

Research Report

Knowledge, Awareness, and Perceived Threat Toward Alzheimer's Disease Among the Family Caregivers of Individuals with Chronic Physical Conditions in Bangladesh

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Abstract.

Background: Alzheimer's disease (AD) is a growing public health concern affecting millions of individuals worldwide. This disease burden is exacerbated in countries like Bangladesh, where public awareness and knowledge about the condition remains limited.

Objective: This study aimed to assess the level of AD knowledge, awareness, and perceived threat among family caregivers of individuals with chronic physical conditions of Bangladesh.

Methods: A descriptive cross-sectional study was conducted among the caregivers of patients selected via convenience sampling in six public hospitals between October 2022 and March 2023. The data was collected via face-to-face interviews employing a semi-structured questionnaire that contained information about socio-demographic characteristics, personal experiences with AD, knowledge of AD, level of awareness regarding AD, and perceived threat toward AD.

Results: The findings revealed a poor knowledge of AD among the study participants. Regarding AD awareness, 52.5% considered memory loss in older individuals abnormal, 26.2% attributed AD to causes like black magic, psychological distress, or bad eyes. Regarding perceived threat, 60.2% wanted to assess their AD risk, while 68.2% disagreed with the likelihood of developing the disease. Multiple linear regression analysis revealed that age, place of residence, education, and employment status significantly contribute to AD knowledge scores.

Conclusions: This study highlights the urgent need for public education and awareness campaigns to address the knowledge gap and reduce stigmatization associated with AD in Bangladesh. Targeted efforts, particularly among older age groups and rural communities, can enhance understanding and improve the quality of care and support for AD patients and their caregivers.

Keywords: Alzheimer's disease, awareness, Bangladesh, knowledge, perceived threat

INTRODUCTION

Alzheimer's disease (AD) is the most prevalent type of dementia and is a chronic, progressive, and irreversible neurological illness.^{1,2} AD affects

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more than 46 million individuals globally,³ and it has a significant social burden in some overpopulated countries due to its effects on elderly people.⁴ Bangladesh is an overpopulated country where average life expectancy has risen from 60 years in 1971 to 72 years to date, according to the World Bank.⁵ A recent study found that 8.0% of older Bangladeshi people have dementia.⁶ According to the Bangladesh Bureau of Statistics (BBS), the nation currently has over 2.0 crore seniors, accounting for around 9.28% of the overall population.⁷ According to the World Health Organization's (WHO) statistics released in 2018, AD and dementia mortality in Bangladesh totaled 14,340, accounting for 1.85% of total deaths.

AD is often considered a stigmatized condition.⁸ People typically associate AD with insanity,⁹ or as divine vengeance.¹⁰ Moreover, inadequate knowledge about AD among healthcare professionals has been shown to have a detrimental effect on patient outcomes.¹¹ In general, caregivers (professional or family) possess better knowledge than non-caregivers, particularly when it comes to prognosis, expected personality changes, and community resources.^{12,13} Moreover, individuals obtain information on AD and other age-related memory problems from a variety of sources, which may affect the accuracy of their AD knowledge.¹⁴

The general public's knowledge and views concerning persons with AD have been studied very sporadically.¹⁵ A study discovered a low to extremely low level of AD literacy in a comprehensive analysis of 40 research examining the public's understanding of AD and the most frequently examined correlates of knowledge were age, sex, and education.¹⁶ One study that looked at 34 studies largely from Europe and the United States (US) found that over half of those polled believed that dementia is an inevitable aspect of aging and that it could not be prevented.^{17,18} Goni et al. recently discovered that among diabetic patients in Dhaka, Bangladesh, 94.9% did not know how AD develops, 96.8% did not know how it affects people's lives, and 97.6% did not know what symptoms and risk factors it carries.¹⁹

Previous research has established that AD patients' awareness was particularly deficient in terms of initiative dimensions and emotional blunting.²⁰ Additionally, socio-cognitive theories demonstrated that awareness is a necessary condition for changing behaviors.²¹ To boost individual awareness, a person's knowledge and risk perception should be enhanced or altered.²² A study in Saudi Arabia investigated public awareness of AD reported almost 60%

of those polled believe that forgetfulness in the elderly is a normal part of aging process and does not necessitate medical intervention.²³ Various methods have investigated awareness of impairment in AD, but each has its limitations.²⁴

A few studies have looked into the factors that influence how people perceive the threat of the risk of AD.^{25,26} The role of cultural beliefs and scientific knowledge of AD in influencing the perceived threat of AD in a sample of Chinese American older adults was investigated using a Sociocultural Health Belief Model (SHBM).²⁶ Authors observed that higher levels of the perceived threat of AD were attributed to both cultural beliefs about AD and factual knowledge about AD.²⁵ According to Ostergren and colleagues, the perceived threat was significantly higher for those aged between 50-64 and 65-74 compared to who were 75 or above. Moreover, those with a family history of AD had a significantly higher perceived threat than those without AD.²⁷

Majority of the people in Bangladesh are unaware about the symptoms and consequences of AD and frequently disguised by the fact that it is a natural aging process, and no treatment options are available.²⁸ Lack of adequate research, awareness building initiatives, and existing misconceptions among general population contributes to the treatment derailment, harassment, and lack of empathy towards AD patients.²⁸ Raising public knowledge and awareness of AD is crucial for optimizing care and ultimately enhancing the quality of life of people diagnosed and their caregivers.²⁹ Only a handful of studies looked at the status and knowledge of AD among general Bangladeshi population.^{28,30,31} However, knowledge, awareness, and perceived threat related studies among family caregivers of individuals with chronic physical conditions have not been investigated in Bangladesh previously. Therefore, the aim of this study is to evaluate the level of AD knowledge, awareness, and perceived threat among the family caregivers of individuals with chronic physical conditions of Bangladesh.

METHODS

Study design and sampling technique

A descriptive cross-sectional study was conducted from October 2022 to March 2023 in 6 public hospitals of Bangladesh to ascertain the level of knowledge, awareness, and perceived threat toward AD among the family caregivers of individuals with chronic

physical conditions in Bangladesh. The population under study were selected from six public hospitals in Bangladesh, representing a diverse cross-section of patient caregivers in terms of socioeconomic backgrounds, as well as regional differences. A convenient sampling technique was utilized to select the study participants.

Both males and females, aged 18 years or more, family caregivers of individuals with chronic physical conditions, residents of Bangladesh, and able to understand Bengali were included in the study. Exclusion criteria for the study were those over the age of 65, caregivers serving individuals diagnosed with AD or dementia, individuals with any other mental health or psychiatric conditions, and healthcare professionals. Given caregivers of patients with mental health problems may perceive information about AD and may inflate the actual knowledge, awareness, and perceived threat of all other caregivers regarding AD, we excluded them from this study.

The sample size was calculated using the formula of Cochran's $\left(n = \frac{z^2 * p(1-p)}{e^2}\right)$. Based on frequency of knowledge of AD and as there was no reliable data, 50% prevalence was used and with 5% of margin of error (e), standard normal deviation of 1.96 (z), the required sample size was 385. However, the study team tried to reach a larger sample than the required sample size for greater precision.

Ethical clearance was obtained from the Institutional Review Board (IRB) of North South University. The study's objectives were explained to each respondent prior to data collection, and informed written consent was obtained from the respondents. The study team also ensured the privacy and confidentiality of the study participants.

Data collection tools and procedure

A semi-structured questionnaire was developed by reviewing different literature on similar studies.^{25,32-37} The questionnaire consists of five sections: Socio-demographic questions, questions to gather information about personal experience with AD, questions to assess the knowledge of AD, questions to assess the awareness level of AD, and questions to assess perceived threat regarding AD.

Participant's socio-demographic characteristics includes age, sex, religion, education, employment status, marital status, residence, monthly household income. Age was categorized into five groups following previous studies.^{15,33} The questionnaire

also included information about personal experience with AD and related disorders such as dementia. The questionnaire included the Alzheimer's Disease Knowledge Scale (ADKS) which has been used and validated in a previous study.³⁸ Two other instruments were used to assess the awareness and perceived threat of the participants taken from previous studies,^{23,27} and are outlined below. These instruments were adopted directly from previous studies and were not tailored or modified for this study.

The questionnaire was first composed in English and then translated into Bengali by a language expert. Data were collected via face-to-face interviews. The questionnaire was pre-tested to check for accuracy, ambiguity, and comprehensiveness. Trained personnel were employed to physically collect the data. A pilot study was conducted among 5% of the study participants (which were not included in the data analysis) to determine face and content validity as well as reliability of ADKS. The Cronbach's alpha value was (0.853), indicating an internal consistency of ADKS among this cohort.

Alzheimer's Disease Knowledge Scale (ADKS) questionnaire

Validated and reliable ADKS was used to assess knowledge about AD disease. The primary outcome variable was ADKS scores. This questionnaire consists of 30 knowledge assessment items with answers recorded as true/false. Assessment of knowledge of AD covers 7 domains including risk factors, assessment and diagnosis, symptoms, life course, treatment and management, and caregiving. Correct responses were summed into a score ranging from 0-30 for individuals who provided response for each ADKS items.³⁸ Higher scorers were considered to have better ADKS knowledge.³⁸

Awareness level of AD

Another instrument consisting of 10 items was used to assess the awareness level of AD.^{23,39} The awareness scale of AD was chosen for this study because it covers a wide range of relevant topics, from social perceptions and caregiving choices to symptoms. This scale, in line with the study's goals, made it possible to systematically evaluate participants' understanding of and beliefs about the disease. The scale, which accounts for both biological and cultural factors, is especially pertinent in multicult-

tural contexts like as Bangladesh. It provides valuable information on how cultural beliefs might influence attitudes and actions linked to AD. It assists in identifying areas in which caregivers' understanding and competence may be improved through educational interventions or awareness campaigns. Participants indicated their level of agreement (i.e., agree, disagree) with 10 statements about the awareness level of AD. Those who agreed with the statements were considered to have better awareness level compared to the individuals who disagrees.

Perceived threat of AD

Examining caregivers' perceived threat of AD sheds light on caregivers' perceptions of the severity and potential impact of AD on themselves. Perceived threat of AD was assessed by 3 items taken from previous work²⁷ The scale offers a standardized method for evaluating perceived susceptibility and severity of AD by including items that measure participants' beliefs and feelings about their chance of getting the disease. This is essential for determining people's anxiety and worry levels about AD, which might affect their health-related actions like consulting a doctor and taking preventative action. We sought to understand caregivers' emotional reactions and concerns about AD by measuring perceived threat. We also sought to identify possible areas for interventions targeted at reducing caregivers' anxiety and fears about AD. Participants indicated their level of agreement (i.e., strongly disagree, disagree, neither agree nor disagree, agree, strongly agree) with 3 statements about the possibility of getting AD. Responses of "strongly agree" were classified as agreeing with each statement. All other responses, including neither agree nor disagree responses were classified as non-agreement. Therefore, items were recoded into 3 categories: "1 = Disagree", "2 = Neither agree nor disagree" and "3 = Agree" to aid model interpretability, and a composite mean score was calculated for each participant by averaging scores across the 3 items.

Data management and analysis plan

The entered data was analyzed using Stata for windows version 17. Descriptive statistics were used to determine sample characteristics of all variables, ADKS items, the ADKS domain scores, as well as percentage of correct answers, percentage of awareness of AD, and percentage of perceived threat

toward AD. Independent t-test was applied to test for differences between two independent groups and One-way ANOVA was applied to test for the difference between more than two group means. Pearson's correlation test was conducted to see the association between perceived threat score and domains of ADKS score. A multivariable linear regression model was used to explore the relative contribution of independent variables in predicting the ADKS scores and perceived threat after controlling other covariates. A p-value less than 0.05 was considered to determine statistical significance.

It is to be noted that, to assess the caregiver's awareness regarding AD, we utilized a 10-item scale for which no validated scoring system is available. Therefore, similar to related literature,^{23,39} we presented awareness data using frequency and percentages without imposing our subjective judgment.

RESULTS

About 45% of the participants were at or below the age of 30, and 26.3% were between 31-40 years (Table 1). The male (52.3%) participants were slightly higher than the female participants. Most participants (77.6%) were married. The participants came from different regions of the country whereas Dhaka and Chattogram each had 20.7% of the participants, Mymensingh had 19.2%, and Barisal and Rangpur had the rest. Two-thirds of the respondents lived in rural areas, while one-third lived in cities. About 17.6% had no formal education, 27.6% had ended primary school, 21.5% had completed the SSC, 20.5% had finished the HSC, and only 12.8% had a bachelor's degree or higher. Even though most of the participants had completed different levels of education, only 14.8% were engaged in jobs; other 14.0% were in business, and the remaining 71.3% were classified as "others" which included retirees, people without jobs, and people who works temporarily. Regarding their monthly income, 30.8% of the participants made less than 10,000 BDT per month, 51.7% between 10,000 and 30,000 BDT per month, and only 17.5% earned more than 30,000 BDT per month.

Table 2 enumerates the key findings regarding knowledge of AD among the study participants. The majority (68.2%) of the participants did not know people with dementia or AD. Among the rest of the respondents who knew people with AD reported that they were related to the patients through family member (9.2%), through relatives (9.6%), via

Table 1
Socio-demographic characteristics of the respondents (N = 522)

Variable	Categories	n (%)
Age (y)	At or below 30	232 (44.4)
	31–40	137 (26.3)
	41–50	81 (15.5)
	51–60	46 (8.8)
	>60	26 (5.0)
Division	Dhaka	108 (20.7)
	Chattogram	108 (20.7)
	Rajshahi	50 (9.6)
	Mymensingh	100 (19.2)
	Barisal	106 (20.3)
	Rangpur	50 (9.6)
Sex	Female	249 (47.7)
	Male	273 (52.3)
Place of residence	Urban	172 (33.0)
	Rural	350 (67.0)
Education level	No formal education	92 (17.6)
	Primary	144 (27.6)
	SSC	112 (21.5)
	HSC	107 (20.5)
	Bachelor and above	67 (12.8)
Employment status	Service	77 (14.8)
	Business	73 (14.0)
	Others (retired, jobless, day laborer etc.)	372 (71.3)
Marital status	Married	405 (77.6)
	Single (unmarried/divorced/widowed)	117 (22.4)
Household monthly income (in BDT)	Below 10,000	161 (30.8)
	10,000-30,000	270 (51.7)
	30,001-50,000	76 (14.6)
	Above 50,000	15 (2.9)

SSC, Secondary School certificate; HSC, Higher Secondary School Certificate.

Table 2
Alzheimer's disease or dementia related observations (N = 522)

Variable	Categories	n (%)
Known patients with dementia or AD	No	356 (68.2)
	Yes	166 (31.8)
Relationship with patients of dementia/AD	Family member	48 (9.2)
	Relative	50 (9.6)
	Friend	2 (0.4)
	Others (colleague, acquaintances)	66 (12.6)
	No	456 (87.4)
Personal experience of caring for people with dementia/AD	Yes	66 (12.6)
	No	398 (76.2)
Interaction with patients of dementia/AD	Yes	124 (23.8)
	No	505 (96.7)
Participation in relevant support groups or educational programs regarding AD	Yes	17 (3.3)
	No	505 (96.7)
Source of information regarding AD	Family	21 (4.0)
	Healthcare professionals	15 (2.9)
	Friends and acquaintances	23 (4.4)
	Media sites	85 (16.3)
	Never obtained any information	378 (72.4)

friends (0.4%), and “others” category (12.6%) which includes coworkers and acquaintances. Only 12.6% of participants reported personal experience providing care for people with dementia or AD. Regarding interacting directly with patients, 23.8% of participants had done so with people with dementia or AD,

while the majority (76.2%) did not. Regarding AD-related support groups and educational programs, only 3.3% ever participated. The information sources regarding AD were diverse, with 4.0% turning to family, 2.9% to healthcare professionals, 4.4% to friends and acquaintances, and 16.3% to media websites.

Table 3
Awareness about Alzheimer's disease among the study participants (N = 522)

Awareness of Alzheimer's disease	Disagree (%)	Agree (%)
Do you think that the loss of memory and forgetting names, appointments, and task repetition of questions are normal in the elderly and do not require medical consultation?	52.5	47.5
Do you think that the change in the planning matters of everyday life and the difficulty of balancing the financial accounts is expected in the elderly?	33.0	67.0
If one of your relatives was diagnosed with Alzheimer's disease, do you prefer not to tell the person with illness?	72.8	27.2
In the case of the patient diagnosed with Alzheimer's, do you think that it is best to avoid going to social events and life activities in order to avoid embarrassment to the patient?	72.6	27.4
Alzheimer's disease may result from black magic or psychological distress or bad eye?	73.8	26.2
In the case of the appearance of symptoms of dementia and memory disorder for a relative, will you resort to the popular types of alternative medicine?	43.9	56.1
In case of difficulty in performing everyday tasks in a patient with Alzheimer's, do you see it necessary to resort to the judiciary to save the patient's rights?	43.9	56.1
Do you feel embarrassed if the diagnosis of your relative is Alzheimer's disease?	85.6	14.4
Do you tend to deny the diagnosis when one of your relatives has Alzheimer's disease?	86.2	13.8
Are you with the care of these patients in nursing homes by the government instead of keeping them at home?	43.9	56.1

Table 4
Participant's perceived threat toward Alzheimer's disease (N = 522)

Perceived threat of Alzheimer's disease	Disagree	Agree
You would like to know your chances of someday getting Alzheimer's	39.8	60.2
You believe you will get Alzheimer's someday	68.2	31.8
You worry about getting Alzheimer's someday	73.2	26.8

A significant number of people (72.4%) said they needed access to information related to AD.

The majority of participants (95.98%) did not respond correctly to the statement that "It has been scientifically proven that mental exercise can prevent a person from getting AD." as presented in Supplementary Table 1. Most participants (59.20%) correctly responded that "Poor nutrition can make the symptoms of AD worse." Items with the poorest responses, included those related to AD's symptoms (Mean = 1.02, SD = \pm 1.06 in 4 items). Conversely, items with the highest correct responses included those related to life impact.

About 47.5% of the participants mentioned that memory loss and forgetfulness in older people were abnormal and should be checked out by a doctor, but 52.5% disagreed with this perception (Table 3). Assessment of changing the planning matters for everyday life, 67.0% of respondents agreed that the difficulty in balancing the financial accounts was expected in the elderly. Additionally, 72.8% of participants disagreed with the fact that if one of their relatives diagnosed with AD, they are not going to notify them. It was observed that 26.2% of participants believed black magic, psychological distress, or bad eyes as potential causes of AD, contrary to scientific understanding. In addition, 56.1% of the study

participants acknowledged that they would entertain a popular alternative medicine treatment if one their relatives get AD. Approximately 56% respondents agreed that the courts should intervene to protect patient rights if the AD patients face difficulty with everyday tasks. Approximately 85% of the participants disagreed that they will neither embarrassed nor deny the diagnosis if one of their relatives diagnosed with AD.

Table 4 shows how the participants perceived threat toward AD. When asked if they wanted to know how likely they would get AD in the future, 60.2% of participants answered positively. However, when questioned about their belief in eventually developing the disease, only 31.8% of the participants agreed that they will develop AD someday. Moreover, only 26.8% stated that they were worried about getting AD someday.

Table 5 presents and compares the mean scores of ADKS based on different categories of independent variables. The mean ADKS score was higher among younger age group, respondents living in the urban areas, respondents who completed graduation. The age group, place of living, and education were found to be significant for all ADKS dimensions. Regarding employment status, the results showed that ADKS scores for most of the ADKS dimensions were

Table 5
Comparison of mean ADKS score between groups using bivariate analysis (N = 522)

Variable	n	ADKS	Domains of ADKS						
			Risk factor	Life impact	Assessment	Symptoms	Treatment management	Care giving	Course of disease
	Total	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)
Age groups ⁱ									
<= 30	232	9.7 (5.7)***	1.5 (1.4)**	1.3 (1.0)***	1.6 (1.3)***	1.2 (1.1)**	1.5 (1.0)***	1.3 (1.1)***	1.3 (1.1)***
31–40	137	9.2 (5.8)***	1.4 (1.4)**	1.1 (1.0)***	1.6 (1.2)***	1.0 (1.0)**	1.4 (1.1)***	1.5 (1.1)***	1.3 (1.2)***
41–50	81	9.5 (5.0)***	1.7 (1.4)**	1.1 (0.8)***	1.3 (1.2)***	1.1 (1.0)**	1.6 (1.0)***	1.1 (1.0)***	1.5 (1.1)***
51–60	46	5.3 (5.9)***	0.9 (1.2)**	0.6 (0.9)***	0.8 (1.0)***	0.6 (1.0)**	0.7 (1.0)***	0.8 (1.2)***	0.9 (1.2)***
> 60	26	4.6 (6.5)***	0.7 (1.2)**	0.6 (1.0)***	0.6 (1.0)***	0.7 (1.0)**	0.7 (1.0)***	0.7 (1.1)***	0.6 (1.1)***
Sex ⁱ									
Female	249	8.9 (5.6)	1.5 (1.4)	1.1 (1.0)	1.5 (1.2)	1.0 (1.0)	1.4 (1.0)	1.2 (1.1)	1.2 (1.1)
Male	273	8.9 (6.1)	1.3 (1.4)	1.1 (0.9)	1.4 (1.3)	1.1 (1.1)	1.3 (1.1)	1.3 (1.1)	1.2 (1.2)
Place of residence ⁱ									
Urban	172	10.9 (5.8)***	1.7 (1.4)**	1.3 (1.0)***	1.9 (1.2)***	1.2 (1.1)***	1.7 (1.1)***	1.6 (1.1)***	1.5 (1.2)**
Rural	350	7.9 (5.7)***	1.3 (1.4)**	1.0 (0.9)***	1.2 (1.2)***	0.9 (1.0)***	1.2 (1.0)***	1.1 (1.1)***	1.2 (1.1)**
Highest level of education ^j									
No formal education	92	5.8 (5.9)***	1.1 (1.3)*	0.6 (0.8)***	0.8 (1.1)***	0.6 (0.9)***	0.9 (1.0)***	0.9 (1.2)***	0.9 (1.2)***
Primary	144	8.0 (5.6)***	1.5 (1.4)*	0.9 (0.9)***	1.3 (1.2)***	1.0 (0.9)***	1.2 (1.0)***	1.0 (1.1)***	1.1 (1.1)***
SSC	112	9.5 (5.5)***	1.4 (1.4)*	1.2 (0.9)***	1.5 (1.2)***	1.1 (1.0)***	1.4 (1.0)***	1.4 (1.0)***	1.5 (1.1)***
HSC	107	10.6 (5.7)***	1.7 (1.5)*	1.4 (1.1)***	1.8 (1.2)***	1.2 (1.1)***	1.6 (1.1)***	1.5 (1.1)***	1.5 (1.2)***
Graduate and above	67	11.3 (5.4)***	1.5 (1.3)*	1.5 (0.9)***	1.9 (1.3)***	1.4 (1.3)***	1.7 (1.1)***	1.6 (1.0)***	1.6 (1.1)***
Employment ^l									
Business	73	9.7 (5.9)**	1.5 (1.4)	1.2 (0.9)*	1.6 (1.2)**	1.1 (1.0)**	1.5 (1.0)*	1.5 (1.2)**	1.4 (1.2)
Service	77	10.9 (5.3)**	1.7 (1.5)	1.3 (0.9)*	1.8 (1.3)**	1.3 (1.2)**	1.6 (1.1)*	1.6 (1.0)**	1.5 (1.2)
Others	372	8.3 (5.9)**	1.4 (1.4)	1.0 (1.0)*	1.3 (1.2)**	0.9 (1.0)**	1.3 (1.1)*	1.2 (1.1)**	1.2 (1.1)
Household monthly income (BDT) ^j									
Below 10,000	161	7.2 (6.0)***	1.3 (1.4)	0.8 (0.9)***	1.2 (1.3)***	0.7 (0.9)***	1.1 (1.1)***	1.1 (1.2)**	1.0 (1.1)**
10,000–30,000	270	9.2 (5.7)***	1.5 (1.4)	1.1 (1.0)***	1.4 (1.2)***	1.2 (1.1)***	1.4 (1.0)***	1.3 (1.1)**	1.4 (1.2)**
30,001–50,000	76	10.9 (5.2)***	1.6 (1.4)	1.5 (1.0)***	1.9 (1.1)***	1.0 (1.0)***	1.8 (1.0)***	1.6 (1.1)**	1.6 (1.1)**
Above 50,000	15	11.3 (5.8)***	0.9 (1.1)	1.9 (0.9)***	2.0 (1.2)***	1.5 (1.1)***	2.0 (1.3)***	1.9 (1.3)**	1.1 (1.1)**
Marital status ⁱ									
Married	405	8.5 (5.9)**	1.4 (1.4)	1.0 (1.0)**	1.4 (1.2)**	0.9 (1.0)***	1.3 (1.1)*	1.2 (1.1)	1.3 (1.2)
Single	117	10.5 (5.6)**	1.6 (1.4)	1.3 (1.0)**	1.7 (1.3)**	1.5 (1.1)***	1.6 (1.0)*	1.5 (1.1)	1.4 (1.1)

(Continued)

Table 5
(Continued)

Variable	n	ADKS	Domains of ADKS						
			Risk factor	Life impact	Assessment	Symptoms	Treatment management	Care giving	Course of disease
	Total	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)	Mean (SD ^d)
Known patients with dementia or AD ⁱ									
No	356	7.9 (5.9)***	1.3 (1.4)***	1.0 (1.0)***	1.3 (1.3)***	1.0 (1.1)*	1.2 (1.0)***	1.1 (1.1)***	1.1 (1.1)***
Yes	166	11.2 (5.2)***	1.8 (1.4)***	1.4 (0.9)***	1.8 (1.2)***	1.2 (1.0)*	1.8 (1.1)***	1.6 (1.1)***	1.6 (1.2)***
Personal experience of caring for people with dementia/AD ⁱ									
No	456	8.3 (5.9)***	1.3 (1.4)***	1.1 (1.0)**	1.3 (1.3)***	1.0 (1.0)***	1.3 (1.1)**	1.2 (1.1)***	1.2 (1.1)***
Yes	66	12.9 (3.9)***	2.2 (1.4)***	1.4 (0.9)**	2.2 (1.0)***	1.6 (0.9)***	1.7 (0.9)**	1.9 (1.0)***	2.0 (1.1)***
Interaction with patients of dementia/AD ⁱ									
No	398	7.7 (5.9)***	1.3 (1.4)***	0.9 (0.9)***	1.2 (1.2)***	0.8 (1.0)***	1.2 (1.1)***	1.1 (1.1)***	1.2 (1.2)***
Yes	124	12.9 (3.7)***	2.0 (1.3)***	1.6 (0.9)***	2.2 (1.0)***	1.7 (0.9)***	1.9 (0.9)***	1.8 (1.0)***	1.7 (1.1)***
Participation in relevant support groups or educational programs regarding AD ⁱ									
No	505	8.7 (5.9)***	1.4 (1.4)*	1.1 (1.1)	1.4 (1.3)**	1.0 (1.1)***	1.4 (1.1)*	1.2 (1.1)***	1.3 (1.2)
Yes	17	13.7 (2.6)***	2.2 (1.2)*	1.5 (0.6)	2.2 (1.0)**	1.9 (0.6)***	1.9 (0.8)*	2.4 (1.0)***	1.5 (1.1)
Source of information about AD ⁱ									
Never obtained any information	378	8.2 (6.2)***	1.4 (1.4)**	0.9 (0.9)***	1.4 (1.3)**	1.0 (1.1)**	1.2 (1.0)***	1.2 (1.1)**	1.2 (1.2)***
Media sites	85	9.5 (4.7)***	1.2 (1.2)**	1.6 (0.9)***	1.5 (1.2)**	0.8 (1.1)**	1.7 (1.0)***	1.3 (1.2)**	1.4 (1.1)***
Friends and acquaintances	23	11.8 (3.6)***	1.9 (1.4)**	1.4 (0.9)***	1.6 (0.9)**	1.2 (1.0)**	2.2 (1.0)***	1.6 (0.8)**	2.0 (1.0)***
Healthcare professionals	15	13.5 (3.0)***	2.5 (1.1)**	1.3 (0.9)***	2.3 (0.9)**	1.8 (0.6)**	1.6 (0.7)***	2.0 (1.0)**	1.9 (1.3)***
Family	21	12.3 (4.6)***	1.1 (1.3)**	1.8 (0.9)***	2.2 (0.9)**	1.5 (0.8)**	2.1 (1.2)***	1.8 (1.0)**	1.8 (1.1)***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ^dStandard deviation; ⁱIndependent t-test for variables with 2 independent categories. ^jOne-way ANOVA used for variables with more than 2 categories.

Table 6
Correlation between domains of ADKS and perceived threat score (N = 522)

	ADKS								
	1	2	3	4	5	6	7	8	9
1. Perceived threat									
2. Risk factor	0.32***								
3. Impact	0.25***	0.37***							
4. Diagnosis	0.22***	0.48***	0.54***						
5. Disease course	0.20***	0.45***	0.42***	0.48***					
6. Care	0.25***	0.45***	0.52***	0.58***	0.46***				
7. Symptom	0.20***	0.42***	0.44***	0.49***	0.39***	0.43***			
8. Treatment	0.19***	0.42***	0.48***	0.57***	0.42***	0.45***	0.36***		
9. ADKS	0.32***	0.73***	0.72***	0.81***	0.71***	0.76***	0.68***	0.72***	

*** $p < 0.001$. ADKS, Alzheimer's Disease Knowledge Scale.

statistically significant, except for the risk factors and course of disease dimensions. ADKS scores also varied based on whether or not respondents had previously interacted with patients with dementia or AD. People who have cared for someone with dementia or AD in the past tend to have higher mean scores on the dimensions than those who have not.

The correlation assessment in the Table 6 reveals that perceived threat was positively associated with all domains of ADKS. Within ADKS, all domains were found to be positively inter-related. All correlations were found to be highly significant ($p < 0.001$).

The multiple linear regression results in Supplementary Table 2 demonstrated that several factors influencing the mean ADKS score of the participants. Individuals aged 30 or below (Coeff: 3.90, $p = 0.001$), 31-40 years (Coeff: 3.78, $p = 0.001$), and 41-50 years (Coeff: 4.41, $p < 0.001$) had significantly higher ADKS scores compared to the reference group (above 60 years), after controlling for all other covariates. The place of residence was also statistically significant. Compared to the rural, after controlling for all other explanatory factors, urban residents had higher mean ADKS score (Coeff: 1.45, $p = 0.004$). Participants with primary education (Coeff: 1.29, $p = 0.073$), SSC (Coeff: 2.02, $p = 0.010$), HSC (Coeff: 2.59, $p = 0.002$), and graduate and above (Coeff: 3.40, $p < 0.001$) exhibited significantly higher ADKS scores compared to those with no formal education. Employment status also influenced the ADKS scores significantly. Respondents who were service holders observed a 1.50-point higher mean score of ADKS compared to the others' professional group.

The multiple linear regression results in Table 7 demonstrates that several factors influencing the mean perceived threat score of the participants. Males (Coeff: -0.35, $p = 0.073$), and married individuals (Coeff: -0.16, $p = 0.512$) had comparatively

lower perceived threat toward AD compared to females, and single individuals, after controlling for all other covariates. Participants with primary education (Coeff: 0.20, $p = 0.410$), SSC (Coeff: 0.09, $p = 0.746$), HSC (Coeff: 0.21, $p = 0.456$), and graduate and above (Coeff: 0.25, $p = 0.459$) exhibited higher perceived threat compared to those with no formal education. Those with known AD patients had lower perceived threat (Coeff: -0.06, $p = 0.760$) compared to those with no known AD patients; whereas individuals having personal experience of caring AD people had higher perceived threat toward AD (Coeff: 0.60, $p = 0.077$). None of the variables were found to be significant except the variable "Source of information about AD." Specifically, individuals who obtained information about AD from family had a lower score (Coeff: -0.89, $p = 0.038$) compared to those who never received any information about AD.

DISCUSSION

The present study was designated to assess knowledge, awareness, and perceived threat toward AD among the patient caregivers of Bangladesh. The results of the present study revealed that the majority of respondents had insufficient knowledge and lacked awareness about AD. The mean ADKS score was poor among the respondents in the current study. Similar finding was reported in another Bangladeshi study.³⁰ A study conducted among the college students in Nepal reported better knowledge scores among the respondents compared to the current study.⁴⁰ However, comparatively higher scores were reported in studies carried out among pharmacists in Malaysia,³⁵ healthcare professionals in Australia,⁴¹ and psychologists in Norway.³³ These results could be attributed to the fact that the patient caregivers may lack open access to high quality information, contrary

Table 7
Perceived threat score regressed on sociodemographic factors, and AD related factors (N = 522)

	Coefficient	Std error	p	95% CI
Age group				
<=30 y	0.29	0.39	0.459	[-0.48, 1.07]
31–40 y	0.35	0.39	0.376	[-0.42, 1.11]
41–50 y	0.13	0.41	0.744	[-0.67, 0.94]
51–60 y	0.30	0.44	0.488	[-0.55, 1.16]
>60 (reference category)				
Sex				
Female (reference category)				
Male	-0.35	0.20	0.073	[-0.73, 0.03]
Marital status				
Single (reference category)				
Married	-0.16	0.25	0.512	[-0.65, 0.32]
Residence				
Rural (reference category)				
Urban	-0.03	0.17	0.870	[-0.37, 0.31]
Highest level of education				
No formal education (reference category)				
Primary	0.20	0.25	0.410	[-0.28, 0.69]
SSC	0.09	0.27	0.746	[-0.44, 0.60]
HSC	0.21	0.29	0.456	[-0.35, 0.77]
Graduate and above	0.25	0.33	0.459	[-0.41, 0.90]
Employment				
Service holder	-0.14	0.26	0.583	[-0.66, 0.37]
Business	-0.03	0.27	0.927	[-0.55, 0.50]
Others (reference category)				
Monthly household income (in BDT)				
Below 10,000 (reference category)				
10,000–30,000	0.03	0.19	0.886	[-0.34, 0.39]
30,001–50,000	0.21	0.27	0.432	[-0.32, 0.74]
Above 50,000	0.19	0.50	0.712	[-0.80, 1.18]
Type of disease				
No-neurological disease (reference category)				
Neurological disease	-0.17	0.16	0.286	[-0.48, 0.14]
Known patient of dementia or AD				
No (reference category)				
Yes	-0.06	0.21	0.760	[-0.48, 0.35]
Personal experience of caring for people with dementia/AD				
No (reference category)				
Yes	0.60	0.34	0.077	[-0.07, 1.27]
Interaction with patients of dementia/AD				
No (reference category)				
Yes	0.33	0.28	0.230	[-0.21, 0.87]
Participation in relevant support groups or educational programs regarding AD				
No (reference category)				
Yes	0.14	0.50	0.775	[-0.84, 1.13]
Source of information about AD				
Never obtained any information (reference category)				
Media sites	-0.22	0.22	0.336	[-0.65, 0.22]
Friends and acquaintances	0.37	0.40	0.360	[-0.42, 1.15]
Physicians and/or other healthcare professionals	0.58	0.57	0.306	[-0.54, 1.70]
Family	-0.89	0.43	0.038	[-1.74, -0.05]

to those who are working in the medical field. These consistent findings across different settings underline a global challenge in people's perception and knowledge about AD.

A substantial number of study participants had no personal contact with individuals with dementia or AD, which could be attributed to poor AD knowl-

edge among the study participants. Lack of personal or vicarious experiences with the disease can significantly affect understanding and stigmatization, as reported in previous literature.^{42,43} The participants' reliance on media websites for AD information points to the influential role media plays in shaping public knowledge and attitudes towards the disease.

However, the risk of misinformation through media underscores the importance of ensuring accurate representation and coverage of AD in media outlets.⁴⁴

Regarding awareness about AD in the current study, majority of the respondents agreed that the elderly may experience changes in their ability to plan everyday tasks and face difficulties in balancing their financial accounts; similar finding was demonstrated in a study conducted among Saudi population.²³ It is to be noted that while most participants did not feel embarrassed about having a relative with AD, many favored nursing homes over home care. This preference, contrasting with traditional Asian norms favoring home care,^{45,46} may reflect shifting care dynamics in Bangladesh and requires further exploration.

A significant number of participants in the current study expressed concern about the perceived threat of AD and the likelihood of developing the disease in the future. This finding aligns with researches in various settings showing widespread fear and anxiety about dementia and AD.^{47,48} Psychological factors were also reported to be associated with perceived threat among general population²⁷ which was not explored in the current study. Future study should consider determining factors associated with perceived threat toward AD in Bangladesh.

In this study, younger individuals tended to have higher ADKS scores. This significant positive association supports the notion that younger individuals are potentially more aware of AD and dementia-related information. This could be attributed to a variety of factors, such as better access to information, increased interest in health-related knowledge, or the effects of educational and awareness campaigns.³³ A Brazilian study conducted among general population also reported better ADKS score in younger age group.⁴⁹ The place of residence played a significant role in predicting ADKS scores, with urban residents exhibiting higher scores. This is consistent with previous research indicating that urban residents tend to have better access to health care services and information, contributing to a better understanding and awareness of various health conditions, including AD and dementia.⁵⁰ There was a notable pattern of increasing ADKS scores with each higher level of education attained in the present study. Previous research also showed a positive correlation between education level and knowledge about dementia and AD.^{49,51} The increased knowledge among the highly educated might be due to their better access to health information and their ability to comprehend complex

medical and health-related information. Individuals who are service holders or business professionals showed higher scores than other professional groups. This could be due to these groups' exposure to diverse situations, enhancing their understanding and knowledge about various health conditions, including AD.

Caregivers who had known patients with AD demonstrated better knowledge as compared to the caregivers who did not know someone with AD in the current study. That is, prior interaction with dementia or AD patients was related to improved ADKS scores in this study. This finding aligns with the existing body of literature suggesting that personal experience with a disease condition improves one's understanding and knowledge about that condition.^{23,52} The highest known subscale of AD in the present survey was life impact, followed by assessment, course of the disease, and treatment management, whereas the lowest known subscale was symptoms. Diverse findings were observed in other studies. For instance, in China, poor knowledge was reported regarding life impact, symptoms, and care giving.⁵³ In Malaysia, symptoms, course of the disease, and life impacts were the lowest known items.³⁵ Although we used the same tool, our study population varied from these studies in regard to age, education, and occupation.

We also found significant associations between all domains of AD and perceived threat. This indicated people having higher endorsement for different domains of ADKS, perceive greater threat to have AD. Stronger endorsement of the importance of risk factors were significantly associated with greater perceived threat. The association between the risk factor beliefs and heightened perceived AD threat may also indicate that respondents who strongly endorse risk factors may feel they have viewed the disease as less preventable. Ostergren also reported similar findings.²⁷

In line with the current study, some prior research has identified gender as a significant predictor of perceived threat towards AD, with findings indicating that women tend to report higher levels of perceived threat compared to men.²⁷ Moreover, marital status has emerged as another important factor influencing threat perceptions in the current study while the opposite was found in previous research.^{21,27} Single individuals may experience heightened perceptions of threat, reflecting concerns about potential future caregiving burdens and lack of immediate familial support in this continent. Furthermore, the influence of personal experiences, such as caregiving responsibilities and familial connections to AD, aligns with

previous research highlighting the significant impact of lived experiences on threat perceptions.²⁵ Individuals with direct caregiving experiences may develop a deeper understanding of the challenges associated with AD, leading to heightened perceptions of threat.

This study revealed that essential areas of concern in the people's understanding of AD in Bangladesh, with significant implications for public health policy and interventions. Multi-sectoral approaches, including the involvement of healthcare professionals, educators, policymakers, and media (both print and social), are necessary to enhance AD literacy and counteract prevailing misconceptions. Our research manifested the need to develop AD education and awareness programs targeted towards individuals and their families to improve the quality of AD care. Moreover, media outlets should facilitate consistent broadcasting of educational content about AD. Lastly, future studies require to be conducted to understand why there is such a lack of knowledge regarding AD and how it can be effectively addressed. Longitudinal studies might also be helpful in tracking the progress of awareness campaigns and interventions.

Strength and limitations

This research benefits from a substantial sample size, encompassing a diverse range of participants in terms of age, education, and geographic location within Bangladesh. Additionally, the study employed a comprehensive approach, assessing participants' knowledge, awareness, and perceived threat related to AD using validated questionnaires. The use of face-to-face interviews and pre-testing of the questionnaire adds rigor to the data collection process. Convenience sampling, employed in this study which could potentially limit the generalizability of the findings. The reliance on self-reported data is another limitation, as it can be prone to recall bias and social desirability bias. Additionally, the cross-sectional study design provides a snapshot of data only at a specific point in time, which limits our ability to establish causal relationships.

Conclusion

In conclusion, this research underscores the critical need for increased public education and awareness regarding AD in Bangladesh. While the study revealed a significant lack of knowledge and awareness among the patient caregivers, the situation is

expected to be worse among the general population. This study also highlighted the influence of demographic factors such as age, education, and personal experiences with dementia on AD knowledge. Strengthening educational campaigns, particularly targeting older age groups and rural residents, can play a pivotal role in enhancing understanding and reducing stigmatization associated with AD.

AUTHOR CONTRIBUTIONS

Azaz Bin Sharif (Conceptualization; Formal analysis; Investigation; Project administration; Supervision); Ishrat Jahan (Conceptualization; Data curation; Formal analysis; Methodology; Writing – original draft; Writing – review & editing); A.B.M. Nahid Hasan (Conceptualization; Data curation; Formal analysis; Methodology; Writing – original draft; Writing – review & editing).

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The authors have no conflict of interest to report.

DATA AVAILABILITY

The data supporting the findings of this study are available on request from the corresponding author.

SUPPLEMENTARY MATERIAL

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