



International Research Journal of Diabetes and Metabolism
(DOI:10.28933/IRJDM)



TRACK (by NEHEP) Implementation: A Bangladesh Scenario

Abdul Kader Mohiuddin

Dr. M. Nasirullah Memorial Trust, Tejgaon, Dhaka 1215, Bangladesh

ABSTRACT

With the increasing burden of non-communicable diseases in low-income and middle-income countries (LMICs), biological risk factors, such as hyperglycemia, are a major public health concern in Bangladesh. Optimization of diabetes management by positive lifestyle changes is urgently required for prevention of comorbidities and complications, which in turn will reduce the cost. Diabetes had 2 times more days of inpatient treatment, 1.3 times more outpatient visits, and nearly 10 times more medications than non-diabetic patients, as reported by British Medical Journal. And surprisingly, 80% of people with this so-called "Rich Man's Disease" live in low- and middle-income countries. According to a recent study of American Medical Association, China and India collectively are home of nearly 110 million diabetic patients. The prevalence of diabetes in this region is projected to increase by 71% by 2035. Bangladesh was ranked as the 8th highest diabetic populous country in the time period of 2010-2011. In Bangladesh, the estimated prevalence of diabetes among adults was 9.7% in 2011 and the number is projected to be 13.7 million by 2045. The cost of diabetes care is considerably high in Bangladesh, and it is primarily driven by the medicine and hospitalization costs. According to Bangladesh Bureau of Statistics, in 2017 the annual average cost per T2DM was \$864.7, which is 52% of per capita GDP of Bangladesh and 9.8 times higher than the general health care cost. Medicine is the highest source of direct cost (around 85%) for patients without hospitalization. The private and public financing of diabetes treatment will be severely constrained in near future, representing a health threat for the Bangladeshi population.

Keywords: blood sugar screening; compliance; overweight; lifestyle; regular health checkup; Ramadan fasting; climate issue of diabetes

*Correspondence to Author:

Abdul Kader Mohiuddin
Dr. M. Nasirullah Memorial Trust,
Tejgaon, Dhaka 1215, Bangladesh

How to cite this article:

Abdul Kader Mohiuddin. TRACK (by NEHEP) Implementation: A Bangladesh Scenario. International Research Journal of Diabetes and Metabolism, 2019, 2:11

 **eSciPub**
eSciPub LLC, Houston, TX USA.
Website: <https://escipub.com/>

Introduction

Bangladesh is among the top 10 countries with the highest rates of projected age-standardized mortality among selected LMICs due to chronic diseases, particularly for CVDs and diabetes [1]. The age adjusted death rate 40 per 100,000 of population ranks Bangladesh 57 in the world, says WHO [2]. Diabetes is one of the four major types of non-communicable diseases that make the largest contribution to morbidity and mortality worldwide. The International Diabetes Federation (IDF) estimated that, worldwide, approximately 425 million people had diabetes in 2017, projected to be 629 million by 2045. Again, worldwide \$727 billion was spent in 2017 for treating and preventing diabetes, projected to be US\$776 billion by 2045 [2]. In Bangladesh, specifically, the IDF projects the prevalence of diabetes will increase to more than 50% in the next 15 years [4]. About 129,000 deaths were attributed to diabetes in Bangladesh in 2015, as reported by leading research organization ICDDR, B [5]. According to the WHO-Diabetes country profile of Bangladesh in 2016, the physical inactivity was prevailing among 25.1% of population [6]. Around 85% population of age group 25-65 never checks for diabetes [7]. A recent study by British Medical Journal says, 1 in 10 Bangladeshi adults aged ≥ 18 years have hyperglycemia (among urban residents) [4]. Even in rural Bangladeshi community, undiagnosed diabetes was high, 7.2% found in a 2016 [8] and 10% in 2019. Roughly 20%–30% of adults in rural areas of Bangladesh have abnormal fasting glucose or impaired glucose tolerance, with the prevalence of diabetes (mostly type 2 diabetes) expected to reach 24%–34% by 2030 [9]. And IDF says, there are 7.1 million people with undetected diabetes in Bangladesh and this number will be double by 2025 [10]. Das et.al, 2019 reported prevalence of dyslipidemia was over 70% to both male and female subjects, which indicates the urgency of lifestyle intervention strategies to prevent and manage this important health problem and risk factor [11]. Among 8400 stroke patients from

different hospitals in Bangladesh over a period of sixteen years, diabetic patients were nearly 25% [12]. Prevention strategies should focus on increasing physical activity, weight loss, smoking cessation, and stricter control of hypertension and glycemic level [13].

Material and Methods

A. The TRACK Concept

National Eye Health Education Program (NEHEP) developed a tool using the word “TRACK” to help you remember how to stay on track with diabetes. To keep blood sugar level on target and avoid problems with eyes, kidneys, heart and feet, patients should eat right and be active, and may need to take medication. This helps them make choices in eating and being active so body can perform at its best. By regularly monitoring, patients get it on track and prevent long-term health problems [14, 15]. TRACK was developed for diabetic retinopathy prevention but in real life it prevents all other diabetic complication by disease progression. The criteria, in short are regular health checkup and compliance of treatment guidelines along with some lifestyle modifications.

B. Methodology

Research conducted a year-round comprehensive literature search, which included technical newsletters, newspapers journals, and many other sources. The present study was started at the beginning of 2019. PubMed, ALTAVISTA, Embase, Scopus, Web of Science, and the Cochrane Central Register were thoroughly searched. The keywords were used to search for different publishers' journals such as Elsevier, Springer, Willey Online Library, and Wolters Kluwer which were extensively followed. Medicine and technical experts, pharmaceutical company representatives, hospital nurses, and journalists were given their valuable suggestions. Projections were based on TRACK criteria of regular health checkup by diabetic and non-diabetic Bangladeshi population. There are many studies regarding diabetes in Bangladeshi population. This is the first study so far, where

TRACK criteria (suggested by NEHEP of National Institute of Health, England) fulfillment is studied in Bangladesh.

Results and Discussion:

TRACK Vs Bangladesh: Perplexity of the Present Situation

A. Compliance Issue

Poor adherence is a well-documented obstacle in therapeutic control of diabetes. For an effective control and prevention of diabetes, 87% of Bangladeshis were noncompliant, compared to 71% of Indians and 52% Europeans [16]. Out-of-pocket expenditure, emotional status, frequency of counseling, patient's family priorities, availability of medication (mainly insulin) are the factors greatly influence patient compliance to treatment guidelines. In 2016, the median monthly cost of diabetes maintenance was close to \$10, approximately 10% of the median monthly

income [17]. According to a 2018 BBC record, insulin availability found supplies were low in six countries - Bangladesh, Brazil, Malawi, Nepal, Pakistan and Sri Lanka [18]. Also, huge gap between the number of diabetic patients and doctors are well-known. The Diabetic Association of Bangladesh (DAB) record shows, except Dhaka and Chittagong, there are no tertiary facilities in Bangladesh to preventing blindness due to diabetic retinopathy [19]. Children with diabetes are still managed by adult physicians or occasionally by adult diabetologists, except in institutions like BIRDEM, and Dhaka Shishu Hospital. Children and adolescents have special needs at different stages e.g., nutrition, schooling, growth, puberty etc. Improving detection, awareness, and treatment strategies is urgently needed to prevent the growing burden associated with diabetes [20].



Figure 1. TRACK, a program of National Institute of Health (NIH), England to memorize the factors that can contribute to health while living with diabetes [14].

B. Overweight Issue

Overweight or obese children have a higher risk of becoming obese in adulthood and are at higher risk of associated chronic diseases [21]. Al Muktadir et.al, 2019 revealed that around 22% to 27% Bangladeshi youth were recorded as obese with different stages of obesity [22]. Another study says nearly 40% Bangladeshi youth, taking fast foods were recognized as overweight where 32% were noted as obese with different phases of obesity and overall prevalence of fast food consumption was about 53.8% [23]. In a newspaper interview, Professor AK Azad Khan, President, Diabetic Association of Bangladesh said 40% school going children of Dhaka city were either obese or overweight [24]. "Children with type 2 diabetes is rising "alarmingly" in Bangladesh. A 300% raise in the last five years", according to the Changing Diabetes in Children Program of the BIRDEM hospital [25]. A community level study shows 35% of mothers perceived that childhood overweight/obesity could be a health problem and nearly 70% were not aware of any health consequences of childhood obesity [26]. Another study shows 97.4% students consume fast food contain Monosodium Glutamate which causes obesity and other body discomforts [27]. In a similar study among students of 4 private universities of Dhaka, 98% of the students were well informed about the negative effects associated with excessive fast food consumption, they were still profoundly addicted to it [28]. Prevalence rates of overweight and obesity are higher in urban peoples compared to rural peoples living in Bangladesh. Hoque et.al, 2015 reported higher average annual rate of reduction of underweight was found among wealthier, highly educated, urban-living women, while a higher average annual rate of increase of overweight was found among poorer, uneducated, rural-living women [29]. Tanwi et.al, 2019 reported prevalence of overweight and obesity was 34% among urban Bangladeshi women [30], increased by 17.5% between 1996 and 2011 [31]. Another study reveals that a

nearly 30% married women in Bangladesh are overweight [32]. Women's employment status was only associated with overweight or obesity for urban residents. Working urban women had a lower probability of being overweight. Socio-demographic factors including age, education, wealth index, marital status, watching TV and employment status were associated with the increased trend of overweight and obesity [33]. The highest prevalence of overweight and obesity were observed in those women with the highest education level and wealth, larger family size, living in urban areas and not being in paid employment [34].

C. Lifestyle Issues

According to the WHO-Diabetes country profile of Bangladesh in 2016, the physical inactivity was prevailing more than 25% of population. Bangladeshi women more at health risk than men due to inactivity. Two big reasons to diabetes among Bangladeshi people are carbohydrate-dependent food pattern and sedentary lifestyle [35-37]. While males can go outside, socialize and take part in outdoor activities such as cricket or football or cycling, females are often confined to domestic chores and not allowed to go outside freely. Parents are likely to restrict or discourage their daughters from outdoor activities such as recreational walking or bicycling. Young females are vulnerable to crime while travelling and so are more likely to avoid walking. Uddin et.al, 2019 reported that 80% young adults in Dhaka City, did not meet the WHO recommended level of physical activity (150 minutes of moderate- to vigorous-intensity activity per week) for optimal health, with higher rates of insufficient activity among females than males [38]. Unplanned urbanization in the capital is clear, where people have very limited scope for physical activities. Even in the rural areas people now take rickshaw/vans or other rides to go to marketplaces. Evidence shows that prevalence of physical inactivity 35% to 38% in Bangladeshi adults aged 25 years and older [39]. Adults engage in high levels of sedentary behavior

during waking hours, said another study [40]. Prevalence of self-reported depression was respectively 47.7% in Bangladesh. Lower frequency of vigorous physical activity was significantly associated with higher rates of depression diagnosed [41]. People with depressive disorders have a 65% greater risk of developing diabetes than the general population, which is a double-trouble according to the WHO [42].

D. Regular Health Checkup

Despite the high levels of diabetes and intermediate hyperglycemia, awareness and control of the condition is low in rural Bangladesh. In Bangladesh, one in three people over the age of 35 are diabetic or pre-diabetic, only 12% of them have their condition under control [43]. Fottrell et.al, 2019 reported only 25% of diabetics were aware of their status, women with diabetes were 37% less likely than men to know that they were diabetic and, even among known diabetics, 75% had suboptimal control of the condition [44]. It is mentioned earlier that 1 in 10 Bangladeshi urban adult (aged ≥ 18 years) have hyperglycemia, with dyslipidemia prevalent over 70% male and females. Among those aged over 35, the Bangladesh Demographic and Health Survey (BDHS) reported that approximately 25% had abnormal fasting glucose [45]. The glycated hemoglobin (HbA1c) method does not require the candidate to fast for eight hours or take glucose and he or she can have the test done by the HbA1c method any time [46]. However, for individuals diagnosed with diabetes, screening is associated with a reduction in mortality and cardiovascular disease risk [47].

E. Tobacco Smoking

Tobacco kills more than seven million people a year worldwide and responsible for 1 in 5 deaths in Bangladesh, according to the WHO, kills more than 161,000 people on average every year [48]. A number of experimental and clinical studies suggest that smoking decreases insulin sensitivity, and indirectly role plays in elevated blood sugar and LDL, decreased HDL and

postprandial lipid intolerance [49-57]. A 2018 survey by BRAC University shows several risk factors of diabetes includes smoking (almost 60%), abdominal obesity (43.3%), hypertension (14.3%), depression (43%) whereas the incidence of routine bodily exercise (only 1.3%) and the habit of consuming seasonal fruits as well as vegetables (8.6%) remain significantly low among the people of Bangladesh [58]. Bangladesh has been identified as a high-achieving country for several tobacco control measures, including tobacco taxation, health warning labels and anti-tobacco mass-media campaigns. The high level of achievement for Bangladesh in cigarette taxation is, however, contradicted by an increase in per capita cigarette consumption [59]. Urban male smokers in Bangladesh consume more cigarettes than bidis and smoke more per day than rural smokers. More than half of Bangladeshi men over the age of 25 years smoke cigarettes or bidis, small handmade cigarettes containing about one fourth the amount of tobacco found in cigarettes [60]. Despite the reduction in overall tobacco use, the male smoking prevalence in Bangladesh is still high at 37% [61]. Although, government is taking initiatives from administration, more than one fourth (25.5%) of the police personnel in Bangladesh are currently smokers and this should be intervened [62].

F. Other Issues

(a) **Climate and Environment:** Not only food and lifestyle, global warming also plays an important role in diabetes prevalence. A Netherlands based study in CNN Health says, "a 1-degree Celsius rise in environmental temperature could account for more than 100,000 new diabetes cases per year in the USA alone" [18]. A similar study says Bangladesh will exceed 35-degree Celsius before the end of the century [63]. Consuming arsenic contaminated food grains could be another reason of high diabetes prevalence [64]. In sex-stratified analyses with 641 subjects from rural Bangladesh, Paul et.al, 2019 reported

arsenic exposure (50.01-150 µg/L) showed a clearer pattern of dose-dependent risk for hyperglycemia in females than males [65]. Again, 15% of expecting women are diagnosed with gestational diabetes among these 60% contribute to permanent diabetes within 10 years, says Dr Samsad Jahan (professor of Obstetrics and Gynecology, BIRDEM) [66].

(b) **Skipping Meals:** Breakfast skipping is highly prevalent among urban adult population with significant association of obesity in Bangladesh [67,68]. Kabir et.al, 2018 reported skipping breakfast by public university students for cost saving [69] and Bipasha et.al, 2014 reported the same by private university students due to late sleep and rush for classes in the morning [28]. Either way, skipping breakfast hikes both obesity and diabetes risk [70].

(c) **Fatty and Fried Food after Religious Fasting:** It is common knowledge that fasting has myriad health benefits. Fasting during Ramadan is significantly associated with decrease in blood lipid profile, blood pressures, glucose, and HbA1C level among diabetic patients [71-77]. The total energy intake decreases during Ramadan, whereas the dietary fat consumption increases because of an augmentation of fatty food that does not occur during other periods [78]. Following Prophetic tradition, it is customary to open the fast with dates, which is unique in its nutrient content (β -D-glucan, a soluble fiber) that gives the stomach a 'full' feeling [79].

(d) **Food Adulteration:** ICDDR, B, estimated 150 food items in the country. More than 50% of the food samples they tested were adulterated reported by the Institute of Public Health (IPH). Undoubtedly human health is now under the domination of formalin, in Bangladesh about 400 tons of formalin is being imported which are goes to human stomach, creates deadly mistreats on long term exposure [80]. Several studies

highlighted formaldehyde-induced neurodegeneration, diabetes risk and diabetes-associated cognitive impairments [81-84]. Even more unfortunate is the fact that nefarious practice of food adulteration increases exponentially during the month of Ramadan in Bangladesh, according to a study of European Journal of Sustainable Development Research, 2019 [85]. The number of patients suffering from cancer, diabetes, and kidney diseases is on the rise due to food adulteration [86-89].

(e) **Child Marriage:** According to UNICEF, Bangladesh has the fourth highest prevalence rate of child marriage in the world, and the second highest number of absolute child brides – 4.5 million. Around 30% of girls in Bangladesh married before the age of 15 and nearly 80% got married before the age of 18 [90-92]. The prevalence of nutritional deficiency was relatively higher among rural, illiterate and early married women and among those with a low standard of living [93]. Child marriage, low-birth-weight, mother nutrition and diabetes closely related to each other [46], [93-96].

(f) **Low Health Literacy (LHL):** In low-income countries such as Bangladesh, the less than optimum use of services could be due to LHL. Emphasis on health literacy has been inadequate. And also, health service delivery is pluralistic with a mix of public, private and informally trained healthcare providers [97]. Despite the high levels of diabetes and intermediate hyperglycemia, awareness and control of the condition is low [44]. In a cross-sectional study in urban population of Bangladesh, more than 60% of the diabetic patients had inadequate functional health literacy of them and nearly 90% had inadequate glycemic control ($HbA1c > 8\%$). Therefore, Mehzabin et.al, 2019 concluded that LHL is consistently associated with inadequate glycemic control [98]. LHL also indicates that the health promotion techniques are not used appropriately and it

is linked to the declining health status of the people and results in low compliance to disease prevention programs. Also, Islam et.al, 2018 concluded that diabetes-related health literacy in rural Bangladesh is a major factor associated with diabetic retinopathy (DR) screening [99]. Diabetes prevention and control efforts in this population must include large-scale awareness initiatives which focus not only on high-risk individuals but the whole population. Innovations in increasing diabetes knowledge and health behavior change are recommended specially for females, those with lower education and less income [100].

(g) **Malnutrition & other Social Challenges:** Mother nutrition and diabetes situation is already discussed. Very little is known about the occurrence of T1DM in resource-poor countries and particularly in their rural hinterlands. Bangladesh is among the 20 countries where 80% undernourished children are living. Underweight (weight-for-age z-score <-2) among children aged less than five years is more than 40% and nearly one-third of women are undernourished with body mass index of <18.5 kg/m² in Bangladesh [101]. The IDF atlas estimated the incidence of type 1 diabetes in Bangladesh as 4.2 new cases of T1DM/100,000 children (0–14 years)/year, in

2013 [20]. The social challenges faced by T1DM children are numerous. Many of them are poor, with little access to education. They are often considered a burden on the family, especially girls; they have little prospect of getting married or being employed. Diabetes is likely to be hidden from society, prospective spouse and employer, often with far-reaching consequences. Lack of motivation, inability to manage common complications e.g., hypoglycemia, sick day management, drop out from the clinic (which may be due to lack of motivation or extra cost involved in travel), psychological issues, are other common problems.

(h) **Negative Attitude and Unemployment:** Negative attitudes toward physical activity were more likely among girls, adolescents who slept ≤8 h/night, and adolescents who were overweight or obese, found in a study among eight secondary schools in Dhaka [102]. Earlier stated that, four out of five young adults in Dhaka City did not meet the physical activity recommendations [38]. In Bangladesh, a nearly 80% unemployed are youth, more than 46% unemployed youths are university graduates [103]. This has a direct association of physical inactivity, drinking, smoking, drug/alcohol abuse and depression among youth.

Table 1. Summary of Diabetic Risk Factors in Bangladesh

Risk Factors	Prevalence	Future Risk/Comments
Physical inactivity (overall)	25.1%	In the general population, sedentary behavior has been associated with an increased risk of a range of health problems including, obesity, infertility, cardiovascular conditions, mood disorders and all-cause mortality [104-106]. Physical activity not only contributes to prevention or delay in development of other long-term diabetes complications, such as neuropathy, retinopathy, and nephropathy, but also may slow the progression of existing complications [107].
Physical inactivity (among adults)	35% to 38%	
Young adults among capital who unmet recommended physical activity	80%	
Adults who never checks diabetes	85%	The IDF estimates that one in every 11 adults has diabetes. Lack of regular self-monitoring of blood glucose predicts hospitalization for diabetes-related complications [108]. Usage of continuous glucose monitor in the management of T2DM is associated with benefits of reduction in HbA1c especially in poorly controlled T2DM patients [109].
Undiagnosed diabetes among rural population	7.2%	

Adults with hyperglycemia	10%	Untreated hyperglycemia may leads to cardiovascular disease, nerve damage (neuropathy), kidney damage (diabetic nephropathy) or kidney failure, damage to the blood vessels of the retina (diabetic retinopathy), potentially leading to blindness; clouding of the normally clear lens of eye (cataract), feet problems, caused by damaged nerves or poor blood flow that can lead to serious skin infections, ulcerations, and in some severe cases, amputation; bone and joint problems, teeth and gum infections [110-117].
Abnormal fasting glucose among rural population	20%-30%	
People over the age of 35 having diabetes under control	12%	
People over 35 had abnormal fasting glucose	25%	
Stroke among diabetic patients	25%	Diabetes mellitus is one of the major risk factors for the development of atherosclerosis and the excess risk of stroke [118]. Approximately one-third of all stroke patients have diabetes [119]. People with diabetes are at a twofold to fivefold increased risk for stroke compared with people without diabetes [120].
Non-compliance with medication	87%	Factors found to be associated with non-adherence to antidiabetic medication include financial difficulties, forgetfulness, younger age, level of education, existing diabetes complications and difficulties in taking the medications alone [121]. Patients' non-adherence to diabetes medication is associated with poor glycemic control and suboptimal benefits from their prescribed medication, which can lead to worsening of medical condition, development of comorbidities, reduced quality of life, elevated health care costs, and increased mortality [122].
Prevalence of dyslipidemia	More than 70%	Approximately 44% of the diabetes burden, is attributable to overweight or obesity [102]. Interventions that include diet combined with physical activity interventions can reduce the risk of obesity (zBMI and BMI) in young children aged 0 to 5 years [123]. Students in private schools are at a greater risk of being overweight/obese relative to students in government schools [124]. Poor quality of the early maternal-child relationship to be associated with higher prevalence of adolescent obesity [125]. In Bangladesh, a thin child is likely to be perceived by others as coming from a poor family. Mothers of skinny children are, in many cases, held guilty for not taking proper care of their children; thinness is often judged as proof of the mother's negligence of responsibility. Because of a lack of knowledge, these mothers frequently consider their offspring's thinness as analogous to parenting failure. As a result, parents are willing to see their children carrying excess weight [26]. During a 30-year follow-up, the risk of CVD was 54.8% in normal-weight women versus 78.8% among obese women with diabetes and 78.6% versus 86.9% among normal and obese men with diabetes, respectively [126]. In general, on average men were found to spend three-fold more time doing physical activity than women in both urban and rural areas [127].
Obesity among young adults	22% to 27%	
Obesity among school going children	40%	
Mothers unaware of consequences of childhood obesity	70%	
Obesity among urban women	34%	
Obesity among married women	30%	
Obesity increase among women in 15 years study	17.5%	
Higher prevalence of diabetes among males	7.4%	
Overall consumption of fast food consumption among youth and children	Around 54%	
Prevalence of self-reported depression	47%	Depression occurrence is two to three times higher in people with diabetes mellitus [129]. In people with diabetes the comorbidity with depression is associated with micro- and

		macrovascular complications and increased mortality [130]. However, people with depressive disorders have a 65% greater risk of developing diabetes than the general population [131].
Smokers (male)	37%	Up to 65% of cardiovascular mortality is attributable to interaction between smoking and diabetes. Research suggests that diabetic people who smoke have poorer diabetes control, greater insulin needs, increased insulin resistance and increased risk of hypoglycemia [132].
GDM	15%	The most common risk factors include obesity and overweight, high maternal age, family history of T2D, previous history of GDM, polycystic ovary syndrome, persistent glucosuria, recurrent abortions, previous history of a large baby (birth weight ≥ 4000 g), history of stillbirth, history of chronic hypertension or blood pressure associated with pregnancy. Among these risk factors, women with overweight, obesity and morbid obesity are related to an increased risk of developing GDM at a rate of two, four and eight times, respectively [133].
Adulterated food in daily consumption	50%	Extensive studies on food adulteration confirm that ~50% of the food is either adulterated or contaminated with toxic compounds. WHO reveals that unsafe foods can be significant reasons of many chronic and non-chronic diseases including but not limited to diarrhea, different types of cancer, heart diseases, various kidney diseases, and birth defects [134].
Child marriage	30%	Illnesses associated with nutrient deficiencies have significantly reduced the productivity of women in less developed countries [135]. Evidence shows that women with undernutrition before and during pregnancy have increased risk of metabolic disorders (i.e., gestational diabetes mellitus) and are at increased risk of complications during labor and birth [136].
Undernourished women	33%	
Underweight among children aged less than five years	40%	
Low health literacy (among urban people)	60%	It was significantly positively associated with understanding of diabetes care, self-efficacy, communication with doctors, and medication adherence, with compliance to treatment being a major issue. Health literacy increases patients' self-efficacy and knowledge about diabetes and thereby improves self-management of diabetes [137]. Individuals with poorly controlled diabetes and low HL believed that they were optimally controlling their blood glucose, although they did not take measures to improve their glycemic control [97].

Conclusion

The prevalence of type 2 diabetes showed an increasing trend in both urban and rural population in Bangladesh. People with no education, lower socio-economic status, and those who lived in disadvantaged regions in terms of education and economic profile are found lacking of diagnosis, treatment, and control of diabetes. Emphasizing medication adherence with multiple comorbid diseases should be strongly considered in future diabetes management programs to improve glycemic

control in patients with type 2 diabetes. Recently, Telenor Health and DAB have launched the first-ever diabetes management service, Dia360, to help people with diabetes manage their blood sugar levels and reduce risks of complications. People can enroll in three DAB centers in Dhaka—Bangladesh Institute of Health and Sciences, BIRDEM General Hospital, and the National Health Network Hospital. It has more than 400,000 diabetics registered at its tertiary center, BIRDEM in Dhaka. However, the most important thing is patient education, that the

modern world is giving the highest priorities. Rich or poor, privileged or unprivileged, all segment of population should be brought under the arena of compliance through patient education, at least by health campaign. Both government, profit taking NGOs and pharmaceutical companies should take initiatives in this regard.

Acknowledgment

I'm thankful to Dr. Afsana Afroz, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia for her valuable time to audit my paper and for her thoughtful suggestions. I'm also grateful to seminar library of Faculty of Pharmacy, University of Dhaka and BANSDOC Library, Bangladesh for providing me books, journal and newsletters.

Abbreviations

Low- And Middle-Income Countries (LMICs); International Diabetes Federation (IDF); National Eye Health Education Program (NEHEP); Bangladesh Demographic and Health Survey (BDHS); Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM); Institute of Public Health (IPH)

Financial Disclosure or Funding: N/A

Conflict of Interest: The author declares that he has no competing interests.

Informed Consent: N/A

Author contributions: N/A

References

1. Ali, Nausad et al. "Sex-specific prevalence, inequality and associated predictors of hypertension, diabetes, and comorbidity among Bangladeshi adults: results from a nationwide cross-sectional demographic and health survey." *BMJ open* vol. 9,9 e029364. 17 Sep. 2019, doi:10.1136/bmjopen-2019-029364
2. Mohiuddin AK. Diabetes Fact: Bangladesh Perspective. *International Journal of Diabetes Research* 2019; 2(1): 14-20. doi: 10.17554/j.issn.2414-2409.2019.02.12. Available from: URL:

- http://www.ghrnet.org/index.php/ijhr/article/view/2457
3. Afroz, Afsana et al. "Type 2 diabetes mellitus in Bangladesh: a prevalence based cost-of-illness study." *BMC health services research* vol. 19,1 601. 27 Aug. 2019, doi:10.1186/s12913-019-4440-3
4. Islam, Jessica Yasmine et al. "Prevalence and determinants of hyperglycaemia among adults in Bangladesh: results from a population-based national survey." *BMJ open* vol. 9,7 e029674. 24 Jul. 2019, doi:10.1136/bmjopen-2019-029674
5. Salahuddin T. The rising threat of NCDs in Bangladesh. *The Daily Star*, January 06, 2019.
6. Salahuddin T. Obesity is increasing among the younger generation in Bangladesh. *The Daily Star*, September 23, 2018.
7. Star Online Report. 80 lakh Bangladeshis suffering from diabetes: State minister. *The Daily Star*, April 06, 2016.
8. Islam FM, Chakrabarti R, Islam MT, Wahab M, Lamoureux E, Finger RP, Shaw JE. Prediabetes, diagnosed and undiagnosed diabetes, their risk factors and association with knowledge of diabetes in rural Bangladesh: The Bangladesh Population-based Diabetes and Eye Study. *J Diabetes*. 2016 Mar;8(2):260-8. doi: 10.1111/1753-0407.12294.
9. Fottrell, Edward et al. "Community groups or mobile phone messaging to prevent and control type 2 diabetes and intermediate hyperglycaemia in Bangladesh (DMagic): a cluster-randomised controlled trial." *The lancet. Diabetes & endocrinology* vol. 7,3 (2019): 200-212. doi:10.1016/S2213-8587(19)30001-4
10. Shariful Islam, Sheikh Mohammed et al. "Healthcare use and expenditure for diabetes in Bangladesh." *BMJ global health* vol. 2,1 e000033. 3 Jan. 2017, doi:10.1136/bmjgh-2016-000033
11. Das H, Banik S. Prevalence of dyslipidemia among the diabetic patients in southern Bangladesh: A cross-sectional study. *Diabetes Metab Syndr*. 2019 Jan - Feb;13(1):252-257. doi: 10.1016/j.dsx.2018.09.006.
12. Mohammad QD, Habib M, Mondal BA, Chowdhury RN, Hasan MH, Hoque MA, Rahman KM, Khan SU, Chowdhury AH, Haque B. Stroke in Bangladeshi patients and risk factor. *Mymensingh Med J*. 2014 Jul;23(3):520-9.
13. Afroz A, Zhang W, Wei Loh AJ, Jie Lee DX, Billah B. Macro- and micro-vascular complications and their determinants among people with type 2 diabetes in Bangladesh. *Diabetes Metab Syndr*. 2019 Sep - Oct;13(5):2939-2946. doi: 10.1016/j.dsx.2019.07.046.

14. National Institute of Health (UK). Stay on TRACK To Prevent Blindness From Diabetes. Available From: https://www.nei.nih.gov/sites/default/files/nehpdfs/NDM_SM_Toolkit_2015.pdf
15. American Association of Diabetes Educators. Resources for People Living with Diabetes (Monitoring). Available From: <https://www.diabeteseducator.org/living-with-diabetes/aade7-self-care-behaviors/aade7-self-care-behaviors-monitoring>
16. Mohiuddin AK. Domination of Nephrotic Problems among Diabetic Patients of Bangladesh. Archives of Nephrology and Urology 1 (2018): 009-016. DOI: 10.26502/anu.2644-2833002
17. Vanderlee L, Ahmed S, Ferdous F, Farzana FD, Das SK, Ahmed T, Hammond D, Faruque ASG. Self-care practices and barriers to compliance among patients with diabetes in a community in rural Bangladesh. Int J Diabetes Dev Ctries 2016; 36: 320. DOI: 10.1007/s13410-015-0460-7
18. Azad A. How climate change will affect your health. CNN health, October 12, 2018.
19. Diabetic Association of Bangladesh. WDF-494 Extension of Diabetic Retinopathy Care in Bangladesh. Available from: https://www.dab-bd.org/sub-page.php?sub_category=35
20. Azad, Kishwar. "Type 1 diabetes: The Bangladesh perspective." Indian journal of endocrinology and metabolism vol. 19, Suppl 1 (2015): S9-S11. doi:10.4103/2230-8210.155344
21. Alam MM, Hawlader MDH, Wahab A, Hossain MD, Nishat SA, Zaman S, Ahsan GU. Determinants of overweight and obesity among urban school-going children and adolescents: a case-control study in Bangladesh. Int J Adolesc Med Health. 2019 May 9. pii: /j/ijamh.ahead-of-print/ijamh-2018-0034/ijamh-2018-0034.xml. doi: 10.1515/ijamh-2018-0034.
22. Al Muktedir MH, Islam MA, Amin MN, Ghosh S, Siddiqui SA, Debnath D, Islam MM, Ahmed T, Sultana F. Nutrition transition - Pattern IV: Leads Bangladeshi youth to the increasing prevalence of overweight and obesity. Diabetes Metab Syndr. 2019 May - Jun;13(3):1943-1947. doi: 10.1016/j.dsx.2019.04.034.
23. Goon S, Bipasha MS, Islam S. Fast food consumption and obesity risk among university students of Bangladesh. Eur J Prev Med 2014;2:99e104.
24. World Diabetes Day 2018. "Access to insulin is a human right" In conversation with Professor AK Azad Khan, President, Diabetic Association of Bangladesh. The Daily Star, November 14, 2018.
25. Hasib NI. Children getting type 2 diabetes 'alarmingly' in Bangladesh. bdnews24.com 06 April, 2016.
26. Hossain MS, Siddiquee MH, Ferdous S, Faruki M, Jahan R, Shahik SM, Raheem E, Okely AD. Is Childhood Overweight/Obesity Perceived as a Health Problem by Mothers of Preschool Aged Children in Bangladesh? A Community Level Cross-Sectional Study. Int J Environ Res Public Health. 2019 Jan 12;16(2). pii: E202. doi: 10.3390/ijerph16020202.
27. Chaity AJ. Obesity blamed for alarming rise in childhood diabetes DhakaTribune November 13th, 2017.
28. Bipasha M, Goon S. Fast food preferences and food habits among students of private universities in Bangladesh. South East Asia Journal of Public Health 2014; 3(1): 61-64. DOI: 10.3329/seajph.v3i1.17713
29. Hoque ME, Long KZ, Niessen LW, Al Mamun A. Rapid shift toward overweight from double burden of underweight and overweight among Bangladeshi women: a systematic review and pooled analysis. Nutr Rev. 2015 Jul;73(7):438-47. doi: 10.1093/nutrit/nuv003.
30. Tanwi, Tania Sultana et al. "Socioeconomic correlates of overweight and obesity among ever-married urban women in Bangladesh." BMC public health vol. 19,1 842. 28 Jun. 2019, doi:10.1186/s12889-019-7221-3
31. Banik S, Rahman M. Prevalence of Overweight and Obesity in Bangladesh: a Systematic Review of the Literature. Curr Obes Rep. 2018 Dec;7(4):247-253. doi: 10.1007/s13679-018-0323-x.
32. Biswas, Tuhin et al. "The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey." PLoS one vol. 12,5 e0177395. 16 May. 2017, doi:10.1371/journal.pone.0177395
33. Chowdhury, Muhammad Abdul Baker et al. "Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional surveys." BMJ open vol. 8,7 e018468. 19 Jul. 2018, doi:10.1136/bmjopen-2017-018468
34. Biswas T, Uddin MJ, Mamun AA, Pervin S, P Garnett S. Increasing prevalence of overweight and obesity in Bangladeshi women of reproductive age: Findings from 2004 to 2014. PLoS One. 2017 Jul 28;12(7):e0181080. doi: 10.1371/journal.pone.0181080.
35. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358

- population-based surveys with 1.9 million participants. *Lancet Glob Health*. 2018 Oct; 6(10): e1077-e1086. DOI: 10.1016/S2214-109X(18)30357-7.
36. Mahbub I. Why Is Diabetes on The Rise in Bangladesh? *Web Future Startup* October 25, 2016. Available From: <https://futurestartup.com/2016/10/25/why-is-diabetes-on-the-rise-in-bangladesh/>
 37. Tareq S. Obesity is increasing among the younger generation in Bangladesh *The Daily Star* September 23, 2018.
 38. Uddin R, Khan A, Burton NW. Prevalence and sociodemographic patterns of physical activity among Bangladeshi young adults. *J Health Popul Nutr*. 2017 Jul 14;36(1):31. doi: 10.1186/s41043-017-0108-y.
 39. Moniruzzaman, Mohammad et al. "Physical activity levels and associated socio-demographic factors in Bangladeshi adults: a cross-sectional study." *BMC public health* vol. 17,1 59. 11 Jan. 2017, doi:10.1186/s12889-016-4003-z
 40. Vancampfort D, Firth J, Schuch F, Rosenbaum S, De Hert M, Mugisha J, Probst M, Stubbs B. Physical activity and sedentary behavior in people with bipolar disorder: A systematic review and meta-analysis. *J Affect Disord*. 2016 Sep 1;201:145-52. doi: 10.1016/j.jad.2016.05.020.
 41. Bishwajit, Ghose et al. "Physical inactivity and self-reported depression among middle- and older-aged population in South Asia: World health survey." *BMC geriatrics* vol. 17,1 100. 28 Apr. 2017, doi:10.1186/s12877-017-0489-1
 42. WHO Bangladesh. Double trouble: diabetes and depression. Available from: <http://www.searo.who.int/bangladesh/depression/doubletrouble/en/>
 43. Aowsaf SMA. Diabetes management service launched in Bangladesh. *DhakaTribune*, September 25th, 2018.
 44. Fottrell, Edward et al. "Diabetes knowledge and care practices among adults in rural Bangladesh: a cross-sectional survey." *BMJ global health* vol. 3,4 e000891. 23 Jul. 2018, doi:10.1136/bmjgh-2018-000891
 45. Fottrell, Edward. et al. "Distribution of diabetes, hypertension and non-communicable disease risk factors among adults in rural Bangladesh: a cross-sectional survey." *BMJ global health* vol. 3,6 e000787. 12 Nov. 2018, doi:10.1136/bmjgh-2018-000787
 46. Palma P. A worrying picture of diabetes in Bangladesh. *The Daily Star*, November 14, 2018.
 47. Health Tips. Screening reduces mortality for detectable type 2 diabetics. *The Daily Star*, August 27, 2017.
 48. Hasan MK. WHO: Tobacco responsible for 1 in 5 deaths in Bangladesh. *DhakaTribune*, June 01, 2018.
 49. Bergman, Bryan C et al. "Novel and reversible mechanisms of smoking-induced insulin resistance in humans." *Diabetes* vol. 61,12 (2012): 3156-66. doi:10.2337/db12-0418
 50. Kong C, Nimmo L, Elatrozy T, Anyaoku V, Hughes C, Robinson S, Richmond W, Elkeles RS. Smoking is associated with increased hepatic lipase activity, insulin resistance, dyslipidaemia and early atherosclerosis in Type 2 diabetes. *Atherosclerosis*. 2001 Jun;156(2):373-8.
 51. Schofield, Jonathan D et al. "Diabetes Dyslipidemia." *Diabetes therapy : research, treatment and education of diabetes and related disorders* vol. 7,2 (2016): 203-19. doi:10.1007/s13300-016-0167-x
 52. Facchini FS, Hollenbeck CB, Jeppesen J, Chen YD, Reaven GM. Insulin resistance and cigarette smoking. *Lancet*. 1992 May 9;339(8802):1128-30.
 53. Bajaj, Mandeep. "Nicotine and insulin resistance: when the smoke clears." *Diabetes* vol. 61,12 (2012): 3078-80. doi:10.2337/db12-1100
 54. Harris, Kindred K et al. "Metabolic effects of smoking cessation." *Nature reviews. Endocrinology* vol. 12,5 (2016): 299-308. doi:10.1038/nrendo.2016.32
 55. Calcaterra V, Winickoff JP, Klersy C, Schiano LM, Bazzano R, Montalbano C, Musella V, Regalbuto C, Larizza D, Cena H. Smoke exposure and cardio-metabolic profile in youth with type 1 diabetes. *Diabetol Metab Syndr*. 2018 Jul 6;10:53. doi: 10.1186/s13098-018-0355-0.
 56. Rao Ch, Srinivasa, and Emmanuel Subash Y. "The effect of chronic tobacco smoking and chewing on the lipid profile." *Journal of clinical and diagnostic research : JCDR* vol. 7,1 (2013): 31-4. doi:10.7860/JCDR/2012/5086.2663
 57. Gossett, Linda K et al. "Smoking intensity and lipoprotein abnormalities in active smokers." *Journal of clinical lipidology* vol. 3,6 (2009): 372-8. doi:10.1016/j.jacl.2009.10.008
 58. Wasifuzzaman C. A review of prevalence, complications, risk factors, knowledge assessment, self-management, consciousness and treatment of diabetes mellitus in Bangladesh. Available From: <http://dspace.bracu.ac.bd/xmlui/handle/10361/10674>
 59. Nargis, Nigar et al. "A decade of cigarette taxation in Bangladesh: lessons learnt for tobacco control." *Bulletin of the World Health Organization* vol. 97,3 (2019): 221-229. doi:10.2471/BLT.18.216135

60. Alam, Dewan S et al. "Smoking-attributable mortality in Bangladesh: proportional mortality study." *Bulletin of the World Health Organization* vol. 91,10 (2013): 757-64. doi:10.2471/BLT.13.120196
61. Nargis, Nigar et al. "Prevalence and Patterns of Tobacco Use in Bangladesh from 2009 to 2012: Evidence from International Tobacco Control (ITC) Study." *PloS one* vol. 10,11 e0141135. 11 Nov. 2015, doi:10.1371/journal.pone.0141135
62. Khan MK, Hoque HE, Ferdous J. Knowledge and Attitude Regarding National Tobacco Control Law and Practice of Tobacco Smoking among Bangladesh Police. *Mymensingh Med J.* 2019 Oct;28(4):752-761.
63. Tribune Desk. Temperature in Bangladesh to rise to deadly heights by end of century. *DhakaTribune*, August 03, 2017.
64. Mohiuddin AK. Domination of Pollutant Residues among Food Products of South-East Asian Countries. *South Asian Res J Agri Fish; Vol-1, Iss-2 (Aug-Sep, 2019): 50-53.* DOI: 10.36346/sarjaf.2019.v01i02.003
65. Paul SK, Islam MS, Hasibuzzaman MM, Hossain F, Anjum A, Saud ZA, Haque MM, Sultana P, Haque A, Andric KB, Rahman A, Karim MR, Siddique AE, Karim Y, Rahman M, Miyataka H, Xin L, Himeno S, Hossain K. Higher risk of hyperglycemia with greater susceptibility in females in chronic arsenic-exposed individuals in Bangladesh. *Sci Total Environ.* 2019 Jun 10;668:1004-1012. doi: 10.1016/j.scitotenv.2019.03.029.
66. Chaity AJ. 15% pregnant women diagnosed with diabetes. *DhakaTribune*, November 14, 2017.
67. Goon S, Islam MS. Breakfast skipping and obesity risk among urban adults in Bangladesh. *Int J Public Health Sci.* 2014; 3:15–22.
68. Khan A, Khan SR, Burton NW. Missing breakfast is associated with overweight and obesity in Bangladeshi adolescents. *Acta Paediatr.* 2019 Jan; 108(1):178-179. doi: 10.1111/apa.14553.
69. Kabir A, Miah S, Islam A. Factors influencing eating behavior and dietary intake among resident students in a public university in Bangladesh: A qualitative study. *PLoS One.* 2018 Jun 19;13(6):e0198801. doi: 10.1371/journal.pone.0198801.
70. Mohiuddin, A. "Skipping Breakfast Everyday Keeps Well-Being Away". *Acta Medica*, Vol. 50, no. 1, Mar. 2019, pp. 26-33, doi:10.32552/2019.ActaMedica.331.
71. Bener A, Yousafzai MT. Effect of Ramadan fasting on diabetes mellitus: a population-based study in Qatar. *J Egypt Public Health Assoc.* 2014 Aug;89(2):47-52. doi: 10.1097/01.EPX.0000451852.92252.9b.
72. Yeoh EC, Zainudin SB, Loh WN, Chua CL, Fun S, Subramaniam T, Sum CF, Lim SC. Fasting during Ramadan and Associated Changes in Glycaemia, Caloric Intake and Body Composition with Gender Differences in Singapore. *Ann Acad Med Singapore.* 2015 Jun;44(6):202-6.
73. Bener, Abdülbari et al. "Effect of ramadan fasting on glycemic control and other essential variables in diabetic patients." *Annals of African medicine* vol. 17,4 (2018): 196-202. doi:10.4103/aam.aam_63_17
74. Bener A, A Al-Hamaq AOA, Öztürk M, Çatan F, Haris PI, Rajput KU, Ömer A. Effect of ramadan fasting on glycemic control and other essential variables in diabetic patients. *Ann Afr Med.* 2018 Oct-Dec;17(4):196-202. doi: 10.4103/aam.aam_63_17.
75. Ahmed, Mohamed H et al. "Diabetes and Ramadan: A concise and practical update." *Journal of family medicine and primary care* vol. 6,1 (2017): 11-18. doi:10.4103/2249-4863.214964
76. Malinowski, Bartosz et al. "Intermittent Fasting in Cardiovascular Disorders-An Overview." *Nutrients* vol. 11,3 673. 20 Mar. 2019, doi:10.3390/nu11030673
77. Siaw, Melanie Y L et al. "Metabolic parameters in type 2 diabetic patients with varying degrees of glycemic control during Ramadan: An observational study." *Journal of diabetes investigation* vol. 7,1 (2016): 70-5. doi:10.1111/jdi.12374
78. Khaled, Boumédiène Méghit, and Slimane Belbraouet. "Effect of Ramadan fasting on anthropometric parameters and food consumption in 276 type 2 diabetic obese women." *International journal of diabetes in developing countries* vol. 29,2 (2009): 62-8. doi:10.4103/0973-3930.53122
79. Ali, Sharique A et al. "Links between the Prophet Muhammad (PBUH) recommended foods and disease management: A review in the light of modern superfoods." *International journal of health sciences* vol. 12,2 (2018): 61-69.
80. MOHIUDDIN, A. "The Mysterious Domination of Food/Drinking Water Contaminants and Adulterants in Bangladesh". *PharmaTutor*, Vol. 7, no. 1, Jan. 2019, pp. 42-58, doi:10.29161/PT.v7.i1.2019.42.
81. Tan T, Zhang Y, Luo W, Lv J, Han C, Hamlin JNR, Luo H, Li H, Wan Y, Yang X, Song W, Tong Z. Formaldehyde induces diabetes-associated cognitive impairments. *FASEB J.* 2018

- Jul;32(7):3669-3679. doi: 10.1096/fj.201701239R.
82. Hipkiss, Alan R. "Depression, Diabetes and Dementia: Formaldehyde May Be a Common Causal Agent; Could Carnosine, a Pluripotent Peptide, Be Protective?." *Aging and disease* vol. 8,2 128-130. 1 Apr. 2017, doi:10.14336/AD.2017.0120
 83. Tulpule K, Dringen R. Formaldehyde in brain: an overlooked player in neurodegeneration? *J Neurochem.* 2013 Oct;127(1):7-21. doi: 10.1111/jnc.12356.
 84. Grotton C. Research Update: Protect Against Formaldehyde Exposure. *Life Extension Magazine®*, Issue: Jan 2019.
 85. Mohiuddin, A. K. (2019). Chemical Contaminants and Pollutants in the Measurable Life of Dhaka City. *European Journal of Sustainable Development Research*, 3(2), em0083. <https://doi.org/10.29333/ejosdr/5727>
 86. Ullah A. Sale of Adulterated Spice Powder: Public health at risk. *The Daily Sun*, October 16, 2019.
 87. Staff Correspondent. Food adulteration rings alarm bell: STAR-RDRS roundtable told most food items adulterated, pose lethal risks to public health. *The Daily Star*, August 11, 2011.
 88. Majed N, Real MIH, Akter Mand Azam HM (2016) Food Adulteration and Bio-Magnification of Environmental Contaminants: A Comprehensive Risk Framework for Bangladesh. *Front. Environ. Sci.* 4:34. doi: 10.3389/fenvs.2016.00034
 89. Chowdhury MFI. Evaluating Position of Bangladesh to Combat 'Adulterated Food' Crisis in Light of Human Rights. *OSR Journal of Humanities And Social Science (IOSR-JHSS)* Volume 19, Issue 3, Ver. VI (Mar. 2014), PP 45-54.
 90. Child Marriage in Bangladesh. Marry Before Your House is Swept Away. *Human Rights Watch*, June 9, 2015.
 91. Kamal SM, Hassan CH, Alam GM, Ying Y. Child marriage in Bangladesh: trends and determinants. *J Biosoc Sci.* 2015 Jan;47(1):120-39. doi: 10.1017/S0021932013000746.
 92. Hossain MG, Mahumud RA, Saw A. PREVALENCE OF CHILD MARRIAGE AMONG BANGLADESHI WOMEN AND TREND OF CHANGE OVER TIME. *J Biosoc Sci.* 2016 Aug;48(4):530-8. doi: 10.1017/S0021932015000279.
 93. Zahangir, M S et al. "Malnutrition and non-communicable diseases among Bangladeshi women: an urban-rural comparison." *Nutrition & diabetes* vol. 7,3 e250. 20 Mar. 2017, doi:10.1038/ntud.2017.2
 94. Silva-Zolezzi, Irma et al. "Maternal nutrition: opportunities in the prevention of gestational diabetes." *Nutrition reviews* vol. 75,suppl 1 (2017): 32-50. doi:10.1093/nutrit/nuw033
 95. Tunçer M, Tunçer M. Fetal malnutrition in infants born to diabetic mothers. *Turk J Pediatr.* 1982 Oct-Dec;24(4):245-9.
 96. Independent Online Desk. Malnutrition major cause of premature child birth in Bangladesh. *The Independent*, 23 March, 2018.
 97. Das S, Mia MN, Hanifi SM, Hoque S, Bhuiya A. Health literacy in a community with low levels of education: findings from Chakaria, a rural area of Bangladesh. *BMC Public Health.* 2017 Feb 16;17(1):203. doi: 10.1186/s12889-017-4097-y.
 98. Mehzabin, R., K. Hossain, M. Moniruzzaman, and S. K. J. Sayeed. "Association of Functional Health Literacy With Glycemic Control: A Cross Sectional Study in Urban Population of Bangladesh". *Journal of Medicine*, Vol. 20, no. 1, Jan. 2019, pp. 19-24, doi:10.3329/jom.v20i1.38816.
 99. Islam FMA, Kawasaki R, Finger RP. Factors associated with participation in a diabetic retinopathy screening program in a rural district in Bangladesh. *Diabetes Res Clin Pract.* 2018 Oct;144:111-117. doi: 10.1016/j.diabres.2018.08.012.
 100. Siddique, Md Kaoser Bin et al. "Diabetes knowledge and utilization of healthcare services among patients with type 2 diabetes mellitus in Dhaka, Bangladesh." *BMC health services research* vol. 17,1 586. 22 Aug. 2017, doi:10.1186/s12913-017-2542-3
 101. Ahmed, Tahmeed et al. "Nutrition of children and women in Bangladesh: trends and directions for the future." *Journal of health, population, and nutrition* vol. 30,1 (2012): 1-11. doi:10.3329/jhpn.v30i1.11268
 102. Burton NW, Kadir MA, Khan A. Physical activity attitudes among adolescents in Bangladesh. *Public Health.* 2019 Nov 13;179:59-65. doi: 10.1016/j.puhe.2019.10.004.
 103. Rawlings GH, Williams RK, Clarke DJ, et al. Exploring adults' experiences of sedentary behaviour and participation in non-workplace interventions designed to reduce sedentary behaviour: a thematic synthesis of qualitative studies. *BMC Public Health.* 2019;19(1):1099. Published 2019 Aug 13. doi:10.1186/s12889-019-7365-1
 104. Neyazi SN. The Rise Of Joblessness Among The Youths In Bangladesh. *FinTech*, July 15, 2019.
 105. Aravinda J. Risk factors in patients with type 2 diabetes in Bengaluru: A retrospective

- study. *World J Diabetes*. 2019;10(4):241–248. doi:10.4239/wjd.v10.i4.241
106. Foucaut AM, Faure C, Julia C, et al. Sedentary behavior, physical inactivity and body composition in relation to idiopathic infertility among men and women. *PLoS One*. 2019;14(4):e0210770. Published 2019 Apr 24. doi:10.1371/journal.pone.0210770
 107. Pati S, Lobo E, Pati S, Desaraju S, Mahapatra P. Type 2 diabetes and physical activity: barriers and enablers to diabetes control in Eastern India. *Prim Health Care Res Dev*. 2019;20:e44. Published 2019 Apr 29. doi:10.1017/S146342361800097X
 108. Kirk JK, Stegner J. Self-monitoring of blood glucose: practical aspects. *J Diabetes Sci Technol*. 2010;4(2):435–439. Published 2010 Mar 1. doi:10.1177/193229681000400225.
 109. Janapala RN, Jayaraj JS, Fathima N, et al. Continuous Glucose Monitoring Versus Self-monitoring of Blood Glucose in Type 2 Diabetes Mellitus: A Systematic Review with Meta-analysis. *Cureus*. 2019;11(9):e5634. Published 2019 Sep 12. doi:10.7759/cureus.5634
 110. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: Distinct or continuum?. *Indian J Endocrinol Metab*. 2016;20(4):546–551. doi:10.4103/2230-8210.183480
 111. St Onge EL, Motycka CA, Miller SA. A review of cardiovascular risks associated with medications used to treat type-2 diabetes mellitus. *P T*. 2009;34(7):368–378.
 112. de la Monte SM. Insulin Resistance and Neurodegeneration: Progress Towards the Development of New Therapeutics for Alzheimer's Disease. *Drugs*. 2017;77(1):47–65. doi:10.1007/s40265-016-0674-0
 113. Jingsi AM, Tankeu AT, Ateba NA, Noubiap JJ. Mechanism of worsening diabetic retinopathy with rapid lowering of blood glucose: the synergistic hypothesis. *BMC Endocr Disord*. 2017;17(1):63. Published 2017 Oct 10. doi:10.1186/s12902-017-0213-3
 114. Kiziltoprak H, Tekin K, Inanc M, Goker YS. Cataract in diabetes mellitus. *World J Diabetes*. 2019;10(3):140–153. doi:10.4239/wjd.v10.i3.140
 115. Rosen J, Yosipovitch G. Skin Manifestations of Diabetes Mellitus. [Updated 2018 Jan 4]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. *Endotext* [Internet]. South Dartmouth (MA): MDTText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK481900/>
 116. Mendes AL, Miot HA, Haddad V Junior. Diabetes mellitus and the skin. *An Bras Dermatol*. 2017;92(1):8–20. doi:10.1590/abd1806-4841.20175514
 117. Al Wahbi A. Autoamputation of diabetic toe with dry gangrene: a myth or a fact?. *Diabetes Metab Syndr Obes*. 2018;11:255–264. Published 2018 Jun 1. doi:10.2147/DMSO.S164199
 118. Fekadu G, Chelkeba L, Kebede A. Risk factors, clinical presentations and predictors of stroke among adult patients admitted to stroke unit of Jimma university medical center, south west Ethiopia: prospective observational study. *BMC Neurol*. 2019;19(1):187. Published 2019 Aug 7. doi:10.1186/s12883-019-1409-0
 119. Lau LH, Lew J, Borschmann K, Thijs V, Ekinci EI. Prevalence of diabetes and its effects on stroke outcomes: A meta-analysis and literature review. *J Diabetes Investig*. 2019;10(3):780–792. doi:10.1111/jdi.12932
 120. Chowdhury MZI, Yeasmin F, Rabi DM, Ronksley PE, Turin TC. Predicting the risk of stroke among patients with type 2 diabetes: a systematic review and meta-analysis of C-statistics. *BMJ Open*. 2019;9(8):e025579. Published 2019 Aug 30. doi:10.1136/bmjopen-2018-025579
 121. Aminde LN, Tindong M, Ngwasiri CA, et al. Adherence to antidiabetic medication and factors associated with non-adherence among patients with type-2 diabetes mellitus in two regional hospitals in Cameroon. *BMC Endocr Disord*. 2019;19(1):35. Published 2019 Apr 3. doi:10.1186/s12902-019-0360-9
 122. Alqarni AM, Alrahbeni T, Qarni AA, Qarni HMA. Adherence to diabetes medication among diabetic patients in the Bisha governorate of Saudi Arabia - a cross-sectional survey. *Patient Prefer Adherence*. 2018 Dec 24;13:63-71. doi: 10.2147/PPA.S176355.
 123. Brown T, Moore TH, Hooper L, Gao Y, Zayegh A, Ijaz S, Elwenspoek M, Foxen SC, Magee L, O'Malley C, Waters E, Summerbell CD. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2019 Jul 23;7:CD001871. doi: 10.1002/14651858.CD001871.pub4.
 124. Gautam S, Jeong HS. Childhood Obesity and Its Associated Factors among School Children in Udupi, Karnataka, India. *J Lifestyle Med*. 2019;9(1):27–35. doi:10.15280/jlm.2019.9.1.27
 125. Brødsgaard A, Wagner L, Poulsen I. Childhood Overweight Dependence on Mother-Child Relationship. *Health Psychol Res*.

- 2014;2(2):1583. Published 2014 Sep 4. doi:10.4081/hpr.2014.1583
126. Pi-Sunyer X. The medical risks of obesity. *Postgrad Med.* 2009;121(6):21–33. doi:10.3810/pgm.2009.11.2074.
127. Moniruzzaman, M., et al. “Physical Activity Levels in Bangladeshi Adults: Results from STEPS Survey 2010.” *Public Health, W.B. Saunders,* 7 Apr. 2016, <https://www.sciencedirect.com/science/article/pii/S0033350616000858>.
128. Alsabieh M, Alqahtani M, Altamimi A, et al. Fast food consumption and its associations with heart rate, blood pressure, cognitive function and quality of life. Pilot study. *Heliyon.* 2019;5(5):e01566. Published 2019 May 17. doi:10.1016/j.heliyon.2019.e01566
129. Bădescu SV, Tătaru C, Kobylinska L, et al. The association between Diabetes mellitus and Depression. *J Med Life.* 2016;9(2):120–125.
130. Petrak F, Röhrig B, Ismail K. Depression and Diabetes. [Updated 2018 Jan 14]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. *Endotext* [Internet]. South Dartmouth (MA): MDTText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK498652/>
131. Web WHO. Double trouble: diabetes and depression Country Of - fice for Bangladesh Available From: <http://www.searo.who.int/bangladesh/depressiondoubletrouble/en/>
132. Georges A, Galbiati L, Clair C. Smoking in men and women with type 2 diabetes: A qualitative gender-sensitive exploration of barriers to smoking cessation among people with type 2 diabetes. *PLoS One.* 2019;14(8):e0221783. Published 2019 Aug 28. doi:10.1371/journal.pone.0221783
133. Nasiri-Amiri F, Sepidarkish M, Shirvani MA, Habibipour P, Tabari NSM. The effect of exercise on the prevention of gestational diabetes in obese and overweight pregnant women: a systematic review and meta-analysis. *Diabetol Metab Syndr.* 2019 Aug 27;11:72. doi:10.1186/s13098-019-0470-6.
134. Majed, et al. “Food Adulteration and Bio-Magnification of Environmental Contaminants: A Comprehensive Risk Framework for Bangladesh.” *Frontiers, Frontiers,* 26 Apr. 2016, <https://www.frontiersin.org/articles/10.3389/fenvs.2016.00034/full>.
135. Elder L, Ransom E. Nutrition of Women and Adolescent Girls: Why It Matters. Population Reference Bureau (US), July 21, 2003.
136. Nguyen, Hoang Anh. “Undernutrition during Pregnancy.” *IntechOpen,* 9 Jan. 2019, <https://www.intechopen.com/books/complications-of-pregnancy/undernutrition-during-pregnancy>.
137. Ueno H, Ishikawa H, Suzuki R, et al. The association between health literacy levels and patient-reported outcomes in Japanese type 2 diabetic patients. *SAGE Open Med.* 2019;7:2050312119865647. Published 2019 Jul 23. doi:10.1177/2050312119865647

