

Malnutrition Concerning Geriatric Depression and Associated Risk Factors: A Community-based Case-control Study in Rural Elderly of Bangladesh

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Abstract

Background: Malnutrition and depression are highly prevalent in the elderly and can lead to disparaging outcomes. Analytical studies on malnutrition concerning geriatric depression (GD) are very scarce in Bangladesh, although the size of the elderly population is increasing fast in the country. The current study aimed to assess the association between malnutrition and depression and associated risk factors in the rural elderly.

Methods: A case-control study was conducted in 600 elderly residents (aged ≥ 60 years) of three rural communities of Bangladesh from January to October 2019. Three hundred depressed elderly people were enrolled as cases and 300 non-depressed elderly individuals were included as community controls by matching the age and living area of the cases. We used a semi-structured questionnaire based on the Geriatric Depression Scale-15 and the Bangla version of Mini-Nutritional Assessment-Short Form to collect data through face-to-face interviews. Measures included baseline and personal characteristics, malnutrition, GD, and associated risk factors. A binary logistic regression model was fitted to identify variables associated with the risk of GD.

Results: The study found no significant difference in gender (male Vs. female) between cases (44.0% Vs. 56.0%) and controls (46.0% Vs. 54.0%). The study revealed that malnutrition was significantly ($p < 0.01$) higher in cases (56.0%) than in controls (18.0%). The malnourished elderly had around three times AOR=3.155; 95% CI: 1.53-6.49, $p=0.002$) more (risk of having depression than the controls. The unemployed elderly (AOR=4.964; 95% CI: 2.361-10.440; $p=0.0001$) and the elderly of the lower and middle class (AOR=3.654; 95% CI: 2.266-7.767; $p=0.001$) were more likely to experience depression. The elderly having a poor diet were more likely to experience depression (AOR=3.384; 95% CI: 1.764-6.703; $p=0.0001$). The single elderly (AOR=2.368; 95% CI: 1.762-6.524; $p=0.001$) and the elderly tobacco users (AOR=2.332; 95% CI: 1.663-5.623; $p=0.003$) were more likely to experience depression.

Conclusions: A significant association between malnutrition and depression is evident in the rural elderly individuals of Bangladesh. It will be a prolific initiative if policymakers merge malnutrition and the risk factors associated with geriatric depression in the provision of universal health care for better health and well-being of the rural elderly populations.

Highlights

- A community-based case-control study was conducted with a total of 600 (300 cases and 300 controls) rural elderly individuals.
- Malnutrition was significantly higher (56.0%) in cases than in controls (18.0%).
- Unemployment, lower monthly family income, marital status, lower education, and having a poor diet of the elderly were significantly associated with geriatric depression.
- Tobacco use (including smoking and smokeless tobacco) was significantly associated with geriatric depression.

- Malnourished rural elderly had a significantly higher risk (AOR = 3.115) of having depression than the well-nourished elderly.

Background

The majority of the total population of Bangladesh resides in rural areas, and the rural older population still lives below the poverty line [1]. They are increasingly exposed to a lack of fundamental needs and social healthcare facilities that may significantly undermine the risk of malnutrition and geriatric depression (GD) [2, 3].

The elderly population of Bangladesh is susceptible to poor health as there are diverse risk factors encountered in providing good health. The household's food insecurity, inadequate knowledge due to illiteracy, poor appetite, weight loss, lack of awareness predispose illness like malnutrition. Limited access to health facilities could be considered as another underlying cause that could lead to poor elderly health and illness [4, 5]. Besides these, the rural people confront an unhealthy environment, inadequate social supports, and poor health amenities, which intensify their health risks, cause malnutrition, and invite various communicable and non-communicable diseases, where the older people are worse victims [6, 7].

Some existing literature from the developing countries reported that the rural people suffered from different health risks due to poverty, unemployment, insufficient health facilities, and absence of social security, where the risk is severe with the elderly people [8, 9, 10]. A community-based study conducted among the population of Kalapara Upazila (one of our sampling areas) of Patuakhali district showed that for every 8000 people there is only one health facility [11]. These lacking; basic humanitarian needs, socio-economic insecurity, and limited access to health facilities create a burden of poor health among the rural elderly.

According to the World Health Organization (WHO), 80% of older people will be living in low- and middle-income countries in 2050. GD is a common health condition in rural communities of developing countries. The elderly people are constantly at threat of this health problem due to socio-economic, physical, and social environment, and factors related to aging [12, 13, 14]. Rural elderly people of the developing countries are the most vulnerable group for various physical and mental health consequences, and diverse age-specific sufferings [13, 14, 15]. Their quality of life deteriorates and needs comprehensive health care, and increases healthcare utilization costs [16, 17]. As a consequence, the majority of elderly individuals suffer from major depression and commit suicide, although multiple other reasons can also be involved in most cases [18].

Several risk factors (i.e., biological, social, psychological, environmental, etc.) have been suggested in the development of GD such as being female, older, single or widow, smoker, drug user, and multiple medication users, and having lower educational status [19, 20]. Low income, being unemployed, financial insecurity, poor physical health like malnutrition, co-morbidities, sleeping disorders, frailty, loneliness, lack of social support, stressful life events, poverty, and cognitive impairment are also established as determinants of GD [21, 22].

Malnutrition and depression are interrelated geriatric health medical disorders and diverse studies revealed an interdependent relationship between these two geriatric health issues. Globally, the depression status of elderly individuals has been well researched but still, it is an unfinished agenda [9]. A previous study conducted in Bangladesh examined the issue and reported a 24% prevalence of malnutrition among Bangladeshi hospital-attending elderly patients [23]. In developing a public-health response to GD and malnutrition, it is imperative to devise strategies, which may reinforce recovery, adaptation, and sound health in the elderly population. But, most of the developing countries confront challenges to ensure that their health and social systems are ready to address these major geriatric health issues.

Research has demonstrated that earlier diagnosis and treatment of malnutrition can lead to improved outcomes and better quality of life as well as reduced health consequences among the elderly. However, studies especially community-based case-control studies concerning GD and malnutrition especially in a rural setting are scarce in Bangladesh. In this context, the present community-based case-control study investigated GD as the dependent variable while malnutrition and associated risk factors as independent variables among the rural elderly people in Bangladesh. The study intends to explore the relationship of GD with malnutrition and related risk factors, and contribute to devising effective approaches to prevent this leading geriatric medical disorder in the country.

Methods

Aim, design, and settings of the study

We conducted this case-control study to assess the association between malnutrition and GD, and ascertain the associated risk factors in rural elderly of Bangladesh. The study was conducted from January to October 2019 in three rural villages; Dhankhali, Tiakhali, and Lalua in Kalapara Upazila of Patuakhali district in Bangladesh. The villages are located in remote areas in the coastal belt of the country besides the Bay of Bengal [Figure 1].

Participants

The cases were defined as elderly aged 60 years or more having depression, and controls were elderly having no depression. We identified the cases and controls based on the score estimated by the Geriatric Depression Scale-15 (GDS-15). An elderly with a GDS score of <5 was classified as a control while an elderly participant with a score of ≥ 5 was classified as a case. The study participants were included in the study having criteria such as; (i) a permanent resident of the selected rural community; (ii) aged ≥ 60 years; (iii) capable of giving informed written (or verbal) consent, and (iv) absence of severe illness.

Sample size and sampling

Without considering the matching and considering 10% non-response rate, and rounding, a sample size of 600 elderly individuals would allow identifying an odds ratio of 2 for exposure of 10.6% among controls (confidence level = 0.95 and power = 0.80). We recruited 300 elderly individuals having depression as cases and 300 individuals without depression as controls who were individually matched for age (± 2 years) and neighborhood (residence of cases and controls in the same rural community). We recruited 200 elderly individuals (100 cases and 100 matched controls) from each village and a total of 600 elderly individuals (300 cases and 300 matched controls) from three villages following systematic random sampling. In the beginning, the principal investigator estimated the sampling interval using the total households and sample size in each village. Considering the sampling interval, the data enumerators attended the selected households for finding the elderly individuals living there. Based on the selection criteria, we identified the expected number of cases and matched controls for recruiting in the study.

Data collection

A semi-structured questionnaire was applied for data collection by face-to-face interviews by trained interviewers of both sexes. The questionnaire was pretested among the elderly individuals in a similar rural community of neighbor Upazila (sub-district) and finalized the following necessary corrections and modifications based on the findings. All interviewers were medical graduates and had a Master of Public Health (MPH) degree. Interviews took place at the houses of cases and controls. The questionnaires consisted of a common set of questions, and information was obtained from cases and controls. These included baseline and personal characteristics, and malnutrition-related variables. We took the informed consent from each elderly individuals to interviews at their residences.

Measures

Baseline characteristics:

Information concerning baseline characteristics included age, gender, religion, marital status, monthly income, level of education, employment status, and family type. Although the country has four major religions, only two (i.e., Islam and Hinduism) were found in the present sample. Family income was used as an indicator of social class: less than 10,000 BDT (lower class), 10,000 to 20,000 BDT (middle class), and more than 20,000 BDT (upper class) based on the recommendations of Mamun MA et al., [24]. The marital status of being single included those who were divorced, separated, and widowed elderly individuals.

Personal characteristics:

Information concerning personal characteristics included psychosocial, physical health, lifestyle, and dietary factors. Relevant variables included peer group support history of suffering from chronic illnesses, active in daily life, having a poor diet, and tobacco use. For assessing peer group support, participants were asked if they received any type of support from friends and others. Regarding tobacco use, participants were asked about including smoking and smokeless tobacco use. For active in daily life, participants were asked if they performed daily activities on their own such as shopping, household chores, washing clothes, etc. For having a poor diet, participants were asked if they had consumed the foods regularly, timely, adequately, and nutritious for health.

Geriatric Depression

Depression in the elderly was assessed with GDS-15, the most well-established scale for assessing GD, which has been validated and widely used in both community and clinical settings [25]. The GDS assessed depressive symptoms experienced in the preceding week. The scale comprises 15 questions requiring a binary ('yes/no') response. Out of the 15 items, 10 indicated the presence of depression when answered positively, while the other remaining (Items 1, 5, 7, 11, and 13) indicated depression when answered negatively. The scale has a total score of 15 (ranged 0 to 15), where depression level is classified into normal (scores 0–4) [26] and a score of ≥ 5 indicates probable depression [27]. The internal consistency of the scale in the present study was very good (Cronbach's alpha = 0.85).

Malnutrition:

The Bangla version of the Mini-Nutritional Assessment-Short Form (MNA-SF) was used for the collection of data on malnutrition. The revised MNA-SF of the MNA was developed and validated in Bangla especially for use among elderly individuals [≥ 60 years] [28]. It comprised of six questions (relating to appetite, weight loss, mobility, recent illness/stress, dementia/depression, and BMI), and was scored from 0 to 14. A score of 0-7 was used as the cutoff score for malnutrition [29]. The internal consistency of this scale in the present study was very good (Cronbach's alpha= 0.89).

Statistical analysis

The data were analyzed using SPSS STATISTICS (Version 25.0, IBM Statistical Product and Service Solutions, Armonk, NY, USA) software. Descriptive statistics included frequency, percentage, means, and standard deviation. To assess the association between depression status and variables related to malnutrition, baseline, and personal characteristics of the elderly individuals, inferential statistics (Chi-square test and regression analysis) were carried out. All the variables statistically significant in bivariate analysis were entered into the binary logistic regression models [30]. The results of the logistic regression are reported as adjusted odds ratios with 95% confidence intervals (CI), and a p-value less than 0.05 was accepted as the significant level for this study.

Results

A total of 600 rural elderly individuals (300 depressed as case cases and 300 non-depressed as controls) participated in this case-control study. The study found no significant differences in gender and age between cases and controls. Females shared 54.0% of cases and 56.0% of controls while males shared 46.0% of cases and 44.0% of controls. Regarding marital status, the majority of the cases (61.7%) were single while the majority of the controls (76.0%) were married, and this difference was statistically significant ($p < 0.01$). In respect of social class (based on monthly family income), lower and middle class (having monthly family income $\leq 20,000$ BDT) was significantly ($p < 0.01$) higher in cases (81.3%) than in controls (50.7%) while upper class (having monthly family income $> 20,000$ BDT) was significantly higher in the controls (49.3%) than in the cases (18.7%). In respect of educational status, higher education (Graduation and above) was significantly ($p < 0.05$) higher in the controls (56.4%) than in the cases (43.6%). Concerning employment status, the majority of the cases (82.7%) were unemployed while the majority of the controls (60.7%) were employed and this difference was statistically significant ($p < 0.01$) [Table 1].

Table 1
Association between depression and baseline characteristics of elderly

Baseline Characteristic	Type of Participants		<i>p</i> -value
	Case; n (%)	Control; n (%)	
Age group (Years)			
60–69	154 (51.3)	198 (59.3)	0.233
70–79	86 (28.7)	82 (27.3)	
≥ 80	60 (20.0)	40 (13.3)	
Total	300 (100.0)	300 (100.0)	
Gender			
Male	138 (46.0)	132 (44.0)	0.481
Female	162 (54.0)	168 (56.0)	
Total	300 (100.0)	300 (100.0)	
Religion			
Islam	263 (88.0)	276 (92.0)	0.248
Hinduism	37 (12.0)	24 (8.0)	
Total	300 (100.0)	300 (100.0)	
Marital Status			
Single	184 (61.3)	72 (24.0)	0.001
Married	116 (38.7)	228 (76.0)	
Total	300 (100.0)	300 (100.0)	
Social Class (Based on monthly family income)			
Upper class (> 20,000 BDT)	56 (18.7)	148 (49.3)	0.001
Lower and Middle class (≤ 20,000 BDT)	244 (81.3)	152 (50.7)	
Total	300 (100.0)	300 (100.0)	
Educational status			
Illiterate	62 (20.7)	30 (10.0)	0.026
Non-institutional education	52 (17.3)	68 (22.7)	
n: number of observation; %: Percentage; S S.S.C.: Secondary School Certificate; H.S.C.: Higher Secondary School Certificate; Significance: Chi-square test, $p < 0.05$ with 95% CI			

Baseline Characteristic	Type of Participants		<i>p</i> -value
	Case; n (%)	Control; n (%)	
Between class 1–5	44 (14.7)	38 (12.7)	
Between class 6–10	54 (18.0)	32 (10.7)	
S.S.C	18 (6.0)	28 (9.3)	
H.S.C	36 (12.0)	60 (20.0)	
Graduation and above	34 (43.6)	44 (56.4)	
Total	300 (100.0)	300 (100.0)	
Employment Status			
Employed	52 (17.3)	182 (60.7)	0.001
Unemployed	248 (82.7)	118 (39.3)	
Total	300 (100.0)	300 (100.0)	
Family Type			
Nuclear family	224 (74.7)	228 (76.0)	0.789
Joint family	76 (25.3)	72 (24.0)	
Total	300 (100.0)	300 (100.0)	
n: number of observation; %: Percentage; S S.S.C.: Secondary School Certificate; H.S.C.: Higher Secondary School Certificate; Significance: Chi-square test, $p < 0.05$ with 95% CI			

Regarding the association between GD with selected personal characteristics, Pearson's chi-square test showed that the cases had significantly ($p < 0.05$) less peer group support than the controls (50.7% Vs. 64.0%). Active daily life was also significantly ($p < 0.01$) less prevalent in the cases than the controls (46.7% Vs. 64.7%). Having a poor diet was significantly ($p < 0.01$) higher in the cases than in the controls (37.3% Vs. 77.3%). Tobacco use (both smoking and smokeless tobacco) was significantly higher in the cases than in the controls (55.7% Vs. 37.3%). The study didn't find any significant differences in chronic diseases between cases and controls [Table 2].

Table 2
Association between depression and personal characteristics of elderly

Personal characteristic	Type of Participants		<i>p</i> -value (Chi-square test)
	Case; n (%)	Control; n (%)	
History of chronic disease			
Having history	176 (58.7)	146 (45.3)	0.132
No History	124 (41.3)	154 (54.7)	
Total	300 (100.0)	300 (100.0)	
Peer group support			
Yes	152 (50.7)	192 (64.0)	0.020
No	148 (49.3)	108 (36.0)	
Total	300 (100.0)	300 (100.0)	
Active in daily life			
Yes	140 (46.7)	194 (64.7)	0.002
No	160 (53.3)	106 (35.3)	
Total	300 (100.0)	300 (100.0)	
Tobacco use (Smoking and SLT)			
Yes	167 (55.7)	112 (37.3)	0.003
No	133 (44.3)	188 (62.7)	
Total	300 (100.0)	300 (100.0)	
Having a poor diet			
Yes	188 (62.7)	68 (22.7)	0.001
No	112 (37.3)	232 (77.3)	
Total	300 (100.0)	300 (100.0)	
n: number; %: Percent; Significance, $p < 0.05$ with 95% CI; SLT: Smokeless tobacco			

The study found a significant ($p < 0.01$) association between malnutrition and GD; where 56.0% of the cases and 18.0% of the controls had malnutrition. The study also found that 82.0% of the controls and 34.0% of the cases had no malnutrition [Table 3].

Table 3
Association between depression and malnutrition in rural elderly

Malnutrition	Type of participants		<i>p</i> -value
	Case; n (%)	Control; n (%)	
Yes	168 (56.0)	54 (18.0)	0.001
No	132 (44.0)	246 (82.0)	
Total	300 (100.0)	300 (100.0)	
n: number of observation; %: Percent; Significance: Pearson's Chi-square test, $p < 0.05$			

The logistic regression analysis showed that single elderly individuals were more likely to experience depression (AOR = 2.368; 95% CI: 1.762–6.524; $p = 0.001$). Concerning social class, the lower and middle classes were more likely to experience depression (AOR = 3.654; 95% CI: 2.266–7.767; $p = 0.001$). The malnourished rural elderly had more than three times higher [AOR = 3.155, 95% CI: 1.534–6.494, $p = 0.002$] risk of having depression than the well-nourished elderly individuals. Concerning social class, the lower and middle class were more likely to experience depression (AOR = 3.654; 95% CI: 2.266–7.767; $p = 0.001$). The unemployed elderly had around five times higher (AOR = 4.964; 95% CI: 2.361–10.440; $p = 0.001$) risk of having depression, and the elderly individuals having a poor diet had more than three times higher (AOR = 3.384; 95% CI: 1.764–6.703; $p = 0.001$) risks of having depression. The rural elderly tobacco users had more than two times higher risk of having depression (AOR = 2.332; 95% CI: 1.663–5.623; $p = 0.003$). The study also found a lower risk of depression among the elderly having SSC or below education in comparison to the elderly having HSC or above education [Table 4].

Table 4
Logistic regression analysis of the factors associated with depression in elderly

Associated factor	Adjusted Model		
	Adjusted odds ratio (AOR)	95% Confidence Interval (CI)	p-value
Marital status			
Married	Reference		0.001
Single	2.368	(1.762–6.524)	
Social class (Based on monthly family income)			
Upper class (> 20,000 BDT)	Reference		0.001
Lower and Middle class (\leq 20,000 BDT)	3.654	(2.266–7.767)	
Educational status			
H.S.C and above	Reference		0.023
S.S.C and below	0.730	(0.556–0.957)	
Employment status			
Employed	Reference		0.001
Unemployed	4.964	(2.361–10.440)	
Peer group support			
Yes	Reference		0.935
No	0.947	(0.484–1.807)	
Active in daily life			
Yes	Reference		0.266
No	1.465	(0.748–2.871)	
Having a poor diet			
Yes	3.438	(1.764–6.703)	0.001
No	Reference		
Tobacco use (Both smoking and SLT)			
Yes	2.332	(1.663–5.623)	0.003

SLT: Smokeless tobacco; S.S.C.: Secondary School Certificate; H.S.C.: Higher Secondary School Certificate; AOR: Adjusted odds ratio; CI: Confidence interval; Significance: $p < 0.05$ with 95% CI

Associated factor	Adjusted Model		
	Adjusted odds ratio (AOR)	95% Confidence Interval (CI)	p-value
No	Reference		
Malnutrition status			
Well-nourished	Reference		0.002
Mal-nourished	3.155	(1.534–6.491)	
SLT: Smokeless tobacco; S.S.C.: Secondary School Certificate; H.S.C.: Higher Secondary School Certificate; AOR: Adjusted odds ratio; CI: Confidence interval; Significance: $p < 0.05$ with 95% CI			

Discussion

Diverse literature depicts that the causal relationship between malnutrition and depression in the elderly is still inconclusive. Both malnutrition and depression are inherently related to each other; depression may lead to appetite loss and undernutrition, while malnutrition may denigrate depression and apathy [31]. We conducted this case-control study in the rural setting of Bangladesh to assess the association between malnutrition and depression, and associated risk factors. A study reported that elderly depressed people have a greater risk of psychological disorders, which provoke suicide and suicidal behaviors [32]. The existing health care delivery system in Bangladesh provides limited health care for the elderly population in urban communities, but it is scarce in rural settings. Accordingly, the rural elderly individuals do not get need-based health services within rural health facilities. Robust data on these health issues and other related risk factors are essential for devising an effective solution to reduce the occurrences of GD and malnutrition.

A comprehensive literature review revealed that relevant data on GD in association with malnutrition is not available in the context of rural Bangladesh. Consequently, the present case-control study investigated the malnutrition concerning GD and associated risk factors in rural elderly individuals of the country. The current study is a pioneering initiative using a community-based case-control design in the country to unmask the real picture on geriatric depression and malnutrition. The study conserves enormous academic and policy implications because the study attempted to determine the temporality of the association between malnutrition and geriatric depression in the rural setting.

The present study depicted that majority of the cases (51.3%) and controls (59.3%) were aged 60–69 years. Another study conducted among the rural residents of Narail Upazila of Bangladesh reported a similar finding where 58.7% of those aged 60–69 years were suffering depression as a psychological disorder [33] 36. Our study found single marital status (single elderly), lower education, unemployment, and less monthly income were significantly associated with GD. In the context of Bangladesh, the rural elderly population is mostly kept unemployed and dependent on other family members, which compel them to suffer from financial scarcity, lack of access to nutritious foods, healthy living, and need-based

health care. A study conducted by Haseen et al. reported that illiteracy and unemployment aggravated economic constraints and poverty, which sequentially contributed to malnutrition and the occurrence of geriatric depression [34].

The current study portrayed that cases (50.7%) had significantly ($p < 0.05$) less peer group support than the controls (64%). Another study conducted by Disu TR and colleagues found that among the elderly individuals having peer group support 31.3% were depressed (cases in the present study), and 68.7% were non-depressed (controls in the present study) [35]. In the local context of Bangladesh, rural elderly individuals have poor access to peer group support due to the prevailing social structure, community design, and lifestyles of local people. The rural elderly citizens of the country confront these social realities and suffer from loneliness, mental stress, and depression.

In the present study, cases (62.7%) had significantly ($p < 0.01$) higher poor diet than the controls (22.7%). It was depicted that the rural elderly individuals having a poor diet had more than three times higher risk of having depression. Another study found that among the elderly people having a poor diet, 77% were depressed (cases), and 22.6% were non-depressed (controls) [35]. It may be a result of variation in methodological factors such as the sample size (small vs. large), sampling (systematic random vs. convenience), study design (Case-control vs. cross-sectional), and study place (Rural vs. urban and rural both) between the current and former studies. It is also evident that poor diet intake invites malnutrition and consequently develops malnutrition in rural elderly populations.

Tobacco use was significantly ($p < 0.01$) higher in the cases (55.7%) than in the controls (37.3%). The study revealed that elderly people who were tobacco users had more than two times higher risk of having depression. The study of Disu and colleagues didn't find any significant difference, where among the smokers, 39.3% were depressed 60.7% were non-depressed elderly individuals [35]. It could be argued that in our study we assessed tobacco use considering both smoking and smokeless tobacco use while the other study considered smoking only. Moreover, variations in study design and places also contributed to the differences. It is evident that in the rural communities, elderly males use to do smoking while elderly females use to take smokeless tobacco in the forms of *Jarda, Gul, Sadapata, Nasshi, Khaini, etc* [36]. It is evident that tobacco stimulates the dopamine section from the pituitary gland of the human brain, which stimulates systemic functions and gradually produces diverse neurological disorders including depression in the elderly tobacco users.

Depression is associated with decreased energy, increased fatigue, loss of interest in daily activities, and less concentration on tasks or daily activities. In the present study, elderly individuals who engaged in sweat-producing activities like active in daily household activities and engaging in regular exercise etc. had lower levels of depression as have been found in previous studies [37, 38]. In the present study, the depressed elderly individuals (46.7%) were significantly ($p < 0.01$) less active in daily life in comparison to the controls (64.7%). In this regard, the study of Disu and colleagues found that 29.2% depressed and 70.8% non-depressed elderly people were active in daily life [35]. It could be explained by the fact that active involvement in such activities mediates the release of various bodily chemicals like endorphins,

norepinephrine, serotonin, etc., which help to prevent the occurrence of depression in elderly individuals [39].

Our study revealed that 56.0% of rural depressed elderly (cases) had malnutrition while it was 18% in the non-depressed elderly individuals (controls). The malnourished elderly individuals had more than three times higher risk of having depression. In this regard, another study depicted that depression is significantly affected by malnutrition, which is associated with the food-intake behavior of the elderly population [40]. The study carried out by German L and colleagues also found malnutrition remarkably higher in depressed than the non-depressed patients [41]. Since malnutrition has a significant effect on appetite and eating habits, it seems that having malnutrition could be a risk factor for geriatric people to be depressed. Furthermore, food insecurity might have an association with depression [40], particularly in the elderly [42], and taking a poor diet may lead to mood disorders, depression, and poor cognitive performance [43].

Given that rural elderly individuals are more likely to live in an extended family with financial paucity, poor diet, poor family and social support, and poor access to health care. As a result, they are more vulnerable to malnutrition, consequently suffer from mental stress and depression. Furthermore, studies indicate that diverse food elements like micronutrients, trace elements, and vitamins are related to the occurrence of different neurological complications including degenerative changes of the brain in late life, which could lead to depression [44, 45].

Strength And Limitations

The generalizability of findings in the current study is limited by the small sample size, the use of self-report, and the non-representative sample from three selected rural communities of a district. Those who said they had a current illness or sickness (excluding long-term chronic conditions) were excluded from the study. Therefore, the prevalence of malnutrition was likely to be lower in both cases and controls. The study also missed some relevant risk factors including chronic diseases, comorbidities, and psychosocial factors that may affect GD. Despite these limitations, the present community-based case-control study suggested crucial risk factors associated with depression in a country where there is a lack of available data. The study findings also preserve crucial policy inferences in devising effective interventions and health programs to ameliorate these major geriatric health disorders in the rural elderly population of the country and other developing countries.

Conclusion

The current study intended to identify the temporality of the relationship between malnutrition and GD. The study suggested a wide range of risk factors, where there is a lack of relevant data in the rural context of the country. The study findings would help to devise risk-reducing programs to ensure the physical and mental wellbeing of the rural elderly populations. The study also proposes mental health

education, awareness-raising programs as well as elderly nutritional interventions to reduce the burden of the malnutrition of GD.

Abbreviations

AOR: Adjusted Odds Ratio

CI: Confidence Interval

GD: Geriatric Depression

GDS-15: Geriatric Depression Scale-15

HSC: Higher Secondary School Certificate

IPHN: Institute of Public Health Nutrition

IRB: Institutional Review Board

MNA-SF: Mini-Nutritional Assessment-Short Form

MPH: Master of Public Health

NIPSOM: National Institute of Preventive and Social Medicine

SPSS: Statistical Package for Social Science

SSC: Secondary School Certificate

TK.: Taka (Currency of Bangladesh)

WHO: World Health Organization

Declarations

Availability of data and material:

Availability was only given to the participants for their information and specific members of the study. The datasets generated and/or analysed during the current study are not publicly available as the ethical vote did not include open data access but are available from the corresponding author on reasonable request.

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Authors' contributions

MZI: Contributed to study conception, study design, data acquisition, interpretation of data, preparation, and reviewing the manuscript. MZI had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. TRD: Contributed to study design, interpretation of data, preparing, and reviewing the manuscript. SF: Contributed to study design, data acquisition, data analysis, interpreting results, preparation, and reviewing the manuscript. MMR: Contributed to study design, data analysis, interpretation of results, and reviewing the manuscript. Each author has approved the submitted version of the manuscript and has agreed to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the authors were not personally involved, are appropriately investigated, resolved and the resolution documented in the literature.

Ethics declaration

We obtained ethical approval for the study from the Institutional Review Board (IRB) of the National Institute of Preventive and Social Medicine (NIPSOM), Mohakhali, Dhaka-1212, Bangladesh (Ref. No:

NIPSOM/IRB//2018/07, Date: 18.12.2018). Keeping compliance with Helsinki Declaration for medical research involving human subjects, we obtained informed consent (written or verbal) from every participant by explaining the study design, purpose, procedure, risk, and benefits before the interview. The participation was voluntary. We maintained privacy, anonymity, and confidentiality of data strictly.

Competing interests

The authors declare that they have no competing interests

Consent for publication

The manuscript does not contain any individual person's data in any form including any individual details, images or videos. So, we didn't obtain consent for publication from the elderly person.

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Figures

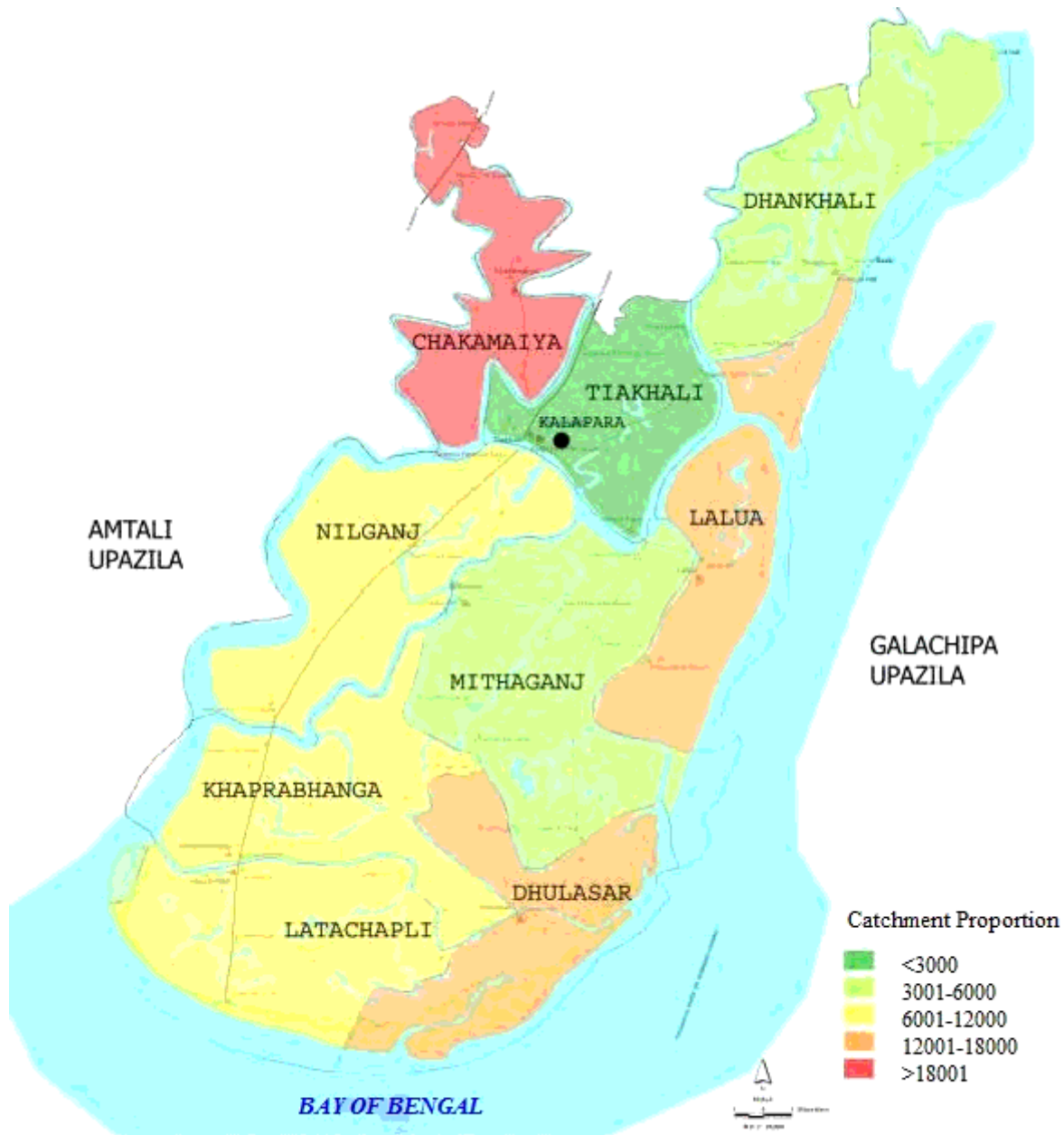


Figure 1

Study area with access to health facilities of southern rural region (Kalapara Upazila, Potuakhali district) of Bangladesh [11]. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.