

## Determinants of Selected NCD Biomarkers of Women in Bangladesh: A Multinomial Logit Analysis Using BDHS Dataset

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### Abstract

Non-communicable diseases (NCDs) are a significant public health concern in developing countries like Bangladesh, where women face an elevated susceptibility to them due to the confluence of various risk factors. This study delves into the socioeconomic determinants of women's health focusing on selected NCD biomarkers (Body Mass Index (BMI) and blood pressure measurement), utilizing the 2017-2018 Bangladesh Demographic and Health Survey (BDHS). Understanding the complex socioeconomic determinants and dynamics of women's health in Bangladesh, especially from the NCDs' perspective, is essential given the critical role that women's health plays in societal welfare and socioeconomic advancement, particularly in the face of rapid economic growth and demographic shifts. The multinomial logit analysis shows that wealth, age, and women's education were significant factors in all BMI categories, whereas employment status was significant only in the case of obesity. Being employed as opposed to being unemployed lowered the probability of being in higher BMI categories, whilst age, wealth, and higher education levels raised that likelihood. Age emerged to be a significant predictor of hypertension, with older individuals more likely to be hypertensive. Employment negatively impacted hypertension, while higher wealth slightly increased the likelihood of normal blood pressure. Given that older and wealthier women are predisposed to overweight, obese, and hypertensive, and considering the advantageous impact of employment in reducing hypertension risks, public health policies should focus on age-specific interventions to manage and prevent hypertension and obesity among older women. Moreover, efforts to promote health education and lifestyle modifications among wealthier individuals, enhance workplace wellness programs to leverage the protective effects of employment on health, and increase educational initiatives to raise awareness about healthy living and preventive healthcare are warranted. These targeted strategies can address the socioeconomic determinants of health, improving NCD biomarker outcomes for women across different age groups and economic backgrounds in Bangladesh.

**Keywords:** Non-communicable Diseases; NCD Biomarker; BMI; Hypertension; BDHS; Bangladesh.

## 1. Introduction

In developing countries like Bangladesh, non-communicable diseases (NCDs) represent a formidable public health concern, exerting considerable influence on societal and economic advancement. These conditions encompass a spectrum of ailments, notably cardiovascular diseases (CVD), cancer, chronic respiratory disorders, and diabetes, collectively ranking as the primary contributors to global mortality and morbidity (Biswas *et al.*, 2016; Chowdhury *et al.*, 2023; World Health Organization, 2023). As explained by World Health Organization (2023), an estimated 17 million individuals succumb to death annually from NCDs prior to attaining the age of 70, with a disproportionate burden borne by low- and middle-income countries (LMICs). Noteworthy is Bangladesh's experience, where NCDs accounted for approximately 70% of total deaths in 2019, underscoring the profound impact on population health. The nation grapples with alarming epidemiological trends, exemplified by a prevalence of smoking among 52% of men and hypertension affecting one in five adults. Moreover, the year 2021 witnessed a reported incidence of approximately 13.14 million cases of diabetes in Bangladesh, with an associated 75,617 deaths attributed to this condition (Icddr, 2024). However, NCDs exhibit a pattern of gender disparity-women face an elevated susceptibility to non-communicable diseases (NCDs) due to the confluence of various behavioral and metabolic risk factors (Chowdhury *et al.*, 2023).

Gender profoundly shapes health outcomes for both women and men in Bangladesh, as gender norms, roles, and relationships intertwine with biological determinants to shape susceptibility to diseases and health risks. Furthermore, a plethora of social, economic, and environmental factors beyond the healthcare domain, including poverty, educational attainment, employment status, and physical safety, significantly impact health outcomes

(World Health Organization, 2022). This complex interplay underlines the pervasive challenge of gender disparity in Bangladesh, where women consistently trail behind men across key indicators such as adult literacy rates (72% vs 77.8%), access to tertiary education (6.7% vs 12.5%), and utilization of mass media and mobile technologies (65% vs 84%) (GSM, 2022; The World Bank, 2024). Additionally, the lower labor force participation rate among women (37% compared to the male participation of 80.3%) and their disproportionate burden of unpaid caregiving responsibilities highlights entrenched gender inequalities (The World Bank, 2024). Recognizing the pivotal role of women's health in societal welfare and socioeconomic advancement, especially amidst rapid economic growth and demographic transitions, necessitates a nuanced understanding of the intricate socioeconomic determinants and dynamics shaping women's health in Bangladesh (United Nations Children's Fund UNICEF, 2015), particularly from the perspective of NCDs. This understanding is essential for crafting effective policies and interventions that address the multifaceted roles of women in society, spanning reproduction, caregiving, and productivity, and ultimately contribute to the holistic well-being of families and communities (World Health Organization, 2022).

While numerous studies have scrutinized the determinants of health status among Bangladeshi adults, often drawing upon data from the Bangladesh Health and Demographic Survey of various years, there remains a gap in understanding the socioeconomic factors influencing women's health, particularly on the NCD biomarkers<sup>1</sup> perspective. This study endeavors to fill this gap by elucidating the socioeconomic determinants underpinning women's health focusing on selected NCD biomarkers. Its objectives are threefold: firstly, to identify the socioeconomic factors influencing the biomarkers (blood pressure measurement and Body Mass Index) shaping the health outcomes of women; secondly, to explore how these determinants manifest in impacting the health trajectories of women; and thirdly, to analyze the dynamic patterns of the NCD biomarkers characterizing the health status of women.

## 2. Literature Review

Several studies have explored the health status of Bangladeshi adults, with some focusing particularly on women of reproductive age. These studies have highlighted potential socioeconomic factors associated with it. For instance, Kamruzzaman *et al.* (2017) analyzed data from the 2011 Bangladesh Demographic and Health Survey (BDHS) to investigate the health status of married Bangladeshi non-pregnant women within the reproductive age bracket, focusing on Body Mass Index (BMI) metrics. Their findings revealed a positive correlation between BMI and advancing age as well as age at first marriage, juxtaposed with a negative correlation regarding the number of children. Moreover, women residing in rural areas, hailing from financially disadvantaged households, possessing spouses with limited educational attainment, lacking access to household television sets, and currently engaged in breastfeeding exhibited a propensity towards lower BMI values.

A study centered on urban women in Bangladesh, drawing upon data sourced from the Bangladesh Demographic and Health Survey (BDHS) of 2014, unveiled noteworthy associations between BMI and variables encompassing wealth index, educational attainment, age, and marital status. As urban women progress in age, they tend to manifest elevated prevalence rates of overweight and obesity vis-à-vis their younger counterparts. Furthermore, individuals with heightened levels of education and income demonstrated augmented BMI values in comparison to their less educated and economically disadvantaged counterparts. Intriguingly, women who were separated from or no longer cohabiting with their spouses exhibited diminished likelihoods of being overweight or obese in contrast to their married counterparts (Tanwi *et al.*, 2019). Analogous trends were discerned across studies incorporating diverse geographic locales. Utilizing the identical BDHS 2014 dataset, Hossain *et al.* (2020) and Hashan *et al.* (2020) analyzed the BMI profiles of Bangladeshi women of reproductive age across urban and rural contexts, proffering insights indicative of an elevated likelihood of underweight status among women partnered with less educated spouses, those possessing minimal or negligible educational attainment, and those originating from economically deprived rural areas. Additionally, rural women adopting contraceptive measures evinced substantially diminished odds of underweight status relative to their non-user counterparts, with such an association not observed among urban counterparts.

A subsequent investigation utilizing data from the Bangladesh Demographic and Health Survey (BDHS) spanning 2017-18 suggests that women who have completed primary and secondary education, originate from economically advantaged households, practice breastfeeding, and possess exposure to media sources such as newspapers and television, exhibit heightened likelihoods of experiencing overweight or obesity. In contrast, women from the most economically disadvantaged households manifest a notably heightened susceptibility to underweight status when juxtaposed with their counterparts from more affluent socioeconomic backgrounds. Moreover, the likelihood of being underweight is exacerbated among women lacking formal education, adolescent females, and those forgoing contraceptive utilization (Khanam *et al.*, 2021).

Similar trends have been documented across neighboring South Asian countries. An investigation centered on Indian women of reproductive age elucidates that being young, non-utilization of contraceptives, unmarried status, lower educational attainment, diminished wealth, and rural residency correlate positively with a lower BMI,

<sup>1</sup> Biomarkers serve as essential tools utilized by healthcare providers to facilitate the diagnosis and management of chronic diseases. They possess the capacity to offer valuable insights for diagnostic, predictive, or prognostic purposes. Four primary metabolic alterations associated with an elevated susceptibility to non-communicable diseases (NCDs) stem from metabolic risk factors such as hypertension, obesity, hyperglycemia (elevated blood glucose levels), and hyperlipidemia (elevated levels of fat in the blood) Sarank (2022). Biomarkers of Non-Communicable Chronic Diseases. *Biomark J.*, 8: 148. <https://doi.org/10.35841/2472-1646-8.8.148>.

indicative of underweight status. Conversely, advanced age, history of pregnancy, marital experience, higher educational attainment, elevated socioeconomic status, and urban habitation are associated with increased probabilities of overweight or obesity (Al Kibria *et al.*, 2019). Moreover, congruent findings emerge from a study leveraging data from the Nepal Health and Demographic Survey, which underscores the significant impact of age, marital status, education level, wealth index, geographic province, fuel used for cooking, religious affiliation, sanitation facilities, ownership of electronic appliances, and transportation means on BMI levels, predisposing individuals to overweight and obesity (Rana *et al.*, 2021). In Pakistan, an investigation delineates noteworthy associations between gender, marital status, residential locality, and categories of BMI. Specifically, females, individuals with a history of marriage, and urban dwellers exhibit heightened susceptibilities to overweight or obesity compared to their counterparts (Asif *et al.*, 2020). Additionally, Liew (2017) identifies diverse determinants influencing the health and well-being of middle-aged individuals (aged 15 and above) in Indonesia, utilizing data derived from the 2007 Indonesian Family Life Survey (IFLS4). Employing a seemingly unrelated regression analysis, her inquiry investigates the influence of individual attributes such as age, gender, education, and marital status on health outcomes and overall well-being. Furthermore, Liew observes that Indonesian women, smokers, individuals who are divorced or separated, and those with lower educational attainment encounter barriers in accessing adequate healthcare services and achieving socioeconomic prosperity.

Various studies examining the health status of Bangladeshi adults, regardless of gender, utilizing blood pressure as a metric, have identified several key determinants. These include age, gender, overweight or obesity, diabetes, educational attainment, awareness levels regarding hypertension, and residential locale. Females exhibit heightened susceptibility to hypertension compared to males, with factors such as elevated BMI (indicative of overweight or obesity), advanced age, higher educational and socioeconomic status, smoking habit, and the presence of diabetes positively correlating with hypertension risk (Chowdhury *et al.*, 2016; Ghosh *et al.*, 2023; Iqbal *et al.*, 2021; Islam *et al.*, 2020; Khanam *et al.*, 2015; Kibria *et al.*, 2018; Rahman *et al.*, 2021). Furthermore, Sayed *et al.* (2020) investigate the determinants of pre-hypertension and hypertension among ever-married women in Bangladesh, utilizing data from the Bangladesh Demographic and Health Survey (BDHS) of 2011. Their study reveals that employed women exhibit lower odds of developing pre-hypertension and hypertension compared to their non-working counterparts. Notably, educational attainment does not demonstrate significant differences in the prevalence of pre-hypertension and hypertension among women. Additionally, women with a normal weight display a reduced risk of hypertension relative to those who are overweight or obese. Moreover, as women's age cohorts advance, the prevalence of hypertension proportionally increases. These findings emphasize the marked geographic disparities in the prevalence of pre-hypertension and hypertension among women across Bangladesh.

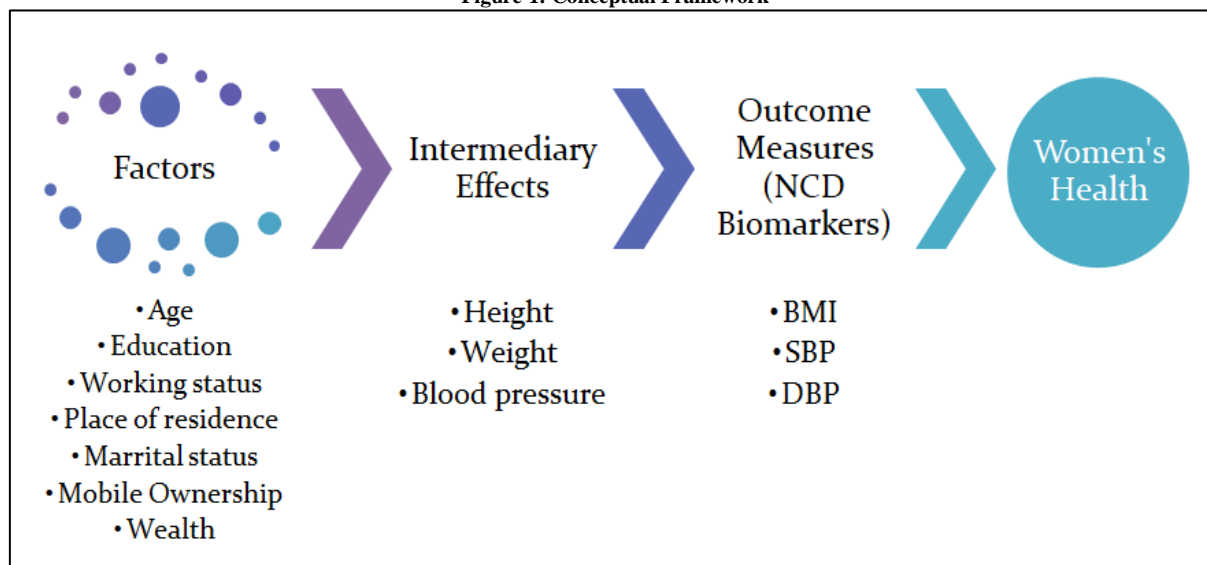
Given this background, this study aims to fill the gap in understanding the socioeconomic factors influencing women's health, particularly across distinct age cohorts and concerning NCD biomarkers. This study will provide a nuanced understanding essential for policy development and interventions aimed at improving women's health outcomes in Bangladesh, thereby contributing to broader societal welfare and socioeconomic advancement.

### 3. Material and Method

#### 3.1. Conceptual Framework

The conceptual framework for this study aims to elucidate the socioeconomic determinants and dynamics of NCD biomarkers of women's health in Bangladesh. This framework is designed to address the research objectives and questions by identifying and analyzing the various socioeconomic factors that influence women's health through their NCD biomarkers and understanding how these factors manifest differently. The conceptual framework can be summarized as follows:

Figure-1. Conceptual Framework



### 3.2. Data and Variables

This study utilized data from the 2017-2018 Bangladesh Demographic and Health Survey. Bangladesh Demographic and Health Survey (BDHS) is a traditional, nationally representative, informative, and cross-sectional survey regarding the health and demographic context in Bangladesh.

**Table-1.** Dataset Information

<b>Households:</b>	<b>Sample Size: 19457</b>
<b>Female:</b>	Ever Married Women
<b>Age:</b>	15 to 49
<b>Sample Size:</b>	20127
<b>Male:</b>	No male respondents
<b>Implementing Organization:</b>	Mitra and Associates (MA)
<b>Fieldwork:</b>	October 2017 - March 2018

Source: (Anonymous, 2020)

This study used Body Mass Index (BMI) and blood pressure measurement as the NCD biomarkers of women to examine the socioeconomic determinants and dynamics of women's health. BMI was calculated through the well-known formula:  $BMI = \text{kg}/\text{m}^2$  where kg is a person's weight in kilograms and  $\text{m}^2$  is the height in meters squared. The calculated BMI served as a measure of health status and was one of the dependent variables in this study. The BMI classification according to WHO and Asia-Pacific guidelines is as follows:

**Table-2.** BMI Classifications

Underweight	< 18.5
Normal	18.5 - 24.9
Overweight	25 - 29.9
Obese	$\geq 30$

Source: World Health Organization Western Pacific Region (2000)

Therefore, this study utilized the above guideline to estimate the multinomial logit model.

The study also used blood pressure measurement as another outcome variable. This measurement was also reported in the 2017-2018 BDHS dataset. The study used optimal, normal, high normal, and hypertension as blood pressure measures according to the guidelines of the International Consortium on Health Outcome Measures (ICHOM) for the Asian population (the systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) as follows to estimate the multinomial logit models:

**Table-3.** Blood Pressure Classifications

<b>Optimal</b>	<b>SBP &lt;120 mmHG and DBP &lt;80 mmHG</b>
Normal	SBP <130 mmHG and/or DBP <85 mmHG
High Normal	SBP 130 - 139 mmHG and/or DBP 85-89 mmHg
Hypertension	SBP > 130 mmHG and/or DBP > 89 mmHG

Source: (Justin et al. (2022))

The independent variables were the respondent's age, education, working status, place of residence, marital status, mobile ownership, and household wealth index. All the variables added have been informed by our literature review and their data comes from the BDHS datasets.

### 3.3. Econometric Model

To examine the determinants and dynamics of NCD biomarkers of women's health the study will use the multinomial logit model. The outcome variable,  $y_i$ , BMI, is one of  $j$  (four) alternatives. The probability that the outcome for individual  $i$  is alternative  $j$ ,  $I$  is conditional on the regressors  $X_i$ , is

$$P_{ij} = \Pr(y_i = j) = F_j(X_i, \Theta), j = 1, 2, 3, 4.$$

where  $F_j(X_i, \Theta)$  is the multinomial logit model with  $X$  regressors.  $X$  is the set of all independent variables.

The multinomial logit model will be estimated by the maximum likelihood estimation technique. The estimated coefficients and marginal effects will be analyzed to answer the research question.

## 4. Results

Table 4 presents the distribution of women's Body Mass Index (BMI) across three age groups (15-29, 30-39, and 40-49 years) and shows that the majority of women fell within the normal weight category (BMI 18.5-25). The youngest age group (15-29) had the highest number of participants (10,082), while the number of women decreased with increasing age. The underweight (BMI < 18.5) and obese (BMI > 30) categories both showed a decreasing trend as age increased. The overweight category (BMI 25-30) remained relatively stable across the age groups but peaked in the 30-39 age group. Overall, the table highlights age-specific health trends, suggesting the need for targeted health interventions.

**Table-4.** Age-specific BMI Trend

Body Mass Index	Age			
	15-29	30-39	40-49	Total
Less Than 18.5	1,339	566	523	2,428
18.5-25	5,623	3,308	2,387	11,318
25-30	1,851	1,997	1,359	5,207
More Than 30	1,269	848	628	2,745
<b>Total</b>	10,082	6,719	4,897	21,698

Table 5 outlines the distribution of blood pressure categories among women in three age groups (15-29, 30-39, and 40-49 years). The data indicates that a significant majority of women across all age groups fell into the hypertension category, with the highest number in the youngest age group (15-29) at 7,943, and this number decreased with age. The number of women with optimal blood pressure also decreased with age, with 1,393 in the 15-29 group and only 350 in the 40-49 group. Normal and high normal blood pressure categories remained relatively low across all age groups, with normal blood pressure being slightly more common than high normal. Overall, the table underscores a high prevalence of hypertension among women, particularly in younger age groups, pointing to a critical public health concern that needs to be addressed through targeted interventions.

**Table-5.** Age-specific Blood Pressure Trend

Blood Pressure	Age			
	15-29	30-39	40-49	Total
Optimal	1,393	716	350	2,459
Normal	557	434	277	1,268
High Normal	189	198	171	558
Hypertension	7,943	5,371	4,099	17,413
<b>Total</b>	10,082	6,719	4,897	21,698

The multinomial logistic regression (mlogit) results in Table 6 display the relationships between various socioeconomic factors and the body mass index (BMI) categories of women, with the "18.5-25" BMI category serving as the reference group. Age, women's education, and wealth were significant predictors across different BMI categories, while employment status was significant only for obesity.

**Table-6.** Multinomial Logit Regression model for outcome variable BMI

	Body Mass Index (BMI)			
	less than 18.5	18.5-25	25-30	more than 30
<b>Age</b>	-0.181**	0	0.366***	0.250***
	(-2.71)	(.)	(7.94)	(4.19)
<b>educ</b>	-0.145*	0	0.110**	0.194***
	(-2.40)	(.)	(2.63)	(3.61)
<b>work</b>	0.0322	0	-0.0278	-0.528***
	(0.35)	(.)	(-0.40)	(-5.50)
<b>resid</b>	-0.00495	0	-0.0385	-0.147
	(-0.05)	(.)	(-0.51)	(-1.53)
<b>Marr</b>	0	0	0	0
	(.)	(.)	(.)	(.)
<b>MobOwn</b>	-0.333	0	0.137	0.249
	(-1.65)	(.)	(0.60)	(0.66)
<b>wealth</b>	-0.253***	0	0.295***	0.481***
	(-6.32)	(.)	(9.94)	(11.55)
<b>_cons</b>	-0.0976	0	-2.569***	-3.632***
	(-0.31)	(.)	(-8.81)	(-8.12)
<b>N=5648</b>	Note: t statistics in parentheses; *** p<0.001      ** p<0.05      * p<0.1			

For BMI less than 18.5 (underweight), compared to a BMI of 18.5-25 (normal weight), the likelihood of being underweight decreased (coefficient = -0.181, p<0.01) with every additional year of age; higher education levels were associated with a lower likelihood of being underweight (coefficient = -0.145, p<0.05), and higher wealth was strongly associated with a lower likelihood of being underweight (coefficient = -0.253, p<0.001). For BMI 25-30 (overweight), older age significantly increased the likelihood of being overweight (coefficient = 0.366, p<0.001), higher education levels significantly increased the likelihood of being overweight (coefficient = 0.110, p<0.01), and higher wealth significantly increased the likelihood of being overweight (coefficient = 0.295, p<0.001). Lastly, for BMI more than 30 (obese), older age significantly increased the likelihood of being obese (coefficient = 0.250, p<0.001), higher education levels significantly increased the likelihood of being obese (coefficient = 0.194,

p<0.001), and higher wealth significantly increased the likelihood of being obese (coefficient = 0.481, p<0.001), compared to a BMI of 18.5-25 (normal weight). Additionally, employment status (working as opposed to not working) significantly decreased the likelihood of being obese (coefficient = -0.528, p<0.001). Hence, age, education, and wealth were significant predictors across different BMI categories, while employment status was significant only for obesity. Wealth consistently increased the likelihood of being in higher BMI categories, indicating a strong correlation between socioeconomic status and body weight among women.

Table 7 shows the relationship between various socioeconomic factors and blood pressure categories (Optimal, Normal, High Normal, and Hypertension). The reference category is ‘Optimal’ blood pressure.

**Table-7. Multinomial Logit Regression model for outcome variable Blood Pressure Group**

	<b>Blood Pressure Group</b>			
	Optimal	Normal	High-Normal	Hypertension
<b>Age</b>	0	0.330***	0.632***	0.828***
	(.)	(6.55)	(9.53)	(16.73)
<b>educ</b>	0	-0.0446	-0.0686	-0.0282
	(.)	(-1.00)	(-1.14)	(-0.64)
<b>work</b>	0	0.0790	-0.0800	-0.309***
	(.)	(1.09)	(-0.80)	(-4.15)
<b>resid</b>	0	-0.0601	0.00323	0.00664
	(.)	(-0.75)	(0.03)	(0.08)
<b>Marr</b>	0	0	0	0
	(.)	(.)	(.)	(.)
<b>MobOwn</b>	0	-0.0160	0.0816	-0.222
	(.)	(-0.08)	(0.27)	(-1.06)
<b>wealth</b>	0	0.0667*	0.133**	0.187***
	(.)	(2.21)	(3.20)	(6.04)
<b>_cons</b>	0	-1.271***	-2.955***	-2.305***
	(.)	(-4.60)	(-7.47)	(-8.18)
<b>N=5648</b>	<i>Note: t statistics in parentheses.</i>			
	*** p<0.001		** p<0.05	* p<0.1

Older age was associated with a higher likelihood of having normal blood pressure compared to optimal blood pressure (coefficient = 0.330, p<0.001). This is consistent with the natural aging process, which often leads to increases in blood pressure. The likelihood of having high normal blood pressure increased significantly with age (coefficient = 0.632, p<0.001). This reflects the progressive nature of blood pressure changes as individuals age. Age was a strong predictor of hypertension, with older individuals much more likely to be hypertensive (coefficient = 0.828, p<0.001). This is due to cumulative lifestyle factors, decreased arterial elasticity, and other age-related physiological changes.

Employment was negatively associated with hypertension (coefficient = -0.309, p<0.001). Working individuals may have better access to healthcare, more regular routines, and potentially less time to engage in behaviors that elevate blood pressure, such as excessive eating and sedentary activities.

Higher wealth slightly increased the likelihood of having normal blood pressure compared to optimal blood pressure (coefficient = 0.0667, p<0.1). Wealthier individuals may have better access to healthcare but also more lifestyle factors (e.g., diet, sedentary behavior) that elevate blood pressure. Higher wealth significantly increased the likelihood of having high normal blood pressure (coefficient = 0.133, p<0.01). This could be due to higher stress levels, richer diets, and other lifestyle factors associated with higher socioeconomic status. Wealth was strongly associated with a higher likelihood of hypertension (coefficient = 0.187, p<0.001). Wealthier individuals might have lifestyles that include higher consumption of rich foods and lower levels of physical activity, contributing to higher blood pressure.

Hence, the regression results illustrate how age and wealth were significant predictors of higher blood pressure categories, reflecting the natural progression of blood pressure with age.

## 5. Discussion

Age plays a critical role in BMI, with younger women more likely to be underweight and older women more likely to be overweight or obese due to metabolic and lifestyle changes. This dichotomy may be due to the fact that younger women are more likely to have higher metabolic rates and more active lifestyles, whereas as women age, they are more likely to have decreasing metabolic rates, reduced physical activity, hormonal changes, and lifestyle shifts that often include more sedentary behaviors and higher caloric intake.

The effect of education on women of different age brackets is even more interesting here as higher education leads to a higher likelihood of being underweight in younger women and an increased likelihood of overweight and obesity in older women. Although contradictory, this effect may be explained by the positive effect of education on nutritional knowledge and women’s job opportunities. Educated women tend to have better knowledge of nutrition, access to healthier food options, and health-conscious behaviors, thus leading to the probability of being underweight when younger. Concurrently, as women get aged, higher education may lead to more sedentary jobs,

higher disposable incomes leading to increased food consumption, and potential lifestyle factors that include less physical activity.

Employment status influences BMI for obesity, where working women have structured routines and potentially higher levels of physical activity compared to non-working women that may protect against obesity.

Wealth determines access to food and lifestyle choices, with higher wealth associated with greater access to high-calorie foods and processed options, and more sedentary lifestyles, contributing to weight gain (increasing overweight and obesity), and lower wealth is linked to a lack of access to sufficient and nutritious food (leading to undernutrition).

Similarly, for hypertension, as people age, the likelihood of having normal blood pressure (rather than optimal) increases due to natural physiological changes. Aging arteries and increased vascular resistance contribute to this trend. The likelihood of high normal blood pressure increases with age due to cumulative lifestyle factors such as diet, physical inactivity, and stress, which negatively affect cardiovascular health. Notably, older age is strongly associated with hypertension, which may be due to factors associated with aging, such as - the progressive stiffening of arteries, increased prevalence of comorbidities, and prolonged exposure to risk factors such as poor diet and lack of physical activity.

Employment is associated with a lower likelihood of hypertension possibly because employed individuals might have better access to healthcare services, more structured daily routines, and possibly healthier lifestyles due to workplace wellness programs and insurance benefits.

Higher wealth slightly increases the likelihood of having normal blood pressure, possibly because wealthier individuals have better access to healthcare and preventive services that help maintain blood pressure within a normal range. Higher wealth significantly increases the likelihood of having high normal blood pressure. This may be due to lifestyle factors associated with wealth, such as higher stress levels, richer diets, and more sedentary behavior, which can contribute to elevated blood pressure. The strong association between higher wealth and hypertension could be explained by similar lifestyle factors: stress from high-pressure jobs, dietary habits that include higher salt and fat intake, and lower physical activity levels, which are more prevalent among wealthier individuals. Education levels do not show significant effects on blood pressure in this context, suggesting that other factors like lifestyle, genetic predispositions, and direct access to health resources may play more critical roles in determining blood pressure levels.

These findings highlight the complex interplay of age, wealth, and other socioeconomic factors in influencing blood pressure levels. While age naturally predisposes individuals to higher blood pressure due to physiological changes, wealth influences blood pressure through lifestyle factors and access to healthcare. Employment appears protective against hypertension, possibly due to associated health benefits and structured lifestyles, while education, marital status, residence, and mobile phone ownership show less direct impact in this context.

## 6. Conclusion

This study comprehensively examines the impact of socioeconomic factors on the health of women in Bangladesh, focusing on two critical NCD biomarkers: Body Mass Index (BMI) and blood pressure. The analysis provides significant insights into how age, education, employment status, residence, marital status, mobility ownership, and wealth influence these health outcomes.

The study's findings on BMI reveal distinct socioeconomic determinants across different BMI categories. For women with a BMI less than 18.5 (underweight), age and education are negatively correlated, suggesting that younger and less educated women are more likely to be underweight. Wealth also negatively affects this category, indicating that poorer women have a higher likelihood of being underweight. For women with a BMI of 25-30 (overweight) and more than 30 (obese), age, education, and wealth have significant positive correlations. Older, more educated, and wealthier women are more likely to fall into these BMI categories. Employment status negatively impacts BMI in the obese category, implying that employed women are less likely to be obese, possibly due to the structured lifestyle and better healthcare access associated with employment.

The findings on blood pressure levels reinforce the socioeconomic influences observed with BMI. Age is a significant determinant of higher blood pressure levels. Older women are more likely to experience high normal blood pressure and hypertension. This pattern aligns with physiological changes associated with aging, such as arterial stiffening. Wealth positively correlates with higher blood pressure categories, including high normal and hypertension. This can be attributed to lifestyle factors prevalent among wealthier individuals, such as diets high in fats and salts and higher stress levels. Employment status shows a protective effect against hypertension, highlighting the health benefits of structured work routines and access to health resources.

The combined analysis of BMI and blood pressure indicates that age and wealth are critical determinants of both indicators. Older and wealthier women are at a higher risk of being overweight, obese, and hypertensive. This underscores the need for targeted public health interventions that address lifestyle modifications, stress management, and improved healthcare access for these demographics. Employment status emerges as a protective factor for both BMI and blood pressure, emphasizing the role of structured lifestyles and workplace wellness programs in promoting better health outcomes. Education also plays a crucial role, particularly in preventing underweight conditions and managing obesity.

The study's findings suggest that public health policies should focus on age-specific interventions to manage and prevent hypertension and obesity among older women, promote health education and lifestyle modifications among wealthier individuals, enhance workplace wellness programs to leverage the protective effects of employment on health, and increase educational initiatives to raise awareness about healthy living and preventive healthcare. These

targeted strategies can address the socioeconomic determinants of health, improving NCD biomarker outcomes for women across different age groups and economic backgrounds in Bangladesh.

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We are grateful to the authority of DHS for allowing us access to the 2017–18 DHS dataset for Bangladesh.

## Availability of Data and Materials

The dataset utilized in this study (BDHS 2017-18) is openly available at the DHS website at the following link: [https://dhsprogram.com/data/dataset/Bangladesh\\_Standard-DHS\\_2017.cfm?flag=0](https://dhsprogram.com/data/dataset/Bangladesh_Standard-DHS_2017.cfm?flag=0)

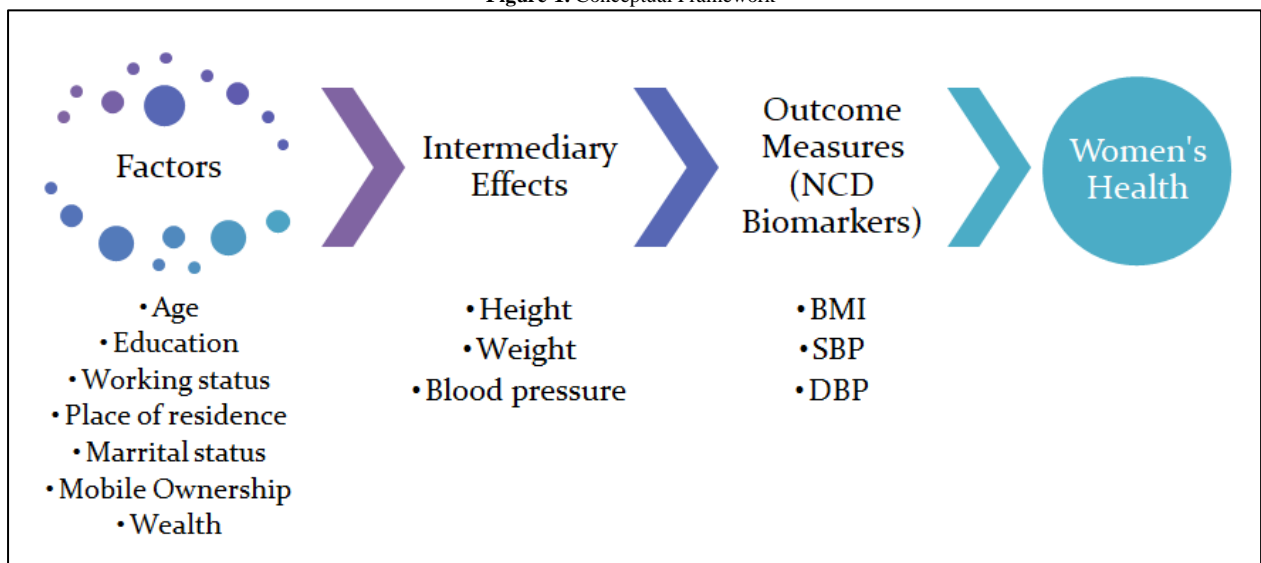
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Figure-1. Conceptual Framework



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