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Hemoglobin and Nutritional Status among the Elderly in Selected Rural Area of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author TAIA designed the study, collected socio-economic data and blood samples (with the help of a trained medical technologist), transported the blood samples, performed the biochemical analyses in laboratory, wrote the protocol, managed the literature searches, aided in statistical analysis and also wrote the first draft of the manuscript. Authors MSH and IH performed and managed the statistical analysis, aided in obtaining anthropometric measurements, socio-economic data collection. Author MSA supervised the study. Author MA supervised the laboratory analysis and provided relevant logistics and instrumental supports in his laboratory. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To assess the hemoglobin levels and nutritional status of selected elderly people.
Study Design: Cross-sectional observational study.
Place and Duration of Study: Ushayer Hatra village, Mohanpur, Rajshahi, Bangladesh and Institute of Nutrition and Food Science, University of Dhaka, over an one month period.
Methodology: Sixty elderly participants (40 males, 20 females; age range 60-95 years) were included, all being non-hospitalized, non-smoker, non-alcoholic and no one having any history of recent major blood loss. Hb analysis was done by Cyanmethemoglobin method. Anthropometric measurements (height, weight and mid upper arm circumference) were taken following standard measurement guidelines of the World Health Organization. Socio-economic data were collected using a pre-tested questionnaire.

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Results: The mean (±SD) Hb content was higher in males than females (11.87 (±1.50) g/dL in males and 10.16 (±1.04) g/dL in females) and the difference was highly statistically significant (*P* < .0005). Low Hb levels (<13 g/dL in males and <12 g/dL in females) in 67.5% male and 95.0% female participants were observed. The mean BMI of males and females were 21.76 kg/m^2 and 22.58 kg/m^2 respectively. Fifty percent female and 57.5% male participants were in normal body weight (BMI=18.5-24.9 kg/m^2). The Mean value of MUAC were 27.13 cm in males and 25.14 cm in females. Based on MUAC, 90.0% male and 75.0% female participants had normal nutritional status (MUAC ≥ 23.5 cm in males and ≥ 22 cm in females). The association between BMI and MUAC categories of the participants were found to be statistically significant in both groups (*P* =.049 and .001 in male and female groups respectively).

Conclusion: Most of the study participants had low hemoglobin levels but normal nutritional status. However, further studies with considerable sample size are required to determine the prevalence of anemia and malnutrition among the elderly people of Bangladesh.

Keywords: Hemoglobin; Nutritional status; Malnutrition; Elderly; Anemia; Bangladesh.

ABBREVIATIONS

g : Gram
kg : Kilogram
mg : Milligram
mL : Milliliter
dL : Deciliter
m : Meter
nm : Nanometer
cm : Centimeter
km : Kilometer
Tk : Taka (currency of Bangladesh)

1. INTRODUCTION

Ageing is a natural physiological process that affects cells, tissue components and the systems of the human body [1]. In old age human becomes physiologically vulnerable and susceptible to malnutrition. Certain changes are also observed in blood counts during ageing. Research study found that age is significantly associated with both hemoglobin (Hb) counts and anemia [2]. Low Hb level is found to be prevalent among elderly people and it can be a potential indicator of adverse outcomes such as morbidity and mortality that affect the quality of life in older people [3]. In general, low Hb levels indicate anemia. One gram of Hb is able to carry 1.34 mL of oxygen per 10 mL of blood. The oxygen carrying capacity of the blood is directly proportional to the Hb concentration. In case of RBC (Red Blood Cell) count, it is found that some RBC contain more Hb than others [4]. Therefore, determination of blood Hb concentrations is necessary for assessing anemia and thus this indicator was used in the current study.

Malnutrition is not an inevitable consequence of ageing, but certain changes associated with the process of ageing can promote malnutrition. For the purpose of this research paper, malnutrition was referred to as undernutrition. Undernutrition may occur due to lack of one or more nutrients and it is also influenced by medical, social or psychological factors [5]. Undernutrition in the elderly can be observed by certain characteristics like declination of fat-free mass (FFM) and skeletal muscles. A general agreement supports the increase of body fat mass up to about 75 years of age and later on decreasing or remaining stable. Muscle, skin, bone and organ tissue are considered as FFM. FFM tends to decline with age, starting at an earlier age than fat mass loss, around 40-50 years. Another consequence of aging is loss of skeletal muscle and dysfunction. Such kind of muscle loss can occur due to lack of physical activity, anorexia and low calorie and protein intake, inflammation and other age-related factors. [5]. A study conducted in rural area of Bangladesh displayed that 26.0% of elderly population were malnourished and 62.0% were at risk of malnutrition [6].

MUAC (Mid Upper Arm Circumference) being easy to measure and highly correlating with BMI (Body Mass Index), can be used conveniently to assess skeletal muscle loss as a form of undernutrition in elderly subjects. MUAC provides estimates of the protein reserves of the body, and hence protein nutritional status [7]. Therefore, BMI and MUAC measurements are likely to determine both voluntary and involuntary muscle loss as a form of malnutrition in the elderly.

In Bangladesh, there are several studies regarding anemia and iron deficiency that include different age and sex groups such as pregnant

women [8], children [9], university students [10], and adolescent girls [11]. However, none of them includes the geriatric (60+ years) age group. In 2020, population aged 60+ years in Bangladesh was 13.1 million people [12]. Despite the number of the elderly population of Bangladesh being considerable in size and somewhat vulnerable to nutritional deficiency and anemia, there seems to be no such study to their concern. To our knowledge, this is the first study to explore the low Hb status (anemia) and nutritional status of the elderly population in rural area of Bangladesh.

The present study was undertaken with the primary objective to study Hb levels and nutritional status by means of the anthropometric measurements such as BMI and MUAC. The secondary objectives were to find the prevalence of low hemoglobin level (an indicator of anemia) in male and female participants and to observe the differences between the sex groups and also to find out an association between BMI and MUAC categories in each group.

2. METHODOLOGY

2.1 Study Area

The study was conducted at Ushayer Hatra village which is located at Mohanpur upazilla in Rajshahi district. Rajshahi is located in the west-central region of Bangladesh.

2.2 Criteria for Selection

The study area was selected considering the availability of elderly people and the convenience of the researchers to carry out the study. House-to-house survey was conducted to identify elderly. A total of 60 elderly persons (40 males and 20 females) were selected from separate households by simple random sampling in July, 2019 considering the available resources and agreement of the participants. The sample population was selected irrespective of religion, ethnicity, occupation, and educational and cultural background. All the participants were of 60 years of age or older and each of them was non-smoker, non-alcoholic and non-hospitalized. None of them had any recent history with major blood loss due to illness, surgery or any other cause. No participants used to take iron supplements. Before interviewing and data collection, it was made sure that all the participants were able to stand on their own.

2.3 Collection of Data

The selected participants were interviewed by a pre-tested questionnaire. Both qualitative and quantitative data were collected by: (a) interviewing (b) anthropometric measurements (c) observation (d) blood sample collection and laboratory analyses.

2.4 Collection and Analyses of Blood Samples

Blood sample (5 mL) was drawn aseptically by venipuncture preferably from antecubital vein using a sterile needle and syringe with the help of a trained medical technologist and collected in ethylenediaminetetraacetic acid (EDTA) tubes. The blood sample in the EDTA tube was mixed thoroughly and was instantly stored in dry ice containing thermocol boxes. Then they were transported ensuring safety precautions by a train of Bangladesh Railway to a laboratory situated in Dhaka, which is located approximately 275 km away from the field area. The journey took a total of 6.5 hours. The blood samples in the laboratory were stored at -80°C until analysis. All the samples were analyzed within 72 hours of collection.

The biochemical analysis was performed in the laboratory of the Institute of Nutrition and Food Science, University of Dhaka, Dhaka, Bangladesh. Strict quality control measures were ensured. For this purpose, hemoglobin standard with every batch of samples was established.

Measurement of Hb was done by direct Cyanmethemoglobin method [13]. In this method, 5 mL of Drabkin's solution was taken in a test tube. Twenty microliter of whole blood sample was pipetted from the EDTA tube and then added to the Drabkin's solution. The tubes were vortexed for 60 seconds and kept for 15 minutes. The absorbance was taken from the spectrophotometer at 540 nm wavelength against the reagent blank. The absorbance of the pure stock hemoglobin standard was also recorded for each run. The Hb value was derived from the following formula:

Hb (gm/dL) = [Absorbance of test sample ÷ Absorbance of standard] x concentration of standard x [Dilution factor ÷ 100]

Hb levels <13 g/dL in males and <12 g/dL in females were considered as low hemoglobin status.

2.5 Anthropometric Measurements

Anthropometric measurements i.e., height, weight, MUAC were measured as per the standard measurement guidelines of the World Health Organization (WHO) [14]. All the measurements were performed by two of the authors. The instruments were only used in the field after calibration by experts among five non-diseased adult individuals.

Height and weight were measured twice and the average value was considered for analysis. MUAC was measured for both arms and the average of left and right side measurements was considered for analysis. Elderly participants were identified as underweight if BMI (measured as BMI = Weight in kg/(Height in m)^2) was <18.5 kg/m^2 and undernourished if MUAC was <23.5 cm in males <22 cm in females. Socio-economic information i.e., family income, family expenditure on food, individual dietary diversity score, educational status and information about physical activity level were collected using a pre-tested questionnaire by interviewing.

2.6 Statistical Analyses

Statistical analyses including descriptive statistics (frequency, percentage, mean, median, standard deviation), Independent Samples t Test, Mann-Whitney U test and Fisher's Exact Chi square Test were performed using SPSS software (version 22.0). $P < .05$ was considered as statistically significant.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics

All the male (40) and female (20) participants of this study were chosen from separate households. Results for the socio-economic characteristics of the study participants are presented in Table 1a and 1b. The mean age, monthly family income, expenditure on food and daily dietary diversity score were higher in males than females (Table 1a).

Majority of the participants were illiterate i.e., did not receive institutional education (70.0% males and 95.0% females). Half of the male participants had a medium level of family income (10000-20000 Tk/month) but most of the female participants (90.0%) had a low level of family income (< 10000 Tk/month). Majority of both male and female participants had a low level of family expenditure on food (< 5000 Tk/month), the percent being about 2 times higher in females than males (85.0% in females and 45.0% in males). Most of the participants were found to have a high level of dietary diversity score (≥ 6 food groups/day), the percent being about 1.5 times higher in males than females (95.0% in males and 65.0% in females). Half of the female and two-fifths of the male participants had a light physical activity level (Table 1b).

3.2 Anthropometric and Biochemical Measurements

The comparative results for the biochemical (Hb) and anthropometric (BMI, MUAC) measurements of the study participants are presented in Table 2. The mean (±SD) Hb content was higher in males than females (11.87 (±1.50) g/dL in males and 10.16 (±1.04) g/dL in females) and the difference was statistically significant ($P < .0005$). The mean (±SD) BMI was higher in females than males (22.58 (±4.64) kg/m^2 in females and 21.76 (±3.75) kg/m^2 in males) and the difference was not statistically significant ($P = .316$). The mean (±SD) MUAC was higher in males than females (27.13 (±3.24) cm in males and 25.14 (±4.38) cm in females) and the difference was found to be statistically significant ($P = .051$).

The findings on Hb status and nutritional status (based on BMI and MUAC) are presented in Table 3. In terms of Hb status, majority of the participants were found to have low Hb level (<13 g/dL in males and <12 g/dL in females), the percentage being higher in females than males (95.0% and 67.5% respectively). In terms of nutritional status based on BMI, three-fifths of the males and more than one-half of the females (55.0%) were identified to have normal weight (BMI 18.5-24.9 kg/m^2), one-fifth of both males and females were underweight (BMI < 18.5 kg/m^2), one-fifth of the males and one-fourth of the females were overweight (BMI ≥ 25.0 kg/m^2). In terms of nutritional status based on MUAC, majority of the male participants (90.0%) and three-fourths of the female participants were in normal nutritional status (MUAC ≥ 23.5 cm in males and ≥ 22 cm in females).

The associations between BMI and MUAC categories of the participants are presented in Table 4a and 4b. More than one-half of the male participants (57.5%) and one-half of the female participants with normal health based on MUAC (≥ 23.5 cm in males and ≥ 22 cm in females) were found to have normal weight based on BMI

(18.5-24.9 kg/m^2). These associations were found to be statistically significant in both groups (P = .049 and .001 in male and female groups respectively).

Table 1a. Descriptive statistics of socio-economic characteristics of the study people

Variables	Mean±SD (Range)	
	Male (40)	Female (20)
Age (Years)	69.00±9.78 (60.00-95.00)	68.45±9.00 (60.00-87.00)
Family income (Taka/month)	12245.00±5349.67 (4500.00-25000.00)	7810.00±2082.23 (4800.00-12000.00)
Family expenditure on food (Taka/month)	6327.50±2574.13 (2500.00-13000.00)	4055±1126.00 (2400.00-6500.00)
Daily dietary diversity score of the participants	7.28±1.11 (5.00-9.00)	6.15±1.18 (5.00-9.00)

SD: standard deviation

Table 1b. Category wise distribution of socio-economic characteristics of the study people

Variables	Categories	Frequency (%)	
		Male (40)	Female (20)
Educational status	Received institutional education	12 (30.0%)	1 (5.0%)
	Illiterate	28 (70.0%)	19 (95.0%)
Family income (Taka/month)	Low (< 10000 Tk)	17 (42.5%)	18 (90.0%)
	Medium (10000-20000 Tk)	20 (50.0%)	2 (10.0%)
	High (> 20000 Tk)	3 (7.5%)	0 (0.0%)
Family expenditure on food (Taka/month)	Low (< 5000 Tk)	18 (45.0%)	17 (85.0%)
	Medium (5000-8000 Tk)	15 (37.5%)	2 (10.0%)
	High (> 8000 Tk)	7 (17.5%)	1 (5.0%)
Daily dietary diversity score of the participants	Low (≤ 3 food groups/day)	0 (0.0%)	0 (0.0%)
	Medium (4-5 food groups/day)	2 (5.0%)	7 (35.0%)
	High (≥ 6 food groups/day)	38 (95.0%)	13 (65.0%)
Physical activity level	Sedentary	15 (37.5%)	8 (40.0%)
	Light	16 (40.0%)	10 (50.0%)
	Moderate	9 (22.5%)	2 (10.0%)

Table 2. Difference between male and female groups based on Hb, BMI and MUAC

Variables	Sex (n)	Mean±SD (95% CI)	Median	Range	*P* value
Hb (g/dL)	Male (40)	11.87±1.50 (11.39, 12.35)	12.15	9.40-14.90	
	Female (20)	10.16±1.04 (9.67, 10.65)	10.10	8.90-12.80	.000[a]
BMI (kg/m^2)	Male (40)	21.76±3.75 (20.56, 22.96)	20.93	16.38-33.08	
	Female (20)	22.58±4.64 (20.41, 24.76)	22.32	14.46-33.46	.316[a]
MUAC (cm)	Male (40)	27.13±3.24 (26.10, 28.17)	26.60	21.40-34.00	
	Female (20)	25.14±4.38 (23.09, 27.19	24.90	18.80-35.80	.051[b]

n: number of samples; SD: standard deviation; CI: confidence interval. [a]calculated from Mann-Whitney U Test; [b]calculated from Independent Samples t Test

Table 3. Hb and nutritional status of the study people

Sex (n)	Hb and nutritional Status	Frequency (%)
Male (40)	Low Hb status (Hb < 13 g/dL)	27 (67.5%)
	Normal Hb status (Hb ≥ 13 g/dL)	13 (32.5%)
	Underweight (BMI < 18.5 kg/m^2)	8 (20.0%)
	Normal weight (BMI 18.5-24.9 kg/m^2)	24 (60.0%)
	Overweight (BMI ≥ 25.0 kg/m^2)	8 (20.0%)
	Undernourished (MUAC < 23.5 cm)	4 (10.0%)
	Normal (MUAC ≥ 23.5 cm)	36 (90.0%)
Female (20)	Low Hb status (Hb < 12 g/dL)	19 (95.0%)
	Normal Hb status (Hb ≥ 12 g/dL)	1 (5.0%)
	Underweight (BMI < 18.5 kg/m^2)	4 (20.0%)
	Normal weight (BMI 18.5-24.9 kg/m^2)	11 (55.0%)
	Overweight (BMI ≥ 25.0 kg/m^2)	5 (25.0%)
	Undernourished (MUAC < 22 cm)	5 (25.0%)
	Normal (MUAC ≥ 22 cm)	15 (75.0%)

Table 4a. Association between BMI and MUAC categories of male participants (n=40)

BMI categories	MUAC categories		*P* value
	Undernourished (< 23.5 cm)	Normal Nutritional Status (≥ 23.5 cm)	
Underweight (< 18.5 kg/m^2)	3 (7.5%)	5 (12.5%)	.049*
Normal weight (18.5-24.9 kg/m^2)	1 (2.5%)	23 (57.5%)	
Overweight (≥ 25 kg/m^2)	0 (0.0%)	8 (20.0%)	

*P < .05 was considered as statistically significant. *calculated from Fisher's Exact Chi square Test*

Table 4b. Association between BMI and MUAC categories of female participants (n=20)

BMI categories	MUAC categories		*P* value
	Undernourished (< 22 cm)	Normal Nutritional Status (≥ 22 cm)	
Underweight (< 18.5 kg/m^2)	4 (20.0%)	0 (0.0%)	.001*
Normal weight (18.5-24.9 kg/m^2)	1 (5.0%)	10 (50.0%)	
Overweight (≥ 25 kg/m^2)	0 (0.0%)	5 (25.0%)	

*P < .05 was considered as statistically significant. *calculated from Fisher's Exact Chi square Test*

3.3 Discussion

Anemia among the geriatric age group can be a common concern that affects the quality of life to a great extent [15]. Incidence of anemia in this age group is observed to be several times higher than it is suspected clinically and it also rises as the age increases [16].

In the current study, 67.5% males and almost all the females (95.0%) were found to be anemic according to the WHO criteria for anemia (based by Hb level). This difference in the prevalence of anemia between the two sex groups could be explained by the difference in dietary and socioeconomic pattern. In a research carried out in Minnesota, U.S also found an analogous finding to our study which shows that prevalence of anemia in the elderly is higher in males than that of females [16].

India is a neighboring country of Bangladesh and Indian people share the similar race and food habits with Bangladeshis. A study carried out at

a community-dwelling elderly of Assam, India (The age group included and the criteria for defining anemia is similar to our study) shows a 45.5% prevalence of anemia among the elderly participants [17]. This finding is contradictory to ours as in our study the prevalence of anemia would be relatively much higher considering the prevalence of anemia in each sex groups. However, some participants of that study used to take iron supplements and iron supplementation was found to have a significant association with the status of anemia. While in our study, participants involved in iron supplementation were excluded. This could be an explanation for the difference between the prevalence of anemia in these two studies.

In the present study, anemia was seen to be prevalent in the rural elderly participants even though the daily individual dietary diversity scores of 95.0% male and 65.0% female participants were high i.e., ≥ 6 food groups/day, which can conclude that in some cases, daily consumption of foods from a diversified groups might not necessarily prevent anemia in the elderly.

Malnutrition in the elderly can serve both as a cause and as consequence of ill health [18]. Moreover, It can lead to numerous health problems including muscle weakness, weak immune response and risk of infections [19]. Due to available resources and convenience, in our study BMI and MUAC were used as indicators to assess the undernutrition among the selected geriatric participants. The present study shows a prevalence of 10.0% undernourishment in male and 25.0% in female participants based on MUAC. Furthermore, in terms of BMI 20.0% male and 20.0% female participants were found to be underweight. A study conducted by Ferdous et al. in rural area of Bangladesh showed that 26.0% of elderly population were malnourished and 62.0% were at risk of malnutrition [6]. Another study carried out in elderly home care population in Bangladesh shows a prevalence of 25.5% malnutrition among the elderly participants but unlike in our study the prevalence was higher in males (28.5%) when compared to females (22.5%) [20]. The findings of these two studies with almost similar settings are somewhat concurrent to our findings.

The reason BMI and MUAC category of most of the study participants of the present study (irrespective of gender) being normal could be the existing high individual dietary diversity scores of the participants. Therefore, diet could be a possible indicator for determining the nutritional status in terms of BMI and MUAC of the elderly population.

4. CONCLUSION AND RECOMMENDATION

Majority of the participants were found to be anemic in terms of the WHO standards of Hb level but had normal nutritional status in terms of BMI and MUAC. The prevalence of anemia of the particular age group should not be neglected. Given the rising numbers of older adults in Bangladesh, more attention should be given to the geriatric people for the detection and management of anemia. Therefore, further studies with a considerable sample size are required as the current study only reflects the condition of the elderly of a selected area.

5. LIMITATIONS OF THE STUDY

Considering the available budget and resources, the current study was a cross-sectional observational study which was conducted with a very small sample size and hence the findings of this study are not nationally representative for the geriatric age group.

CONSENT AND ETHICAL APPROVAL

Blood samples of the study subjects were collected from selected area by an expert medical technologist under the permission of the ethical clearance committee of the Faculty of Biological Sciences, University of Dhaka. Informed consent was also obtained from the study participants after the purpose and importance of the study were explained. The questionnaire was designed considering the privacy of the participants. Personal information was kept confidential by linking the data of each participant to a code number.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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