PRINT: ISSN 0975-1270 ONLINE: ISSN 2456-6306
J Life Science, 11(1-2): 17-24 (2019)
DOI: 10.31901/24566306.2019/11.1-2.241

Factors Influencing in Developing Type II Diabetes among Married Women in Bangladesh: Data from Bangladesh Demographic and Health Survey 2011

Md. Alhaz Uddin[1*], Md. Abu Sayem[2], Md. Moidul Islam[1#], Md. Masud Rana[3] and Md. Golam Hossain[1+]

[1]Health Research Group, Department of Statistics, University of Rajshahi, Rajshahi 6205, Bangladesh
[2]Institute of Biological Sciences, University of Rajshahi, Rajshahi 6205, Bangladesh
[3]Department of Population Science and Human Resource Development, University of Rajshahi, Rajshahi 6205, Bangladesh
E-mail: [*]<alhaz01757@gmail.com>, [#]<moidulmassted@gmail.com>, [+]<hossain95@yahoo.com>, [2]<sayem072003@yahoo.com>, [3]<masud.raj82@gmail.com>

KEYWORDS Chi-square Test. Logistic Regression. Nationally Representative Sample. Non-communicable Disease. Socio-economic Variables

ABSTRACT The control of diabetes is a key challenge globally. The researchers' aim was to analyze the factors of diabetes affecting married women in Bangladesh. A cross-sectional study was done in 2011 Bangladesh Demographic Health Survey with a sample of 1959 married women aged 35 to 49 years. Simple logistic regression and chi-square tests were done in the researchers' study. The prevalence of diabetes among married women was 9.1 percent. Prevalence was highest in Dhaka that is, 18.8 percent and lowest in Barisal division that is, eleven percent. Higher educated (13.8%) women were more prone to develop diabetes than uneducated (5.6%). The rich had higher prevalence of diabetes than their counterpart [OR= 0.370, 95 % CI, 0.244 - 0.561, p<0.001]. Obese women were more likely to get diabetes than underweight, normal and overweight. It was found that hereditary, lifestyle and socio-demographic factors were influencing diabetes among non-pregnant married women.

INTRODUCTION

Diabetes is a major non-communicable disease worldwide including Bangladesh. It is now considered as global public health problem due to its several health hazards (IDF 2017; Khan et al. 2014). Estimated about 415 million people have diabetes throughout the world. The number may rise to 642 million by 2040. Globally, 1 in 11 adults have diabetes and around twelve percent of global health expenditure is spent on diabetes (IDF 2017). The disease diabetes is a clinical syndrome characterized by hyperglycemia (that is, increased blood glucose level more than normal range) as a consequence of relative or absolute lack of insulin secretion from pancreas or improper utilization of insulin (Haslett et al. 2002). The hormone "insulin" carries the glucose to cell and tissues of the body to obtain energy through its proper utilization. When shortage of insulin or improper utilization of insulin is reported, the glucose utilization becomes hampered. As a result, blood glucose level increases thus affecting multiple organs and systems. So, diabetic people develop several health problems (Chowdhury et al. 2016). In addition to hereditary influence, the other causes of increased blood glucose level depend on person's lifestyle, socio-demographic, education and cultural factors. The type-II diabetes is the commonest form which affects more than ninety percent of people in their adulthood (Khongbu et al. 2005). It can affect both male and female particularly when they undergo obesity, sedentary lifestyle and excess fatty food consumption (Mawaw et al. 2017; Khan et al. 2014). In addition, females have different reproductive biology; hormonal influ-

Address for correspondence:
Dr. Md. Golam Hossain
Professor of Health Research Group
Department of Statistics, University of Rajshahi, Rajshahi - 6205, Bangladesh
HP: +8801914254013
E-mail: hossain95@yahoo.com

ence, marital status, use of oral contraceptive pill, lack of education affects their lifestyle and increases the risk of diabetes (Mawaw et al. 2017). Furthermore, women develop gestational diabetes in certain conditions (Kim 2014). During pregnancy, growth of fetus in uterus has greater needs of glucose. The hormonal changes during pregnancy also affect the action of other hormones such as insulin which brings about high blood glucose level. However, pregnant women who have a greater risk of developing gestational diabetes particularly are those who are over 25 years of age, overweight and who have family history of diabetes. However, blood glucose level usually returns to normal after childbirth. But they may develop type-II diabetes in later life (Herath et al. 2017). To reduce the risk of incidence, healthier food consumption and physical activities are required (Gavurová et al. 2017). It is also necessary to ensure normal BMI and disciplined lifestyle for reducing the risk of diabetes. A study shows that age over 65 years and overweight issues were associated with hypertension in both men and women and the prevalence of diabetes was also higher among them (Moreira et al. 2017). Low socioeconomic condition and BMI over 30 increases the risk of type II diabetes (Dendup et al. 2018; Giridhara et al. 2018; Lee et al. 2016). Diabetes also affects sexual life of both sexes. A study in Iran shows that the women of reproductive age with type-II diabetes had less sexual function than healthy women (Afshari et al. 2017). They suggest an improvement in lifestyle for its effective control. A study in Saudi Arabia suggested that preconception counseling among women of child bearing age starting at the age of puberty and at the time of diagnosis of type-II diabetes can improve pregnancy outcomes (Lee et al. 2016). Another study also shows that type-I diabetes is mostly associated with sexual dysfunction among women (Mazzilli et al. 2015).

Though the magnitude of the disease is worldwide, the prevalence of diabetes in South East Asia (SEA) region is well marked. More than eight percent of total population in this region has diabetes which affects about 78.3 million people. Of them, fifty-six percent of the population in this region doesn't know that they are prone to develop diabetes as a deadly disease (Tabák et al. 2012).

In 2015, this region reported 1.2 million deaths caused by diabetes which is second among all seven IDF regions. This region spent twelve percent of its healthcare budget for diabetes (IDF 2015). As a member of SEA, diabetes is also a major health challenge as fastest growing disease in Bangladesh. Around half of the affected people don't know that they have diabetes and a very small percentage of them were treated (Latif et al. 2014). Diabetes has serious consequences for individuals and poses a large burden on health services, especially in developing countries like Bangladesh. Diabetes poses a major challenge to the sustainable development goals (SDG) as more than twelve percent of the adult population in Bangladesh is estimated to be affected by either diabetes or prediabetes (IDF 2014). Almost all population-based research in Bangladesh indicates an increasing trend of diabetes with recent level as high as seven percent (Rahim et al. 2016). In another survey among slum populations in Bangladesh, the prevalence of diabetes was nine percent among women and eight percent among men (Hussain et al. 2005). Another study in urban areas stated that the prevalence of diabetes was higher among both women and men aged 35 years and older in the non-slum areas (17% among women and 14% among men respectively) than in the slums (6% among women and 8% among men) (NIPORT 2008). WHO study in Bangladesh estimated that the diabetes prevalence was four percent (WHO 2011). Among women and men aged 35 years and older, one third of the households were selected for the BDHS (2011) report as eligible for testing of blood glucose levels (NIPORT 2014). However, Bangladesh has a disproportionately high diabetes prone population with more than 7.1 million, 8.4 percent or 10 million of the adult population affected by the disease (WHO 2013). The number will be 13.6 million in 2040. According to latest census report, Bangladesh has 161 million population. The country had a relatively low diabetes affected population in 1990. In 1995, it was only four percent which grew to five percent in 2000 and nine percent in 2006 to 2010. According to the International Diabetes Federation, the prevalence will be thirteen percent by 2030 (NIPORT 2014; IDF 2014). According to WHO Bulletin in November 2013, there is a quite significant correlation between age and diabetes. Older people were more likely to have diabetes. A greater number of affected population were educated and more likely to come from affluent

family with 40.7 percent from the richest quintile, whereas 12.7 percent from the poorest quintile. The report also suggests that, urban people are slightly more prone to diabetes than the rural people. The individual with diabetes require lifelong personal care to reduce the possibility of developing long-term complications. A good knowledge about risk factors of diabetes, including obesity, dyslipidemia, hypertension, family history of DM, and sedentary lifestyle, play an essential role in prevention and treatment. The socio-demographic, economic, psychological, and environmental factors are directly and indirectly associated with diabetes control and health outcomes. It has been reported that obesity is an important predictor for diabetes. It is needed to determine the prevalence and risk factors of diabetes of each cut-off point of BMI among Bangladeshi adults. Special attention should be paid to married women considering their potential influence on the family and their contribution to the nation's workforce and productivity. Due to their unique role in the population, it is important to investigate the relationship between diabetes among married women with their BMI and socio-demographic and anthropometric factors to ensure that corrective measures can be undertaken.

Objective of this Study

The objective of this study is to determine the prevalence and associated factors of type II diabetes among non-pregnant married women in Bangladesh.

MATERIAL AND METHODS

A cross sectional study was conducted among 1959 non-pregnant married women. The data were extracted from Bangladesh Demographic and Health Survey (BDHS 2011). The survey collected the data from these women from all over the country from July 8, 2011 to December 27, 2011. The primary sampling unit (PSU) for the survey was enumeration areas (EAs) with average120 households in each EA. The survey was based on a two-stage stratified sample of households. In the first stage, 600 EAs were selected with probability proportional to the EA size, with 207 clusters in urban areas and 393 in rural areas. In the second stage, a total of 18,000 households were selected with an average 30 household per EA. In addition, in a sub sample of one-third of the households, all ever married women of reproductive age (15-49 years) were selected for biomarker component of the survey including diabetes. The diabetes tests were done among 5902 ever married women for measuring the diabetes status. Most of the measurements (95%) were reported as complete and credible. The sampling technique, survey design, survey instruments, measuring system, quality control, ethical approval and subject consent for the BDHS (2011) have been described elsewhere. After excluding the pregnant women from sample, statistical techniques were used to check the data set for outliers. In the researchers' study, 5293 non-pregnant, ever married women aged 15-49 years were available for the study sample. The mean age of the women was 30.78±9.27 years.

Outcome Variable

Diabetes status was the outcome variable in present study. A standard method was used for detection of diabetes status following the range of blood glucose level. High blood glucose level particularly above the normal range was considered as diabetes status. Blood glucose was measured using the HemoCue 201+ blood glucose analyzer in capillary whole blood obtained from the middle or ring finger from adults after an overnight fast. The finger was cleaned with a swab containing seventy percent isopropyl alcohol, allowed to dry, and pricked with a retractable, no reusable lancet. The first two drops of blood were wiped away, and the third drop was drawn into the glucose micro cuvette by capillary action; after placing the tip of the microcuvette in the middle of the blood drop. The outside of the microcuvette was wiped clean with gauze and placed in the analyzer to obtain aglucose measurement. The HemoCue 201+ analyzer displayed the blood glucose measurement in milligram per deciliter (mg/dl). This unit of measurement was converted into milli moles per liter (mmol/l) to maintain consistency with the WHO recommended unit. To convert the blood glucose measurement from mg/dl to mmol/l, the values were multiplied by 0.0551 (Lehman and Henry 2001). However, capillary sampling is widely used, particularly in resource-limited countries. The WHO cut-off points corresponding to the clinical classification for normal fasting plasma

glucose levels, pre-diabetes, and diabetes were followed in this study. The normal plasma glucose value range 3.9-6.0 mmol/l, pre-diabetes range 6.1-6.9 mmol/l and the value greater than or equal to 7.0 mmol/l were considered as diabetes.

Independent Variable

Socio-demographic and individual household information was collected using pre-coded open ended questions. Body height and weight were measured and the body mass index (BMI) was calculated: ratio of weight in kilograms to height in meters squared (kg/m^2). The independent variables used in the study were: residence, women education, wealth index, BMI and availability of electricity at home.

Statistical Analysis

Chi-square (χ^2-test) was utilized in the present study to find the association between diabetes among non-pregnant married women in Bangladesh aged 35-49 years and their socio-economic, demographic, anthropometric and behavior factors. The significantly associated factors that were provided by χ^2-test were to be used as independent variables in simple logistic regression models.

Ethics Statement

The 2011 BDHS received ethics approval from Bangladesh Medical Research Council. Written informed consent was also obtained from participants.

RESULTS

A total of 1959 non-pregnant married women were selected in this study. The prevalence of diabetes mellitus type-II among married women in reproductive age in Bangladesh was 8.7 percent, of them; urban peoples were more prone to diabetes than rural people. Chi-square test demonstrated that the association between type of residence and diabetes mellitus type-II of Bangladeshi women was significant ($p<0.05$). The most affected division was Barisal (12.6 %), followed by Chittagong (10%), Rajshahi (9.1%), Dhaka and Rangpur (7.9%), Sylhet (7.5%) and Khulna (7.0%), however the variation of the prevalence of diabetes mellitus type-II of married women among divisions was not significant ($p>0.05$). The highest rate of diabetes was observed among obese (21.1%) women, and the association between women's BMI categories and their diabetes mellitus type-II was highly significant ($p<0.01$). The women who lived with husband had less prone to develop diabetes (8.4%) which indicates mental stability and family support reduce stress and diabetes. Our study showed that educated women were more exposed to improved and stressful life and faced more diabetes (13.8%) than their counterparts (5.6%). The association between women's education level and diabetes mellitus type-II was significant ($p<0.01$). Electricity also impacts on life style. Improved life style with electricity increases the risk of diabetes (10.3%) than their counter part (5.6%), the association between these two factors was significant ($p<0.05$). The middle income group had more prone to diabetes (7.6 %) than upper (5.7%) and lower income (4.7%) groups, association between household wealth index and diabetes status was significant ($p<0.01$). Old age group had more diabetes than middle and young age groups, however the association between these two factors was not significant ($p>0.05$). The working mothers had more diabetes (9.2%) than unemployed mothers (8.6 %) indicates work stress impacts on diabetes, but the association was not significant ($p>0.05$) (Table 1).

The simple logistic regression model demonstrated that the women who lived in urban areas were more likely to get diabetes than the women who lived in rural areas [OR= 1.338, 95%CI, 0.600 - 1.264, $p<0.044$]. The higher educated women had more chances of getting diabetes than uneducated [OR= 0.437, 95%CI, 0.244 - 0.782, $p<0.005$] and primary educated women [OR= 0.558, 95%CI, 0.310 - 1.003, $p<0.051$]. The probability of getting diabetes among the women who came from rich family was higher than the women who came from poor [OR= 0.370, 95 % CI, 0.244 - 0.561, $p<0.001$] and middle family [OR= 0.612, 95%CI, 0.399 - 0.938, $p<0.024$]. Obese women were more likely get diabetes than underweight [OR= 0.177, 95% CI, 0.090 - 0.348, $p<0.001$], normal weight [OR= 0.329, 95% CI, 0.192 - 0.564, $p<0.001$] and overweight [OR= 0.516, 95 % CI, 0.287 - 0.926, $p<0.027$]. The women who used hygienic toilet were more likely to get diabetes than women who used unhygienic

Table 1: Rate of diabetes mellitus type-II by different characteristics of sample

Diabetes mellitus type-II, Yes =8.70%, No =91.30%		
Variable, N(%)	*DM-2 N(%)*	*χ^2-value*
Type of Residence		
Urban, 702(35.8)	73 (10.4)	4.089*
Rural, 1257(64.2)	97 (7.7)	
Division		
Dhaka, 364(18.8)	29 (7.9)	
Chittagong, 271(13.8)	27 (10.0)	
Barisal, 215(11.0)	27 (12.6)	
Khulna, 342(17.5)	24 (7.0)	6.789
Rajshahi, 296(15.1)	27 (9.1)	
Rangpur, 240(12.3)	19 (7.9)	
Sylhet, 227(11.6)	17 (7.5)	
BMI Status		
Underweight, 421(21.5)	19 (4.5)	
Normal weight, 1079(55.1)	87 (8.1)	
Overweight, 364(18.6)	44 (12.1)	33.428**
Obese, 95(4.8)	20 (21.1)	
Currently Marital Status Group		
Living with husband (1736, 88.6)	146 (8.4)	1.38
Not living with husband (223, 11.4)	24 (10.8)	
Has Electricity		
No (681, 34.8)	38 (5.6)	12.641*
Yes (1278, 65.2)	132 (10.3)	
Women Education Level		
Uneducated, 810(41.3)	53 (6.5)	
Primary, 621(31.7)	51 (8.2)	14.914**
Secondary, 405(20.7)	49 (12.1)	
Higher, 123(6.3)	17 (13.8)	
Wealth Index		
Poor, 636(32.5)	30 (4.7)	24.807**
Middle, 383(19.6)	29 (7.6)	
Rich, 940(48.0)	111 (5.7)	
Age Group		
Age 35-39 years, 734(37.5)	60 (8.2)	
Age, 40-44 years, 651(33.2)	50 (7.7)	4.334
Age 45-49 years, 574(29.3)	60 (10.5)	
Currently Working		
No, 1645(84.0)	141 (8.6)	0.147
Yes, 314(16.0)	29 (9.2)	

toilet [OR= 0.1.729, 95 % CI, 1.260 - 2.372, p<0.001]. Logistic regression model demonstrated that women whose family has electricity was more likely to get diabetes than the women whose family has no electricity [OR= 0.513, 95 % CI, 0.353 - 0.745, p<0.01] (Table 2).

DISCUSSION

The researchers analyzed the Bangladesh Demographic Health Survey data which covered all divisions, all geographic areas (urban as well as rural) and targeted population group with highly representative sample. In addition, the quality of data was checked and re-checked to extract actual findings. However, the researchers analyzed the association and influencing factors in developing diabetes among currently non-pregnant married women in Bangladesh. The researchers found that a significant portion of married women had diabetes which may have the chance of affecting the mothers and up-coming newly born babies with low birth weight, pre-term or pre-mature babies who may belong to poor health and poor nutritional risks throughout their life (Dean et al. 2013). Several macro and micro-vessel's health hazards such as neuropathy, retinopathy or renal failure may develop if the diabetes is not effectively controlled throughout the lifetime. Along with morbidity, 3.96 million of adult deaths are caused by diabetes at global level (Sanal et al. 2011). It indicates the necessity of controlling diabetes for reducing complication and mortality. A study shows that the prevalence of diabetes was higher among women than men (Ahasan et al. 2011). The re-

Table 2: Effects of socio-economic, demographic, anthropometric and behaviors factors on diabetes using simple logistic regression

Variable	*Co-efficient*	*Standard error*	*Wald*	*df*	*p-value*	*OR*	*95.0% CI for OR*	
							Lower	*Upper*
Residence (Urban vs. Rural)	0.328	0.163	4.061	1	0.044	1.388	0.6	1.264
Education level			14.508	3	0.002			
No education vs. Higher	-0.829	0.297	7.767	1	0.005	0.437	0.244	0.782
Primary vs. Higher	-0.584	0.299	3.8	1	0.049	0.558	0.31	1.003
Secondary vs. Higher	-0.153	0.302	0.256	1	0.613	0.858	0.474	1.553
Wealth index			23.474	2	0.001			
Poor vs. Rich	-0.995	0.213	21.903	1	0.001	0.37	0.244	0.561
Middle vs. Rich	-0.491	0.218	5.079	1	0.024	0.612	0.399	0.938
Body Mass Index (BMI)			30.589	3	0.001			
Under weight vs. Obese	-1.73	0.344	25.274	1	0.001	0.177	0.09	0.348
Normal weight vs. Obese	-1.112	0.275	16.307	1	0.001	0.329	0.192	0.564
Over weight vs. Obese	-0.662	0.299	4.919	1	0.027	0.516	0.287	0.926
Has electricity (No vs. Yes)	-0.667	0.191	12.261	1	0.001	0.513	0.353	0.745

N.B: β= Coefficients, S.E = Standard Error, OR = Odd ratio, CI = Confidence interval

searchers showed that 8.7 percent women who had diabetes were at risk of being mother of preterm or LBW babies. In addition, both the mother and babies are at risk of deaths and disability than normal individual. Similar results were found in different research in Bangladesh (9.8%), India (9.1%) and China (9.4%) (Ahasan et al. 2011; Khongbuh et al. 2005; Ramachandran et al. 2012). The researchers also found that the urban women were more prone to develop diabetes than rural women. The findings indicate that the urban lifestyle, stress, food consumption behavior was different from rural areas that largely affects urban people in Bangladesh. Similar findings were also observed in different researches conducted in Bangladesh, China, India, Nepal and Pakistan. (Ahasan et al. 2011; Ramachandran et al. 2012). The researchers also analyzed the divisional difference and found more diabetic people in Dhaka division than their counterparts. Dhaka division is denser than any other division of Bangladesh. Population density and overcrowding augments psychological stress, competition and confrontation which are also the contributing factors of developing diabetes. In this study, old age groups (40 years and above) had more prevalence of diabetes than young age group. To validate the results, they reviewed several articles conducted in different countries including Bangladesh and found similar results for age (Anna et al. 2008; Rahman et al. 2007). According to BMI, overweight and obese women had higher rate of diabetes than their counterparts indicating that higher BMI is risk factor for diabetes. Several studies also validated the researchers' findings (Rahman et al. 2007; Chaudhry et al. 2007). On the other hand, some studies also argued that the association between higher BMI and diabetes is not consistent (Uchenna et al. 2010; Hussain et al. 2006). However, the researchers' study revealed that higher educated and middle to rich income groups were more prone to develop diabetes than their counterparts. It indicates that the educated people have high income opportunity with stressful workload instead of physical labor. In the researchers' study, they found that the people who had electricity facilities were more prone to diabetes than non-electricity households. It may indicate the utilization of light at night that affects lifestyle. Similarly, there are several causal and confounding factors which contribute to develop diabetes in both sex. But among women, there are additional factors that are increasing the risk of developing diabetes such as hormonal influence particularly in pregnant period. In addition, oral hormonal contraceptive pills are increasing the risk of obesity among non-pregnant married women thus increasing the risk of diabetes. Recently, Dendup et al. (2018) reported that environment was a one of the risk factors for Developing Type 2 Diabetes Mellitus. Clearly, more research is required.

CONCLUSION

A total number of 1959 Bangladeshi non-pregnant married women were considered as a sample in this study for investigation of diabetes mellitus type II of Bangladeshi population. The data were extracted from Bangladesh Demographic and Health Survey (BDHS 2011). Frequency distribution provided that a remarkable number of married women had diabetes mellitus type II in Bangladesh. Chi-square test and binary logistic regression model demonstrated that type of residence, BMI, household electric facilities, education level and household wealth index were most important factors for women diabetes mellitus type II.

RECOMMENDATIONS

This study suggests to policy makers for developing programs following above mentioned factors for successful health outcomes. The study also suggests all married women to avoid sedentary lifestyle, to avoid use of oral contraceptive pills, maintain BMI, try to live in a stress-free environment such as avoidance of smoking, avoidance of extreme job load and seek regular physical check-up and advice from qualified physician.

ACKNOWLEDGEMENTS

The researchers would like to thank the Bangladesh Demographic and Health Survey (BDHS) for providing nationally representative based data collected in 2011.

REFERENCES

Ahasan HAMN, Islam Z, Alam B, Nur TMZ, Mohammed FR, Khan MAI et al. 2011. Prevalence and risk factors of type 2 diabetes mellitus among secretariat

employees of Bangladesh. *Journal of Medicine,* 12(2): 125-130.

Afshari P, Yazdizadeh S, Abedi P, Rashidi H 2017. The relation of diabetes type 2 with sexual function among reproductive age women in Iran, a case-control study. *Advances in Medicine, 2017*. doi: 10.1155/2017/4838920.

Anna V, van der Ploeg HP, Cheung NW, Huxley RR, Bauman AE 2008. Socio-demographic correlates of the increasing trend in prevalence of gestational diabetes mellitus in a large population of women between 1995 and 2005. *Diabetes Care,* 31(12): 2288-2293.

Chaudhry R, Sheikh NH 2007. Socio-demographic differentials and health services utilization practices among known hyperglycaemic females. *E Biomedica,* 23: 125-130.

Chowdhury MRK, Kabir R, Sayem MA, Alam MM, Chowdhury MRHK, Akter et al. 2016. Socio-demographic and biomedical factors were associated with control of diabetes among diabetic people attended at Rajshahi Diabetes Hospital, Rajshahi, Bangladesh. *IOSR- JPBS,* 11(2): 48-56.

Dean SV, Mason EM, Howson CP, Lassi ZS, Imam AM, Bhutta ZA 2013. Born too soon: Care before and between pregnancy to prevent preterm births: From evidence to action. *Reproductive Health,* 10(1): S3.

Dendup T, Feng X, Clingan S, Astell-Burt T 2018. Environmental risk factors for developing type 2 diabetes mellitus: A systematic review. *Int J Environ Res Public Health.* 15(1): 78. doi: 10.3390/ijerph15010078.

Gavurová B, Kubák M,Šoltés M, Barták M, Vagašová T 2017. Time trend, age and sex distribution of deaths from diabetes mellitus at the regional level in the Slovak Republic. *Cent Eur J Public Health,* 25(2): 64-71.

Giridhara RB, Murthy GVS, Ana Y, Patel P, Deepa R, Neelon SEB et al. 2018. Association of obesity with hypertension and type 2 diabetes mellitus in India: A meta-analysis of observational studies. *World J Diabetes,* 9(1): 40–52.

Haslett C, Chilvers ER, Boon NA, Colledge NR, Hunter JAA 2002. *Davidson's Principles and Practice of Medicine.* Edinburgh, London, New York: Churchill Livingstone Elsevier.

Herath H, Herath R, Wickremasinghe R 2017. Gestational diabetes mellitus and risk of type 2 diabetes 10 years after the index pregnancy in Sri Lankan women: A community based retrospective cohort study. *PLoS ONE,* 12(6): e0179647.

Hussain A, Vaaler S , Sayeed MA, Mahtab H, Ali SMK, Khan AKA 2006. Type 2 diabetes and impaired fasting blood glucose in rural Bangladesh: A population based study. *European J of Public Health,* 17(3): 291-296.

Hussain F, Birch DJ, Pickup JC 2005. Glucose sensing based on the intrinsic fluorescence of sol-gel immobilized yeast hexokinase. *Analytical Biochemistry,* 339(1): 137-143.

IDF 2014. *International Diabetes Federation. Diabetes Atlas.* 6th Edition. Brussels, Belgium: Idf.

IDF 2015. *International Diabetes Federation. Diabetes Atlas.* 7th Edition. Brussels, Belgium: Idf.

IDF 2017. *International Diabetes Federation. Diabetes Atlas.* 8th Edition. Brussels, Belgium: Idf.

Khan MM, Gruebner O, Kraemer A 2014. The geography of diabetes among the general adults aged 35 years and older in Bangladesh: Recent evidence from a cross-sectional survey. *PLoS One,* 9(10): e110756.

Khongbuh B, Walia I, Kapoor S 2005. Prevalence of diabetes and treatment seeking behavior among adult population at Village Dhanas, U.T., Chandigarh. *Nur and Midwif Res Journal,* 1(3): 138-143.

Kim C 2014. Maternal outcomes and follow-up after gestational diabetes mellitus. *Diabet Med,* 31(3): 292-301.

Latif B, Javaran MJ, Alizadeh H, Memari HR, Mohammadi R 2014. Interactions of genotype and plant growth regulators affecting direct shoot regeneration of lettuce. *Int J Biosci,* 5(1): 315-322.

Lee J, Madanat S, Reger D 2016. Pavement systems reconstruction and resurfacing policies for minimization of life cycle costs under greenhouse gas emissions constraints. *Transportation Research Part B Methodological,* 93: 618-630.

Lehman HP, Henry JB 2001. SI units. In: JB Henry (Ed.): *Clinical Diagnosis and Management by Laboratory Methods*. 20th Edition. Philadelphia: WB Saunders Company, pp. 1426-1441.

Mawaw P, Yav T, Lukanka O, Mukuku O, Kakisingi C, Kakoma JB, Luboya ON 2017. A cross-sectional study on obesity and related risk factors among women of the central market of Lusonga in Lubumbashi, Democratic Republic of Congo. *Pan African Medical Journal*, 28: 157. doi:10.11604/pamj.2017. 28. 157. 13762.

Mazzilli R, Imbrogno N, Elia J, Delfino M, Bitterman O, Fernando M et al. 2015. Sexual dysfunction in diabetic women: Prevalence and differences in type 1 and type 2 diabetes mellitus. *Diabetes Metab Syndr Obes,* 8: 97-101.

Moreira APL, Malta DC, Vianna RPT, Moreira PVL, Carvalho AT 2017. Risk and protection factors for self-reported hypertension and diabetes in João Pessoa, Brazil. The VIGITEL Survey, 2014. A cross-sectional study. *Sao Paulo Med J,* 135(5): 450-461.

National Institute of Population Research and Training (NIPORT) 2008. *Bangladesh Demographic and Health Survey 2007.* NIPORT, Mitra & Associates and ICF International, Dhaka, Bangladesh and Calverton, MD, USA.

National Institute of Population Research and Training (NIPORT) 2013. *Bangladesh Demographic and Health Survey 2011.* NIPORT, Mitra & Associates and ICF International, Dhaka, Bangladesh and Calverton, MD, USA.

National Institute of Population Research and Training (NIPORT) 2014. *Bangladesh Demographic and Health Survey 2014.* NIPORT, Mitra & Associates and ICF International, Dhaka, Bangladesh and Calverton, MD, USA.

Rahim A, Safin SZ, Kheng LK, Abas N, Ali SM 2016. Factors influencing purchasing intention of smartphone among university students. *Procedia Economics and Finance,* 37: 245- 253.

Rahman MM, Rahim MA, Nahar Q 2007. Prevalence and risk factors of type 2 diabetes in an urbanizing rural community of Bangladesh. *Bangladesh Med Res Counc Bull,* 33: 48-54.

Ramachandran A, Snehalatha C, Shetty AS, Nanditha A 2012. Trends in prevalence of diabetes in Asian countries. *World J Diabetes,* 3(6): 110-117.

Sanal TS, Nair NS, Adhikari P 2011. Factors associated with poor control of type 2 diabetes mellitus: A systematic review and meta-analysis. *Journal of Diabetology,* 2(3): 4.

Tabák AG, Herder C, Rathmann W, Brunner EJ et al. 2012. Prediabetes: A high-risk state for developing diabetes. *Lancet,* 379(9833): 2279-2290.

Uchenna O, Ijeoma E, Pauline E, Sylvester O 2010. Contributory factors of diabetes dietary regimen non adherence in adults with diabetes. *International Journal of Psychological and Behavioral Sciences,* 4(9): 2004-2011.

WHO 2011. *World Health Organization. Annual Diabetes Report*. Geneva: WHO.

WHO 2013. *World Health Organization. Diabetes Bulletin.* Geneva: WHO.

Paper received for publication in January 2019
Paper accepted for publication in March 2019