Association Between Health Literacy and BMI: A Cross-Sectional Study of Suburban Adult Population in Bangladesh

Md. Karimul Islam[1], Nishad Nasrin[1]*, Abu Jaber[1], and Md. Tanvir Hossain[2]

[1] Economics Discipline, Social Science School, Khulna University, Bangladesh
[2] Sociology Discipline, Social Science School, Khulna University, Bangladesh
* Nishad Nasrin, corresponding author. Email: nishad.nasrin@ku.ac.bd
Submitted: 23 June 2021, Accepted: 8 November 2021, Published: 21 January 2022
Volume 30, 2022. pp. 288-308. http://doi.org/10.25133/JPSSv302022.018

Abstract

Bangladesh is experiencing heightened incidences of obesity among its urban population. This study investigated the relationship between health literacy and body mass index (BMI) among the suburban adult population in the southwestern region of Bangladesh. Data were collected from 196 random participants. Inferential statistics and multinomial logistic regression were used to analyze the data. The BMI was calculated using the World Health Organization standard, and a health literacy index was constructed using the principal component analysis. Results obtained from the relative risk ratio suggested that a higher level of health literacy directly correlates with a reduction of the obesity, overweight, and underweight categories. The health literacy indicators, including healthy behavior (0.38, p<0.01), nutrition knowledge (0.47, p<0.10), and preventive care knowledge (0.47, p<0.05), significantly influenced BMI. Furthermore, years of schooling have a substantial negative effect on the underweight category (0.71, p<0.01). The government should launch health literacy campaigns at all levels of education and promote the campaigns through social and mass media. A longitudinal study on nationally representative samples should be carried out to assess the impact of health literacy campaigns on the overall health and well-being of the Bangladeshi population.

Keywords

Adults; Bangladesh; body mass index; health literacy; suburban

Introduction

Bangladesh has made remarkable headway in the health sector over the last two decades. The average life expectancy (ALE) of its population has increased by around 25 years, from about 47 years in 1971 to over 72 years in 2018 (World Bank, 2021). Such improvement was achieved through reducing birth and mortality rates and overcoming other associated issues, including literacy, life satisfaction, and controlled health behavior (Khan & Awan, 2017; Tareque et al., 2015). Nevertheless, other health conditions, including infectious diseases, diarrheal diseases, malnutrition (Ahmed et al., 2016; Muhammad et al., 2016), and anemia (Bashar et al., 2020; Rahman et al., 2019), are still the most common health issues in Bangladesh. A persistent disparity in healthcare between urban and rural areas (Islam & Ullah, 2009) and between rich and poor (Khullar & Chokshi, 2018; Woolf et al., 2015) are considered the major reasons behind existing poor health conditions.

Bangladesh faces a growing challenge in combating obesity and overweight problems among children and adolescents (Biswas, Garnett, et al., 2017). Likewise, obesity, overweight, and underweight statuses are also predominant among the adult population (Biswas, Islam, et al., 2017). It is important to note that BMI-related issues are the key factors behind the heightened prevalence of non-communicable diseases, such as diabetes and high blood pressure among the Bangladeshi people (Alam et al., 2016; Muhammad et al., 2016).

In the recent past, studies in Bangladesh noted a significant rise in obesity, especially in urban areas (Hossain et al., 2021; Tanwi et al., 2019). Evidence suggests that unhealthy eating habits, minimum or no physical activity, and sedentary pursuits, i.e., watching television, playing online games, or sharing screens, are common elements of increasing obesity and overweight (Ishaque et al., 2012; Rachmi et al., 2017; Steyn et al., 2011). Obesity or high BMI is also reportedly linked to a higher prevalence of disease in Bangladesh (GBD 2015 Obesity Collaborators, 2017). Obesity and overweight fueled by the economic growth effect such as rapid urbanization and high-calorie diet, are deleterious to chronic disease prevention and responsible for increasing higher morbidity and mortality worldwide (Hruby & Hu, 2015). Apart from sedentary health behaviors, existing literature indicates that a low level of health literacy is another vital predictor of obesity (Lam & Yang, 2014; Michou et al., 2018; Shih et al., 2016). Over the past few decades, public health researchers have attempted to sketch the relationship between health status, e.g., obesity, underweight, and overweight, with health literacy (Cheng et al., 2018; Eltayeb et al., 2016; Rachmi et al., 2017; Steyn et al., 2011).

Health literacy generally refers to the motivation, knowledge, competencies, understanding of health-related information, and applying that information for healthcare, health promotion, and disease prevention purposes (Sørensen et al., 2012). Health literacy is considered a necessary precondition for improving health status (Islam & Ullah, 2009). Numerous studies found a direct and indirect connection between health literacy and weight statuses (Islam & Ullah, 2009). For example, Eltayeb et al. (2016) deduced that overweight and obesity are associated with poor health literacy. Other studies also found significant positive and negative associations between health literacy and obesity (Chari et al., 2014; Cheng et al., 2018). Lam and Yang (2014) emphasized improving health literacy to reduce overweight and obesity problems. Researchers have also advocated the identification of the nature and extent of health literacy for public health policy interventions to achieve better health outcomes (Enomoto et al., 2020; Sentell et al., 2011).

Considering the absence of scholarly works on the linkage between health literacy and imbalanced body weights in Bangladesh, this study was designed to investigate the relationship between health literacy and BMI status, i.e., obesity, overweight, and underweight, in the suburban areas. More precisely, this study examines whether any systematic pattern or relationship exists between health literacy and BMI among the suburban adult population in Bangladesh.

Methods

Study sites

This study was conducted in the Khulna district, a southwestern regional hub of Bangladesh. Khulna is one of the least dense and progressive districts of Bangladesh with the seventh-highest literacy rate of around 60% and eighth-most urbanized areas of Bangladesh, housing over 2 million people in approximately 4,394 Km^2 area (Bangladesh Bureau of Statistics, 2015a, 2015b, 2015c, 2015d). The Khulna district consists of nine *upazilas* [sub-districts] (Bangladesh Bureau of Statistics, 2015a). For this study, four upazilas, i.e., Dumuria, Paikgachha, Terokhada, and Batiaghata, were selected randomly from within the Khulna district.

Participants and sampling

This study carried out a multistage random sampling procedure to collect data from the respondents. In the first stage, the primary sampling unit (PSU) was upazilas, the urban and suburban areas of Khulna city. After randomly selecting four upazilas as the PSUs, two wards from each selected PSU were drawn randomly as secondary sampling units (SSUs) in the second stage. In the final stage, a door-to-door census was conducted to initially select 80 participants from each ward based on the information provided by the local Ward Commissioner. These participants were the ultimate sampling unit (USU). It is important to note that the survey in the final stage followed a systematic random sampling technique where every fifteenth participant in a row of residents was selected. When the invited participant (the household head) refused to participate in the interview, the data collection team selected the following immediate household head.

The participants were selected based on certain specifications: the participants (i) must be a household head, (ii) living in the selected suburban area, and (iii) must have been living in the suburban area for over five years. Based on the criteria mentioned above, 196 out of the 240 household heads participated in face-to-face interview sessions. Starting from early February in 2019, the data collection lasted for six months and was held once a week – at the weekend only. The study interviewed the household head because other members might not provide their family members' accurate and credible health records.

Ethical issues

The Khulna University Ethical Clearance Committee of Bangladesh approved the study (Reference No. – KUECC – 2021/04/18). The participants responded to the interview by filling out an informed consent letter in the first section of the interview schedule. In the consent form, all the participants were provided with detailed information concerning the research

purpose, the confidentiality of information, and the right to revoke participation without prior justification.

Interview schedule

An interview schedule in English was developed for this study after an intensive review of relevant literature. The interview schedule contains three interrelated but distinct sections. Section One consists of the socio-demographic information. Section Two pertains to information regarding the measurement of BMIs of the participants. The final section includes 53 two-point Thurstone-scale items divided into six mutually inclusive sub-sections focusing on health literacy issues: eight items on 'nutrition knowledge,' 10 items on 'disease knowledge,' nine items on 'preventive care knowledge,' eight items on 'healthy behavior knowledge,' 10 items on 'sanitation knowledge,' and eight items on 'compliance knowledge.'

Measures

Socio-demographic information

In this study, specific socio-demographic characteristics were considered to understand their interplay with BMI, for example, age (Eltayeb et al., 2016; Lassetter et al., 2015), gender (Frederick et al., 2014), income (Eltayeb et al., 2016; Frederick et al., 2014; Lassetter et al., 2015), and education (D. Nakamura et al., 2018).

Health literacy

Health literacy has not been unequivocally defined yet (Altin et al., 2014), although many have used the definition and concepts relying on former studies (Sørensen et al., 2012). For instance, Nutbeam (2000) defined health literacy as individual, cognitive, and social skills that influence an adult's capacity to obtain, interpret, and use knowledge to promote and sustain good health. Similarly, Arabin et al. (2019) and Tian et al. (2020) described health literacy as an individual's ability to obtain, evaluate, comprehend, and utilize health-related information and services. The purview of health literacy also includes public health decisions (Freedman et al., 2009; O' Neill et al., 2014).

Sørensen et al. (2012) included the major components of health literacy from both medical and public health literacy perspectives. Public health literacy generally considers three domains, i.e., health care, disease prevention, and health promotion. The three domains are practically met by access, understanding, appraising, and using information related to health. Therefore, health literacy is determined by environmental factors such as culture, demographic condition, language; socio-political system; personal characteristics such as gender, age, education, occupation, and income; and situational factors such as social support, influence by peers, family members and media.

Many scholars such as Cho et al. (2008) and Mirowsky and Ross (2003) emphasized health literacy related to health outcomes. Under such findings, we added some crucial composites in the health literacy components like knowledge on health behaviors (Feinstein, 1993), preventive health care (Abdulraheem et al., 2012; Cho et al., 2008), and knowledge on nutrition (Kumar et al., 2005).

This study considered six indicators while building a framework of health literacy. The indicators were classified into nutrition, general health, preventive care, healthy behavior, sanitation, and compliance knowledge. Each indicator consists of a set of dichotomous questions (0=No, 1=Yes) considering three main dimensions of health literacy, i.e., health care, disease prevention, and health promotion (see Appendix, Table II). The instruments gather self-reported data, and they represent a multidimensional construct of health literacy incorporating the functional, comprehensive, and critical aspects (Altin et al., 2014). The functional aspect focus on the common practice of the participants in maintaining healthy behavior, preventive care, sanitation, and nutritional requirements. After a factor score for each indicator was produced through principal component analysis, a reliability test was conducted for the health literacy instrument. The overall Cronbach's alpha of health literacy was 0.934, suggesting that the instruments be reliable and consistent (see Appendix, Table I).

Body mass index

Body mass index (BMI) has long been used to measure body weight (Nuttall, 2015). In this study, the BMI value was determined by Equation (1) (Bleich et al., 2012). The World Health Organization classified the BMI into four bodyweight categories: i.e., underweight (below 18.5), healthy weight (18.5-24.9), overweight (25-29.9), and obesity (30 or above) (Hughes & Kumari, 2017).

$$Body\ Mass\ Index\ (BMI) = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}} \quad (1)$$

The participants were asked about their weight and height, and the associated obtained data were self-reported. While the weight data were collected in kilograms, height data were collected in feet but converted into meters during data input.

Analytical framework

Data were analyzed in three consecutive phases by STATA, version 13. Firstly, we executed principal component analysis (PCA) to construct the health literacy indicators. Secondly, the study relied upon a one-way between-groups analysis of variance (ANOVA) to trace the variations among different BMI groups regarding health literacy. Finally, multinomial logistic regression was performed to determine the association between BMI and health literacy indicators along with socio-demographic variables.

Principal component analysis

Principal component analysis (PCA) produces a factor score for the response of each participant based on the components of health literacy. We obtained the factor score by summing up the PCA variables multiplied by their weight. Equation (2) demonstrates the reflection of these core components. The sub-components, treated formally to obtain scores for each head, construct the core components. The values generated after running the PCA considering different aspects of health literacy formed six dimensions (see Appendix, Table I for details).

$$PC_i = b_1X_1 + b_2X_2 + \cdots\cdots\cdots + b_nX_n \quad (2)$$

Multinomial logistic regression

Equation (3) and Equation (4) demonstrate the multinomial logistic regression model where Y_i refers to the dependent variable, i.e., BMI. The variable was decomposed into four categories (j=4) based on the BMI value. According to the BMI, the categories of this variable were underweight, healthy weight, overweight and obese. In this study, the base category is the healthy weight, and it remains as the reference class while interpreting the coefficients. P_{ij} denotes the probability value of BMI categories under the dependent variable. The probability can be calculated as:

$$P_r(y_i = j \mid x_i = P_{ij} = \frac{exp(x_i\beta_i)}{1+\sum_{j=4}^{j-1} exp(x_i\beta_j)} \quad (3)$$

For the base category,

$$P_r(y = 0 \mid x_i = P_{ij} = \frac{1}{1+\sum_{j=4}^{j-1} exp(x_i\beta_j)} \quad (4)$$

In Equations (3) and (4), X_i denotes the vector of explanatory variables. B_i is the coefficient on all those variables. Before executing multinomial regression, the study checked multicollinearity and heteroskedasticity among variables by performing diagnostic tests such as variance inflation factor (VIF) and white test, respectively. The tests confirm that there is no multicollinearity and heteroskedasticity.

Results

Socio-demographic and health literacy statistics

Table 1 presents the descriptive statistics for socio-demographic and health literacy regarding the four weight categories to compare the sample statistics. Table 1 also demonstrates the ANOVA data, showing the differences in the mean value of variables for the weight categories.

Of the 196 participants, around 56% had balanced weight. The average age for the healthy weight category was 41 years, compared to 42 years for the overweight, 54 years for the obese, and 37 years for the underweight, and the mean age varied statistically among the weight categories (F [3] = 23.98, p<0.001; η^2 = 0.272). The Chi-square value also indicated that the four weight categories had a significant age difference, meaning a steady increase in weight gain as people became older. From the variance outcome of participant income, a similar inference can be drawn. The weight of the participants increased in direct proportion to their average income. Precisely, the higher the level of average income, the greater the weight of the participants (F [3] = 23.67, p<0.001; η^2 = 0.270).

Surprisingly, the mean difference in the value of all socio-demographic and health literacy variables varied significantly among the participants. This difference indicates that the average value of each variable varied from one weight category to the next. For instance, the category with a higher degree of health literacy retained a healthy weight. Conversely, the average extent of health literacy was lower for the rest weight groups, and the variations were

statistically significant. For instance, the level of nutrition knowledge was not identical for the four weight classes (F [3] = 24.22, p<0.001; η^2 = 0.274). As a result, it is reasonable to assume that the higher the health awareness of an individual, the greater the chance of maintaining a healthy weight.

Table 1: Socio-Demographic, BMI, and Health Literacy

Variables / Sources	Descriptive Statistics								ANOVA				
	Underweight (n=6.12%)		Healthy Weight (n=56.12%)		Overweight (n=16.33%)		Obesity (n=21.43%)		Variance Test with df=3				
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*SS*	*F*	*p-value*	χ^2	η^2
Age	37.25	4.02	40.95	8.82	42.03	7.78	54.24	11.79	6,081.14	23.98	0.000	16.94	0.272
Years of Schooling	1.58	2.06	5.75	3.58	6.28	4.27	3.98	3.80	291.10	7.16	0.000	6.85	0.101
Monthly Income[1]	7,417	2,376	13,177	4,700	14,409	4,762	19,190	5,959	1.712	23.67	0.000	11.33	0.270
Health Literacy[2]													
Nutrition knowledge	1.58	1.44	4.44	2.06	2.94	1.10	2.02	0.94	244.05	24.22	0.000	28.16	0.274
Disease knowledge	2.33	2.74	4.22	1.97	3.47	1.64	2.23	1.30	140.69	13.69	0.000	13.97	0.176
Preventive care knowledge	5.42	2.43	6.65	2.08	6.16	2.21	3.45	2.37	317.60	22.08	0.000	1.31	0.256
Health-behavior knowledge	3.17	1.03	6.74	1.74	4.03	2.05	3.24	1.59	514.32	57.03	0.000	6.83	0.471
Sanitation knowledge	4.42	2.43	7.67	1.84	6.47	2.69	5.14	2.16	269.96	20.32	0.000	8.33	0.241
Compliance knowledge	2.67	1.67	4.94	2.04	4.78	2.48	2.43	2.12	230.22	17.11	0.000	3.06	0.211
Gender	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*	***95% CI***			***P>|z|***	
Male	3	2.07	82	56.55	21	14.48	39	26.90	0.678-0.801			0.000	
Female	9	17.65	28	54.90	11	21.57	3	5.88					

Note: *SD. Standard deviation; SS. Sum of Squares; f = frequency; % = percent.*

[1]Monthly income was measured in BDT (Bangladeshi taka) (85.67 BDT = 1 USD); [2]Health literacy was measured by principal component analysis (PCA)

Impact of health literacy on BMI

Balanced weight is considered as the reference category to distinguish the relative risk ratio on three other statuses from the reference category. The study executed the multinomial logistic regression with robust standard error to avoid the specification error of heteroskedasticity. The regression results and relative risk ratio are reported in Table 2.

A one percent increase in age reduced the relative risk of being underweight by a factor of 0.03 (p<0.05) compared to a healthier weight. Furthermore, this increase in age raised the risk of obesity by a factor of 838.22 (p<0.01). Males and females had different experiences in terms of the risk of being obese. The risk of obesity rose for males by a factor of 6.58 (p<0.05) instead of having a healthier weight. They, however, also have a lower chance of becoming underweight, as the risk dropped by 0.10 points (p<0.01). Monthly income delineates a similar finding. There was a negative association between monthly income and the state of being underweight. Compared to the base outcome, the relative risk of being underweight was expected to reduce by a factor of 0.00 (p<0.10) due to a 1% rise in the monthly income. Even though there is an inverse relationship between monthly income and the likelihood of being underweight, the weight loss was minimal. However, income influenced the state of being obese significantly. Monthly income has a positive effect on obesity by a factor of 6.03 (p<0.10) compared to a healthy weight.

Interestingly, the state of an individual's weight is often determined by their educational attainment. For example, one extra year of schooling was estimated to minimize the relative likelihood of becoming underweight by a factor of 0.71 (p<0.01) instead of a healthy weight. However, no statistically meaningful impact of schooling on the risk of becoming overweight or obese was found.

Table 2 also demonstrates the relationships between health status and health literacy. The health literacy variables that exasperate obesity were knowledge of nutrition, preventive care, and healthy behavior. To elucidate, the relative risk for being obese compared to being healthy reduced by 0.47 points (p<0.10) with the one-point improvement in the level of nutrition knowledge. Similarly, preventive care and healthy behavior negatively impacted obesity by a factor of 0.47 (p<0.05) and 0.38 (p<0.01), respectively.

Table 2: *The Relative Risk Ratio for Multinomial Logistic Regression*

Variables	Underweight		Overweight		Obese	
	Coefficient (SE)	e^{β}	*Coefficient*	e^{β}	*Coefficient*	e^{β}
Age (In Log)	-3.459	0.032**	0.751	2.120	6.731	838.239***
	(1.758)	0.055	(1.189)	2.520	(2.550)	2,137.759
Gender (Female =0, Male =1)	-4.625	0.010***	0.00474	1.004	1.883	6.576**
	(1.588)	0.015	(0.580)	0.582	(0.945)	6.214
Monthly Income (In Log)	-7.811	0.000*	0.355	1.425	1.797	6.029*
	(4.272)	0.002	(0.808)	1.152	(1.006)	6.064
Years of Schooling	-0.337	0.713***	0.00759	1.007	0.0670	1.069
	(0.124)	0.088	(0.0691)	0.069	(0.108)	0.116
Nutrition Knowledge	-0.0353	0.965	-0.0945	0.910	-0.763	0.466*
	(0.469)	(0.453)	(0.180)	(0.164)	(0.390)	(0.185)
Disease Knowledge	1.606	4.981**	-0.0439	0.957	-0.103	0.902
	(0.805)	(4.007)	(0.177)	(0.169)	(0.342)	(0.308)
Preventive Care index	-0.749	0.473*	-0.112	0.894	-0.750	0.472**
	(0.425)	(0.201)	(0.194)	(0.174)	(0.381)	(0.180)
Healthy Behavior index	-1.374	0.253***	-0.712	0.490***	-0.963	0.382***
	(0.528)	(0.134)	(0.149)	(0.073)	(0.206)	(0.079)
Sanitation index	-0.399	0.671	-0.0511	0.950	0.216	1.241
	(0.272)	(0.182)	(0.189)	(0.179)	(0.190)	(0.235)
Compliance index	-1.020	0.361	0.241	1.272	0.445	1.561
	(0.685)	(0.247)	(0.218)	(0.277)	(0.290)	(0.452)
Constant	83.17	0.000**	-7.391	0.000	-46.97	0.000***
	(41.38)	(0.000)	(9.220)	(0.006)	(12.71)	(0.000)
Pseudo R^2				0.534		
Log Likelihood				-102.478		
Observations				196		

Notes: *Base Outcome. Healthy weight;* *SE. Standard error;* *e^{β}. Relative risk ratio;* *$^{***}p<0.01$; $^{**}p<0.05$; $^{*}p<0.10$*

Likewise, literacy on healthy behavior minimized the overweight by a significant factor relative to a healthy weight. More specifically, the relative risk of being overweight was 0.49 points lower (p<0.01) than that of the healthy weight for a one-point rise in the level of health literacy. Healthy behavior, for instance, negatively affects the chance of being underweight relative to being healthy by a factor of 0.25 (p<0.01) due to a one-point improvement in healthy behavior. Similarly, the relative risk for being underweight was 0.47 points lower (p<0.01) than being healthy because of having an additional level of knowledge on healthy behavior. Disease knowledge, on the contrary, exerts an unconventional relationship with the state of being underweight. A one-point rise in the level of disease knowledge was expected to enhance the relative risk for being underweight by a factor of 4.98 (p<0.05) compared to the healthy weight.

Discussion

One of the most important aspects of maintaining a quality health status is health literacy (Guo et al., 2020). This research aimed to explore whether socio-demographic indicators and health literacy are related to body mass index (BMI) status, such as the underweight, overweight, or obese categories. The investigation shows several major outcomes that are statistically significant.

Socio-demographic traits influence health status, as evident in other studies (Eltayeb et al., 2016; Frederick et al., 2014). This study found that age was one of the critical socio-demographic characteristics that determined the variations in BMI. Earlier studies showed that when people get older, they are expected to become obese (Alemu et al., 2014; Smith et al., 2008), which is also evident in the present study. Nutritionists argue that the rate of consumption rises with the higher ages (Stöver, 2012), and simultaneously the rate of metabolism slows down (Shimokata & Kuzuya, 1993). As a result, people gain weight as they grow older. These findings, however, contradict that of Haney (2020). Moreover, it is claimed that younger age groups are more prone to obesity and overweight than older age groups (Eltayeb et al., 2016) because the young population generally intake high-fat and high-calorie foods (Musaiger, 2011).

Gender claims to be an important factor explaining the BMI of an individual. Males were more likely to be obese than females, and our findings complement the results of Al Junaibi et al. (2013) and Eltayeb et al. (2016). The possible explanation could be that men and women differ in eating habits and food preferences; thus, they vary in body shape and weight. Furthermore, based on the differences in the regions, females may have a lower nutritional intake than males (Mirowsky & Ross, 2003). In contrast, Kanter and Caballero (2012) found that females bear obesity more because of their frequent consumption of sugar-laden foods than males. This weight difference between sexes can prevail due to disparity in food consumption (Garawi et al., 2014) and occupation (Di Tecco et al., 2020).

According to our findings, monthly income also plays a crucial role in determining BMI. Monthly income is projected to increase the risk of obesity and lower the incidence of being underweight. An increase in earnings leads to a rise in the standard of living (Ahmed et al., 2010; Ross & Wu, 1995). As a result, higher income-led consumption raises obesity while lowering the likelihood of being underweight (Schmeer, 2010). Our findings are consistent with the existing literature.

Education has a negative association with the state of being underweight. In the current study, due to an extra year of schooling, the risk of getting underweight was smaller than the risk of gaining healthy weight. The fact that supports this finding is—higher education enables people to attain higher health literacy (Enomoto et al., 2020; T. Nakamura et al., 2018; Svendsen et al., 2020). Reasonably, educated individuals minimize the risk of being underweight (Osborne et al., 2007; Taylor et al., 1991). One widely held belief about education is that it propels people to become more conscious about healthy eating habits and nutrition intake. As a result, people can avoid the inconveniences associated with being overweight or obese.

The study also documents insightful evidence of a link between health literacy and BMI. Many scholarly works showed that higher health literacy helps people avoid obesity and overweight while maintaining a healthy weight (Chari et al., 2014; Eltayeb et al., 2016). However, low health literacy is not necessarily a predictor of obesity and overweight (Lanpher et al., 2016; Sentell et al., 2011). Moghaddam et al. (2019) also explored that due to the heterogeneity in health literacy, the BMI did not show any significant disparities in the weight of students.

Likewise, literacy on nutrition, preventive care, and healthy behavior significantly influence BMI. Health awareness reduces the possibilities of obesity, compared to a healthier weight, to a greater extent. This negative relationship emphasizes education about nutrition, preventive care (Scott et al., 2002), and healthy behavior to minimize the risk of obesity and the associated comorbidity (Svendsen et al., 2020). One of the benefits of a balanced diet and nutrition is the ability to maintain good health. This improved health status continues when people with a good understanding of diet realize the value of eating at regular intervals, getting enough protein, performing enough exercise, and eliminating foods and drinks that contribute to obesity (Musaiger, 2011). On the other hand, sedentary behavior is harmful to health as it increases the chance of being overweight or obese (Eltayeb et al., 2016).

A good understanding of preventive health care allows people to take proactive steps, such as routine clinic appointments, to improve their health condition (Cho et al., 2008; James et al., 2015). Furthermore, a positive attitude toward healthy behaviors, such as avoiding smoking and abstaining from medications, aids in maintaining a healthy weight (Nutbeam, 2000). We discovered an inverse association between healthy behavioral knowledge and being overweight; however, this outcome contradicts Cha et al. (2014). Because of healthy behavior knowledge scaling up, overweight is predicted to decrease by a more extensive scale than a healthier weight. Therefore, training and education on healthy behavior can bring forth a ground of balanced weight. It is well-documented that a balanced weight reduces the risk of certain deadly diseases caused by unhealthy, irregular, and unregulated fast-food consumption (Mohiuddin & Nasirullah 2019; Musaiger, 2011).

However, disease knowledge increases the risk of being underweight. Though this is a rare case, early understanding of illness can sometimes lead to overconsumption of medication without prescriptions from licensed physicians. Such would jeopardize the well-being, as in this case is the underweight issue. This observation was consistent with Cho et al. (2008). They concluded that sensitivity toward diseases could lead to an exaggeration of the illness and the use of needless drugs as a means of healing. The possible explanation for the deteriorated health status is that people become meticulous and over concerned through gathering disease knowledge and, therefore, can be involved in excessive physical activity and medication. The validity of these results needs more intensive investigation covering a more comprehensive range of urban areas.

However, several academic works contradict the current study's findings, claiming that health literacy has no relation with health status (Enomoto et al., 2020; Liu et al., 2015). For example, Enomoto et al. (2020) did not find any relationship between health literacy and BMI categories, such as underweight or overweight status. In contrast, a significant number of other studies reported a strong association between health literacy and BMI categories (Chari et al., 2014; Eltayeb et al., 2016; Lassetter et al., 2015; D. Nakamura et al., 2018).

Strengths and limitations

Several issues are determining the strengths and limitations of the current study. For example, this study deployed globally approved and validated quantitative tools to measure BMI and health literacy. In this cross-sectional study, randomized data were collected from different spatial locations with a heterogeneous population, increasing the possibilities of broader acceptability of the findings. Although the current research accomplished the data collection for six months, it considered a smaller sample size that might be insufficient for generalizing the results. The BMI depended on a single analytical tool for its measurement, and no other certified mechanisms validated the measure. Thus, the outcome variables might have biases in reporting BMI. Moreover, the cross-sectional nature of the sample design and a tendency to provide socially desirable information could produce bias in the data. Therefore, more comprehensive studies on nationally representative samples are recommended to comprehend the association between health literacy and BMI issues.

Conclusion and recommendations

This study aimed at finding the association between health literacy and body mass index in urban Bangladesh. Findings suggest health literacy reduces the risk of being underweight, overweight as well as obese. While a higher level of health literacy retains a healthy weight, other weight classes possess significantly lower health literacy. Participants with higher nutrition levels, preventive care, and healthy behavior knowledge manage to curb the threat of being obese. Certain socio-demographic variables such as income and age also play a pivotal role in the health status of individuals. It is not surprising that income is positively associated with overweight and obesity, and it helps to overcome the state of being underweight. Such an outcome may lead to the assumption that higher income causes overconsumption. On the other hand, age reduces the possibility of being underweight but increases being overweight. The results also indicate that educating people on different health knowledge can help overcome the barriers to a healthy lifestyle.

In line with the results, we recommend that the government initiate country-wide health literacy programs teaching basics of nutrition, preventive health care, and healthy behavior at the primary, secondary, and tertiary levels of education. This strategy will enhance health literacy among the students who will be encouraged to train their family members. Adult household heads and family members might be enrolled in various community-based health literacy initiatives to pass on their knowledge to other family members. This spillover effect will empower family guardians to safeguard family members from multiple health conditions at the family and community levels. Moreover, government and its development stakeholders should propagate the significance of health literacy for a complete 'physical, social and mental well-being' through mass media and social media. In addition, steps should be undertaken to enable people with higher abilities to search, understand, and evaluate the available options.

They need to decide within a given health setting to enhance their capabilities to maintain the better health status of their own and family members using available health services and facilities. As a result, communities may find it simpler to acquire healthier weight and good wealth. Longitudinal research can also be directed to evaluate the outcomes of different health literacy programs. Sensible expenditure practices can also be taught alongside literacy programs. The findings suggested that a rise in income results in excessive expenditures on food items and increases avoidable health risks.

References

Abdulraheem, I. S., Olapipo, A. R., & Amodu, M. O. (2012). Primary health care services in Nigeria: Critical issues and strategies for enhancing the use by the rural communities. *Journal of Public Health and Epidemiology*, *4*(1), 5-13. https://doi.org/10.5897/JPHE11.133

Ahmed, F., Prendiville, N., & Narayan, A. (2016). Micronutrient deficiencies among children and women in Bangladesh: Progress and challenges. *Journal of Nutritional Science*, *5*, Article E46. https://doi.org/10.1017/jns.2016.39

Ahmed, S., Creanga, A. A., Gillespie, D. G., & Tsui, A. O. (2010). Economic status, education and empowerment: Implications for maternal health service utilization in developing countries. *PloS ONE*, *5*(6), Article e11190. https://doi.org/10.1371/journal.pone.0011190

Al Junaibi, A., Abdulle, A., Sabri, S., Hag-Ali, M., & Nagelkerke, N. (2013). The prevalence and potential determinants of obesity among school children and adolescents in Abu Dhabi, United Arab Emirates. *International Journal of Obesity*, *37*, 68-74. https://doi.org/10.1038/ijo.2012.131

Alam, D. S., Talukder, S. H., Chowdhury, M. A. H., Siddiquee, A. T., Ahmed, S., Pervin, S., Khan, S., Hasan, K., Koehjmoos, T. L. P., & Niessen, L. W. (2016). Overweight and abdominal obesity as determinants of undiagnosed diabetes and pre-diabetes in Bangladesh. *BMC Obesity*, *3*, Article 19. https://doi.org/10.1186/s40608-016-0099-z

Alemu, E., Atnafu, A., Yitayal, M., & Yimam, K. (2014). Prevalence of overweight and/or obesity and associated factors among high school adolescents in Arada Sub city, Addis Ababa, Ethiopia. *Journal of Nutrition & Food Sciences*, *4*(2), Article 1000261. http://dx.doi.org/10.4172/2155-9600.1000261

Altin, S. V., Finke, I., Kautz-Freimuth, S., & Stock, S. (2014). The evolution of health literacy assessment tools: A systematic review. *BMC Public Health*, *14*, Article 1207. https://doi.org/10.1186/1471-2458-14-1207

Arabin, B., Timmesfeld, N., Noever, K., Behnam, S., Ellermann, C., & Jenny, M. A. (2019). How to improve health literacy to reduce short- and long-term consequences of maternal obesity? *The Journal of Maternal-Fetal & Neonatal Medicine*, *32*(17), 2935-2942. https://doi.org/10.1080/14767058.2018.1450383

Bangladesh Bureau of Statistics. (2015a). *Changing pattern of urbanization in Bangladesh: An analysis of census data (Population Monograph: Vol. 12).*

Bangladesh Bureau of Statistics. (2015b). *Education and literacy in Bangladesh: An analysis from social inclusion perspective (Population Monograph: Vol. 2).*

Bangladesh Bureau of Statistics. (2015c). *Population and Housing Census 2011- Zila Report: Khulna.*

Bangladesh Bureau of Statistics. (2015d). *Population density and vulnerability: A challenge for sustainable development of Bangladesh (Population Monograph: Vol. 7).*

Bashar, M. A., Haque, A. R., & Rahman, R. (2020). Prevalence of anaemia among pregnant women in a rural area of Bangladesh: Impact of socio-economic factors, food intake and micronutrient supplementation. *American Journal of Pure and Applied Biosciences*, 2(1), 1-7. https://doi.org/10.34104/ajpab.0200107

Biswas, T., Garnett, P. S., Pervin S., & Rawal, L. B. (2017). The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. *PloS ONE*, 12(5), Article e0177395. https://doi.org/10.1371/journal.pone.0177395

Biswas, T., Islam, A., Islam, M. S., Pervin, S., & Rawal, L. B. (2017). Overweight and obesity among children and adolescents in Bangladesh: A systematic review and meta-analysis. *Public Health*, *142*, 94-101. https://doi.org/10.1016/j.puhe.2016.10.010

Bleich, S. N., Bennett, W. L., Gudzune, K. A., & Cooper, L. A. (2012). Impact of physician BMI on obesity care and beliefs. *Obesity*, *20*(5), 999-1005. https://doi.org/10.1038/oby.2011.402

Cha, E., Kim, K. H., Lerner, H. M., Dawkins, C. R., Bello, M. K., Umpierrez, G., & Dunbar, S. B. (2014). Health literacy, self-efficacy, food label use, and diet in young adults. *American Journal of Health Behavior*, *38*(3), 331-339. https://doi.org/10.5993/AJHB.38.3.2

Chari, R., Warsh, J., Ketterer, T., Hossain, J., & Sharif, I. (2014). Association between health literacy and child and adolescent obesity. *Patient Education and Counseling*, *94*(1), 61-66. https://doi.org/10.1016/j.pec.2013.09.006

Cheng, Y. L., Shu, J. H., Hsu, H. C., Liang, Y., Chou, R. H., Hsu, P. F., Wang, Y. J., Ding, Y. Z., Liou, T. L., Wang, Y. W., Huang, S. S., Lin, C. C., Lu, T. M., Leu, H. B., Lin, S. J., & Chan, W. L. (2018). High health literacy is associated with less obesity and lower Framingham risk score: Sub-study of the VGH-HEALTHCARE trial. *PloS ONE, 13*(3), Article e0194813. https://doi.org/10.1371/journal.pone.0194813

Cho, Y. I., Lee, S. Y. D., Arozullah, A. M., & Crittenden, K. S. (2008). Effects of health literacy on health status and health service utilization amongst the elderly. *Social Science & Medicine*, *66*(8), 1809-1816. https://doi.org/10.1016/j.socscimed.2008.01.003

Di Tecco, C., Fontana, L., Adamo, G., Petyx, M., & Iavicoli, S. (2020). Gender differences and occupational factors for the risk of obesity in the Italian working population. *BMC Public Health*, *20*, Article 706. https://doi.org/10.1186/s12889-020-08817-z

Eltayeb, R., Salmiah, M. S., & Suriani, I. (2016). Association of health literacy with obesity and overweight among Arabic secondary school students in Kuala Lumpur and Putrajaya, Malaysia. *International Journal of Public Health and Clinical Sciences*, *3*(5), 110-121. http://publichealthmy.org/ejournal/ojs2/index.php/ijphcs/article/view/348

Enomoto, A., Saito, A., Takahashi, O., Kimura, T., Tajima, R., Rahman, M., & Iida, K. (2020). Associations between health literacy and underweight and overweight among Japanese adults aged 20 to 39 years: A cross-sectional study. *Health Education & Behavior*, *47*(4), 631-639. https://doi.org/10.1177/1090198120919675

Feinstein, J. S. (1993). The relationship between socioeconomic status and health: A review of the literature. *The Milbank Quarterly*, *71*(2), 279-322. https://doi.org/10.2307/3350401

Frederick, C. B., Snellman, K., & Putnam, R. D. (2014). Increasing socioeconomic disparities in adolescent obesity. *Proceedings of the National Academy of Sciences*, *111*(4), 1338-1342. https://doi.org/10.1073/pnas.1321355110

Freedman, D. A., Bess, K. D., Tucker, H. A., Boyd, D. L., Tuchman, A. M., & Wallston, K. A. (2009). Public health literacy defined. *American Journal of Preventive Medicine*, *36*(5), 446-451. https://doi.org/10.1016/j.amepre.2009.02.001

Garawi, F., Devries, K., Thorogood, N., & Uauy, R. (2014). Global differences between women and men in the prevalence of obesity: Is there an association with gender inequality? *European Journal of Clinical Nutrition*, *68*, 1101-1106. https://doi.org/10.1038/ejcn.2014.86

GBD 2015 Obesity Collaborators. (2017). Health effects of overweight and obesity in 195 countries over 25 years. *New England Journal of Medicine*, *377*, 13-27. https://doi.org/10.1056/NEJMoa1614362

Guo, S., Yu, X., Davis, E., Armstrong, R., Riggs, E., & Naccarella, L. (2020). Adolescent health literacy in Beijing and Melbourne: A cross-cultural comparison. *International Journal of Environmental Research and Public Health*, *17*(4), Article 1242. https://doi.org/10.3390/ijerph17041242

Haney, M. O. (2020). Health literacy and predictors of body weight in Turkish children. *Journal of Pediatric Nursing*, *55*, e257-e262. https://doi.org/10.1016/j.pedn.2020.05.012

Hossain, M. B., Khan, J. R., Adhikary, A. C., Anwar, A. H. M. M., Raheem, E., Siddiqee, M. H., & Hossain, M. S. (2021). Association between childhood overweight/obesity and urbanization in developing countries: Evidence from Bangladesh. *Journal of Public Health*, *2021*, 1-10. https://doi.org/10.1007/s10389-021-01560-8

Hruby, A., & Hu, F. B. (2015). The epidemiology of obesity: A big picture. *PharmacoEconomics*, *33*, 673-689. https://doi.org/10.1007/s40273-014-0243-x

Hughes, A., & Kumari, M. (2017). Unemployment, underweight, and obesity: Findings from Understanding Society (UKHLS). *Preventive Medicine*, *97*, 19-25. https://doi.org/10.1016/j.ypmed.2016.12.045

Ishaque, A., Ahmad, F., Zehra, N., & Amin, H. (2012). Frequency of and factors leading to obesity and overweight in school children. *Journal of Ayub Medical College Abbottabad*, *24*(2), 34-38. https://pubmed.ncbi.nlm.nih.gov/24397047/

Islam, M. S., & Ullah, M. W. (2009). People's participation in health services: A study of Bangladesh's rural health complex. *Bangladesh Development Research Center (BDRC)*, *Working Paper Series 7.* http://bangladeshstudies.org/files/WPS_no7.pdf

James, D. C. S., Harville, C., Efunbumi, O., & Martin, M. Y. (2015). Health literacy issues surrounding weight management among African American women: A mixed methods study. *Journal of Human Nutrition and Dietetics*, *28*(s2), 41-49. https://doi.org/10.1111/jhn.12239

Kanter, R., & Caballero, B. (2012). Global gender disparities in obesity: A review. *Advances in Nutrition*, *3*(4), 491-498. https://doi.org/10.3945/an.112.002063

Khan, J. R., & Awan, N. (2017). A comprehensive analysis on child mortality and its determinants in Bangladesh using frailty models. *Archives of Public Health*, *75*, Article 58. https://doi.org/10.1186/s13690-017-0224-6

Khullar, D., & Chokshi, D. A. (2018). Health, income, & poverty: Where we are & what could help. *Health Affairs Health Policy Brief*. https://doi.org/10.1377/hpb20180817.901935

Kumar, R. H., Venkaiah, K., Arlappa, N., Kumar, S., Brahmam, G. N. V., & Vijayaraghavan, K. (2005). Diet and nutritional situation of the population in the severely drought affected areas of Gujarat. *Journal of Human Ecology*, *18*(4), 319-326. https://doi.org/10.1080/09709274.2005.11905849

Lam, L. T., & Yang, L. (2014). Is low health literacy associated with overweight and obesity in adolescents: an epidemiology study in a 12–16 years old population, Nanning, China, 2012. *Archives of Public Health*, *72*, Article 11. https://doi.org/10.1186/2049-3258-72-11

Lanpher, M. G., Askew, S., & Bennett, G. G. (2016). Health literacy and weight change in a digital health intervention for women: A randomized controlled trial in primary care practice. *Journal of Health Communication*, *21*(sup1), 34-42. https://doi.org/10.1080/10810730.2015.1131773

Lassetter, J. H., Clark, L., Morgan, S. E., Brown, L. B., VanServellen, G., Duncan, K., & Hopkins, E. S. (2015). Health literacy and obesity among Native Hawaiian and Pacific Islanders in the United States. *Public Health Nursing*, *32*(1), 15-23. https://doi.org/10.1111/phn.12155

Liu, Y. B., Liu, L., Li, Y. F., & Chen, Y. L. (2015). Relationship between health literacy, health-related behaviors and health status: A survey of elderly Chinese. *International Journal of Environmental Research and Public Health*, *12*(8), 9714-9725. https://doi.org/10.3390/ijerph120809714

Michou, M., Panagiotakos, D. B., & Costarelli, V. (2018). Low health literacy and excess body weight: A systematic review. *Central European Journal of Public Health*, *26*(3), 234-241. https://doi.org/10.21101/cejph.a5172

Mirowsky, J., & Ross, C. E. (2003*). Education, social status, and health (1st ed.)*. Routledge.

Moghaddam, R., Mokhtari Lakeh, N., Rahebi, S. M., & Kazemnezhad Leili, E. (2019). Health literacy and its relationship with body mass index. *Journal of Holistic Nursing and Midwifery*, *29*(3), 8-14. http://dx.doi.org/10.32598/JHNM.29.3.130

Muhammad, F., Chowdhury, M., Arifuzzaman, M., & Chowdhury, A. A. (2016). Public health problems in Bangladesh: Issues and challenges. *South East Asia Journal of Public Health, 6*(2), 11-16. http://dx.doi.org/10.3329/seajph.v6i2.31830

Mohiuddin, A. K., & Nasirullah, M. (2019). UTI prevalence among population with chronic conditions. *Journal of Medical Research and Case Reports*, *1*(2), 1-13. https://escientificpublishers.com/assets/data1/images/JMRCR-01-0011.pdf

Musaiger, A. O. (2011). Overweight and obesity in Eastern Mediterranean region: Prevalence and possible causes. *Journal of Obesity*, *2011*, Article 407237. https://doi.org/10.1155/2011/407237

Nakamura, D., Ogawa, M., Nakamura, T., & Izawa, K. P. (2018). Impact of parents' comprehensive health literacy on BMI in children: A multicenter cross-sectional study in Japan. *Journal of School Health*, *88*(12), 910-916. https://doi.org/10.1111/josh.12700

Nakamura, T., Nakamura, Y., Saitoh, S., Okamura, T., Yanagita, M., Yoshita, K., Kita, Y., Murakami, Y., Yokomichi, H., Nishi, N., Okuda, N., Kadota, A., Ohkubo, T., Ueshima, H., Okayama, A., & Miura, K. (2018). Relationship between socioeconomic status and the prevalence of

underweight, overweight or obesity in a general Japanese population: NIPPON DATA 2010. *Journal of Epidemiology*, *28*(Supplement III), S10-S16. https://doi.org/10.2188/jea.JE20170249

Nutbeam, D. (2000). Health literacy as a public goal: A challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International, 15*(3), 259-267. https://doi.org/10.1093/heapro/15.3.259

Nuttall, F. Q. (2015). Body mass index: Obesity, BMI, and health: A critical review. *Nutrition Today, 50*(3), 117-128. https://doi.org/10.1097/NT.0000000000000092

O' Neill, B., Gonçalves, D., Ricci-Cabello, I., Ziebland, S., & Valderas, J. (2014). An overview of self-administered health literacy instruments. *PloS ONE*, *9*(12), Article e109110. https://doi.org/10.1371/journal.pone.0109110

Osborne, R. H., Elsworth, G. R., & Whitfield, K. (2007). The Health Education Impact Questionnaire (heiQ): An outcomes and evaluation measure for patient education and self-management interventions for people with chronic conditions. *Patient Education and Counselling*, *66*(2), 192-201. https://doi.org/10.1016/j.pec.2006.12.002

Rachmi, C. N., Li, M., & Baur, L. A. (2017). Overweight and obesity in Indonesia: Prevalence and risk factors—a literature review. *Public Health*, *147*, 20-29. https://doi.org/10.1016/j.puhe.2017.02.002

Rahman, S., Lee, P., Raqib, R., Roy, A. K., Khan, M. R., & Ahmed, F. (2019). Effect of Micronutrient Powder (MNP) with a low-dose of iron on hemoglobin and iron biomarkers, and its effect on morbidities in rural Bangladeshi children drinking groundwater with a high-level of iron: A randomized controlled trial. *Nutrients*, *11*(11), Article e2756. https://doi.org/10.3390/nu11112756

Ross, C. E., & Wu, C. (1995). The links between education and health. *American Sociological Review, 60*(5), 719-745. https://doi.org/10.2307/2096319

Schmeer, K. K. (2010). Household income during childhood and young adult weight status: Evidence from a nutrition transition setting. *Journal of Health and Social Behavior*, *51*(1), 79-91. https://doi.org/10.1177/0022146509361178

Scott, T. L., Gazmararian, J. A., Williams, M. V., & Baker, D. W. (2002). Health literacy and preventive health care use among Medicare enrollees in a managed care organization. *Medical Care*, *40*(5), 395-404. https://doi.org/10.1097/00005650-200205000-00005

Sentell, T., Baker, K. K., Onaka, A., & Braun, K. (2011). Low health literacy and poor health status in Asian Americans and Pacific Islanders in Hawai'i. *Journal of Health Communication*, *16*(sup3), 279-294. https://doi.org/10.1080/10810730.2011.604390

Shih, S. F., Liu, C. H., Liao, L. L., & Osborne, R. H. (2016). Health literacy and the determinants of obesity: A population-based survey of sixth grade school children in Taiwan. *BMC Public Health*, *16*, Article 280. https://doi.org/10.1186/s12889-016-2879-2

Shimokata, H., & Kuzuya, F. (1993). Aging, basal metabolic rate, and nutrition. *Japanese Journal of Geriatrics, 30*(7), 572–576. https://doi.org/10.3143/geriatrics.30.572

Smith, K. R., Brown, B. B., Yamada, I., Kowaleski-Jones, L., Zick, C. D., & Fan, J. X. (2008). Walkability and body mass index: Density, design, and new diversity measures. *American Journal of Preventive Medicine, 35*(3), 237-244. https://doi.org/10.1016/j.amepre.2008.05.028

Sørensen, K., Van den Broucke., S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., & Brand, H., (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health, 12*, Article 80. https://doi.org/10.1186/1471-2458-12-80

Steyn, N. P., Nel, J. H., Parker, W. A., Ayah, R., & Mbithe, D. (2011). Dietary, social, and environmental determinants of obesity in Kenyan women. *Scandinavian Journal of Public Health*, *39*(1), 88-97. https://doi.org/10.1177/1403494810384426

Stöver, B. (2012). The influence of age on consumption. *Discussion Paper No. 49080*. Gesellschaft für Wirtschaftliche Strukturforschung mbH. http://ecomod.net/system/files/Discussion%20Paper_Britta%20Stoever.pdf

Svendsen, M. T., Bak, C. K., Sørensen, K., Pelikan, J., Riddersholm, S. J., Skals, R. K., Mortensen, R. N., Maindal, H. T., Bøggild, H., Nielsen, G., & Torp-Pedersen, C. (2020). Associations of health literacy with socioeconomic position, health risk behavior, and health status: A large national population-based survey among Danish adults. *BMC Public Health*, *20*, Article 565. https://doi.org/10.1186/s12889-020-08498-8

Tanwi, T. S., Chakrabarty, S., Hasanuzzaman, S., Saltmarsh, S., & Winn, S. (2019). Socioeconomic correlates of overweight and obesity among ever-married urban women in Bangladesh. *BMC Public Health*, *19*, Article 842. https://doi.org/10.1186/s12889-019-7221-3

Tareque, M. I., Saito, Y., & Kawahara, K. (2015). Healthy life expectancy and the correlates of self-rated health in Bangladesh in 1996 and 2002. *BMC Public Health, 15*, Article 312. https://doi.org/10.1186/s12889-015-1640-6

Taylor, C. B., Fortmann, S. P., Flora, J., Kayman, S., Barrett, D. C., Jatulis, D., & Farquhar, J. W. (1991). Effect of long-term community health education on body mass index: The Stanford Five-City Project. *American Journal of Epidemiology*, *134*(3), 235-249. https://doi.org/10.1093/oxfordjournals.aje.a116077

Tian, C. Y., Xu, R. H., Mo, P. K. H., Dong, D., & Wong, E. L. Y. (2020). Generic health literacy measurements for adults: A scoping review. *International Journal of Environmental Research and Public Health*, *17*(21), Article 7768. https://doi.org/10.3390/ijerph17217768

Woolf, S. H., Aron, L., Dubay, L., Simon, S. M., Zimmerman, E., & Luk, K. X. (2015). *How are income and wealth linked to health and longevity?* Urban Institute and Virginia Commonwealth University. http://webarchive.urban.org/UploadedPDF/2000178-How-are-Income-and-Wealth-Linked-to-Health-and-Longevity.pdf

World Bank. (2021). *Country Profile: Bangladesh* [Data set]. World Bank Group. https://data.worldbank.org/country/bangladesh

Appendix

Table I: Validity and Reliability Test of the Health Literacy Instrument for PCA

Health Literacy Indicators	Average Interitem covariance	Number of Items in the Scale	Scale Reliability Coefficient (Cronbach's Alpha)
Indicators of nutrition knowledge	0.054	8	0.757
Indicators of general health knowledge	0.037	10	0.744
Indicators of preventive care knowledge	0.060	9	0.770
Indicators of healthy behavior knowledge	0.072	8	0.828
Indicators of sanitation knowledge	0.042	10	0.747
Indicators of compliance knowledge	0.072	8	0.834
Overall	**0.040**	**53**	**0.934**

Table II: Measurement of Health Literacy Using PCA

Variables	Scoring Factor (α_N)	*Mean*	Std. Dev. (S_N)	Difference Factor (α_N / S_N) [1]
	(a)	(b)	(c)	(d)
I. Indicators of Nutrition Knowledge				
Do you take meals three times per day? (yes=1, 0=no)	0.207	0.925	0.2640	0.784
Do you take healthy food such as fruits, milks, and juice? (yes=1, 0=no)	0.453	0.525	0.5006	0.905
Do you think dietary behavior is helpful for fitness? (yes=1, 0=no)	0.412	0.505	0.5012	0.822
Are you following a diet? (yes=1, 0=no)	0.269	0.075	0.2640	1.019
Is your protein intake sufficient? (yes=1, 0=no)	0.389	0.41	0.4930	0.789
Do you have knowledge of the sources of protein? (yes=1, 0=no)	0.479	0.28	0.4501	1.064
Do you know that junk foods pose a health risk? (yes=1, 0=no)	0.289	0.515	0.5010	0.577
Do you know about the side effects of energy drinks? (yes=1, 0=no)	0.207	0.265	0.4424	0.468
II. Indicators of General Health Knowledge				
Do you know about the side effects of tobacco? (yes=1, 0=no)	0.061	0.91	0.2868	0.213
Do you avoid Tobacco? (yes=1, 0=no)	0.247	0.775	0.4186	0.590
Do you know the consequences of diabetics? (yes=1, 0=no)	0.351	0.64	0.4818	0.729
Do you avoid diabetic food? (yes=1, 0=no)	0.449	0.43	0.4963	0.905
Do you have knowledge of hypertension? (yes=1, 0=no)	0.442	0.25	0.4340	1.018
Do you try to avoid food that causes hypertension? (yes=1, 0=no)	0.415	0.27	0.4450	0.933
Do you know what causes asthma or breathing problem? (yes=1, 0=no)	0.293	0.2	0.4010	0.731
Do you know what precautions should be taken to avoid asthma? (yes=1, 0=no)	0.281	0.085	0.2795	1.005

Variables	Scoring Factor (α_N)	*Mean*	Std. Dev. (S_N)	Difference Factor (α_N / S_N) [1]
	(a)	(b)	(c)	(d)
Do you know about the causes of cancer? (yes=1, 0=no)	0.275	0.265	0.4424	0.622
Do you follow the necessary health measures to avoid cancer? (yes=1, 0=no)	0.004	0.13	0.3371	0.012
III. Indicators of Preventive Care Knowledge				
Do you know why diseases such as cold, diarrhea, fever etc. occur? (yes=1, 0=no)	0.276	0.77	1.421	0.194
Do you regularly visit a doctor for health care and checkups? (yes=1, 0=no)	0.396	0.605	0.490	0.808
Do you know that a regular medical checkup is beneficial to the health? (yes=1, 0=no)	0.320	0.455	0.499	0.641
Do you know what medicine should be taken for which disease? (yes=1, 0=no)	0.227	0.7	0.459	0.495
Do you understand the instructions prescribed by the physician? (yes=1, 0=no)	0.212	0.685	0.465	0.456
Do follow the prescription while taking medicine? (yes=1, 0=no)	0.386	0.64	0.481	0.802
Do you know that unfinished doses are harmful to your health? (yes=1, 0=no)	0.297	0.72	0.450	0.660
Do you know that one should not stop prescribed doses without consulting with a doctor? (yes=1, 0=no)	0.451	0.64	0.481	0.938
Do you know that one should not reuse an old prescription without consultancy? (yes=1, 0=no)	0.353	0.59	0.493	0.716
IV. Indicators of Healthy Behavior Knowledge				
Do you know smoking is harmful to your health? (yes=1, 0=no)	0.120	0.975	0.156	0.769
Do you know about the diseases associated with smoking? (yes=1, 0=no)	0.390	0.7	0.459	0.850
Do you know brushing your teeth is good for your health? (yes=1, 0=no)	0.216	0.87	0.337	0.641
Do you know that you should brush your teeth twice a day? (yes=1, 0=no)	0.424	0.555	0.496	0.855
Do you know that drug addiction is harmful to your health? (yes=1, 0=no)	0.342	0.555	0.498	0.687
Are you aware of the health hazards of drug addiction? (yes=1, 0=no)	0.411	0.425	0.495	0.830
Do you think that proper sleeping is good for your health? (yes=1, 0=no)	0.345	0.72	0.450	0.767
Do you know one should sleep 8 hours on average every day? (yes=1, 0=no)	0.446	0.565	0.497	0.897
V. Indicators of Sanitation Knowledge				
Do you know that washing your hands before eating is good for your health? (yes=1, 0=no)	0.271	0.905	0.293	0.925
Do you wash your hands before and after eating? (yes=1, 0=no)	0.326	0.8	0.401	0.813
Do you know it is unhygienic to wash your hands without soap? (yes=1, 0=no)	0.459	0.605	0.490	0.937
Do you think that you should wash your hands using soap? (yes=1, 0=no)	0.358	0.615	0.487	0.735
Do you consider drinking only safe tube-well water? (yes=1, 0=no)	0.198	0.88	0.325	0.609

Variables	Scoring Factor (α_N)	*Mean*	Std. Dev. (S_N)	Difference Factor (α_N / S_N) [1]
	(a)	(b)	(c)	(d)
Do you know the health hazards associated with unsafe drinking water? (yes=1, 0=no)	0.266	0.675	0.469	0.567
Do you have a sanitary toilet in your house? (yes=1, 0=no)	0.312	0.67	0.471	0.662
Do you know that improper sanitation can lead to health hazards? (yes=1, 0=no)	0.412	0.395	0.490	0.841
Do you know a septic tank system is necessary for proper waste disposal (yes=1, 0=no)	0.318	0.35	0.478	0.665
Do you think that a sanitary toilet is better than open defecation? (yes=1, 0=no)	0.002	0.865	0.342	0.006
VI. Indicators of Compliance Knowledge				
Do you know that you should follow your medical advice correctly? (yes=1, 0=no)	0.222	0.875	0.331	0.671
Do you know about any diet, exercise plan, and medical treatment? (yes=1, 0=no)	0.325	0.325	0.469	0.693
Do you have proper knowledge about the plan? (yes=1, 0=no)	0.327	0.14	0.347	0.942
Can you read the label on the medicine bottle? (yes=1, 0=no)	0.326	0.275	0.447	0.729
Do you believe that prescribed tablets works? (yes=1, 0=no)	0.344	0.79	0.408	0.843
Do you understand and find it easy to communicate with physicians? (yes=1, 0=no)	0.361	0.75	0.434	0.832
Do you think you have less fear of being ill? (yes=1, 0=no)	0.445	0.555	0.498	0.894
Is it because you are more consent to health safety issues? (yes=1, 0=no)	0.426	0.52	0.500	0.852

Note: *Std. Dev. Standard deviation*

[1] *Difference factor = scoring factor (an) /standard deviation (SN). Each variable takes the value 1 if high, 0 otherwise. The scoring factor is the "weight" assigned to each variable (normalized by its mean and standard deviation) in the linear combination of the variables that constitute the first principal component. For nutrition, the percentage of the covariance explained by the first principal component is 38%. The first eigenvalue is 3.06; the second eigenvalue is 1.09. For disease knowledge, the percentage of the covariance explained by the first principal component is 32%. The first eigenvalue is 3.27; the second eigenvalue is 1.55. For preventive care, the percentage of the covariance explained by the first principal component is 36%. The first eigenvalue is 3.25; the second eigenvalue is 1.28. For healthy behavior, the percentage of the covariance explained by the first principal component is 45%. The first eigenvalue is 3.66; the second eigenvalue is 1.25. For sanitation, the percentage of the covariance explained by the first principal component is 32%. The first eigenvalue is 3.25; the second eigenvalue is 1.48. For compliance, the percentage of the covariance explained by the first principal component is 46%. The first eigenvalue is 3.74; the second eigenvalue is 1.31.*