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Gender differences in hypertension-free life expectancy in Bangladesh

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Abstract: In Bangladesh, although some research on health expectancy exists, life expectancies with and without hypertension (HTN) have never been computed. We examined gender differences in the prevalence of hypertension and Hypertension-Free Life Expectancy (HFLE) in Bangladesh. We used data from a nationally representative survey of 7,864 people aged 35 and older. We classified an individual as having HTN if s/he had blood pressure levels ≥140 mmHg systolic blood pressure or ≥90 mmHg diastolic blood pressure, or s/he was at the time on antihypertensive medication. The Sullivan method was employed to compute HFLE. We found that women have HTN in significantly higher percentages (32% of women vs. 19% of men), and the prevalence of HTN increases as age increases for both men and women. Among individuals with HTN, individuals unaware of HTN make up the largest group, followed by those with uncontrolled HTN, controlled HTN, and those who are aware of HTN but not in treatment. Compared with men, women could expect shorter HFLE at all ages, in terms of both number and proportion of years. To increase HFLE as well as quality of life and to prevent and control HTN in general and unawareness of HTN and uncontrolled HTN in particular, special care and attention should be given to women and older adults. The findings shed important light on the role of HTN in lowering the quality of life in Bangladesh.

Keywords: *hypertension; gender disparities; health expectancy; hypertension-free life expectancy; Bangladesh*

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1 Introduction

Life expectancy (LE) is increasing all over the world (Riley, 2005), but it does not mean a healthier population (Crimmins, Hayward, and Saito, 1994; Jagger, Gillies, Moscone *et al.*, 2008; Robine, Jagger, Mathers *et al.*, 2003) . When people live longer, quality of life becomes a central issue (Liu, Chen, Song *et al.*, 2009), and the health expectancy of a population can be computed to provide an estimate of its quality of life. Health expectancy measures were developed to add a quality-of-life aspect to life expectancy measures (Sanders, 1964). They are very useful in monitoring population health (Saito, Qiao, and Jitapunkul, 2003; Saito, Robine, and Crimmins, 2014; Stiefel, Perla, and Zell, 2010) and should be linked to population and health policy-making in the new era (Saito, Qiao, and Jitapunkul, 2003). Health expectancy data are invaluable for predicting future needs, evaluating health programs, identifying trends and inequalities in health, and planning health, disability and social services, long term care, pensions, *etc*.

In Bangladesh, some research on health expectancy exists, which includes information on disability-free life expectancy and healthy life expectancy for people

of all ages and adults aged 60 years and older as well as information on healthy life expectancy for people aged 15 years and above. For example, in Bangladesh as a whole, despite having longer LE, elderly women have a greater prevalence of disability and shorter disability-free life expectancy than elderly men (Tareque, Begum, and Saito, 2013). Clear inequalities in LE, disability-free life expectancy and LE with disability between rural and urban areas are reported. Urban males and females, respectively, have a longer disability-free life expectancy and shorter LE with disability both in number and proportion when compared to rural males and females (Islam, Tareque, Mondal *et al.*, 2017). Healthy life expectancy declines significantly as age increases in the Rajshahi district of Bangladesh (Tareque, Islam, Kawahara *et al.*, 2015). Men expected fewer life years spent in good health but a much larger proportion of expected life in good health than did women in Bangladesh in 1996 and 2002 (Tareque, Saito, and Kawahara, 2015). However, life expectancies with and without hypertension (HTN) have never been computed in Bangladesh.

Raised or high blood pressure acts as one of the contributing and intermediate risk factors for developing coronary heart disease, stroke, and kidney disease. High blood pressure in adulthood is reported to be associated with reduced LE and more years of expected life with cardiovascular disease, and in the United States, it affects both men and women similarly (Franco, Peeters, Bonneux *et al.*, 2005). The LE benefits of antihypertensive treatment were examined in a study for the United States (Sesso, Chen, L'Italien *et al.*, 2003). Successful blood pressure lowering in hypertensive patients and those with additional cardiovascular disease risk factors such as diabetes or current smoking was reported to have the potential to provide substantial gains in LE. The study revealed that gains in LE occurred with even modest reductions in blood pressure (Sesso, Chen, L'Italien *et al.*, 2003).

A number of studies have been devoted to gender differences in health, mortality, and health expectancy (Doblhammer and Hoffmann, 2010; Knodel and Ofstedal, 2003; Mishra, Roy, and Retherford, 2004; Oksuzyan, Juel, Vaupel *et al.*, 2008; Tareque, Begum, and Saito, 2013), which have been of longstanding interest to researchers. Gender differences in HTN as well as Hypertension-Free Life Expectancy (HFLE) are also areas of interest, particularly in Bangladesh where women are highly disadvantaged compared with men. In Bangladesh, HTN is reported to be higher among women and the older population than among their counterparts (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International, 2013; Saquib, Saquib, Ahmed *et al.*, 2012; Tareque, Koshio, Tiedt *et al.*, 2015). Though there were fluctuations in male and female LE at age 35 and over until 2005, since 2006 female LE at every age has been consistently longer than that of males in Bangladesh (Bangladesh Bureau of Statistics (BBS), 2011). In 2011, female and male LE at age 35 were, respectively, 40.08 and 38.92 years (World Health Organization, 2014). Whether greater LE implies better health and longer HFLE for women is a critical question in Bangladesh. The current study thus examines gender differences in HTN prevalence and in HFLE in Bangladesh.

2 Materials and Methods

2.1 Data

This study utilized data from a nationally representative sample survey, the 2011 Bangladesh Demographic and Health Survey (BDHS). The 2011 BDHS is the sixth Demographic and Health Survey undertaken in Bangladesh. The sampling design, questionnaires, and data collection procedures of the 2011 BDHS are described elsewhere in detail (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International, 2013). The 2011 BDHS is the first survey that collected blood pressure measurements for people aged 35 years and over. It collected data from individuals residing in non-institutional dwelling units in Bangladesh and is based on a two-stage stratified sample of households. Based on the sampling design, a total of 17,964 households were selected, 17,511 of which were

found to be occupied. Interviews were successfully completed in 17,141 households, or 98% of all the occupied households. In one-third of households in the 2011 BDHS, all men and women aged 35 and older (4,524 men and 4,311 women) were selected for blood pressure measurements. We selected those who gave their full consent to participate in blood pressure measurements, and consequently, the final study sample size dropped to 7,864 (3,895 men and 3,969 women).

The participants who were dropped from the whole analysis due to non-consent did not differ by age from those included in the analysis. The dropped participants' mean age was 51.27 years whereas the included participants' mean age was 51.38 years (difference 0.11 years, $p < 0.80$). However, the dropped participants differed significantly from the included participants by sex, marital status, education level, and place of residence. Thirty-five percent of the dropped participants were female, whereas half of the included participants were female ($p < 0.01$). Eighty-one percent of the dropped participants were currently married, whereas 84% of the included participants were currently married ($p < 0.05$). Forty percent of the dropped participants were illiterate, whereas 45% of the included participants were illiterate ($p < 0.01$). Fifty-eight percent of the dropped participants came from rural areas, whereas 67% of the included participants came from rural areas ($p < 0.01$).

2.2 HTN Measurements

The 2011 BDHS used the Life Source UA-767 Plus blood pressure monitor model to measure blood pressure. This model is one of the blood pressure monitors recommended for use by World Health Organization. Three measurements of both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken during the survey at approximately 10-minute intervals. Only the average of the second and third measurements was available in the data set we used to report respondents' blood pressure values. In addition, each respondent was asked whether s/he had ever been told by a doctor or nurse that s/he had high blood pressure. Each respondent was also asked whether s/he was currently taking antihypertensive medication to lower their blood pressure. An individual was considered to have HTN if s/he had blood pressure levels ≥140 mmHg SBP or ≥90 mmHg DBP, or s/he was currently taking antihypertensive medication to lower their blood pressure. Based on the blood pressure measurements, medications, and doctor or nurse diagnoses of respondents' high blood pressure, we classified HTN into four types: (i) unaware of HTN, (ii) aware of HTN but not in treatment, (iii) controlled HTN, and (iv) uncontrolled HTN. An individual was considered to be unaware of HTN if s/he had blood pressure levels ≥140 mmHg SBP or ≥90 mmHg DBP, was not taking any medication, and had never been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to be aware of HTN but not in treatment if s/he had blood pressure levels ≥ 140 mmHg SBP or ≥ 90 mmHg DBP, was not taking any medication, but had been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to have controlled HTN if s/he had blood pressure levels < 140 mmHg SBP or < 90 mmHg DBP, was taking medication, and had been told by a doctor or nurse that s/he had high blood pressure. An individual was considered to have uncontrolled HTN if s/he had blood pressure levels ≥ 140 mmHg SBP or ≥ 90 mmHg DBP, was taking medication, and had been told by a doctor or nurse that s/he had high blood pressure.

2.3 Estimation of HFLE

The Sullivan method (Sullivan, 1971) was employed to compute HFLE for the year 2011 for Bangladesh. It partitions total LE into LE with different types of HTN and HFLE based on the prevalence of HTN within a representative sample at a single point in time. The Sullivan method requires two types of data: a standard period life table where mortality information of a population can be found, and the prevalence of HTN for that population. The life table for Bangladesh for the year 2011 was obtained from the World Health Organization (World Health Organization, 2014). The proportion of the Bangladeshi population with HTN for the year 2011 was obtained from the 2011

BDHS. By combining these data, we estimated HFLE for the study population. See the manual (Jagger, Cox, Le Roy *et al.*, 2006) for more details on the computation of HFLE and confidence intervals using the Sullivan method. To take into account the population living in institutions who were excluded from the 2011 BDHS, we assumed that the prevalence of HTN outside and within institutions does not differ.

2.4 Analysis Plan

We examined the prevalence of HTN by age and sex first. We used STATA/MP version 13.0 (StataCorp LP, College Station, Texas, USA) to perform a two-sided test for equality of proportions in HTN. Sample weights were applied to accommodate the complex survey design. Estimates of HFLE and LE with different types of HTN were then obtained using the Sullivan method. Finally, the estimates of HFLE and LE with different types of HTN were plotted in graph form.

3 Results

Table 1 shows gender differences for different types of HTN prevalence in Bangladesh in 2011. A significantly greater percentage of women have HTN than men (32% of women vs. 19% of men). Among all individuals with HTN, individuals unaware of HTN make up the largest group (56% of men vs. 45% of women), followed by those with uncontrolled HTN (20% of men vs. 25% of women), controlled HTN (16% of men vs. 20% of women), and those aware of HTN but not in treatment (8% of men vs. 11% of women) (results not shown).

Table 1. Prevalence of different types of hypertension by age and sex in Bangladesh in 2011

Age	Male						Female					
	%	%	%	%	%		%	%	%	%	%	
	HTN	UofHTN	AofHTNnoTreat	CHTN	UHTN	n	HTN	UofHTN	AofHTNnoTreat	CHTN	UHTN	n
35-39	9.78*	7.89	0.44*	0.51*	0.94*	682	17.79	7.78	2.31	3.94	3.76	810
40-44	14.40*	8.93	1.77	2.05*	1.65*	641	24.99	10.62	2.10	6.46	5.81	721
45-49	15.65*	10.08*	1.01	2.67*	1.89*	592	30.98	15.74	2.23	6.44	6.56	648
50-54	21.12*	11.80	1.48	2.50*	5.34*	626	33.38	12.90	2.21	8.86	9.41	430
55-59	20.10*	8.80*	2.60	2.24*	6.46	304	37.62	17.08	3.80	6.81	9.93	406
60-64	26.02*	10.94†	2.23†	7.31	5.54	314	35.10	16.95	5.41	3.99	8.74	311
65-69	31.25*	12.64*	1.59*	9.91	7.11	253	54.58	28.96	6.00	7.81	11.81	203
70+	29.75*	17.54	1.80*	3.68*	6.73*	483	50.06	19.41	7.15	7.52	15.99	440
Total	19.31*	10.87*	1.48*	3.11*	3.85*	3895	31.76	14.17	3.38	6.23	7.99	3969

Notes: HTN: Hypertension; UofHTN: Unaware of hypertension; AofHTNnoTreat: Aware of hypertension but no treatment; CHTN: Controlled hypertension; UHTN: Uncontrolled hypertension; n: Number of respondents. Levels of significance for percent difference of hypertension between male and female: $^{*}p < 0.01$, $^{\dagger}p < 0.05$.

At each age, a significantly higher percentage of women have HTN than do men. Across all ages, women also have all types of HTN in higher percentages than do men, except for controlled HTN for age groups 60–69. In general, the prevalence of all types of HTN increases with increasing age. For both men and women, a higher percent of older individuals have all types of HTN than do their younger counterparts, except for the 70+ years age group. At ages 35–39, 10% of men and 18% of women have HTN, whereas at ages 65–69, 31% of men and 55% of women have HTN.

Table 2 presents LE, HFLE, the proportion of expected life without HTN by age and sex, and gender differences in LE and HFLE by age in Bangladesh in 2011. At each age, women have a longer LE compared with men. Women at age 35 could expect to live 40.08 years, which is 1.16 years longer than men. At age 65, women could expect

to live 0.32 years (117 days) longer than men. The differences in LE decrease with increasing ages.

Table 2. LE, HFLE, and proportion of expected life without hypertension by age and sex in Bangladesh in 2011

Age	Male				Female				Differences in LE†	Differences in HFLE§
	LE	HFLE	HFLF 95% CI	Proportion of life without HTN	LE	HFLE	HFLF 95% CI	Proportion of life without HTN	Male-Female	Male-Female
35	38.92	30.69	(30.16, 31.23)	78.87	40.08	25.59	(24.94, 26.24)	63.86	-1.16	5.10*
40	34.29	26.48	(25.95, 27.00)	77.21	35.45	21.71	(21.07, 22.36)	61.25	-1.16	4.76*
45	29.77	22.56	(22.04, 23.08)	75.79	30.90	18.23	(17.60, 18.87)	59.01	-1.13	4.33*
50	25.44	18.85	(18.34, 19.36)	74.09	26.44	15.10	(14.48, 15.72)	57.10	-1.00	3.75*
55	21.35	15.57	(15.07, 16.08)	72.94	22.14	12.16	(11.57, 12.75)	54.92	-0.79	3.41*
60	17.61	12.49	(12.00, 12.97)	70.90	18.18	9.60	(9.03, 10.18)	52.82	-0.57	2.88
65	14.27	9.95	(9.48, 10.43)	69.76	14.59	7.07	(6.51, 7.64)	48.49	-0.32	2.88*
70	11.28	7.92	(7.46, 8.38)	70.25	11.40	5.69	(5.16, 6.23)	49.94	-0.12	2.23*

Notes: LE: Life expectancy; HFLE: Hypertension-free life expectancy; HTN, Hypertension; CI: Confidence interval.
† Differences are not statistically tested.
§ Differences are statistically tested.
* $p < 0.01$.

Despite having longer LE, at each age, women could expect shorter HFLE than men in terms of both number and proportion of years. At age 35, women could expect 64% of their remaining life without HTN (LE: 40.08 years, HFLE: 25.59 years), while men could expect 79% of their remaining life without HTN (LE: 38.92 years, HFLE: 30.69 years). At age 65, women and men, respectively, could expect 49% and 70% of their remaining life without HTN. Men at age 65 could expect a much greater proportion of their remaining life without HTN than women at age 35.

Although women at age 35 could expect to live 1.16 years longer than men, they could expect 5.10 years shorter HFLE than could men. At age 65, women could expect 117 days longer LE but 2.88 years shorter HFLE than men. The differences in HFLE also decrease with increasing ages.

Table 3 displays the decomposition of LE with HTN into LE with four types of HTN by age and sex in Bangladesh in 2011. Across ages, and in terms of both number and proportion of years, men and women who were unaware of HTN could expect the longest LE with HTN, followed by men and women with uncontrolled HTN, controlled HTN, and those with awareness of HTN but who were not in treatment. At age 35, a woman and a man, respectively, could expect 6.44 and 4.46 years of life with unawareness of HTN, 3.79 and 1.74 years of life with uncontrolled HTN, 2.62 and 1.40 years of life with controlled HTN, and 1.64 and 0.62 years of life with awareness of HTN but not receiving treatment. At age 65, a woman and a man, respectively, could expect 3.28 and 2.28 years of life with unawareness of HTN, 2.14 and 0.98 years of life with uncontrolled HTN, 1.11 and 0.81 years of life with controlled HTN, and 0.99 and 0.25 years of life with awareness of HTN but not receiving treatment. The proportion of LE with HTN increases as age increases for both men and women, but the proportion of LE with HTN for men at age 65 is lower than the proportion of LE with HTN for women at age 35.

Figure 1 displays HFLE and LE with four types of HTN by age and sex. Here, each bar represents LE, which comprises HFLE and LE with four types of HTN. At each age, for both men and women, HFLE accounts for the largest proportion of LE, followed by LE with unawareness of hypertension, LE with uncontrolled hypertension, LE with controlled hypertension, and LE with awareness of hypertension but no

treatment. Compared with men, women at all ages are clearly found to expect longer LE, shorter HFLE, and longer LE with all types of HTN.

Table 3. LE with HTN, LE with different types of hypertension and their proportion by age and sex in Bangladesh in 2011

		Expected Years at Age 35	Expected Prop. at Age 35	Expected Years at Age 50	Expected Prop. at Age 50	Expected Years at Age 65	Expected Prop. at Age 65
Male	LE with HTN	8.22	21.13	6.59	25.91	4.31	30.24
	LE with types of HTN						
	LEwUofHTN	4.46	11.47	3.31	13.00	2.28	15.95
	LEwAofHTNnoTreat	0.62	1.60	0.49	1.93	0.25	1.73
	LEwCHTN	1.40	3.59	1.20	4.72	0.81	5.70
	LEwUHTN	1.74	4.46	1.59	6.27	0.98	6.85
Female	LE with HTN	14.49	36.14	11.34	42.90	7.51	51.52
	LE with types of HTN						
	LEwUofHTN	6.44	16.06	4.97	18.80	3.28	22.47
	LEwAofHTNnoTreat	1.64	4.08	1.37	5.17	0.99	6.78
	LEwCHTN	2.62	6.55	1.88	7.10	1.11	7.61
	LEwUHTN	3.79	9.46	3.13	11.84	2.14	14.65

Notes: HTN: Hypertension; Prop: Proportion of life with types of HTN; LE: Life expectancy; LEwUofHTN: LE with unawareness of hypertension; LEwAofHTNnoTreat: LE with awareness of hypertension but no treatment; LEwCHTN: LE with controlled hypertension; LEwUHTN: LE with uncontrolled hypertension.

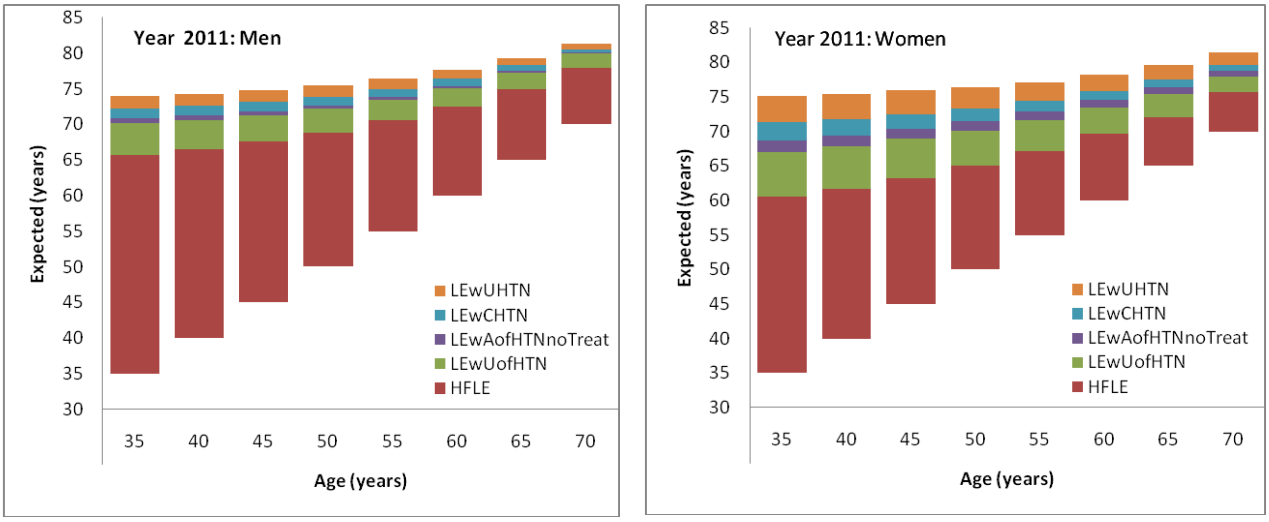

Figure 1. HFLE and LE with different types of hypertension by age and sex in Bangladesh in 2011

Notes: HFLE: Hypertension-free life expectancy; LEwUofHTN = LE with unawareness of hypertension; LEwAofHTNnoTreat = LE with awareness of hypertension but no treatment; LEwCHTN = LE with controlled hypertension; LEwUHTN = LE with uncontrolled hypertension.

4 Discussion

This study has two main findings. First, compared with men, women have all types of HTN in significantly higher percentages across age groups and the prevalence of HTN increases as age increases for both men and women. In the 35–39 age group, 18% of women and 10% of men have HTN. In the 65–69 age group, the prevalence of HTN is 55% for women and 31% for men. Other studies for Bangladesh have also found HTN to be higher among women and the older population (Saquib, Saquib, Ahmed *et al.*, 2012; Tareque, Koshio, Tiedt *et al.*, 2015). Our study, furthermore, reveals that around half of respondents are unaware of HTN, and that among those with HTN, one-fourth of women and one-fifth of men have uncontrolled HTN. The prevalence of

uncontrolled HTN is higher among women than men, and it is higher among older than younger individuals. As HTN is a risk factor for developing coronary heart disease, stroke, and kidney disease, early detection and preventive behavior for HTN can reduce the risk of developing those non-communicable diseases. The high prevalence of unawareness of HTN and uncontrolled HTN in the current study suggests that a substantial number of cardiovascular events could be prevented in Bangladesh if proper steps were taken. This study thus suggests that women and older individuals, in particular, and all Bangladeshi individuals, in general, take appropriate measures to prevent and control HTN.

Second, compared with men, women have longer LE but they could expect shorter HFLE at all ages in terms of both number and proportion of years. As with women elsewhere around the world, Bangladeshi women can expect to live longer than men (Barford, Dorling, Smith *et al.*, 2006; Tareque, Begum, and Saito, 2013; Tareque, Saito, and Kawahara, 2015). While various methods and measures have been used to measure health expectancy, none have computed HFLE, which makes it difficult to compare our findings with others. Studies on health expectancy in terms of disability in several countries have shown that women expect longer life than men with and without disability (Camargos, Machado, and do Nascimento Rodrigues, 2007; Jitapunkul, Kunanusont, Phoolcharoen *et al.*, 2003), but women expect a greater proportion of their later years with a disability than do men (Camargos, Machado, and do Nascimento Rodrigues, 2007; Crimmins and Saito, 2001; Jitapunkul, Kunanusont, Phoolcharoen *et al.*, 2003; Reyes-Beaman, Jagger, Garcia-Peña *et al.*, 2005). However, a study on health expectancy in terms of disability for Bangladesh (Tareque, Begum, and Saito, 2013) used similar methods to our study and reported an exception. Despite having longer LE, elderly women could expect shorter disability-free life expectancy at all ages in both number and proportion of years compared with elderly men. This is in line with our findings. A different LE method than that used in our study was applied to calculate LE for normotensive and hypertensive Japanese people and found that the LE difference between normotensive and hypertensive individuals was 2.2 years for men and 2.9 years for women. The LE of 40-year-old Japanese men and women was 41.7 years and 48.7 years, respectively, in normotensive participants and 39.5 and 45.8 years, respectively, in hypertensive participants (Turin, Murakami, Miura *et al.*, 2012).

For both men and women, the proportion of life with HTN increases as age increases. Compared with men, women could expect much longer proportion of LE with HTN as well as LE with all types of HTN at each age. The proportion of LE with HTN as well as LE with all types of HTN increases as age increases for both men and women, and the proportion of LE with HTN as well as LE with all types of HTN for men at age 65 is lower than the respective proportion for women at age 35. The higher prevalence of HTN as well as all types of HTN for women and older individuals in Bangladesh is the reason behind the higher proportion of LE with HTN as well as LE with all types of HTN for women and older individuals in Bangladesh. The possibility of women developing HTN increases as they grow older, and in turn, more women become hypertensive compared to men. A significant amount of HTN in women is attributable to obesity (Chiang, Perlman, and Epstein, 1969), oral contraceptive use (American Heart Association, 2017; August and Oparil, 1999), preeclampsia and menopause (American Heart Association, 2017). Gender differences in functional status, HTN and health problems could be due to gender inequalities in nutritional status, marital status and education (Onadja, Atchessi, Soura *et al.*, 2013), greater female longevity, and exposures to domestic violence (Guedes, Vafaei, Alvarado *et al.*, 2016; Islam, Tareque, Tiedt *et al.*, 2014). Higher prevalence of HTN among women could also be due to less than adequate care and services for pregnant/delivering mothers, and the impact of gender-related life conditions. Mothers encounter some long lasting health problems during the reproductive period, and the problems remain undisclosed due to cultural reasons. These health problems can cause women to fall sick with greater frequency during reproductive years as well as in later life (Tareque, Begum, and Saito, 2014). Patriarchy is also thought to limit women's advancement, rights, and a cause of lower

status of women in Bangladesh. It could deprive women of many necessities including food, nutrition, health care, secure life, a respectable living, mental peace, and an abuse-free life (Tareque, Begum, and Saito, 2014). Consequently, compared to men, women could have more health problems as well as HTN. Therefore, to effectively detect, prevent, and control HTN, especially unawareness of HTN and uncontrolled HTN, older people, and women in particular, should receive special attention. This will help to increase HFLE and quality of life.

The Sullivan method has several advantages. As a prevalence-based method it is straightforward to apply on data from cross-sectional studies, which are less costly and more readily available than longitudinal studies. It is less influenced by survey design and analytic strategies than methods relying on longitudinal data. The Sullivan method has some limitations as well. The method's assumptions constrain the portrayal of the expected life cycle or functional status histories of persons who are exposed to current mortality and morbidity conditions. It does not permit recovery, once individuals have experienced a health problem. It will yield an inaccurate portrayal of the timing and volume of a cohort's health experiences under conditions in which individuals experience both the onset of health problems and recovery (Robine, Jagger, Mathers *et al.*, 2003). Although the Sullivan method could not detect a sudden change in health problems, it provides fairly stable estimates as multistate life table method if there are smooth and relatively regular changes in health problems prevalence rates over long times (Mathers and Robine, 1997).

5 Conclusions

The most recent and reliable nationally representative data sets from the 2011 BDHS provided insights into gender differences in HFLE and the size of the population at risk for HTN, unawareness of HTN, and uncontrolled HTN among the Bangladeshi people. To prevent and control HTN and to increase HFLE and quality of life, attention should be given to women and older adults. The findings of this study shed important light on the risk of disease and the lowering of quality of life associated with HTN in Bangladesh. The knowledge that HTN among the Bangladeshi people, particularly Bangladeshi women, may be the result of a number of past life-time experiences related to education, health care, physical inactivity, life styles, unhealthy food habits, *etc*., can serve as a guide for public policies in the country. Further work is needed to determine the correlates of HTN, unawareness of HTN, and uncontrolled HTN in Bangladesh to help policy makers and planners formulate appropriate policies regarding HTN.

Authors' Contributions

MI Tareque originated the study and contributed to the study design, analysis, writing and revisions of the article. Y Saito participated in the conception and design of the study, helped analyze data, and critically revised the article. Finally, this version was approved by both the authors.

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Conflict of Interest

The authors declare that they have no competing interests.

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Ethical Approval

Publicly available BDHS data were used for the current study. As the de-identified data for this study came from secondary sources, this study does not require ethical approval.

Availability of Data and Materials

The data underlying the findings in our study are freely available in the DHS Program Archive. Please visit http://www.dhsprogram.com/ for more information. Interested persons may submit his/her research proposal to the DHS Program and obtain the dataset(s) free of cost.

References

American Heart Association (2017). High blood pressure and women. http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/UnderstandYourRiskforHighBloodPressure/High-Blood-Pressure-and-Women_UCM_301867_Article.jsp.

August P and Oparil S (1999). Hypertension in women. *The Journal of Clinical Endocrinology & Metabolism,* 84(6): 1862–1866. https://doi.org/10.1210/jcem.84.6.5724.

Bangladesh Bureau of Statistics (BBS) (2011). *Report on Sample Vital Registration System-2010*. Dhaka, Bangladesh: Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning.

Barford A, Dorling D, Smith GD, *et al*. (2006). Life expectancy: Women now on top everywhere. *British Medical Journal,* 332(7545): 808. https://doi.org/10.1136/bmj.332.7545.808.

Camargos MCS, Machado CJ and Do Nascimento Rodrigues R (2007). Disability life expectancy for the elderly, city of São Paulo, Brazil, 2000: Gender and educational differences. *Journal of Biosocial Science,* 39(3): 455–463. https://doi.org/10.1017/S002193200600142 8.

Chiang BN, Perlman LV and Epstein FH (1969). Overweight and hypertension: A review. *Circulation,* 39(3): 403–421. https://doi.org/10.1161/01.CIR.39.3.403.

Crimmins EM, Hayward MD and Saito Y (1994). Changing mortality and morbidity rates and the health status and life expectancy of the older population. *Demography,* 31(1): 159–175. https://doi.org/10.2307/2061913.

Crimmins EM and Saito Y (2001). Trends in healthy life expectancy in the United States, 1970–1990: Gender, racial, and educational differences. *Social Science & Medicine,* 52(11): 1629–1641. https://doi.org/10.1016/S0277-9536(00)00273-2.

Doblhammer G and Hoffmann R (2010). Gender differences in trajectories of health limitations and subsequent mortality. A study based on the German socioeconomic panel 1995–2001 with a mortality follow-up 2002–2005. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences,* 65B(4): 482–491. https://doi.org/10.1093/geronb/gbp051.

Franco OH, Peeters A, Bonneux L, *et al.* (2005). Blood pressure in adulthood and life expectancy with cardiovascular disease in men and women: Life course analysis. *Hypertension,* 46(2): 280–286. https://doi.org/10.1161/01.HYP.0000173433.67426.9b.

Guedes DT, Vafaei A, Alvarado BE, *et al.* (2016). "Experiences of violence across life course and its effects on mobility among participants in the International Mobility in Aging Study. *BMJ Open,* 6(10). https://doi.org/10.1136/bmjopen-2016-012339.

Islam MS, Tareque MI, Mondal MNI, *et al.* (2017). Urban-rural differences in disability-free life expectancy in Bangladesh using the 2010 HIES data. *PLoS ONE,* 12(7): e0179987. https://doi.org/10.1371/journal.pone.0179987.

Islam TM, Tareque MI, Tiedt AD, *et al.* (2014). The intergenerational transmission of intimate partner violence in Bangladesh. *Global Health Action,* 7(1): 23591. https://doi.org/10.3402/gha.v7.23591.

Jagger C, Cox B, Roy SL, *et al.* (2006). Health expectancy calculation by the Sullivan method: A practical guide. 3rd ed. *EHEMU Technical Report*. France: European Health Expectancy Monitoring Unit.

Jagger C, Gillies C, Moscone F, *et al.* (2008). Inequalities in healthy life years in the 25 countries of the European Union in 2005: A cross-national meta-regression analysis. *The Lancet,* 372(9656): 2124–2131. https://doi.org/10.1016/S0140-6736(08)61594-9.

Jitapunkul S, Kunanusont C, Phoolcharoen W, *et al.* (2003). Disability - free life expectancy of elderly people in a population undergoing demographic and epidemiologic transition. *Age and Ageing,* 32(4): 401–405. https://doi.org/10.1093/ageing/32.4.401.

Knodel J and Ofstedal MB (2003). Gender and aging in the developing world: Where are the men? *Population and Development Review,* 29(4): 677–698. https://doi.org/10.1111/j.1728-4457.2003.00677.x.

Liu J, Chen G, Song X, *et al.* (2009). Trends in disability-free life expectancy among Chinese older adults. *Journal of Aging and Health,* 21(2): 266–285. https://doi.org/10.1177/089826430832897 8.

Mathers CD and Robine JM (1997). How good is Sullivan's method for monitoring changes in population health expectancies? *Journal of Epidemiology and Community Health,* 51(1): 80–86. https://doi.org/10.1136/jech.51.1.80.

Mishra V, Roy TK and Retherford RD (2004). Sex differentials in childhood feeding, health care, and nutritional status in India. *Population and Development Review,* 30(2): 269–295. https://doi.org/10.1111/j.1728-4457.2004.013_1.x.

National Institute of Population Research and Training (NIPORT), Mitra and Associates and ICF International (2013). Bangladesh: Demographic and health survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates and ICF International. https://dhsprogram.com/pubs/pdf/fr265/fr265.pdf.

Oksuzyan A, Juel K, Vaupel JW, *et al.* (2008). Men: Good health and high mortality. Sex differences in health and aging. *Aging Clinical and Experimental Research,* 20(2): 91–102. https://doi.org/10.1007/BF03324754.

Onadja Y, Atchessi N, Soura BA, *et al.* (2013). Gender differences in cognitive impairment and mobility disability in old age: A cross-sectional study in Ouagadougou, Burkina Faso. *Archives of Gerontology and Geriatrics,* 57(3): 311–318. https://doi.org/10.1016/j.archger.2013.06.007.

Reyes-Beaman S, Jagger C, Garcia-Peña C, *et al.* (2005). Active life expectancy of older people in Mexico". *Disability & Rehabilitation,* 27(5): 213–219. https://doi.org/10.1080/09638280400006424.

Riley JC (2005). Estimates of regional and global life expectancy, 1800–2001. *Population and Development Review,* 31(3): 537–543. https://doi.org/10.1111/j.1728-4457.2005.00083.x.

Robine J-M, Jagger C, Mathers CD, *et al.* (2003). *Determining Health Expectancies*. West Sussex, UK: John Wiley & Sons.

Saito Y, Qiao X and Jitapunkul S (2003). Health expectancy in Asian countries. In: Robine J-M, Jagger C, Mathers CD*, et al.* (eds), *Determining Health Expectancies* (p. 289–317). West Sussex, UK: John Wiley & Sons.

Saito Y, Robine J-M and Crimmins EM (2014). The methods and materials of health expectancy. *Statistical Journal of the IAOS,* 30(3): 209–223. https://doi.org/10.3233/SJI-140840.

Sanders BS (1964). Measuring community health levels. *American Journal of Public Health,* 54(7): 1063–1070. https://doi.org/10.2105/AJPH.54.7.1063.

Saquib N, Saquib J, Ahmed T, *et al.* (2012). Cardiovascular diseases and Type 2 diabetes in Bangladesh: A systematic review and meta-analysis of studies between 1995 and 2010. *BMC Public Health,* 12: 434. https://doi.org/10.1186/1471-2458-12-434.

Sesso HD, Chen RS, L'Italien GJ, *et al.* (2003). Blood pressure lowering and life expectancy based on a Markov model of cardiovascular events. *Hypertension,* 42(5): 885–890. https://doi.org/ 10.1161/01.HYP.0000097602.67134.4D.

Stiefel MC, Perla RJ and Zell BL (2010). A healthy bottom line: Healthy life expectancy as an outcome measure for health improvement efforts. *Milbank Quarterly,* 88(1): 30–53. https://doi.org/ 10.1111/j.1468-0009.2010.00588.x.

Sullivan DF (1971). A single index of mortality and morbidity. *HSMHA Health Reports,* 86(4): 347–354. https://doi.org/10.2307/4594169.

Tareque MI, Begum S and Saito Y (2013). Gender differences in disability-free life expectancy at old ages in Bangladesh. *Journal of Aging and Health,* 25(8): 1299–1312. https://doi.org/10.1177/08 98264313501388.

_____ (2014). Inequality in disability in Bangladesh. *PLoS ONE,* 9(7): e103681. https://doi.org/10.1371/journal.pone.0103681.

Tareque MI, Islam TM, Kawahara K, *et al.* (2015). Healthy life expectancy and the correlates of self-rated health in an ageing population in Rajshahi district of Bangladesh. *Ageing and Society,* 35(5): 1075–1094. https://doi.org/10.1017/S0144686X14000130.

Tareque MI, Koshio A, Tiedt AD, *et al.* (2015). Are the rates of hypertension and diabetes higher in people from lower socioeconomic status in Bangladesh? Results from a nationally representative survey. *PLoS ONE,* 10(5): e0127954. https://doi.org/10.1371/journal.pone.0127954.

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

Turin TC, Murakami Y, Miura K, *et al.* (2012). Hypertension and life expectancy among Japanese: NIPPON DATA80. *Hypertension Research,* 35(9): 954–958. https://doi.org/10.1038/hr.201 2.86.

World Health Organization (2014). Life expectancy: Life tables by country, Bangladesh. http://apps.who.int/gho/data/?theme=main&vid=6012 0.