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Risk of Dementia and Its Associated Factors Among the Patients With Coronary Artery Disease Attending a Tertiary Cardiac Hospital of Dhaka City: A Cross-Sectional Study

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Keywords: CAIDE risk score | coronary artery disease | risk factors | risk of dementia

ABSTRACT

Background and Aims: In Bangladesh, data related to the future risk of dementia and its associated factors are scarce. Furthermore, no dementia risk prediction tool has yet been applied to estimate the risk in any population in Bangladesh. Therefore, our objective was to assess the risk of dementia and its associated factors among patients with coronary artery disease (CAD).

Methods: This cross-sectional study conveniently recruited 280 stable patients with CAD who were admitted for coronary revascularization at a tertiary cardiac hospital situated in Dhaka, Bangladesh. Data were collected face-to-face using a pretested questionnaire adapted from the WHO STEP-wise Approach to Surveillance (STEPS) of Noncommunicable Diseases Risk Factors questionnaire (Version 3.2). The questionnaire included background information (sociodemographic, comorbidity), behavioral and metabolic risk factors, physical and biochemical measurements. The next 20 years' risk of dementia was estimated using the "Cardiovascular Risk Factors, Aging, and Incidence of Dementia" score. The risk score, risk levels, and risk factors were presented descriptively. The associated factors of dementia risk were elucidated using hierarchical multiple regression analysis.

Results: The mean ($\pm$ standard deviation) risk score for dementia was 6.26 ± 2.28. The predicted "at-risk" population was 63.6%. The prevalent risk factors were unhealthy diets (84.3%) presented by inadequate fruit/vegetable consumption (70%) and added salt intake (46.4%). In the final model of hierarchical multiple regression, the risk score showed a significant association with several risk factors: family history of diabetes ($p = 0.03$), alcohol intake ($p = 0.03$), current smoking ($p = 0.03$), estimated glomerular filtration rate ($p = 0.001$), and diastolic blood pressure ($p = 0.02$).

Conclusion: A substantial proportion of patients with CAD had a future risk of dementia which demands an urgent risk reduction strategy in Bangladesh. Future longitudinal studies may more precisely justify the current findings.

1 | Introduction

Dementia is an important and spreading public health concern with considerable increases projected in the future, especially in low to middle income countries [1, 2]. There is now a belief that a good proportion of cases are potentially preventable through the identification and modification of risk factors [3, 4]. By 2050, the number of people requiring care aged 60 years and older is expected to increase to 277 million, or 45% of the total population [5]. In Bangladesh, currently, more than 7 million people are in the age group of 60 years or older and by this century it will grow to 65 million which will be about 26% of the total population [6].

Like other countries in Asia, Bangladesh has the same prevalence of dementia in both urban and rural settings [7]. However, the number is slightly lower than other regions of the world [7]. According to a study conducted in Bangladesh, the prevalence of dementia here is 3.6% [7]. On the other hand, according to WHO Country Profile 2018 mortality due to CVD is 30% [8] and coronary artery diseases (CAD) account for the largest portion. People with CADs have a higher chance of developing dementia because they have been exposed to some kind of vascular damage [9]. Many cardiovascular risk factors are shown to increase the risk of vascular dementia (VaD) and Alzheimer's disease (AD) [10]. Systolic hypertension is an important modifiable risk factor for later-life cognitive decline, mild cognitive impairment, and VaD [11]. Chronic hyperglycemia, metabolic syndrome, and diabetes are associated with cognitive decline, vascular and neural damage, with functional changes in cerebral blood flow and neural damage after recurrent episodes of hypoglycemia [12]. Subclinical decrease in cardiac output has a link with lower cognitive function [13]. Previous studies reported coronary artery disease as an independent risk factor for VaD [14].

Globally, dementia poses several challenges for healthcare systems; in impoverished nations like Bangladesh, these challenges and outcomes are more noticeable. These challenges include a lack of knowledge among patients and caregivers, social stigma and false beliefs, a lack of skilled care personnel, inadequate diagnostic facilities, and a fragile healthcare infrastructure. Due to a lack of knowledge among patients and healthcare practitioners, early identification and proper diagnosis of dementia frequently remain elusive in Bangladesh, resulting in delayed treatments. Social stigma and false beliefs exacerbate the challenges in delivering proper treatment by causing underreporting and a reluctance to seek medical help. Furthermore, the provision of ongoing care and support for people with dementia is hampered by resource limitations in both urban and rural healthcare settings [15, 16].

In Bangladesh, data on the risk of dementia are scarce. We found a national study that used the mini-mental state examination to assess the prevalence of dementia among older adults [17]. It reported that the prevalence of dementia was 8% among subjects aged ≥ 60 years. However, this study had limitations as it only considered nonmodifiable demographic factors and excluded conventional and emerging modifiable risk factors that could be helpful in designing future intervention. In Bangladesh, no dementia risk prediction tool is applied or tested for any population to establish baseline evidence for future research on this progressive disorder. In addition to estimating the risk, identifying risk factors and reducing their impact through interventions to prevent the clinical onset of dementia would have a significant effect on the number of cases [18, 19]. Therefore, this study aimed to predict the risk of developing dementia in established CAD patients using a mobile application-based risk prediction tool, namely the "cardiovascular risk factors, aging, and incidence of dementia" (CAIDE) risk score [20]. Furthermore, we also assessed the distribution of several risk factors and examined their association with the measured risk score.

2 | Materials and Methods

2.1 | Study Design and Settings

This cross-sectional study was conducted from July 2019 to June 2020 at Ibrahim Cardiac Hospital and Research Institute (ICHRI), Dhaka. ICHRI is a 150-bed tertiary level specialized cardiac hospital located in the heart of Dhaka, Bangladesh. It is one of the eight affiliated institutes of the Diabetic Association of Bangladesh that has the objective of providing cost-effective preventive and curative cardiac care with quality services.

2.2 | Study Population

We conveniently recruited a total of 285 admitted patients (both sexes and aged 40–59 years) with CAD who were hemodynamically stable and free of acute symptoms and were getting ready for prescribed revascularization. Of the patients with CAD, eligible participants were sorted by the presence or absence of dementia based on the history of diagnosed dementia or the use of drugs for dementia (evidenced by medical records) and by screening the patients with the Bangla adaptation of mini-mental state examination [21]. Those who screened as having dementia were excluded from the study. The sample size was determined using the prevalence of vascular dementia among the Indian population (11.4%) with a precision of 4% at a 95% confidence interval [22]. The final sample size was adjusted considering the 15% nonresponse rate. We excluded those patients who had a history of cognitive impairment, congenital heart disease, were clinically unstable, or were pregnant.

2.3 | Data Collection Procedures

Data were collected through face-to-face interviews using a pretested semistructured questionnaire. The questionnaire included questions adapted from the WHO STEP-wise approach to Surveillance (STEPS) of Noncommunicable diseases risk factors questionnaire (Version 3.2) and was translated into Bengali for better understanding [23]. Data were collected in three steps according to the WHO STEPS survey: Step 1 (sociodemographic and behavioral information), Step 2 (physical measurements), and Step 3 (biochemical data collected from existing investigation profile of patients). Other

comorbid conditions (obesity, hypertension, diabetes, renal impairment, stroke), family history of chronic diseases, and medication history were collected from the patient's history and medical records review. Sociodemographic information included age, gender, education, occupation, income, and marital status. Behavioral factors included smoking, fruit and vegetable intake, tobacco use, physical activity, and alcohol consumption. Biochemical data included lipid profile, serum creatinine, glycated hemoglobin, and fasting blood glucose.

All physical measurements were carried out according to the WHO STEPS survey with adequate privacy [23]. A height measuring scale (Portable Stadiometer- Seca 213l) was used to record height. Generalized obesity was calculated as weight in kg/height in m^2. Blood pressure was measured using an aneroid sphygmomanometer (ALPK2, Aneroid Sphygmomanometer, Japan) on the right arm in a sitting position with their hand resting on the handle of the chair or some objects. After resting for at least 15 min, the first reading is taken, followed by a second reading after 3 min of resting interval. The mean of the two measurements was used to determine the final value of blood pressure.

2.4 | Prediction of Dementia Risk Using CAIDE Score

The long-term risk of dementia was evaluated using the mobile application-based risk prediction tool, namely the "CAIDE risk score" (Supporting Document S1) [20]. The tool uses, for instance, the risk score model to predict the risk of developing dementia in the future (20 years later) among middle-aged and elderly people.

The application poses a series of questions concerning their lifestyle and medical condition and then calculates a dementia risk score based on the answers. It includes age, sex, education, systolic blood pressure (SBP), BMI, physical activity, total cholesterol, personal history of cerebrovascular disease and personal history of heart disease to generate a risk score that ranges from 0 to 15 (Supporting Document S2) [20].

In the detailed study design, questionnaire development and pretesting, data collection methods and procedures were described in the protocol document [24].

2.5 | Ascertainment of Key Variables

2.5.1 | Outcome Variable

The outcome variable was the CAIDE risk score for dementia, which had a range of 0–15. There was a risk score assigned for each predictor: age (<47 years $=0$, 47–53 years $=3$, >53 years $=4$), education (>10 years $=0$, 7–9 years $=2$, <9 years $=3$), gender (female $=0$, male $=1$), SBP (≤ 140 mmHg $=0$, >140 mmHg $=2$), BMI (≤ 30 Kg/m^2 $=0$, >30 Kg/m^2 $=2$), total cholesterol (≤ 6.5 mmol/l $=0$, >6.5 mmol/l $=2$), and physical activity (active $=0$, inactive $=1$) [20]. Based on the total risk score, we classified the risk as "low (0–5)," "moderate (6–7)," and "high (8–15)" using percentiles. Again, for analysis purposes and to design an intervention, we recategorized the risk groups as "at risk" and "no risk." Here, "no risk" represented the risk score from 0 to 5 and "at risk" from 6 to 15.

2.5.2 | Independent Variables

Current smoking: It was defined as smoking in the last 30 days [23].

Past smoking: It was defined as abstaining from smoking for more than 30 days [23].

Physically inactive: Participants who did not engage in physical activity for at least 20 min, two times or more in a week, were considered inactive according to the CAIDE risk prediction tool [20].

Inadequate fruit/vegetable intake: Daily intake of less than three servings of fruit/vegetable was considered inadequate [25, 26].

Current alcohol intake: Those who provided information on the alcohol consumption within the last 30 days were referred as "current" consumers [23].

Added salt consumption: It was defined as consuming dietary salt during a meal [27].

Overweight and obesity: Participants with a BMI of 25–29.9 kg/m^2 and ≥ 30 kg/m^2 were considered over-weight and obese, respectively [28].

Hypercholesterolemia: It was defined as having a total cholesterol level >6.5 mmol/L according to the CAIDE risk prediction tool [20].

2.6 | Statistical Analysis

The 285 responses were thoroughly reviewed for consistency and completeness. Five responses were found to be incomplete or inconsistent, resulting in a final analysis of 280 responses. The data were entered into the predesigned Microsoft Office Excel format and imported later into the software Statistical Product and Service Solutions version 26.0 for Windows (SPSS Inc. Chicago, IL, USA). Descriptive and inferential statistics were used to achieve the objectives, and all precision estimates were presented with a 95% confidence interval (CI) as appropriate. Statistical tests were considered significant (two-sided) at a level of $p < 0.05$.

The descriptive analysis included mean, standard deviation (SD), median, and interquartile range, frequencies, and percentages as appropriate. We used descriptive statistics to present sociodemographic, behavioral, physical, and biochemical findings. The risk of dementia was presented using a pie chart and error bars.

The associated factors of the dementia risk score were identified using hierarchical multiple regression analysis. Independent variables in the regression model were included based on background knowledge from previous studies in the same field of research, as suggested by Harrell [29]. However, we excluded those variables (component of the CAIDE risk tool) which were used to predict the risk. The dependent variable was the risk score for dementia, which was normally distributed. We ensured the presence of no multicollinearity using variance inflation factor to run the regression analysis. Independent variables were sequentially entered: the first model built with a family history of prevalent chronic diseases in Bangladesh (coronary artery disease and diabetes mellitus), the second model included behavioral risk factors (current smoking, past smoking, serving of fruits/vegetables, salt consumption, alcohol intake), and the third model considered metabolic risk factors: estimated glomerular filtration (eGFR) rate for chronic kidney disease, diastolic blood pressure (DBP) for hypertension, fasting blood glucose for diabetes. The model fit information was presented using R^2, R^2 change, F and F changes. Here, R^2 represented the variation in the risk score explained by the risk factors included in each model. The change in the R^2 value from model 1 to model 3 was represented as the "R square change," along with whether this change was statistically significant (p-value) as shown by the "F Change." Again, the F-value along with significance level represented the statistical significance of the models.

2.7 | Ethical Approval

The purpose of the study, rights of the respondents, and data safety issues were explained to each participant. All subjects gave their informed written consent for inclusion before they participated in the study. The study was conducted following the Declaration of Helsinki, and the protocol has been approved by the Ethical Review Committee of Bangladesh University of Health Sciences (identification number: BUHS/BIO/EA/19/208). All authors have read and approved the final version of the manuscript. Lingkan Barua had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

3 | Results

3.1 | Background Characteristics

A total of 280 participants were recruited with a mean (± SD) age of 54 (± 5.2) years. Most of them were men (81.8%), having > 10 years of literacy (60.7%), a service holder (38.6%), and belonged to the upper-middle-income class (75%). Hypertension (78.6%) and diabetes (77.1%) were the most prevalent co-morbidities among the participants (Table 1).

3.2 | Risk Factors of Dementia

Table 2 shows the risk factors of dementia among the study population. In general, the most prevalent risk factor was unhealthy diets (84.3%), presented by inadequate fruit/vegetables consumption (70%) and added salt intake (46.4%). In addition to diet, a family history of diabetes (71.1%) was highly prevalent. Among metabolic risk factors, excluding the previously diagnosed cases of co-morbidities (Table 1), high BMI (≥ 25 Kg/m^2) was the predominant risk factor (71.1%).

TABLE 1 | Background characteristics of the respondents ($n = 280$).

Characteristics	*n* (%)	95% CI
Sociodemographic		
Age, years* (Mean ± SD)	54 ± 5.2	53.3–54.6
< 47	37 (13.2)	9.2–17.2
47–53	67 (23.9)	18.9–28.9
> 53	176 (62.9)	57.2–68.5
Gender		
Men	229 (81.8)	77.3–86.3
Women	51 (18.2)	13.7–22.7
Educational level, years*		
> 10	170 (60.7)	54.9–66.4
7–9	54 (19.3)	14.6–23.9
0–6	56 (20.0)	15.3–24.7
Marital status		
Married	259 (92.5)	89.4–95.6
Others	21 (7.5)	4.4–10.6
Occupational status		
Service holder	108 (38.6)	32.5–43.9
Businessmen	88 (31.4)	25.8–36.6
Housewife	37 (13.2)	9.2–17.2
Others	47 (16.8)	12.4–21.2
Monthly family income, BDT†	40,000 (30,000–50,000)	
Monthly family income categories‡, BDT		
Lower-middle (7102–27,654)	63 (22.5)	17.6–27.4
Upper-middle (27,655–85,663)	210 (75.0)	69.5–80.1
High (> 85,663)	7 (2.5)	0.67–4.4
Co-morbidities previously diagnosed		
Hypertension§	220 (78.6)	69.9–80.1
Diabetes mellitus‖	216 (77.1)	72.1–82.1
Cerebrovascular diseases¶	18 (6.4)	3.5–9.2
Chronic kidney disease**	69 (24.6)	19.6–29.6

Abbreviations: BDT, Bangladesh Taka; CI, confidence interval.
*Age and educational level were categorized according to CAIDE risk profile.
**Chronic kidney disease is based on eGFR level where the value < 60 mL/min/1.73 m^2 is the cut-off.
†Presented as median with interquartile range.
‡According to the July 2019 per-capita gross national income (GNI) and the World Bank calculation, no low-income group detected.
‖known case of diabetes with or without on antidiabetic drug and whose HbA1c level is 6.5 or above.
¶Stroke and history of transient ischemic attack both was considered.
§BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg or known case hypertensive or on the antihypertensive drug.

TABLE 2 | Risk factors of dementia among the study population ($n = 280$).

Risk factors	*n* (%)	95% CI
Nonmodifiable		
Family history of coronary artery disease	121 (43.2)	37.4–49.0
Family history of diabetes mellitus	199 (71.1)	65.8–76.4
Behavioral		
Current smoking*	61 (21.8)	17.0–26.6
Past smoking†	162 (59.6)	53.6–65.3
Physically Inactive‡	120 (42.9)	37.1–48.7
Fruit and/vegetable intake		
Weekly fruits intake (days)§	3.4 ± 1.5	1.3–5.5
Daily fruit servings‖	1 (1–1)	
Weekly vegetable intake (days)§	5.3 ± 1.1	2.7–7.9
Daily vegetable servings‖	1 (1.5–1)	
Inadequate intake (< 3 servings)	196 (70)	64.6–75.4
Current alcohol intake	12 (4.3)	1.92–6.68
Added salt intake	130 (46.4)	40.6–52.2
Metabolic		
Systolic blood pressure§	119.9 ± 12.6	118.4–121.4
Systolic blood pressure ≥ 140 mmHg	33 (11.8)	8.0–15.6
Diastolic blood pressure§	73.6 ± 9.1	72.5–74.7
Diastolic blood pressure ≥ 90 mmHg	17 (6.1)	3.3–8.9
Body-mass index (BMI)§	27.0 ± 3.5	26.6–27.4
Overweight (BMI 25–29.9 kg/m^2)	130 (46.4)	40.6–52.2
Obesity (BMI > 30 kg/m^2)	63 (22.5)	17.6–27.4
Hypercholesterolemia (> 6.5 mmol/L)	14 (5.0)	3.3–8.9
Fasting blood glucose (mmol/L)‖	6.5 (7.6–5.5)	
Fasting blood glucose ≥ 7 mmol/L	105 (37.5)	31.8–43.2
Estimated glomerular filtration rate (mL/min/1.73 m^2)§	74.1 ± 19.4	71.8–76.4
Estimated glomerular filtration rate < 60 mL/min/1.73 m^2	66 (23.6)	18.6–28.6

*Who smoked in the past 30 days.
†Who abstained from smoking more than 30 days.
‡Who did physical Activity (at least 20 min) two times or more in a week is considered as active.
§Presented as mean ± standard deviation.
‖Presented as median with interquartile range.

3.3 | Risk of Dementia Among CAD Patients

The mean (±SD) risk score of dementia was 6.2 ± 2.3. The CAIDE risk score classified the study population as 30.7% for high risk, 32.9% for moderate risk, and 36.4% for low risk of developing future dementia (Figure 1A). Overall, the predicted "at risk" population was 63.6% (Figure 1B).

3.4 | Factors Associated With the Risk of Dementia

Table 3 presents the findings of the hierarchical multiple regression analysis to determine the factors associated with the risk of dementia. It demonstrates a progressive increase in variance (R^2 and R^2 change) and significant improvement of models (model 1, $p < 0.05$; model 2, $p < 0.01$; model 3, $p < 0.001$) as risk factors are sequentially added from model 1 to model 3. In the complete model, the risk score shows a significant association with several risk factors: family history of diabetes ($p = 0.03$), alcohol intake ($p = 0.03$), current smoking ($p = 0.03$), estimated glomerular filtration rate ($p = 0.001$), and diastolic blood pressure ($p = 0.02$).

4 | Discussions

The current study found that more than half of the patients with CAD were at risk (moderate/high) of dementia and were associated with several risk factors which were not included in the tool itself. This is noteworthy because there is no direct evidence on the risk of dementia among the Bangladeshi

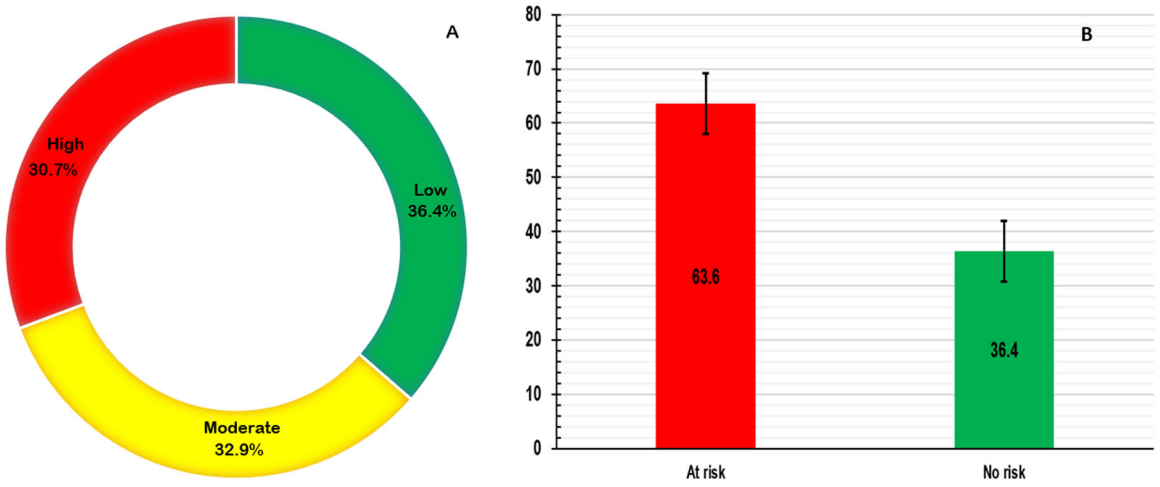

FIGURE 1 | (A, B). Risk of dementia among the patients with coronary artery disease ($n = 280$). (A) Pie diagram showing the overall risk of dementia (mild/moderate/high) among the study population ($n = 280$). (B) Error bars showing the population at risk of dementia.

TABLE 3 | Factors associated with the risk score of dementia using hierarchical multiple regression ($n = 280$).

	Model 1			Model 2			Model 3		
Factors	***p***	***B***	***β***	***p***	***B***	***β***	***p***	***B***	***β***
Constant	0.000***	4.388		0.023*	2.960		0.166	2.617	
Family history									
Coronary artery disease	0.011*	0.713	0.154	0.033*	0.597	0.129	0.052	0.534	0.115
Diabetes mellitus	0.058	0.579	0.115	0.033*	0.652	0.129	0.029*	0.654	0.130
Behavioral risk factors									
Current alcohol intake				0.039*	1.380	0.124	0.028*	1.442	0.130
Fruit/vegetables servings				0.942	−0.018	−0.004	0.916	0.025	0.006
Added salt consumption				0.022*	−0.635	−0.145	0.050	−0.534	−0.117
Current smoking				0.015*	0.933	0.161	0.026*	0.837	0.144
Past smoking				0.166	−0.423	−0.091	0.082	−0.528	−0.114
Metabolic risk factors									
Estimated glomerular filtration rate							0.001**	−0.023	−0.198
Diastolic blood pressure							0.018*	0.035	0.139
Fasting blood glucose							0.341	−0.060	−0.056
Model information									
R^2		0.042			0.090			0.142	
R^2 change		0.042			0.048			0.052	
F (ANOVA)		5.793*			3.704**			4.272***	
F changes		5.793**			2.790*			5.184**	

Note: Model 1: family history (coronary artery disease, diabetes mellitus).Model 2: family history with added behavioral risk factors (alcohol intake, total servings of fruit/vegetables intake, added salt consumption, current smoking, past smoking).Model 3: family history and behavioral risk factors with added metabolic risk factors (estimated glomerular filtration rate, diastolic blood pressure, fasting blood glucose).
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

population with CAD. Similarly, modifiable contributing factors have not yet been explored.

One of the main objectives of the current study was to estimate the risk of dementia. Using the CAIDE risk prediction tool, Kivipelto et al. reported the baseline risk of dementia among 1409 participants as 0.13% for low-risk, 6.91% for intermediate-risk, and 35.55% for high-risk [30]. Considering the "at-risk" population, it (42.5%) was less than the current study (63.6%). In the neighboring country India, in an urban cohort, the

detected high-risk population (34.9%) was similar to the current study (32.9%) [31]. In this case, it is controversial whether the difference in risk from country to country and population to the population was due to the presence of CAD or in combination with any other factors. However, another study using CAIDE found no association of CAD with the development of dementia [32].

In this study, among all risk factors, unhealthy eating habits were highly prevalent (84.3%). Among those who had unhealthy eating habits, nearly three-fourths of them took less than three servings of fruit/vegetables and almost half took added salt while eating a meal. Previous epidemiological studies reported that these two unhealthy eating patterns either alone or together can increase the risk of dementia [33, 34]. Regarding fruit/vegetables consumption, findings of previous studies reported lower intake (< 3 servings) is associated with cognitive decline [33, 35, 36]. Another population-based cohort study investigated whether excessive dietary salt intake was an independent risk factor for cognitive impairment and dementia, and found that higher intake increased the risk by 75%–330% after adjustment for several confounders. Several potential mechanisms have been postulated to explain how insufficient intake of vegetables or fruits alone increases the risk of dementia. First, fruits/vegetables are rich sources of multiple bioactive compounds and nutrients with antioxidant and anti-inflammatory properties. Animal studies found that the deficiency of these bioactive compounds could aggravate dementia pathologies [37]. Second, a single nutrient is unlikely to provide this cognitive benefit mediated by vegetables and fruits, whereas diets rich in multiple nutrients such as Mediterranean, DASH and MIND diets might slow cognitive impairment [38, 39]. Third, an additive or synergistic interaction might exist between fruits and vegetables, which prevents cognitive decline [40]. On the other hand, few studies have examined the association of salt intake with cognitive impairment. Based on available studies, the possible link was described according to an animal study that reported a high-salt diet declining cognitive function by inducing hyperphosphorylation of tau protein and cerebral endothelial dysfunction [41]. Another way of cognitive dysfunction is a high-salt diet-induced imbalance in adaptive immune responses mediated by immunomodulatory Th17 cells [42]. Although the aforementioned discussion revealed the significant impact of fruit/vegetables and added salt intake on the risk of dementia, in our study, we did not find any significant association between unhealthy diets (fruit/vegetable servings, added salt intake) and the risk of dementia. One possibility is self-reported bias, since the dietary evaluation was subjectively done. Another important issue about dietary salt is the skewness of the data toward men, while women in Bangladesh are the real exposed population to dietary salt, as they are the main cooks and a previous study reported a high dietary salt intake among women than their counterparts [43].

In our study, the family history of diabetes showed a significant association with the risk score of dementia. We did not find any study that examined such an association in any population. However, few studies proposed a genetic link between the heredity of diabetes and the risk of dementia in offspring and revealed that such an association is possible. The gene for the amyloid precursor protein (APP) is known to be involved in some cases of dementia. This gene is also responsible for the disruption of the insulin pathway, which is a hallmark of diabetes [44]. If this gene is transgenerationally transmitted from diabetic parents to offspring, the chances of dementia and diabetes are increased [45].

The current study found a significant association between alcohol consumption, current smoking, and the risk score for dementia. A previous study also supported our findings and reported alcohol consumption as an important risk factor that is certainly linked to an increase in dementia risk [46, 47]. Alcohol acts as a neurotoxin which can directly or indirectly damage the brain by causing malnutrition, primarily a loss of thiamine (vitamin B1) [46, 48]. It has already been established that current smoking increases the risk of cognitive decline and dementia [49]. Again, another study reported that the combined impact of smoking and alcohol use accelerated cognitive decline. They concluded that both smokers and alcohol users had a 36% faster cognitive decline [50].

Among metabolic risk factors, DBP and eGFR showed a significant association with the CAIDE risk score for dementia. In global research, there is a clear association between raised SBP and adverse brain health. However, the relationship between DBP and cognition is not straightforward. This is because the relationship showed different findings in different trajectories of life. In some studies, elevated DBP has been shown to be negatively associated with cognition during midlife [51], but positively associated with cognition in later decades of life [52]. However, in our study, we found a positive association with the risk of dementia at midlife that contradicts the later evidence [52].

Our findings on the association of eGFR with the risk of dementia were consistent with other studies that have reported a negative association [53, 54]. The brain and kidneys share similar microvascular structures which means they have similar responses to diseases and are sensitive to endothelial dysfunction. These similarities make it easier for blood proteins to cross the blood-brain barrier and contribute to the development of dementia [55]. Other mechanistic pathways that explain the association between kidney dysfunction and dementia include increased level of uremic neurotoxins, decreased levels of kidney neurotrophins, uremia neuroinflammation, and genetic factors [53, 56].

It is the first study that assessed the long-term risk of dementia among patients with CAD in Bangladesh using the CAIDE score. The main strength of this study is its study population, which is very selective and always carries a risk of various vascular and neurological complications, and is merely addressed by the policy makers of lower-middle income countries. As it is the first study in Bangladesh, its findings will guide the conduct of future large-scale studies in the country to measure the actual burden more precisely. This study will raise awareness among patients with CAD, their family members, and caregivers about dementia. It will also encourage healthcare providers to include dementia as a separate entity to consider in the department of cardiac rehabilitation.

This study has some limitations. Due to the cross-sectional design, the ability of the CAIDE score to stratify the risk cannot be evaluated for Bangladeshi patients with CAD. As the study center was purposively selected, the findings may vary in other cardiac hospitals and the participants were not representative of all patients with CAD in Bangladesh. Finally, due to economic and logistical problems, we used a convenient sampling technique that increased the risk of selection bias.

In conclusion, using the CAIDE risk score, a significant number of patients with CAD were found to have a moderate to high risk of dementia, which was associated with various behavioral and metabolic risk factors. Despite already having CAD, the patients had not yet made changes to these risk factors, as the prevalence of several risk factors remained high. Therefore, introducing cognitive screening to assess risk and contributing factors should be implemented in the cardiac rehabilitation program of Bangladesh as a strategy for reducing risk.

Author Contributions

Fardina Rahman Omi: conceptualization, investigation, funding acquisition, writing–original draft, methodology, project administration, resources. **Lingkan Barua:** conceptualization, funding acquisition, investigation, methodology, project administration, data curation, formal analysis, writing–review and editing, writing–original draft. **Palash Chandra Banik:** data curation, formal analysis, methodology, software, writing–review and editing, conceptualization. **Syed Mosfiqur Rahman:** conceptualization, data curation, formal analysis, methodology, software, writing–original draft. **Mithila Faruque:** conceptualization, methodology, data curation, investigation, formal analysis, supervision, resources, project administration, writing–review and editing, writing–original draft.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Transparency Statement

The lead author Lingkan Barua affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.