Investigate the Effect of Diabetes on Hypertension based on Bangladesh Demography and Health Survey, 2017-18

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Article

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Abstract

Background and objectives: Hypertension is a major public health problem with raising its prevalence and effect among adults overtime worldwide, especially in Bangladesh. The aim is to investigate the effect of diabetes on hypertension.

Materials and methods: The dataset used in this study was extracted from Bangladesh Demographic Health Survey, 2017-18 having a total of 6,965 (male: 3,376 and female: 3,589) adults whose ages were B35 years. Bivariate analysis along with Pearson's chi-square test was executed to observe the association between different selected factors and hypertension. Additionally, binary logistic regression was employed to investigate the effect of diabetes on hypertension based on adjusted odds ratio (AOR) along with p-value in Bangladesh.

Results: The results of the study revealed that average age of the participants was 51.04a12.731 and a total of 34.7 percent participants were identified as hypertension. Logistic regression analysis demonstrated that diabetic patients were 1.280 times (95% CI of AOR: 1.107-1.479; p-value=0.001) higher risk of hypertension compared to non-diabetic. Furthermore, our finding's also showed that diabetic patient who was 35–49 years age, 1.462 times (95% CI of AOR: 1.182-1.807; p-value=0.000) higher risk of hypertension compared to age groups ≥50 years.

Conclusions: Based on the results, this study claimed that people with diabetes was significantly associated with hypertension. This study suggested greater attention of government and policymakers to make appropriate strategies to reduce hypertension as well as associated risk in Bangladesh.

1 Introduction

Hypertension is a major public health problem with raising its prevalence and effect among adults overtime worldwide [1-4]. It is one of the most common serious non-communicable diseases in which blood pressures level is high and as a result people are affected different cardiovascular diseases (CVDs) [5]. High blood pressure affects many major organs and increases high risk of chance of heart disease and stroke [6]. According to the World Health Organization (WHO), around 17 million people were died across the world due to CVDs and 9.4 million people were directly died in caused of hypertension [7]. Globally the prevalence of hypertension was 26% in 2000 and it will be projected to 29.2% in 2025 [8]. In case of Bangladesh, there were 26% hypertensive people in 2011 and 40% in 2018 whose age were greater than 35 years [9]. At the same time and same age groups, the numbers of diabetic people were also increased from 11% to 14% [10].

Thus, people with hypertension and diabetes have been increased alarmingly for both develop and developing countries including Bangladesh [8]. Generally, non-communicable disease (NCD) like hypertension is not completely predictable and preventable but early identification and preventive behavior of the significant risk factors for NCD can be diminished the risk of developing CVDs by 80% and type 2 diabetes by 90% [10]. However, many researchers conducted his/her study on hypertension to examine the prevalence, treatment, control, and associated risk factors in different countries based on different hypertension datasets but they did not investigate the effect of diabetes on hypertension [11-15]. The main objectives were (i) to investigate the effect of diabetes on hypertension; and (ii) also investigate the effect of diabetes on hypertension by age groups as 35-49, and 50 years.

The overall layout of this paper was organized as follows. Section 2 represents the materials and methods including data source and study design, and statistical analysis. The results were discussed in section 3. Section 4 represented the discussion in detail and finally, the conclusion was presented in section 5.

2 Materials And Methods

2.1 Data source and study design

The dataset was extracted from Bangladesh demographic and health survey (BDHS), 2017-18. The BDHS dataset, two-stage stratified cluster sampling was performed to collect the samples from different households [16]. In the first stage of sampling,

a total of 675 sampling units (urban: 250 and rural: 425) were selected with the equal probability proportional to the EA size (average 120 households per EAs). In the second stage of sampling, sample of the 30 households were selected by systematic random sampling from each EA. Based on the sampling design, 20,160 (rural: 12,690, and urban: 7,470) residential households were selected. Among them, 19,457 households were interviewed successfully containing a total of 89,819 household members [16]. For measuring biomarker information, one-fourth eligible households were selected, and these subsamples were included 7,133 (Men: 3,478 and women: 3,655) household members aged ≥35 years [1]. Excluding the missing values and non-responders, about 6,965 (men: 3,376 and women: 3,589) respondents were selected for final analysis. The sample selection procedure and sample sizes were displayed in Figure 1.

2.2 Study variable

The response variable in our study was hypertension. Hypertension was defined based on American Heart Association (AHA) guidelines [9]. The respondents were identified as hypertension if they met with the following criteria as systolic blood pressure (SBP) ≥140 mmHg and/or, diastolic blood pressure (DBP) ≥ 90 mmHg and/or taking antihypertensive medication during the survey [17].

2.3 Risk factors

In this study, 13 factors were selected for hypertension based on previous studies [18-23]. These factors were age, sex, marital status, education level, working status, physical activity, region, residence, wealth index, family size, smoking status, BMI and diabetes. The physical activity variable was not directly available in BDHS, 2017-18. For this reason, the occupation type was used as a proxy variable for measuring physical activity [24]. A respondent was considered physically active if his/her work liability includes physical activity related works; otherwise they were physically inactive [24]. The physically active group consisted of farmer; agricultural worker; fisherman; cattle raising, poultry raising; home based manufacturing; rickshaw driver, road building, brick breaking, construction worker; domestic servant; and factory worker, on the contrarily, the physically inactive group consisted of not working; land owner; carpenter, tailor; doctor, nurse, dentist, lawyer, accountant, teacher; businessman; unemployed/student; and retired person. Wealth index was computed based on principal component analysis (PCA) from the poorest to the richest levels [9]. Body mass index (BMI) was classified as underweight (BMI<18.5 kgm^{-2}), normal (18.5-24.9 kgm^{-2}), overweight (25.0-29.9 kgm^{-2}) and obese (BMI30 kgm^{-2}) [25]. We merged two groups, namely overweight and obese and then considered one category as overweight/obese. In this study, World Health Organization (WHO) cut-off points were used for measuring fasting plasma blood glucose. An individual with fasting plasma glucose values of 7.0 mmol/L (126 mg/dl) or above is considered as having diabetes otherwise non-diabetes [25, 26]. Detail descriptions along with the categorization of the selected factors were shown in Table 1.

Table 1. Definition and categorization of the selected factors in the study

SN	Factors	Data types	Categorization
R1	Age (years)	Categorical	35-49 and ≥50
R2	Sex	Categorical	Male and Female
R3	Marital status	Categorical	Never married, Married, Widowed, and Divorced
R4	Education	Categorical	No education, Primary, Secondary and Higher
R5	Working status	Categorical	No and Yes
R6	Physical activity		Inactive and Active
R7	Region	Categorical	Barisal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, and Sylhet
R8	Residence	Categorical	Urban and Rural
R9	Wealth index	Categorical	Poorest, Poorer, Middle, Richer, and Richest
R10	Family size	Categorical	1-3, 4-6, and 7 and 7+
R11	Smoking status	Categorical	No and Yes
R12	BMI (kg/m^2)	Categorical	Underweight, Normal, and Overweight/Obese
R13	Diabetes	Categorical	No and Yes

2.4 Statistical analysis

The background characteristics of the study population were presented as numbers (%) for the selected factors. Pearson's Chi-square ($\chi 2$) test was performed to assess the association between different selected factors and hypertension. Finally, binary logistic regression model was employed to investigate the effect of diabetes on hypertension. The results of the binary logistic regression analyses was presented using crude odds ratio (COR) and adjusted odds ratios (AOR) along with 95% confidence intervals (CIs). A variable with a p-value<0.05 in the bivariate analysis is considered statistically significant at 5% level of significance and thus, included in the final LR model. All statistical analysis was performed by using Stata version 14.

3 Results

3.1 Background characteristics of the study participants

Figure 1 displayed the rate of having diabetes and hypertension. Among 6,965 respondents, 18.9 percent diabetes respondents were hypertension, on the contrarily, 13 percent diabetes respondents were non-hypertension. Therefore, the rate of having hypertension among diabetes respondents was higher compared to non-hypertension respondents.

The background characteristics of the study participants were presented in Table 2. The average age of the participants was 51.04 12.731. More than half (51.5 percent) of the participants were female and 48.5 percent were male. About 84.2 percent participants were married with having no education and they were physically inactive. Most of the respondents were taken from rural area and belong to richest wealth index quintile. Based on the BMI, 17.1 percent respondents were underweight, 56.5 percent normal and 26.4 percent overweight/obese. With regard to diabetes status as measured by FPG, 15.0 percent participants were diabetic, and 85.0 percent non-diabetic. The majority of the respondents (78.0 percent) were nonsmoker and having 4-6 family members. Table 2 showed that 34.7 percent participants were hypertension. It was also observed that 59.2 percent participants having age range years were higher hypertensive compared with the age ranges 35-49 years, and the association was statistically significant (p-value<0.01). Female respondent was more likely to having hypertension than male.

The association between sex and hypertension was significantly significant. A total of three-fourth (78.9 percent) hypertension respondents were married. Regarding to the education level, more than one-third (38.7 percent) hypertension respondents were no education, (30.1 percent) primary education, (20.5%), secondary education, and (10.7 percent) higher education and their association was statistically significant.

Table 2. Background characteristics of the study participants

Factors	Overall, n (%)	Hypertension status		-Value	p-value[1]
		Hypertension, n (%)	No-hypertension, n (%)		
Overall		2415(34.7)	4550(65.3)		
Age				184.404	<0.001
35-49 years	3618(51.9)	985(40.8)	2633(57.9)		
years	3347(48.1)	1430(59.2)	1917(42.1)		
Sex				29.916	<0.001
Male	3376(48.5)	1062(44.0)	2314(50.9)		
Female	3589(51.5)	1353(56.0)	2236(49.1)		
Marital status				90.085	<0.001
Never married	24(0.30)	5(0.20)	19(0.40)		
Married	5863(84.2)	1905(78.9)	3958(87.0)		
Widowed	965(13.9)	463(19.2)	502(11.0)		
Divorced	113(1.60)	42(1.70)	71(1.60)		
Education level				9.087	0.028
No education	2678(38.4)	934(38.7)	1744(38.3)		
Primary	2242(32.2)	728(30.1)	1514(33.3)		
Secondary	1349(19.4)	494(20.5)	855(18.8)		
Higher	696(10.0)	259(10.7)	437(9.60)		
Working status				88.232	<0.001
No	2385(34.2)	1004(41.6)	1381(30.4)		
Yes	4580(65.8)	1411(58.4)	3169(69.6)		
Physical activity				89.656	<0.001
Inactive	4021(57.7)	1580(65.4)	2441(53.6)		
Active	2944(42.3)	835(34.6)	2109(46.4)		
Region				26.184	<0.001
Barisal	760(10.9)	286(11.8)	474(10.4)		
Chattogram	889(12.8)	318(13.2)	571(12.5)		
Dhaka	872(12.5)	300(12.4)	572(12.6)		
Khulna	1043(15.0)	367(15.2)	676(14.9)		
Mymensingh	817(11.7)	236(9.80)	581(12.8)		
Rajshahi	890(12.8)	321(13.3)	579(12.5)		
Rangpur	922(13.2)	350(14.5)	572(12.6)		
Sylhet	772(11.1)	237(9.80)	535(11.8)		
Residence				6.459	0.011

Urban	2411(34.6)	884(36.6)	1527(33.6)		
Rural	4554(65.4)	1531(63.4)	3023(66.4)		
Wealth index				71.002	<0.001
Poorest	1391(20.0)	409(16.9)	982(21.6)		
poorer	1331(19.1)	397916.4)	934(20.4)		
Middle	1372(19.7)	474(19.6)	898(19.7)		
Richer	1299(18.7)	473(19.6)	826(18.2)		
Richest	1572(22.6)	662(27.4)	910(20)		
Family size				15.667	<0.001
1-3	1547(22.2)	594(24.6)	953(20.9)		
4-6	3814(54.8)	1252(51.8)	2562(56.3)		
7 and 7+	1604(23.0)	569(23.6)	1035(22.7)		
Smoking status				5.386	0.020
No	5436(78.0)	1923(79.6)	3513(77.2)		
Yes	1529(22.0)	492(20.40	1037(22.8)		
BMI(Kg/m^2)				184.185	<0.001
Underweight	1169(17.1)	282(11.8)	887(19.9)		
Normal	3970(56.5)	1253(52.6)	2617(58.6)		
Overweight/Obese	1811(26.4)	848(35.6)	963(21.6)		
Diabetes				42.894	<0.001
No	6918(85.0)	1959(81.1)	3959(87.0)		
Yes	1047(15.0)	456(18.9)	591(13.0)		

About 58.4 percent hypertension respondents having working status and (34.6 percent) were physical active. Working status and physical activity were also significantly associated with hypertension. It was observed that the maximum number of the hypertension respondents taken from rural area and having richest wealth index quintile. The association between residence, wealth index and hypertension were statistically significant. Most of the hypertension respondents were non-smoker than their counterparts and the association was also significant. The higher percentage (51.8 percent) of respondent having hypertension those families whose family members 4 to 6 and the association between family size and hypertension were statistically significant. Among the hypertensive respondents, only 11.8 percent was underweight, 52.6 percent normal and 35.6 percent overweight/ obese and their association was statistically significant. According to FPG, 18.9 percent hypertension respondents having diabetes compared to their counterpart and the association between diabetes and hypertension was statistically significant. Table 2 also represented that region, residence, and wealth index were significantly associated with hypertension.

3.2 Association between different selected factors and hypertension by age groups

Table 3 represented the association between different selected factors and hypertension by age groups (35-49 and 50 years). It was observed that sex, education level, working status, physical activity, wealth index, family size, smoking status, BMI, and diabetes were significantly associated with hypertension while the rest of the factors marital status, region, residence were

statistically insignificant for age group 35-49 years. On the contrary, it was noted that sex, marital status, education level, working status, physical activity, region, residence, wealth index, smoking status, BMI, and diabetes were significantly associated with hypertension whereas family size was insignificantly associated with hypertension for the respondents who age were 50 years.

Table 3. Association between selected factors and hypertension by age groups

Factors		35-49 years				>=50 years		
	Overall, n (%)	Hypertension, n(%)	-Value	p-value[1]	Overall, n (%)	Hypertension, n (%)	-Value	p-value[1]
Sex			37.381	<0.001			9.773	0.002
Male	1640(45.3)	365(37.1)			1736(51.9)	697(48.7)		
Female	1978(54.7)	620(62.9)			1611(48.1)	733(51.3)		
Marital status			2.540	0.468			32.114	<0.001
Never married	20(0.60)	3(0.30)			4(0.10)	2(0.10)		
Married	3389(93.7)	919(93.3)			2474(73.9)	986(69.0)		
Widowed	146(4.00)	45(4.60)			819(24.5)	418(29.2)		
Divorced	63(1.70)	18(1.80)			50(1.50)	24(1.70)		
Education level			11.034	0.010			12.026	0.007
No education	1031(28.5)	250(25.4)			1647(49.2)	684(47.8)		
Primary	1295(35.8)	343(34.8)			947(28.3)	385(26.9)		
Secondary	835(23.1)	254(25.8)			514(15.4)	240(16.8)		
Higher	457(12.6)	138(14.0)			239(7.10)	121(8.50)		
Working status			13.067	<0.001			33.454	<0.001
No	897(24.8)	286(29.0)			1488(44.5)	718(50.2)		
Yes	2721(75.2)	699(71.0)			1869(55.5)	712(49.8)		
Physical activity			24.126	<0.001			45.473	<0.001
Inactive	1915(52.9)	587(59.6)			2106(62.0)	993(69.4)		
Active	1703(47.1)	398(40.4)			1241(37.1)	437(30.6)		
Region			14.086	0.050			20.702	0.004
Barisal	383(10.6)	108(11.0)			377(11.3)	178(12.4)		
Chattogram	453(12.5)	127(12.9)			436(13.0)	191(13.4)		
Dhaka	490(13.5)	138(14.0)			382(11.4)	162(13.3)		
Khulna	548(15.1)	152(15.4)			495(14.8)	215(15.0)		
Mymensingh	377(10.4)	87(8.80)			440(13.1)	149(10.4)		
Rajshahi	469(13.0)	128(13.0)			421(12.6)	173(13.5)		
Rangpur	483(13.3)	153(15.5)			439(13.1)	197(13.8)		
Sylhet	415(11.5)	92(9.3)			357(10.7)	145(10.1)		
Residence			2.800	0.094			9.109	0.003
Urban	1342(37.1)	387(39.3)			1069(31.9)	497(34.8)		
Rural	2276(62.9)	598(60.7)			2278(68.1)	933(65.2)		
Wealth index			49.864	<0.001			31.990	<0.001

Poorest	714(19.7)	147(14.9)			677(20.2)	262(18.3)		
Poorer	695(19.2)	150(15.2)			636(19.0)	247(17.3)		
Middle	698(19.3)	201(20.4)			674(20.1)	273(19.1)		
Richer	678(18.7)	204(20.7)			621(18.6)	269(18.8)		
Richest	833(23.0)	283(28.7)			739(22.1)	379(26.5)		
Family size			10.381	0.006			0.860	0.650
1-3	771(19.9)	230(23.4)			826(24.7)	364(25.5)		
4-6	2164(59.8)	557(56.5)			1650(49.3)	695(48.6)		
7 and 7+	733(20.3)	198(20.1)			871(26.0)	371(25.9)		
Smoking status			7.401	0.007			6.681	0.010
No	2968(82.0)	836(84.9)			2468(73.7)	1087(76.0)		
Yes	650(18.0)	149(15.1)			879(26.3)	343(24.0)		
BMI(Kg/m^2)			181.845	<0.001			95.664	<0.001
Underweight	418(11.8)	46(4.70)			751(22.8)	236(16.7)		
Normal	1985(55.9)	454(46.9)			1885(57.1)	799(56.5)		
Overweight/Obese	1148(32.3)	469(48.4)			663(20.1)	379(26.8)		
Diabetes			33.020	<0.001			9.225	0.002
No	3125(86.4)	798(81.0)			2793(83.4)	1161(81.2)		
Yes	493(13.6)	181(19.0)			554(16.6)	269(18.8)		

3.3 Effect of diabetes on hypertension

The main purpose of this study was to investigate the effect of diabetes on hypertension. For the study purpose, we considered two logistic regression models, namely Model-I and Model-II. In Model-I, only diabetes was treated as an explanatory variable and hypertension as outcome variable. We calculated the crude odds ratio (COR) along with 95% confidence interval from Model-I. In Model II, we adjusted the significant factors as age, sex, marital status, education level, working status, physical activity, region, residence, wealth index, family size, smoking status, BMI which were statistically significant in Table 2. The result of two logistic regression models was presented in Table 4. From Model-I, it was observed that the factor of diabetes showed a significant impact on hypertension. The COR was 1.599 (95% CI of COR: 1.364, 1.782) that means the diabetic respondents were 1.599 times higher risk of hypertension than non-diabetic respondents. In Model II, the AOR was 1.280 (95% CI of AOR: 1.107, 1.479; p-value: 0.001) implies that the diabetic respondents were 1.280 times higher risk of hypertension than non-diabetic respondents after adjusting the significant risk factors. So, we may conclude that diabetes had a significant effect on hypertension.

Table 4. Effect of diabetes on hypertension

Factors	Model I				Model II			
	COR	p-value	95% CI of COR		AOR	p-value	95% CI of AOR	
			Lower	Upper			Lower	Upper
Diabetes								
No (Ref)	1.000	-	-	-	1.000	-	-	-
Yes	1.599	0.000	1.364	1.782	1.280	0.001	1.107	1.479

COR: Crude odds ratio; p-value: probability value; AOR: adjusted odds ratio. Age, sex, marital status, education level, working status, physical activity, region, residence, wealth index, family size, smoking status, and BMI were adjusted in Model II.

3.4 Effect of diabetes on hypertension by age groups (35-49 and 50 years)

The effect of diabetes on hypertension by age groups 35-49 and 50 years was presented in Table 5. Model-I showed that diabetes had a significant impact on hypertension for age groups as 35-49, and 50 years. It was also noted that the COR was higher (COR: 1.768) for the respondents whose age group 35-49 years. That means the diabetic respondents whose age were 35-49 years had the higher risk of hypertension compared to the respondents who was the age 50 years. We adjusted the factors in Model-II which were showed statistically significant at 5% level of significance in Table 3. Model-II revealed that the factor of diabetes was also a significant effect on hypertension whose age was 35-49 years.

Table 5. Effect of diabetes on hypertension by age groups as 35-49 and 50 years

Age (years)	Factors	Model I				Model II			
		COR	p- value	95% CI of COR		AOR	p- value	95% CI of AOR	
				Lower	Upper			Lower	Upper
35-49	**Diabetes**								
	No (Ref)	1.000	-	-	-	1.000	-	-	-
	Yes	1.782	0.000	1.461	2.174	1.462	0.000	1.182	1.807
50	**Diabetes**								
	No (Ref)	1.000	-	-	-	1.000	-	-	-
	Yes	1.327	.002	1.105	1.593	1.142	0.184	0.939	1.390

COR: Crude odds ratio; p-value: probability value; AOR: adjusted odds ratio. Sex, education level, working status, physical activity, wealth Index, family size, smoking status, and BMI were adjusted in Model II.at age group 35-49 years; Sex, marital status, education level, working status, physical activity, region, residence, wealth Index, family size, smoking status, and BMI were adjusted in Model II at age group ≥ 50 years.

4 Discussion

The present study was conducted based on BDHS, 2017-18, and consisted of 6,965 adults aged 35 years in Bangladesh. This study revealed that the overall prevalence of hypertension was 34.7 percent, which was coincided with the previous studies [18]. However, the purpose of the current study was to investigate the effect of diabetes on hypertension. For the purpose of the

current study, first, we conducted the bivariate analysis along with Pearson's Chi-square ($\chi 2$) test, and then binary logistic regression analysis was performed. From the bivariate analysis, it was observed that the female respondents were more hypertension than male. The association between sex and hypertension was statistically significant which reported similar findings in previous studies [27, 28]. Besides the factor of sex of the respondents, other risk factors such as age, marital status, education level, working status, physical activity, region, residence, wealth index, family size, smoking status, BMI, and diabetes were also significantly associated with hypertension, which were coincided with the earlier studies [18, 27-36]. To investigate the effect of diabetes on hypertension, we adopted two logistic regression models, namely Model-I and Model-II. In Model-I and Model-II, it was observed that the diabetic respondents was the higher risk of hypertension than the non-diabetic respondents. Similar results were found in a recent study [37] and another study conducted by the WHO in India and Bangladesh [38]. Additionally, the effect of diabetes on hypertension at differential by age groups (35-49 and 50 years) was investigated using two logistic regression models such as Model-I and Model-II. Form Model-I, it was observed that the COR of 1.782 and 1.327 for the age groups 35-49 and 50 years, respectively and confirmed that a participant having diabetes, the rate of developing hypertension was higher compared to a participant has no diabetes for age groups 35-49 years. Model-II revealed that the AOR of 1.462 and 1.142 for age group 35-49 and 50-64 years, respectively and demonstrated that the factor of diabetes was also a significant impact on hypertension for the respondents who were the age group 35-49 years.

4.1 Limitation and extension of the Study

Although this study was several strengths, it was not free limitations. The dataset used this study was cross sectional. Further, we may use another regressions such as multivariate proportional hazards models, step-wise regression, and multilevel logistic regression instead of multiple logistic regressions. We will want to predict hypertension by using machine learning based techniques such as Linear discriminant analysis (LDA), Naïve Bayes (NB), Support vector machine (SVM), Decision tree(DT), Random forest(RF), Gaussian process classification (GPC), Artificial neural network (ANN), Convolutional neural network (CNN), and Fast neural network (FNN),

5 Conclusion

In conclusion, our objective was that to investigate the effect of diabetes on hypertension among adults aged 35 years based on BDHS, 2017-2018 data. Using Pearson's chi-square criteria, this study revealed that age, sex, marital status, education level, working status, physical activity, region, residence, wealth index, family sizes, smoking status, BMI and diabetes were the significant risk factors of hypertension. The result of the logistic regression analysis was demonstrated that people with diabetes were significantly more likelihood to develop hypertension. The result of the logistic regression analysis also confirmed that the participants who had diabetes along with age group 35–49 years were the higher odds of having hypertension than the age groups 50 years. Finally, the findings of the study suggested greater attention of government and policymakers to make appropriate decisions to reduce hypertension as well as associated risk in Bangladesh.

Declarations

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Authors' contributions

Md. Merajul Islam: Data analysis & draft the original manuscript; Md. Jahanur Rahman: Acquisition of data, interpretation of the results and design the manuscript; Most.Tawabunnahar: Review & editing; Md. Menhazul Abedin: English proofing, strategy, and interpretation data; Md. Maniruzzaman: Principle investigator (PI) of the project.

Ethical approval

This study used secondary data which was provided by Bangladesh Demographic and Health Survey (DHS) 2017-18. The ethical clearance for BDHS, 2017-2018 data collection was taken from the ICF International's Institutional Review Board (IRB). The survey ensured international ethical standards of confidentiality, anonymity, and informed consent. Data authorization letter was performed DHS program CEF international and details are available as: *https://www.dhsprogram.com/What-We-Do/Protecting-the-Privacy-of-DHS-Survey Respondents.cfm.*

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Conflict of interest

The authors declare no conflict of interest.

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Figures

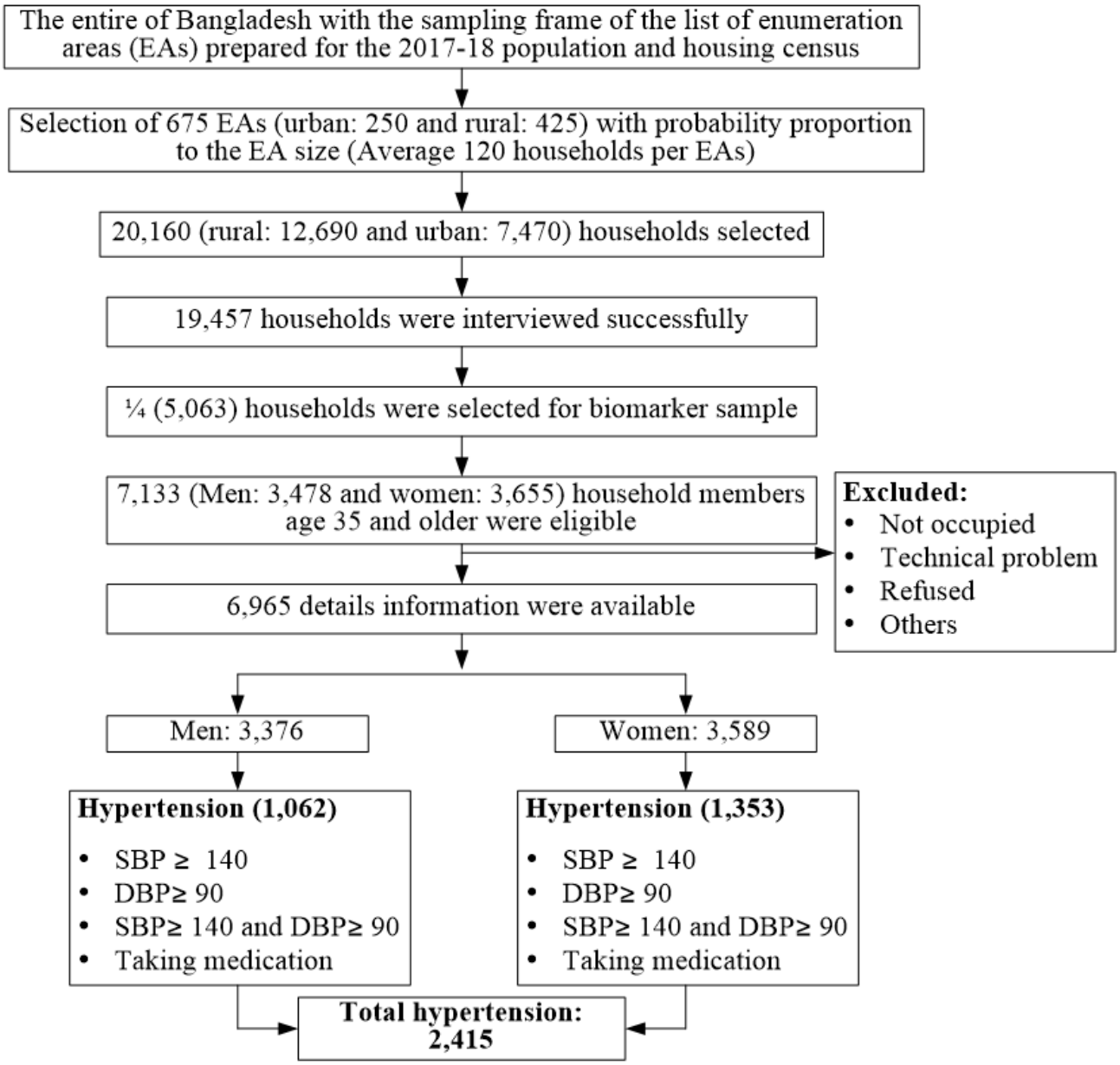

Figure 1

Sampling process and sample sizes

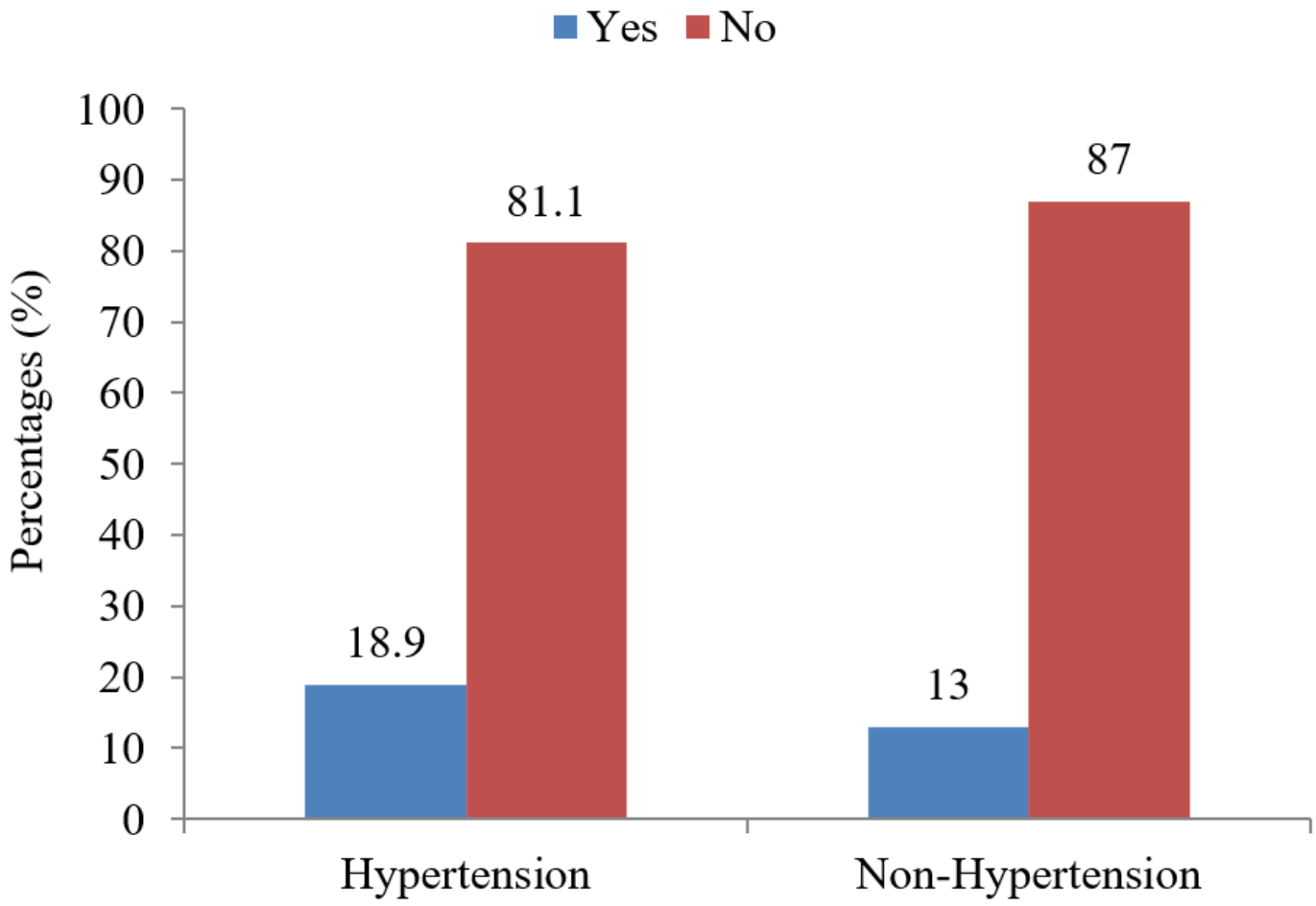

Figure 2

Comparison between prevalence of having diabetes and hypertension