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Assessing Alzheimer's disease knowledge among Egyptian medical students in the context of recent educational reforms

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Abstract

Background Medical students are the future doctors and play an essential role in the management of health issues. Their understanding of Alzheimer's disease (AD) is not only required but also necessary to provide the best possible care to patients. The present study aimed to assess medical students' knowledge about AD within the context of the recent reform of the Egyptian medical educational system, which switched to competency-based instead of outcome-based education since 2017.

Methods A descriptive cross-sectional study was conducted among medical students in public and private Egyptian medical schools. Between August and November 2024, an anonymous self-administered questionnaire was uploaded to Google Forms and distributed online through commonly used social media platforms. The Alzheimer's Disease Knowledge Scale (ADKS), a validated and reliable tool, was used for the measurement of AD-related knowledge. Univariate and multivariable logistic regression models were used to determine the factors associated with having good or poor knowledge about AD among participants.

Results In total, 1100 medical students were included through convenience and snowball sampling methods; their mean age was 20.9 ± 1.9 years, 55.5% were males, 59.6% were in their clinical years, and 15.6% had a positive family history of AD. The students' mean knowledge score was 19.10 ± 2.96 out of 30, representing 63.7% of answers correct, with a range of scores between 9 and 29. About 70.8% of the sample had good knowledge. The highest percentage of correct answers was for the treatment and management domain (76.5%), while the lowest percentage was for the caregiving domain (52.2%). Predictors of good knowledge were females [adjusted odds ratio (aOR) = 1.33 (95% confidence interval (CI): 1.01–1.76, $p = 0.043$], attending a public university [aOR = 1.62 (95% CI: 1.09–2.41), $p = 0.015$), clinical year students [aOR = 1.53 (95% CI: 1.07–2.16), $p = 0.018$], living in an urban area [(aOR = 1.67 (95% CI: 1.23–2.25), $p < 0.001$], and having higher family monthly income [aOR = 1.75 (95% CI: 1.13–2.72), $p = 0.012$].

Conclusions The study highlights gaps in Egyptian medical students' knowledge of AD. Knowledge gaps were found in domains of caregiving and risk factors, urging educators and policymakers to enhance curricula, particularly preclinical curricula, with a specific focus on some socio-economic determinants.

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Introduction

Dementia, a major worldwide healthcare concern, currently affects over 55 million individuals globally. Around 60% of them are living in low and middle-income countries (LMICs) [1]. There are various types of dementia, with Alzheimer's disease (AD) representing 60–70% of cases [2]. AD is a neurodegenerative disease characterized by a progressive decrease in cognition, memory loss and deterioration, and behavioral changes [3]. Globally, AD affects an estimated 87 million people, with 32 million people suffering from mild, moderate, or severe forms of AD. This number is expected to triple by 2050 due to the aging population [4, 5]. AD contributes to being a more prevalent burden with the disability-adjusted life years (DALY) rate of 451 per 100,000 people [6, 7]. Furthermore, AD has an economic and social effect due to increased costs of care and increased burden on healthcare providers [8]. Not only medical expenses, but also the disease impact goes beyond that, as it leads to decreased quality of life, loss of productivity, and dependence on the care provided, whether by families or health systems [9].

Clinically, AD exhibits a spectrum of cognitive impairments, varying from mild impairment of memory to severe dementia. In addition to depression, hallucinations, and nervousness, AD patients also possess difficulties in language, thinking, memory, and learning ability [10]. There are several risk factors for AD, including advanced age, family history, genetic mutations in genes like apolipoprotein E (*APOE*), cardiovascular diseases, and lifestyle factors such as poor diet and lack of exercise. Understanding these interrelations is vital for early AD diagnosis and prevention [11].

To achieve effective treatment of AD and thus minimize healthcare expenditures, early diagnosis and appropriate management care for patients and their caregivers are crucial [12]. Moreover, by using several cognitive function tests, general practitioners can diagnose AD, so they have an important role in early diagnosis [13]. The current literature indicates that diagnosis and proper management recommendations for AD according to guidelines are not likely to be followed [14, 15]. AD is escalating very rapidly while the population is aging, so there is a need for extensive assessment of healthcare providers' knowledge about the management of this disease [8].

Medical students are future doctors and play an important role in this health problem, as their understanding of AD is not only required but also necessary to provide the best possible care to patients. Greater knowledge of AD enhances the effectiveness of early detection and diagnostic programs. In addition, they would spread correct information and practices to their relatives and community members. This would help to reduce myths and stigma, and more effective community engagement [16]. Previous studies indicated a lack of knowledge about AD among medical students. A study among Palestinian and Jordanian medical students revealed insufficient levels of knowledge, with students in the clinical years demonstrating superior knowledge over preclinical students [17, 18]. Similarly, India and Saudi Arabia studies among medical students found significant knowledge gaps [19, 20]. Several factors can influence good AD knowledge, for example, year of study, clinical exposure, training and workshops, curriculum emphasis, awareness and participation in educational programs or campaigns about AD, and socioeconomic factors [17, 19, 21].

Egypt, a lower-middle-income country and the most populous in the Middle East, has a dementia prevalence of 2.01% to 5.07%, based on a meta-analysis covering four geographic regions [22]. In 2019, there were more than 295 thousand prevalent cases due to dementia with a DALYs rate of 362.4 per 100,000 in Egypt [23]. Egypt is currently changing its demographic structure, with the elderly population, defined as persons aged 60 years and above, expected to more than double between 2020 and 2050-from 8.4 million to 22 million- in an abrupt shift in the age structure of the population [24, 25]. This transformation necessitates health considerations related to aging, including factors such as AD, to be addressed through raising awareness and providing medical education. Early diagnosis of AD stands in urgent need, and therefore, knowledge of this problem should be addressed by training medical students, as the problem continues to grow in prevalence.

In 2017, Egyptian medical education underwent significant reforms, transitioning from a traditional outcome-based system to a competency-based approach. This radical change modified the structure of medical training by reducing the six-year academic program and one-year internship to a five-year program followed by two years of internship. Additionally, a modular integrated system replaced the previous discipline-based curriculum, allowing for a combination of theoretical and practical training throughout the

five years. This shift aims to enhance students'practical skills and theoretical knowledge, ultimately improving their self-efficacy through more integrated and comprehensive training [26]. Given the recent changes in the curriculum, this study hypothesized that Egyptian medical students may still have insufficient knowledge about AD, particularly across different clinical and academic years. Therefore, this study aimed to assess the knowledge of future doctors regarding AD. By identifying their knowledge gaps and strengths, we can enhance new educational curricula and equip students with the necessary knowledge and skills to become effective supporters in the fight against AD.

Methods

Study design, setting, and sampling

A descriptive cross-sectional study was conducted among medical students in public and private Egyptian medical schools, between August and November 2024. The included universities are listed in Table S1. Convenience and snowball sampling methods were utilized to recruit participants. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Checklist in its entirety [27]. STROBE checklist is depicted in Table S2. Clinical trial number is not applicable.

Sample size calculation

We calculated the sample size by Epi Info software version 7.2.6, considering a 95% confidence interval, a 35% response distribution, a 5% margin of error, and supposing that 50% of the medical students had good knowledge about AD. The sample size was 1098 individuals. Undergraduate Egyptian medical students of both genders and all academic years were invited to participate in the study. Para-medical students, postgraduate students, and interns were excluded.

Data collection tools

An anonymous self-administered questionnaire was uploaded to Google Forms and distributed online through commonly used social media platforms (Facebook, X previously Twitter, Telegram) with the help of a group of collaborators. The questionnaire was sent to study groups, classes, and official channels of the faculties of medicine.

The questionnaire consists of two sections. The first section included socio-demographic data including age, gender, university type (public and private), academic years divided into pre-clinical (first and second year) and clinical (third, fourth, and fifth year) students, residence, region (Egypt's standard administrative divisions: Canal Region, Delta Region, Upper Egypt, and Cairo/Alexandria), marital status, and income. In addition, we asked about the family history of AD, the presence of older family members (65 years or older) interacting with them constantly, awareness and participation in campaigns about AD, university health clubs, societies, or organizations membership, and primary source of medical information on which student depends permanently and fundamentally.

The second section utilized the Alzheimer's Disease Knowledge Scale (ADKS), a validated and reliable tool for the measurement of knowledge about AD. The ADKS was developed by Carpenter et al. (2009) [28] and comprises 30 true/false questions. It requires about 5–10 min for completion and is divided into seven domains: risk factors (six items), symptoms (four items), assessment and diagnosis (four items), disease progression (four items), life impact (three items), caregiving (five items), and treatment and management (four items). The scale was created for students, healthcare professionals, and the public. The scale demonstrated reliability (test–retest correlation = 0.81; internal consistency = 0.71) and validity (content, predictive, concurrent, and convergent) [28]. ADKS questions with the correct answer depicted in Table S3.

Validation and pilot study

The ADKS was independently translated from English to the Arabic language by two bilingual translators. The two versions were integrated, revised, and re-translated independently into English by professional English translators. We performed content and face validity assessments to ensure questionnaire validity. Three experts examined the Arabic version of ADKS to ensure that content validity was thoroughly assessed for relevance, clarity, and comprehensiveness. The questionnaire was adjusted based on expert feedback. After that, we conducted a pilot study on 20 students to identify any inconsistencies and misunderstandings. Also, to determine the time needed for completion of the survey. Comments from the pilot study were considered to improve the questionnaire's clarity and applicability for the study subject.

Study outcome

The main objective of this study was to assess the level of knowledge about AD among Egyptian medical students, along with its predictors, across different academic years and university types (public vs. private) after implementing the competency-based curriculum.

Confounders

The study considered several confounding variables to more accurately assess the factors influencing knowledge about AD among medical students. These included

socio-demographic factors, such as the type of university attended (public vs. private), which may impact the quality and breadth of education received. The academic year with pre-clinical and clinical years potentially offers different levels of exposure to clinical knowledge related to AD. Additionally, the presence of a family history of AD was taken into account, as it could influence a student's awareness and understanding of the disease. The study also considered students' exposure to AD-related campaigns and participation in university health clubs, as such involvement might enhance their knowledge. Finally, the region and residence of the students were considered, as living in urban or rural areas, as well as the region of Egypt, could affect access to resources and information related to AD.

Bias

The study may have encountered several sources of bias that could have impacted its results. Selection bias was a concern due to the use of convenience and snowball sampling methods, which could have led to an unrepresentative sample of participants. Response bias might have occurred because the online survey was likely to attract individuals with access to the internet and smartphones. Information bias could have emerged from participants'misunderstanding some questionnaire items or providing socially desirable answers, despite efforts to reduce this through pilot testing. Recall bias was also a potential issue, particularly for questions related to family history or participation in campaigns, as participants may have had difficulty accurately recalling past events or experiences.

Ethical considerations

This research was conducted according to the full provisions of the 1964 Declaration of Helsinki, and participation in this study was voluntary [29]. Before participation, all participants gave their informed consent electronically. Moreover, data were collected without mentioning the personal identity, and this data was accessible to the study principal investigator and the statisticians. We obtained ethical approval from the Institutional Review Board (IRB) of the Faculty of Medicine, Al-Azhar University, Cairo, Egypt (Approval number: 0000003/6/24).

Data analysis

Data were entered and organized using Microsoft Excel. Statistical analysis was conducted using International Business Machines Statistical Package for the Social Sciences (IBM SPSS) version 24. Continuous variables were presented as mean and standard deviation (SD) while categorical variables were reported as frequencies and percentages. For knowledge evaluation, the questions were scored by giving one point to the correct answer and zero points to the incorrect answer, resulting in a score range of zero to 30 for each student. Based on expert opinion, participants scoring less than 18 (< 60%) had a poor level of knowledge, whereas participants who scored more than or equal to 18 (≥ 60%) had a good knowledge level. The knowledge level was described in numbers and percentages. Univariate and multivariable logistic regression models were used to determine the factors associated with having good or poor knowledge about AD among participants. The dependent variable was AD knowledge, which was considered binomial (good/poor), and the independent variables included were selected based on theoretical reasons and the literature. A saturated logit model was applied, and Hosmer–Lemeshow revealed a p-value of 0.433, suggesting the goodness of model fit. Results were expressed as crude and adjusted odds ratios (ORs) and 95% confidence interval (CI). Statistical significance was set at $p < 0.05$.

Results

Sociodemographic characteristics of the students

In total, 1100 medical students completed the questionnaire; their mean age was 20.9 ± 1.9 years, 55.5% were males, 59.6% were in their clinical years, and 15.6% had a positive family history of AD. Table 1.

The main medical information sources about AD were the online medical resources (54.3%), followed by the curriculum (25.8%) and healthcare workers (19.9%) (Fig. 1).

Knowledge of medical students regarding Alzheimer's disease

The students'mean knowledge score was 19.1 ± 3.0 out of 30, representing 63.7% of answers were correct, with a range of scores between 9 and 29. Categorization of the students'scores demonstrated that 70.8% of the sample had a good level of knowledge about AD. Moreover, scores across different domains varied from 52.2% to 76.5%, with the "treatment and management" domain having the highest percentage of correct answers and the "caregiving" domain having the lowest percentage of correct answers. Also, the "risk factor" domain showed the second lowest domain with a correct answer at 53.2%. Table 2.

Furthermore, around two-thirds of participants identified high blood pressure and high cholesterol as risk factors for AD. Among participants, 73.8% correctly recognized the role of genetic factors in AD. In contrast, the least identified risk factor was that mental exercises can prevent AD, with 12% of the participants answering correctly. Regarding symptoms of AD, 73.5% correctly identified trouble handling money

Table 1 Sociodemographic characteristics of the studied medical students ($n = 1100$)

Variables	Categories	N	%
Gender	Male	610	55.5
	Female	490	44.5
University	Public	959	87.2
	Private	141	12.8
Academic year	Clinical years	656	59.6
	Pre-clinical years	444	40.4
Residence	Urban	739	67.2
	Rural	361	32.8
Region	Cairo and Alexandria	385	35.0
	Upper Egypt	339	30.8
	Delta Region	276	25.1
	Canal Region	100	9.1
Marital status	Not married	1084	98. 5
	Married	16	1.5
Family monthly income	Not Enough	146	13.2
	Barely sufficient	602	54.8
	More than enough	352	32.0
Older family members (65 years or older)		675	61.3
Family history of Alzheimer's		172	15.6
Awareness and participation in Alzheimer's campaigns		202	18.4
Member of university health clubs, societies, and membership		262	23.8

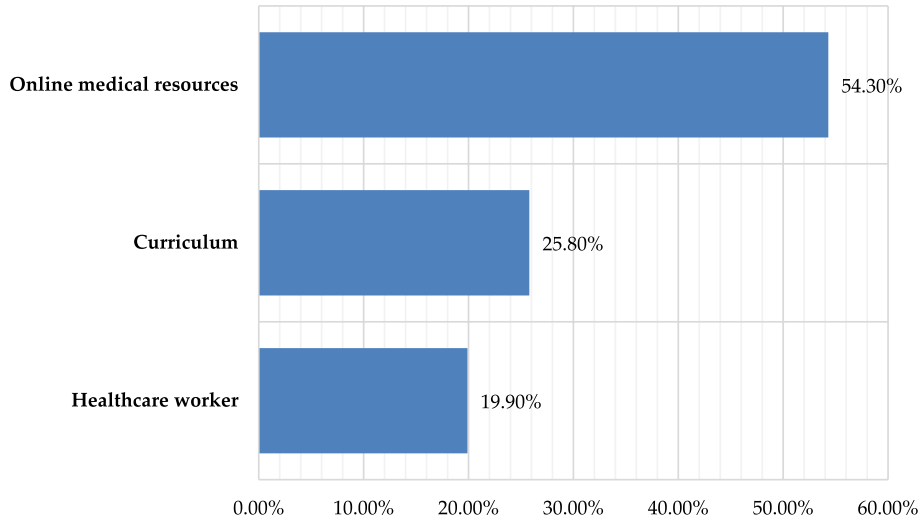

Fig. 1 Primary source of medical information for the studied medical students ($n = 1100$)

and 77.6% accurately identified delusions about others stealing belongings as an AD symptom, 58.9% incorrectly thought that tremor is a common symptom of AD, 85.7% correctly identified that medical examinations are critical in AD patients when they become agitated, 83.8% accurately recognized the uselessness of psychotherapy for depression and anxiety for mild AD patients, 89% correctly identified that people with AD are more prone to developing depression, and 82.1% answered correctly people with AD respond best to straightforward, step-by-step instructions Fig. 2.

Table 2 The Alzheimer's Disease Knowledge Scale (ADKS) subdomain, total scores and average correct rates among the studied medical students ($n = 1100$)

Domains	Score range	Correct rate (%)	Subdomain and total scores for ADKS		
			Mean ± SD	Minimum	Maximum
Risk factors	0–6	53.20	3.19 ± 1.15	0	6
Symptoms	0–4	64.00	2.56 ± 0.91	0	4
Assessment	0–4	71.30	2.85 ± 0.86	0	4
Treatment	0–4	76.50	3.06 ± 0.86	0	4
Course	0–4	70.50	2.82 ± 0.87	0	4
Life impact	0–3	67.60	2.03 ± 0.80	0	3
Caregiving	0–5	52.20	2.61 ± 0.97	0	5
Total ADKS	0–30	63.70	19.10 ± 2.96	9	29

Factors affecting Alzheimer's knowledge among the studied participants

In terms of gender, while the unadjusted odds ratio (OR) suggested that females had slightly higher odds of good AD knowledge [crude OR (cOR) = 1.26, (95% CI: 0.97–1.64), $p = 0.083$], this result was not statistically significant. However, after adjusting for other variables, the odds of females having good knowledge increased significantly [adjusted OR (aOR) = 1.33, (95% CI: 1.01–1.76), $p = 0.043$). University type was found to be significant, with students from public universities having higher odds of good knowledge compared to those in private universities [aOR = 1.67, (95% CI: 1.15–2.40), $p = 0.006$]. After adjustment, this association remained significant [aOR = 1.62, (95% CI: 1.09–2.41), $p = 0.015$]. Academic year was another significant factor, as clinical year students had higher odds of good AD knowledge compared to preclinical year students, both in the unadjusted [cOR = 1.64, (95% CI: 1.26–2.13), $p < 0.001$] and adjusted models [aOR = 1.53, (95% CI: 1.07–2.16), $p = 0.018$). Residence also played a role, with students living in urban areas having significantly higher odds of good knowledge than their rural counterparts [aOR = 1.55, (95% CI: 1.19–2.04), $p < 0.001$]. This association remained strong after adjustment [aOR = 1.67, (95% CI: 1.23–2.25), $p < 0.001$]. Finally, family monthly income was significantly associated with AD knowledge. Those from families with"more than enough"income had higher odds of good knowledge compared to those with insufficient income [cOR = 1.79, (95% CI: 1.18–2.71), $p = 0.006$], and this remained significant in the adjusted model [aOR = 1.75, (95% CI: 1.13–2.72), $p = 0.012$]. Conversely, the association between family income categories such as"barely sufficient"and AD knowledge was not statistically significant in either the unadjusted or adjusted models Table 3.

Discussion

Summary of main results

The study assessed the knowledge of AD among 1100 Egyptian medical students from 20 faculties and identified key factors influencing this knowledge. The studied students demonstrated moderate knowledge about AD, with many correctly identifying key facts about its symptoms and treatment. However, knowledge gaps were evident in certain areas, such as risk factors and caregiving, with some misconceptions about the symptoms of AD. Several factors were found to influence AD knowledge. Females were more likely to have good AD knowledge than males, and students from public universities had better knowledge than private universities. Clinical year students exhibited better knowledge than preclinical students, and students living in urban areas were more knowledgeable than their rural counterparts. Additionally, students from families with higher income levels demonstrated better knowledge of AD.

Prevalence of good knowledge

Nearly three-fourths of students had good knowledge about AD. The mean ADKS score was 19.10, representing 63.7% of answers correctly. Our finding aligns with previous literature conducted in Western India [20], China [30], Jordan [18], Nepal [31], Nigeria [32], and Palestine [17]. These studies suggest that medical students of less developed countries, regardless of their geographical location, generally possess a foundational understanding of AD, possibly due to their medical education curriculum. In contrast, the knowledge level among Egyptian medical students was lower than the level of knowledge of medical students in the United Kingdom [33], Australia

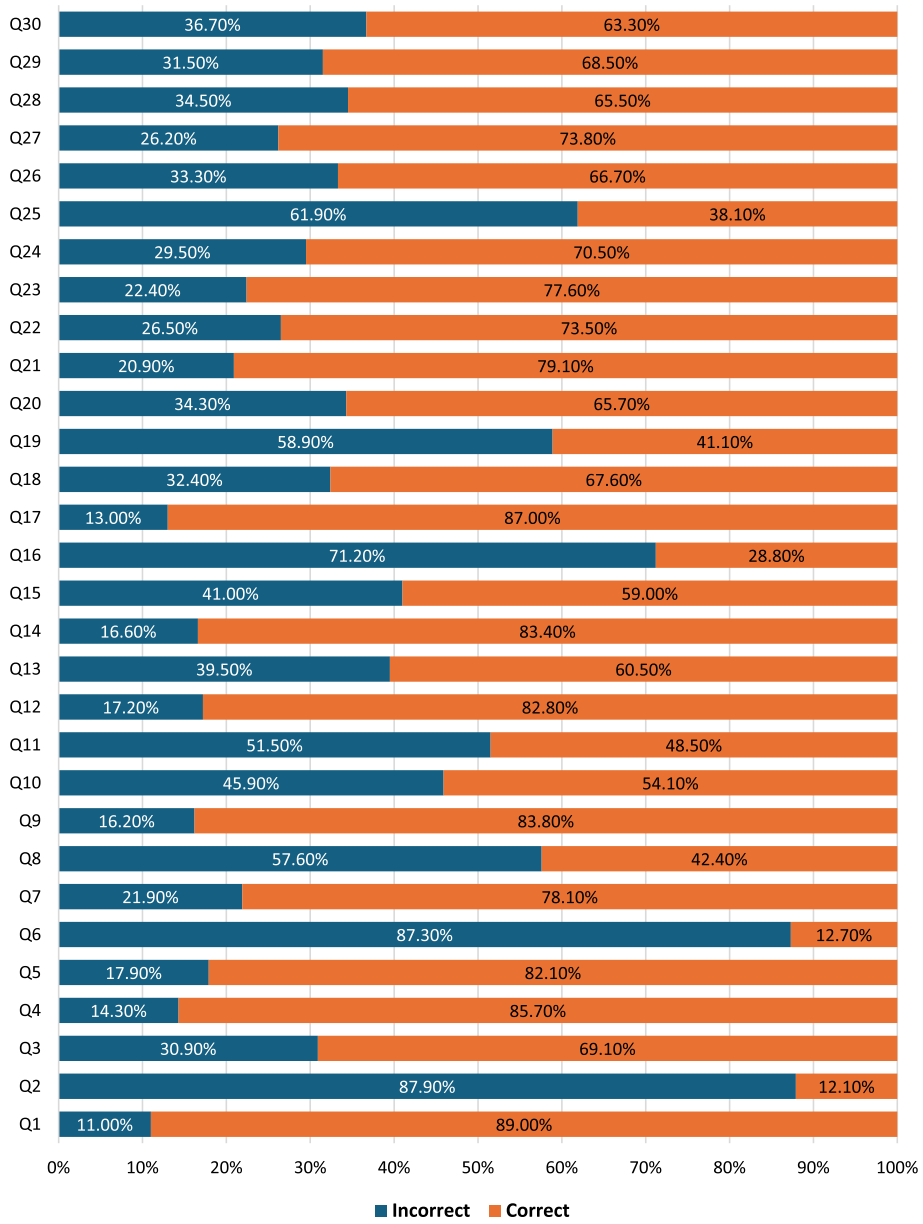

Fig. 2 Response to each question of Alzheimer's Disease Knowledge Scale

[34], and Norway [35]. The variations in knowledge curricular design, resources, and educational priorities lead to noticeable disparities. Aligning regional curricula with international standards while taking local contexts into account could help reduce these inequalities. By aligning local curricula with international standards while considering the unique socio-cultural and healthcare contexts, it is possible to bridge knowledge gaps and improve education quality for medical students in various regions.

Variations in knowledge across the domains of the ADKS

In the current study, we observed a defect in knowledge level highlighted notable variations across different domains of AD, with the treatment and management domains having the highest percentage of correct answers. However, the caregiving domain registered the lowest scores. The lack of knowledge about caregiving is significant, as this area of AD care involves critical aspects of patient management, including emotional support, communication strategies, and practical caregiving techniques. This finding was reported in prior

Table 3 Logistic regression analysis showing predictors of good and poor Alzheimer's knowledge

Variables		Poor knowledge 321(29.2%)	Good knowledge 779 (70.8%)	Unadjusted odds ratio	Adjusted odds ratio
		N (%)	N (%)	cOR (95% CI, *p*-value)	aOR (95% CI, p-value)
Age (Mean ± SD)		20.67 ± 1.95	21.05 ± 1.88	1.12 (1.04–1.20, $p = 0.003$) *	1.05 (0.96–1.15, $p = 0.298$)
Gender	Male	191 (31.3)	419 (68.7)	-	-
	Female	130 (26.5)	360 (73.5)	1.26 (0.97–1.64, $p = 0.083$)	1.33 (1.01–1.76, $p = 0.043$) *
University	Private	55 (39.0)	86 (61.0)	-	-
	Public	266 (27.7)	693 (72.3)	1.67 (1.15–2.40, $p = 0.006$) *	1.62 (1.09–2.41, $p = 0.015$) *
Academic year	Pre-clinical years	157 (35.4)	287 (64.6)	-	-
	Clinical years	164 (25.0)	492 (75.0)	1.64 (1.26–2.13, $p < 0.001$) *	1.53 (1.07–12.16, $p = 0.018$) *
Residence	Rural	128 (35.5)	233 (64.5)	-	-
	Urban	193 (26.1)	546 (73.9)	1.55 (1.19–2.04, $p < 0.001$) *	1.67 (1.23–2.25, $p < 0.001$) *
Region	Canal Region	31 (31.0)	69 (69.0)	-	-
	Delta Region	110 (32.4)	229 (67.6)	0.94 (0.58–1.51, $p = 0.785$)	1.02 (0.62–1.68, $p = 0.924$)
	Upper Egypt	66 (23.9)	210 (76.1)	1.43 (0.86–2.37, $p = 0.166$)	1.42 (0.85–2.40, p = 0.181)
	Cario and Alexandria	114 (29.6)	271 (70.4)	1.07 (0.66–1.72, $p = 0.787$)	0.85 (0.52–1.39, $p = 0.525$)
Marital status	Married	3 (18.8)	13 (81.3)	-	-
	Not married	318 (29.3)	766 (70.7)	0.55 (0.16–1.96, $p = 0.362$)	0.46 (0.12–1.77, $p = 0.265$)
Family monthly income	Not Enough	53 (36.3)	93 (63.7)	-	-
	Barely sufficient	183 (30.4)	419 (69.6)	1.30 (0.89–1.91, $p = 0.169$)	1.22 (0.82–1.81, $p = 0.332$)
	More than enough	85 (24.1)	267 (75.9)	1.79 (1.18–2.71, $p = 0.006$) *	1.75 (1.13–2.72, $p = 0.012$) *
Having older family members	Yes	192 (28.4)	483 (71.6)	-	-
	No	129 (30.4)	296 (69.6)	0.91 (0.69–1.19, $p < 0.498$)	0.86 (0.65–1.44, $p = 0.308$)
Family history of Alzheimer's	No	275 (29.6)	653 (70.4)	-	-
	Yes	46 (26.7)	126 (73.3)	1.15 (0.80–1.66, $p = 0.444$)	1.15 (0.78–1.70, $p = 0.474$)
Awareness and participation in campaigns or educational programs about Alzheimer's	Yes	68 (33.7)	134 (66.3)	-	-
	No	253 (28.2)	645 (71.8)	1.29 (0.93–1.79, $p = 0.122$)	1.34 (0.93–1.92, $p = 0.119$)
University health clubs, societies, or organizations membership	Yes	77 (29.4)	185 (70.6)	-	-
	No	244 (29.1)	594 (70.9)	1.01 (0.74–1.37, $p = 0.933$)	0.95 (0.68–1.33, $p = 0.753$)
Main source of medical information	Online resources	187 (31.3)	410 (68.7)	-	-
	Healthcare workers	70 (32.0)	149 (68.0)	0.97 (0.69–1.35, $p = 0.862$)	0.86 (0.61–1.21, $p = 0.384$)
	Curriculum	64 (22.5)	220 (77.5)	1.57 (1.13–2.18, $p = 0.007$) *	1.39 (0.99–1.95, $p = 0.060$)

Abbreviations: SD Standard deviation, *cORor* unadjusted odds ratio, *aOR* adjusted odds ratio, *CI* Confidence interval

* Indicate significant *p* values at $p < 0.05$

research in Palestine [17] and Western India [20]. In contrast, the student's knowledge level of the caregiving of patients with AD was lower than demonstrated in Norway [35] and China [36]. That's why research indicates a significant need to improve the understanding and attitudes of caregivers for individuals with AD and dementia [37]. Providing targeted education and raising awareness for medical students about the challenges and responsibilities of caregiving can ultimately enhance patient care and support families dealing with AD. Furthermore, our study revealed a notable knowledge gap among Egyptian medical students regarding the risk factors of AD. This deficiency aligns with findings from studies conducted among medical students [17, 20], highlighting a broader need for improved education on AD risk factors in medical curricula. Closing this gap could boost early detection and prevention efforts. Additionally, in this study, the treatment and management domain achieved the highest score, reflecting the curriculum's emphasis on pharmacological and therapeutic approaches. Furthermore, participants of this study correctly identified nearly 70% of questions related to assessment and diagnosis, course, and life impact domains. This was strongly supported by the reported findings in previous studies among medical students in Palestine [17], Norway [35], and Hong Kong [36], suggesting that medical education in these regions prioritizes clinical management.

Specific knowledge gaps about AD among medical students

In the risk factors questions, a small proportion of students correctly answered the following question: "Mental exercise can prevent a person from getting AD." This question points to the mistaken belief that mental exercise will prevent AD. While cognitive activities can be helpful, they are not a predictable prevention strategy [38]. Also, a few participants correctly identified that "Drugs that prevent AD are available." Indeed, there are no drugs available yet that can completely prevent AD. However, some medications can delay the disease process or manage symptoms [39]. Interestingly, this study found that a large proportion incorrectly identified tremor as a common symptom of AD and identified that sudden memory and confused thinking issues as AD-related. This question emphasizes the importance of being aware that tremors are not a sign of AD, and sudden changes in cognition are not always caused by AD. Stroke, infection, and side effects from medication are just some other conditions that can also result in sudden cognitive decline [40].

Predictors of knowledge about AD among the studied medical students

In this work, female medical students had slightly higher odds of having good knowledge compared to their male counterparts. Similarly, Wang et al. [41] indicated that gender was significantly associated with Chinese medical students' knowledge of dementia and AD. In contrast, Dong et al. [30] and Abuawad et al. [17] showed non-significant differences between genders. This discrepancy may stem from the fact that women are generally more proactive in seeking health information and services, spending more time on this pursuit than men do [42]. In addition, our findings indicate that socioeconomic status, particularly monthly income, significantly influenced AD knowledge. Students who reported an income sufficient to comfortably cover their expenses demonstrated higher AD knowledge compared to those with barely sufficient or insufficient income. Additionally, residing in urban areas was associated with greater AD knowledge. This difference could be linked to higher access to educational resources, extracurricular learning opportunities, and healthcare services for students with a higher socioeconomic status and living in urban areas. Similar findings have been reported in Saudi Arabia [43], Palestine [17], and the United States [44]. These disparities highlight the need for targeted educational interventions in lower-income and rural areas, where students may have less access to critical healthcare information and resources.

In the current study, clinical-year medical students had 53% higher odds of demonstrating good knowledge about AD compared to their pre-clinical counterparts. This finding is consistent with previous research, which showed that clinical students typically exhibited a stronger understanding of AD [17, 18, 20, 30, 45]. This can be attributed to clinical students' increased exposure to real-world scenarios, which reinforces their theoretical knowledge and enhances their understanding of AD's clinical manifestations and management. Moreover, clinical students engage more frequently with patient cases, clinical practices, and specialized education on AD and other neurological conditions, further strengthening their knowledge and awareness [33]. This finding indicates that despite implementing a competency-based curriculum in Egyptian medical colleges, a knowledge gap persists between clinical and preclinical students.

In this study, students from public universities demonstrated higher knowledge scores compared to their peers from private institutions. This difference may reflect disparities in academic rigor, resource availability, and the quality of instruction between public and private medical schools in Egypt. Public universities often have more established curricula and better access to clinical resources, providing students with more comprehensive exposure to AD-related content and real-world experiences. In contrast, private institutions may encounter challenges such as limited access to clinical cases and fewer opportunities for hands-on learning, which could contribute to lower levels of knowledge about AD. Addressing these disparities could improve educational outcomes and create a more equitable foundation for medical students across all institutions [46, 47].

Surprisingly, our study did not find a significant association between knowledge level and factors such as a family history of AD, having older family members (65 years or older) and regularly interacting with them, awareness and participation in AD-related campaigns, or membership in university health clubs, societies, or organizations. This finding is consistent with several other studies, suggesting that mere exposure to these factors may not necessarily translate into higher knowledge levels, highlighting the need for more structured educational interventions [31, 48–53]. In contrast, a study of college students in Kuwait revealed that those who had a family member with dementia knew more than those who did not [54]. Having older family members might increase the likelihood of awareness about AD, but if they are not very much involved in the daily life of the family, then they may not be a good source of information about the disease.

Source of information about AD

In this study, more than half of the participants rely primarily on online medical resources and websites,

followed by the curriculum, for getting their medical knowledge. However, the main source of medical information wasn't found to independently affect the level of knowledge. This finding aligns with previous studies among Palestinian [17] and Sudanese medical students [52]. One possible explanation is that online resources do not always provide comprehensive or accurate information about AD, highlighting the need for more structured and reliable educational materials.

Future implications

This research emphasizes the need to enhance medical education by addressing knowledge gaps in AD, particularly in caregiving and risk factors, which were identified as areas of deficiency among medical students. Tailored curricula and targeted training programs for medical students, especially those in pre-clinical years or from private universities, could improve preparedness for managing AD patients holistically. Furthermore, the study highlights the significant role of socioeconomic status and urban residency in influencing AD knowledge, suggesting that students from higher-income backgrounds and urban areas have better access to resources and information.

Strengths and limitations

Our study is distinctive in various strengths. First, it provides a thorough evaluation of AD knowledge among a large sample of medical students across 20 faculties, thus offering valuable insight into the educational gaps and strengths within this population. In addition, the use of a validated tool to assess the knowledge ensures consistency and reliability in evaluating the understanding of medical students across various domains of AD. Despite these strengths, the study has some limitations to consider. Firstly, the cross-sectional design restricts the ability to establish causal relationships between the influencing factors and AD knowledge. Secondly, since the findings are self-reported, they are prone to errors or recall bias, which could affect the validity of the results. Finally, the study is confined to a single country, limiting the generalizability of the results to other regions or educational programs.

Conclusions

Our study highlights significant knowledge gaps among Egyptian medical students regarding AD, particularly in risk factors and caregiving. While students performed well in treatment and management, misconceptions about prevention, symptoms, and care remain prevalent. Socioeconomic factors, university type, and clinical experience influenced knowledge levels. Addressing these gaps through curriculum improvements, practical training, and community engagement is essential to better prepare future healthcare professionals for AD management. Furthermore, ensuring equitable access to educational resources is important to bridge the knowledge gap between diverse student groups.

Abbreviations

LMICs	Low and middle income countries
AD	Alzheimer's disease
DALY	Disability-adjusted life years
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
ADKS	Alzheimer's disease knowledge scale
IBM SPSS	International Business Machines Statistical Package for the Social Sciences
SD	Standard deviation
OR	Odds ratio
CI	Confidence interval

Supplementary Information

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Supplementary Material 1.

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Alzheimer's group of Egypt

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Authors' contributions

AAS: Conceptualization, writing original draft, and writing review. AWH, KE, MMA: Conceptualization, data collection, and writing- original Draft. AHE, MAA: carried out the analysis and interpreted the results. FSA: writing review and editing. RMG: Conceptualization, writing original draft, editing and supervision. Alzheimer's group of Egypt: Data collection. All the authors gave their consent.

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Data availability

Data is available upon the reasonable request of the corresponding author.

Declarations

Ethics approval and consent to participate

This research was conducted according to the full provision of the 1964 Declaration of Helsinki and participation in this study was voluntary. Before participation all students gave their informed consent electronically. Moreover, we didn't gather any personal identified data, and this data was accessible to our study team only. We obtained the ethical approval from the Institutional Review Board (IRB) of the Faculty of Medicine, Al A-zhar University, Cario, Egypt (Approval number: 0000003/6/24).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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