to other sources. Conversely, demographic variables such as family history of AD, type of diabetes, duration of diabetes, comorbidities, smoking habits, and occupation were found to be statistically insignificant in this study.

In Table 5, a statistical analysis assessed the *p*-values for each subdomain in the study. The *p*-value for the life impact was 0.033, *p*-value of 0.015 for risk factor, and *p*-value of 0.011 for caregiving subdomains, indicating statistical significance (p<0.05). In contrast, the course, assessment and diagnosis, treatment and management, and symptoms subdomains showed non-significant results (p>0.05). Thus, the statistically significant subdomains were life impact, risk factor, treatment and management, and caregiving, while the nonsignificant ones were course, assessment and diagnosis, and symptoms.

Table 3 - Respondents' answers to questions "do you think that a healthy diet and follow-up with a nutritionist can improve or alleviate the symptoms associated with Alzheimer's?".

Respondents' answers	Crosstabulation of the question with respondents' levels of education				
	Below high school	College/university education	Graduate/postgraduate education	Total	*P*-value
Yes	73 (32.0)	53 (23.0)	3 (1.0)	129 (57.0)	0.049*
No	33 (14.0)	21 (9.0)	0 (0.0)	54 (24.0)	
I don't know	24 (11.0)	20 (9.0)	1 (1.0)	45 (20.0)	
Total	130 (57.0)	94 (41.0)	4 (2.0)	228 (100)	

Values are presented as numbers and percentages (%). *Significant *p*-value of <0.05.

Table 4 - Comparison of demographic data with Alzheimer's disease knowledge scale questionnaires rate among participants who answered the item correctly.

ADKS subdomains	Life impact	Risk factors	Course	Assessment & diagnosis	Treatment & management	Symptoms	Caregiving	*P*-values
Participants who answered subdomain correctly	165 (72.0)	170 (75.0)	170 (75.0)	170 (75.0)	158 (69.0)	162 (71.0)	165 (72.0)	0.043*
Gender								
Male	65 (29.0)	85 (37.0)	87 (38.0)	66 (29.0)	66 (29.0)	65 (29.0)	71 (31.0)	0.052
Female	100 (44.0)	85 (37.0)	83 (17.0)	104 (46.0)	92 (40.0)	97 (43.0)	94 (41.0)	
Age (year), mean±SD	48.23±20.11	47.05±18.94	48.43±19.91	45.03±62.11	47.01±14.50	45.76±84.10	47.10±9.30	0.067
Educational Level								
High school and below	36 (16.0)	36 (16.0)	37 (16.0)	36 (16.0)	34 (15.0)	40 (18.0)	31 (14.0)	0.051
Collage education	125 (55.0)	130 (57.0)	130 (57.0)	125 (55.0)	121 (53.0)	119 (52.0)	130 (57.0)	
Post graduate education	4 (2.0)	4 (2.0)	3 (1.0)	4 (2.0)	3 (1.0)	3 (1.0)	4 (2.0)	
Family history of Alzheimer's disease								
Yes	35 (15.0)	25 (11.0)	25 (11.0)	30 (13.0)	8 (4.0)	24 (11.0)	0 (0.0)	0.070
No	90 (39.0)	100 (44.0)	100 (44.0)	105 (46.0)	150 (66.0)	134 (59.0)	165 (72.0)	
Unknown	40 (18.0)	45 (20.0)	45 (20.0)	35 (15.0)	0 (0.0)	4 (2.0)	0 (0.0)	
Type of diabetes								
T1DM	48 (21.0)	69 (30.0)	66 (29.0)	66 (29.0)	55 (24.0)	50 (22.0)	53 (23.0)	0.065
T2DM	115 (50.0)	101 (44.0)	100 (44.0)	100 (44.0)	98 (43.0)	112 (49.0)	112 (49.0)	
Pre-diabetic	2 (1.0)	-	4 (2.0)	4 (2.0)	5 (2.0)	0 (0.0)	0 (0.0)	
Duration of diabetes (year)								
<5 years	38 (17.0)	40 (18.0)	38 (17.0)	40 (18.0)	33 (14.0)	37 (16.0)	50 (22.0)	0.077
5-10	60 (26.0)	63 (28.0)	63 (28.0)	63 (28.0)	61 (27.0)	60 (26.0)	60 (26.0)	
11-20	50 (22.0)	45 (20.0)	45 (20.0)	45 (20.0)	35 (15.0)	40 (18.0)	42 (18.0)	
>20 years	17 (7.0)	22 (9.0)	24 (10.0)	22 (9.0)	29 (13.0)	25 (11.0)	13 (6.0)	
Comorbidity								
Cardiovascular disease	47 (21.0)	50 (22.0)	48 (21.0)	53 (23.0)	36 (16.0)	52 (23.0)	49 (21.0)	0.061
HBP	98 (43.0)	100 (44.0)	100 (44.0)	100 (44.0)	89 (39.0)	85 (37.0)	86 (38.0)	
Obesity	20 (9.0)	18 (8.0)	20 (9.0)	11 (5.0)	33 (14.0)	25 (11.0)	30 (13.0)	
Other	0 (0.0)	2 (1.0)	4 (2.0)	6 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Smoking habit								
Smoker	162 (71.0)	168 (74.0)	170 (75.0)	170 (75.0)	154 (68.0)	158 (69.0)	162 (71.0)	0.069
non-smoker	3 (1.0)	2 (1.0)	0 (0.0)	0 (0.0)	4 (2.0)	4 (2.0)	3 (1.0)	
Occupation								
Not working/retired	99 (43.0)	100 (44.0)	100 (44.0)	104 (47.0)	85 (37.0)	95 (42.0)	99 (43.0)	0.084
Housewife	20 (9.0)	32 (14.0)	30 (13.0)	30 (13.0)	25 (11.0)	29 (13.0)	29 (13.0)	
Student	15 (7.0)	10 (4.0)	11 (5.0)	10 (4.0)	19 (8.0)	11 (5.0)	12 (5.0)	
Administrator employee	28 (12.0)	26 (12.0)	27 (12.0)	25 (11.0)	22 (10.0)	20 (9.0)	19 (8.0)	
Other	3 (1.0)	2 (1.0)	2 (1.0)	1 (0.8)	7 (3.0)	7 (3.0)	6 (3.0)	
The source of Alzheimer knowledge								
Health practitioner	130 (57.0)	121 (53.0)	126 (55.0)	126 (55.0)	119 (51.0)	115 (50.0)	120 (53.0)	0.05*
Family and friends	10 (4.0)	20 (9.0)	22 (10.0)	22 (10.0)	15 (7.0)	19 (8.0)	21 (9.0)	
Social media	25 (11.0)	27 (12.0)	20 (9.0)	20 (9.0)	22 (10.0)	25 (12.0)	21 (9.0)	
Other	0 (0.0)	2 (1.0)	2 (1.0)	2 (1.0)	2 (1.0)	3 (1.0)	3 (1.0)	

Values are presented as numbers and percentages (%). *Significant *p*-value of <0.05. ADKS: Alzheimer's disease knowledge scale, SD: standard deviation, T1DM: type 1 diabetes, T2DM: type 2 diabetes, HBP: high blood pressure

Discussion. The objective of this study is to evaluate the awareness, understanding, and outlook regarding AD in diabetic center at Prince Sultan Military Medical City in Riyadh, Saudi Arabia. Published articles discussing the awareness of AD among diabetes patients in Saudi Arabia are rare.[11] This study hold significance due to the association between diabetes and its complications such as dementia or AD, necessitating an effort to increase awareness among diabetic individuals.

The research study presented a comprehensive overview of the demographic. This detailed demographic and health profile provided critical insights into the characteristics of the study population, highlighting important factors interconnected with AD. In this study 56.6% of participants were women.

The findings also, regarding the demographics and health status of participants in Riyadh, Saudi Arabia, offer valuable insights into the awareness of

Table 5 - Overall *p*-values for each subdomain and regarding of the result of each question on these subdomain.

Subdomains	*P*-values
Life impact	0.033*†
Risk factor	0.015*†
Course	0.667‡
Assessment and diagnosis	0.521†
Treatment and management	0.024*‡
Symptoms	0.386†
Caregiving	0.011*†

*Significant *p*-value of <0.05. †ANOVA test. ‡T-test.

AD among individuals with diabetes. Comparatively, existing literature highlights several key aspects that correlate with the study's findings, including the role of educational attainment, gender differences, and sources of knowledge.

The predominance of female participants (56.6%) in the study aligns with other research that emphasizes gender differences in health awareness and health-seeking behaviors. For example, a study by Abbondante et al[12] found that women often engage more with healthcare services than men and are more likely to seek information regarding chronic conditions such as diabetes and AD. Women are frequently caregivers and may be more attuned to diseases that affect their family members, which can also influence their awareness of AD.

The educational level of participants revealed that a significant portion (57%) attended college or university, which is crucial as higher education levels are often linked to better health literacy and more substantial engagement with health information. A systematic review by Huntleyet al,[13] indicated that individuals with higher education are more likely to have better awareness of cognitive health issues, including AD, suggesting that targeted educational programs for lower educational groups could enhance understanding and management of AD in relation to diabetes.

The low percentage of reported family history of AD (17.1%) in this study contrasts with findings by Vrijsen et al,[14] which suggested that individuals with a family history of dementia may have increased vigilance regarding cognitive health. The high proportion of unknown family histories (23.23%) points to a potential gap in communicating familial medical histories, which could be critical for early intervention strategies.

The study showed a near-equal distribution between T1DM and T2DM, with a considerable sample having diabetes duration less than 5 years. Research by Reinke et al[15] supports the association between diabetes duration and the risk of cognitive decline, indicating that longer durations of diabetes are linked to a higher prevalence of dementia-related symptoms, including AD. Therefore, education and resources should aim to provide information tailored to both newly diagnosed and long-term diabetes patients to promote cognitive awareness.

The finding that 64% of participants cited health practitioners as their primary source of knowledge on AD is consistent with health communication literature. A study by Huang et al[16] emphasizes the important role of healthcare professionals in educating patients on the link between chronic diseases and dementia. The reliance on health practitioners also suggests an opportunity for healthcare systems to improve communication strategies and educational outreach regarding cognitive impairment in patients with diabetes.

The demographic findings from the Riyadh study align with and add depth to existing literature on AD awareness among those with diabetes. Identifying gaps in knowledge and tailoring educational efforts to target specific demographics (such as those with lower educational attainment or unfamiliarity with family health histories) may enhance overall awareness and proactive management of AD in the context of diabetes.

In this study, the results indicated a notable level of agreement among participants on several key statements. For instance, 72% of respondents acknowledged that people with AD are particularly prone to depression, while 75% agreed that prescription drugs to prevent AD are not available and recognized the importance of risk factors such as high blood pressure and cholesterol. These insights are critical, as they illuminate misconceptions regarding AD among diabetics, emphasizing the need for enhanced public education campaigns on the disease's complexities and associated lifestyle risk factors.

When comparing these findings to other studies, it becomes evident that awareness levels regarding AD are generally low across various populations. For example, a study carried out by Silva et al[17] found that 70% of participants recognized the genetic risk factors associated with AD, highlighting a significant gap in awareness similar to that observed in the Saudi Arabian cohort regarding the understanding of genetic contributions to AD. In contrast, a previous study reported that approximately 46% of participants believe that the cause of AD is a brain disease.[18] Additionally, the perception that individuals with AD require close supervision (75% agreement) resonates with findings from a previous study, which suggested that caregivers often underestimate the capacities of individuals with

early-stage dementia, leading to misunderstandings regarding the level of independence they can maintain.[19]

These comparisons underline a universal trend in the misunderstanding of AD, regardless of geographic location. The belief that individuals with AD can recover, despite being rooted in 25% of the Saudi participants' responses, reflects a broader public misconception examined in multiple studies, including the one by Black et al,[20] which reported that many caregivers also held unrealistic expectations on recovery. Consequently, the results from Saudi Arabia reinforce the necessity for targeted educational interventions that clarify the realities of AD and underscore the impact of diabetes on cognitive health, which remains an underexplored area in both local and global health discourse.

The results of this study revealed that the majority of 170 (75%) respondents had a well knowledge level of awareness and knowledge of AD among the diabetics in Riyadh, Saudi Arabia. A insignificant association was reported between level of the education and level of knowledge of AD (p=0.05), We could interpret the result as approaching statistical significance; however, since the p-value is slightly above 0.05 (p=0.051), the association was generally considered statistically insignificant. Interestingly, this finding shows an interesting similarity and contrast to a previous study.[21] According to the results of the said study, having higher educational attainment is linked to better awareness and higher knowledge with regards to AD risk factor, AD diagnosis, management, and course.

Moreover, the identification of non-significant results in the course, assessment and diagnosis, treatment and management, and symptoms subdomains suggests a potential gap in understanding the overall impact these areas have. This may guide future research to explore why these subdomains did not demonstrate significant effects and whether this indicates a need for revised methodological approaches or a re-evaluation of their importance in the context of the study. Another study indicated that there is a need to enhance the knowledge and attitudes of caregivers for individuals with particularly those diagnosed with AD.[24]

In this study, several significant trends were highlighted regarding public knowledge of AD among participants, particularly concerning the subdomains of knowledge assessed by the ADKS. Notable was the finding that 75% of participants accurately responded to questions regarding risk factors, course, and assessment and diagnosis, while slightly lower rates were observed in treatment and management (69%) and symptoms (71%). The higher percentages in understanding the disease's life impact and caregiving aspects (both 72%) further suggested that participants had at least a foundational knowledge of caregiving approaches and the broader implications of AD, reflecting an awareness that is critical for those potentially affected or involved in care.

When compared to previous studies, these results were consistent with the findings of McCurry et al,[22] who reported that individuals with higher education levels exhibited better knowledge of dementia-related topics. In the Saudi sample, a high percentage of participants reported having a college education (57%), which may have contributed to their overall knowledge of AD. Conversely, a study by Khan et al[23] indicated that individuals with lower educational attainment showed significant gaps in understanding the disease, exemplifying the importance of education in shaping awareness and knowledge levels. This finding signals a pressing need for targeted educational initiatives, especially aimed at populations with varying educational levels to enhance the understanding of AD.

Additionally, the data highlighted the source of knowledge regarding AD among the participants, with the majority (57%) citing health practitioners as their primary source of information. This finding aligns with research by Bally et al,[24] which emphasized the vital role healthcare providers play in educating patients and families regarding dementia. However, it also raises concerns regarding reliance on health practitioners for comprehensive education, as many people might not seek this information proactively unless prompted during health consultations. Thus, enhancing community outreach and education initiatives can bridge gaps in knowledge (especially for those who may not have frequent contact with healthcare professionals), ensuring that a broader demographic gains access to critical information regarding AD.

In this study, the significance of various subdomains related to ADKS was illustrated. Notably, the life impact of AD, the understanding of risk factors, treatment and management approaches, and caregiving received statistical significance (p<0.05). This indicated that participants demonstrated a relevant awareness and understanding of these key aspects, which are crucial for both caregivers and individuals dealing with AD. The p-value for life impact was 0.033, highlighting the importance of understanding how AD affects the lives of patients and their families. In comparison, the risk factor subdomain showed a p-value of 0.015, further demonstrating participants' knowledge in recognizing potential warning signs and risk factors associated with the disease.

Comparatively, a study by Chang et al[25] examined public awareness of dementia knowledge in a community setting and found similar trends. Their research revealed that understanding risk factors and the impact of dementia on daily life were among the areas where participants had higher knowledge, aligning with the findings of the current study. This is critical as it suggests that the awareness of risk factors may lead to better prevention strategies and earlier detection of the disease among the general population. Furthermore, significant gaps were noted in other subdomains such as assessment and diagnosis (p=0.521) and symptoms (p=0.386). These values indicated a lack of understanding among participants regarding medical assessments, suggesting an area that requires further educational outreach and familiarization, which was also emphasized in the works of Cox.[26]

In conclusion, the significant p-values obtained for caregiving (p=0.011) and treatment and management (p=0.024) suggested that participants demonstrated a strong knowledge base regarding the practical aspects of addressing AD for both patients and caregivers. This finding is paramount since knowledgeable caregivers can significantly improve the quality of life for individuals with AD. In addition, these results parallel the observations carried out by Kwak et al[27] reinforcing that informed caregivers are central to effective disease management. Overall, while the current study indicated some strengths in knowledge regarding certain subdomains, the need for ongoing education focused on assessment and symptoms remains vital for improving overall understanding and care related to AD.

Study strengths & limitations. Overall, the study enhances the understanding of the nuanced outcomes associated with the condition, informing both clinical practice and future research directions. Moreover, the study has several strengths, as it provides valuable evidence in light of the limited number of Saudi studies in this field. It included participants from a wide range of demographic and socioeconomic backgrounds, which can help the Ministry of Health better target its efforts to raise awareness on AD within the population. Furthermore, this study serves as a foundation for future research in this area. This study is one of the few to investigate knowledge of AD among diabetics in Saudi Arabia; however, a larger sample size would enhance the findings' reliability, precision, and statistical power. While the insights gained contribute to the understanding of AD's implications for diabetes patients, limitations exist. The use of convenience sampling may have biased participant selection, making the results less generalizable to the broader diabetic population. Additionally, recall bias could skew data accuracy, as some participants relied on their memories of AD. These issues underscore the need for future research using more rigorous sampling methods and strategies to minimize recall bias to achieve more definitive conclusions regarding diabetics' awareness of AD in Saudi Arabia.

In conclusion, the study findings indicate that being female is significantly linked to greater knowledge in areas such as life impact, risk factors, assessment and diagnosis, caregiving, treatment and management, as well as overall knowledge in the ADKS. Furthermore, individuals with a university education demonstrated increased knowledge in caregiving, risk factors, and treatment. Additionally, health practitioners were the primary source of medical information and were associated with higher knowledge across all ADKS subdomains. To improve awareness on AD across the community, national awareness campaigns are crucial. Moreover, ongoing educational programs for all healthcare providers are necessary to enhance national awareness of AD.

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