Journal of International Women's Studies

Volume 22
Issue 6 *Women—a Multidimensional Spectrum. Selected papers from the National Conference on "Women in Leadership" conducted by the Women Empowerment Cell of Kristu Jayanti College (Autonomous), Bangalore, India.*

Article 6

June 2021

Study on the Prevalence of Type 2 Diabetes Mellitus among Women Population of Bangalore, India

Sangeetha Menon

Shweta Sharma

Manikandan Kathirvel

Study on the Prevalence of Type 2 Diabetes Mellitus among Women Population of Bangalore, India

By Sangeetha Menon[1*], Shweta Sharma[2], Manikandan Kathirvel[3]

Abstract

India has observed the most devastating increase in cases of diabetes today—especially Type 2 diabetes mellitus (T2DM). The high prevalence of diabetes mellitus is due to rapid urbanization of the suburban regions. Diabetes mellitus continues to increase as a result of rapid cultural and social changes, such as increasing urbanization, ageing populations, dietary changes, reduced physical activity, and unhealthy behavior. Development and maintenance of healthy lifestyle behaviors can be the most effective strategy in reducing complications and premature death among women living with T2DM. There is currently insufficient information available on the prevalence of T2DM and associated factors in the women population of Bengaluru. With this context, the present study was undertaken to determine the prevalence of diabetes mellitus and its association with various risk factors among the women population of Bengaluru, Karnataka. Diabetes was found to be prevalent in women in the under 40 years of age group and was prevalent in all categories of workers, i.e., heavy, moderate, and sedentary. Most of the detected diabetes cases had a Body Mass Index (BMI) >25 and Waist Hip Ratio (WHR) > 0.85, both risk factors for the development of diabetes. Most of them had a positive family history and didn't exercise or practice dietary restrictions. The association between increasing age, low educational status, obesity, waist circumference, and diabetes mellitus was found to be significant. It was observed that the association between family history of diabetes and other risk factors in females and diabetes mellitus was highly significant.

Keywords: Type 2 Diabetes Mellitus, BMI, WHR, Risk factors

Introduction

India has emerged as an epicenter of diabetes mellitus (DM) worldwide, owing to the rapid change in the demographic and socioeconomic profile of the country (Unnikrishnan *et al.*, 2016). Tripathy (2017) reported 69.1 million Indians with Type 2 DM (T2DM), the second highest number of cases after China. Diabetes is caused by an abnormality in insulin uptake by target tissues and a mutation in insulin receptors. The metabolism of glucose is also affected by

[1] Sangeetha Menon holds a doctorate in Microbiology and is currently an Assistant professor in the Department of Life Sciences, Kristu Jayanti College, Bangalore, India, and is a member of the Women's Empowerment Cell of the College. She has more than 13 years of experience in teaching and research and is actively involved in the empowerment of girls and women. She believes in gender equality and equal employment opportunities for women. She can be contacted at *sangeethamenon@kristujayanti.com.*

[2] Shweta Sharma has a doctorate in Biochemistry and is an Assistant Professor in the Department of Life Sciences, Kristu Jayanti College, Bangalore, India. She has over two years of research and teaching experience.

[3] Manikandan Kathirvel has a doctorate in Microbiology and Biotechnology and is an Assistant Professor at Department of Life Sciences, Kristu Jayanti College, Bangalore, India. He has over three years of research and teaching experience.

the mutation in insulin receptors (Kharroubi and Darwish, 2015). American Diabetic Association introduced Type 1, Type 2, and gestational diabetes mellitus. This type of diabetes constitutes 5-10% of subjects diagnosed with diabetes (Maahs *et al.*, 2010) and is due to the destruction of β cells of the pancreas (Devendra *et al.*, 2004; Dabelea *et al.*, 2014). Type I is majorly found in children and adolescents (80%-90%) (Mohan, 2004). Autoimmune destruction of the pancreatic β cells through T-cell causes Type I diabetes (Devendra *et al.*, 2004). In Type II diabetes, resistance of insulin uptake by the target cells occurs. The age group of 20-80 is affected by Type II diabetes. Arun *et al.* (2016) reported the rise in incidence of DM in urban India's working population of middle class and lower-class people. An increasing rise in prevalence of diabetes among women in India has been reported by Metzger *et al*. (2008).

Obesity, lifestyle changes due to urbanization, high familial aggregation, and insulin resistance were found to be the contributing factors to the onset of T2DM (Mehta *et al.*, 2009). The increase in Western dietary habits including animal fats, complex carbohydrates, and less fiber content has led the Indian population to a predisposition to diabetes by impaired glucose tolerance (Mitra *et al.*, 2019). Reports by Rimm *et al.* (1993), Chopra *et al.*, 2013, and Agrawal *et al.* (2015) reported smoking, being overweight, and being obese as risk factors of T2DM in women.

Colditz *et al*. (2013) has associated weight gain after the age of 18 with diabetes. For an increase of 20–35 kg, the relative risk was 11.3, and for an increase of more than 35 kg, the relative risk was 17.3. In the National Family Health Survey of India in 2005-06, among participants of both genders between ages 20-49 reported an association between food intake and prevalence of diabetes (Agrawal *et al.*, 2015). Interestingly, another study by Talukder and Hossain (2020) reported statistical association of education of the participants with diabetes with 62% higher occurrence of T2DM for highly educated participants, 63% higher for individuals with hypertension, 42% higher for wealthy people, and double the chance of developing diabetes among overweight participants. However, the individuals engaged in physical labor had less chances of having T2DM (Talukder and Hossain, 2020).

The incidence in women is increasing at a rapid rate in India. Although diabetes is not gender specific, women are more severely impacted by its consequences. Women develop hyperglycemia in pregnancy (HIP) significantly increasing the risk of maternal and perinatal morbidity and mortality and pregnancy complications such as hypertension and pre-eclampsia, obstructed labour, postpartum hemorrhage, infections, stillbirths, pre-mature delivery, both large and small for gestational age (SGA) infants, congenital anomalies, newborn deaths due to respiratory problems, hypoglycemia, and birth injuries. The risk and number of these complications are directly related to level of maternal hyperglycemia (Metzger *et al.*, 2008; Billionnet *et al.*, 2012).

There is currently insufficient information available on the prevalence of type 2 diabetes and associated factors in the women population of Bengaluru. Against this background, the present study was undertaken with the objective of determining the prevalence of diabetes mellitus and its association with various risk factors among the women population of Bengaluru, Karnataka.

Research Methodology

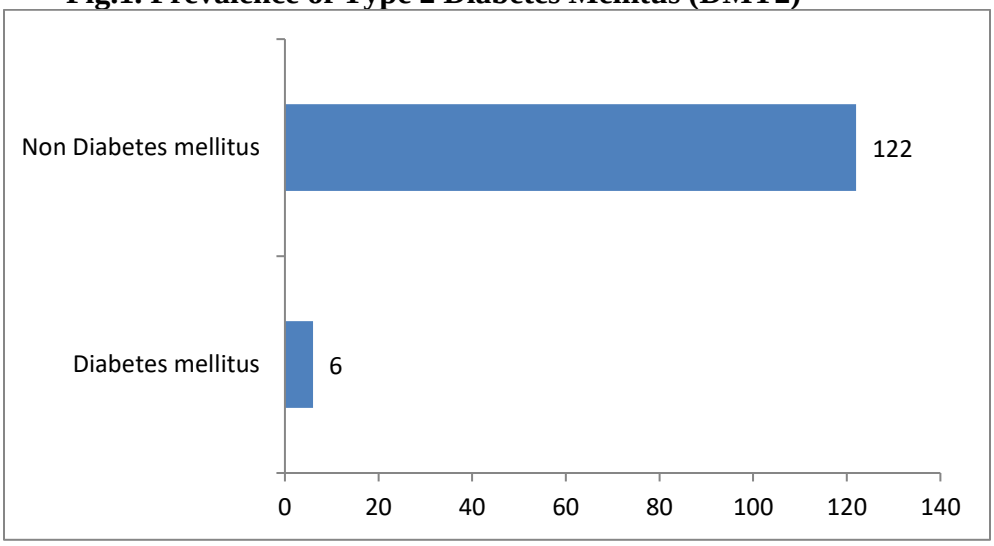
Due to the ongoing pandemic, a structured questionnaire was circulated by email, personal messaging, and other social media platforms to women residing in Bengaluru through

the contacts with the investigators. The questionnaire was divided into two sections. The first section contained personal details (age, marital status, family members, education, employment status, organization, designation, work experience, city of residence). The second section contained details of general health conditions. The prevalence of diabetes (known and unknown) and its associated risk factors was estimated through a standard questionnaire including information for socioeconomic status (SES), demographics, personal history, past history, blood pressure, sugar level, life style practices (smoking, tobacco chewing, alcoholism, diet), physical activity (duration of work of >90, 60–90, 30–59, and <30 minutes per day as heavy, moderate, mild, and sedentary), presence of disease and age at diagnosis, family history of diabetes mellitus and hypertension, dietary history, drug history, obstetric history (females), history of any other disease, and other parameters pertinent to the study objectives. Anthropometric assessment (height, weight, and waist and hip circumference) was estimated. The Body Mass Index (BMI) was calculated using the formula weight (Kg) / height (m^2). Waist and hip were measured using standard techniques, and the mean of two measurements was taken for calculating the waist-hip ratio (WHR). In addition, subjects with previous history or who were taking oral hypoglycemic agents or insulin were considered to have DM. Only women over they age of 18 were included in the study. Respondents with secondary causes of hyperglycemia such as pregnancy, corticosteroid therapy, and other pharmacotherapy leading to hyperglycemia, chronic calcific pancreatitis, or any other organic disease-causing hyperglycemia were excluded from the analysis. Statistical analysis of the data was performed using Statistical Package for Social Sciences version 21.0. Categorical variables were expressed as absolute number and percentage. The data was entered and analyzed using SPSS for Windows, version 21 (SPSS, Chicago, IL, USA). Descriptive statistics were used, and comparisons between qualitative data were made using chi-square tests to gauge significance. A p value of less than 0.05 was considered statistically significant.

Data Analysis and Discussion

The present study received 128 fully filled, usable questionnaire responses from women respondents in Bengaluru Karnataka. As indicated in Figure 1, six respondents (4.7%) reported to have diabetes mellitus.

Fig.1. Prevalence of Type 2 Diabetes Mellitus (DMT2)



Socio-demographic Findings Associated with Type 2 Diabetes

Table 1 shows the relationship between diabetes mellitus and various socio-demographic characteristics. It was observed that the prevalence of diabetes increased with age of the participants. Out of the total respondents, 75.8% belonged to the age range of 18-25 years whereas only 4.6% of the study population was above 40 years. Four of the respondents younger than 40 years of age were diabetic. 39.8% of the population had a high school education whereas only 8.6% had received a postgraduate education. Although the maximum number of diabetic respondents had received a doctorate education, the frequency of diabetes was highest in people with only a high school education (18.1%). Prevalence of diabetes among business people was the highest (14.2%) although most respondents were students (67.2%). Six (20%) of the married respondents had Type 2 diabetes mellitus.

Risk Factors Associated with Type 2 Diabetes Mellitus

The analysis of the present study showed that blood pressure (hypertensive), body mass index (overweight and obese), and family history were significantly related to being diabetic. As shown in Table 2, the prevalence rate of DM was higher among thin (10.5%) and overweight (10.3%) respondents. On the other hand, only one (1.4%) of the normal respondent had Type 2 diabetes mellitus. More than half of the respondents—65 (50.8%)—had a history of one or both parents suffering from diabetes and 63 (49.2%) had no history of diabetes in their family. The majority—59 (46.1%)—were sedentary or had limited physical activity and among them four were diabetic (6.8). Four (50%) of the respondents with hypertension had diabetes mellitus. In the current study, two (6.6%) diabetic women had greater waist circumference (>88cm) as per the International Diabetes federation (IDF) standard cutoffs. Among 128 respondents, 5 (11.6%) women with a higher WHR or truncal obesity had diabetes. Smoking and drinking were statistically insignificant factors in patients with diabetes. Associated risk factors such as thyroid problems, menstrual irregularity, polycystic ovaries disorder (PCOD), gestational diabetes, juvenile diabetes, kidney problems, retinopathy, and neuropathy were significantly considered as risk factors for diabetes mellitus (33.3%).

Table 1. The Relationship between DMT2 and Socio-demographic Characteristics (n = 128)

Covariates	Frequency (%)	Diabetic (%)	Non Diabetic (%)	Total	P value
Age					0.0263, S
18-25	75.8	0 (0)	97 (100)	97	
26-30	3.9	1(20)	4(80)	5	
31-40	15.6	3 (15)	17 (85)	20	
41-50	2.3	0 (0)	3 (100)	3	
51-60	2.3	2(66.7)	1(33.3)	3	
above 60	0	0 (0)	0(0)	0	
Education					0.0213, S
School education	39.8	2(18.1)	9 (81.9)	11	
Graduate	35.9	0(0)	20(100)	20	
Post graduate	8.6	1(1.9)	50(98.1)	51	
Doctorate	15.6	3(6.5)	43(93.5)	46	
Occupation					0.0301, S
Business	5.5	1(14.2)	6(85.8)	7	
Service	18	1(4.3)	22(95.7)	23	
Labourer/ Household worker	0	0(0)	0(0)	0	
Housewife	7	0(0)	5(100)	5	
Student	67.2	4(4.4)	86(95.6)	90	
Unemployed	2.3	0(0)	3(100)	3	
Retired	0	0(0)	0(0)	0	
Marital status					0.0223, S
Married	23.4	6(20)	24(80)	30	
Unmarried	75.8	0(0)	97(100)	97	
Separated/ Widowed	0.8	0(0)	1(100)	1	
Place of residence (in Bengaluru)					0.0157, S
Urban	83.6	5(4.7)	102(95.3)	107	
Rural	16.4	1(4.8)	20(95.2)	21	

Key: S-Significant

Table 2: Risk factors for Type 2 Diabetes Mellitus

Covariates	Frequency (%)	Diabetic	Non diabetic	Total	P value
BMI					0.0213, S
Thin	14.8	2(10.5)	17(89.5)	19	
Normal	57	1(1.4)	72(98.6)	73	
Overweight	22.7	3(10.3)	26(89.7)	29	
Obese	5.5	0(0)	7(100)	7	
Hypertension					0.0199, S

Normal: 90/60mmHg-120/80mmHg	83.6	3(2.8)	104(97.1)	107	
Higher: >140/90mmHg	3.1	2(50)	2(50)	4	
Lower: <90/60mmHg	13.3	1(5.9)	16(94.1)	17	
Physical Activity					0.0238, S
Vigorous	8.6	1(9.1)	10(90.9)	11	
Moderate	28.1	0(0)	36(100)	36	
Mild	17.2	1(4.5)	21(95.5)	22	
Least Physical activity	46.1	4(6.8)	55(93.2)	59	
Smoking					0.157, NS
Yes	0.6	0(0)	2(100)	2	
No	88.4	6(4.8)	120(95.2)	126	
Alcohol					0.257, NS
Yes	7	1(11.1)	8(88.9)	9	
No	93	5(4.2)	114(95.8)	119	
Family History					0.0157, S
Yes	50.8	4(6.2)	61(93.8)	65	
No	49.2	2(3.2)	61(96.8)	63	
Waist Circumference					0.0132, S
Less (< 88cm)	74.2	4(4.1)	94(95.9)	98	
Greater (> 88 cm)	25.8	2(6.6)	28(93.3)	30	
Waist – Hip Ratio					0.0223, S
<0.85	66.4	1(1.2)	84(98.8)	85	
≥0.85 (Truncal obesity)	33.6	5(11.6)	38(88.4)	43	
Fasting Blood Sugar					0.0223, S
3.9 mmol/l (70 mg/dl) to 6.0 mmol/l (108mg/dl)	71.7	1(1.2)	85(98.8)	86	
6.1 (110mg/dl) to 6.9 mmol/l (124 mg/dl)	22.6	3(7.7)	36(92.3)	39	
Greater than or equal to 7.0 mmol/l (126mg/d)	5.7	2(66.7)	1(33.3)	3	
Risk of being Diabetic					0.0265, S
Family History	42.1	4(7.4)	50(92.6)	54	
Diet and life style	15.6	0(0)	20(100)	20	
Lack of physical activity	24.2	1(3.2)	30(96.8)	31	
Stress factors	15.6	0(0)	20(100)	20	
Associated risk factors	2.3	1(33.3)	2(66.7)	3	
Age of Diagnosis					0.0285, S
<18 years	0	0(0)	0(0)		
18-25	75.7	0(0)	97(100)	97	
26-30	3.9	1(20)	4(80)	5	
31-40	14.8	3(15.8)	16(84.2)	19	
41-50	2.3	0(0)	3(100)	3	
>50	2.3	2(66.7)	1(33.3)	3	

Key: S-Significant, NS- Not Significant

Discussion

The total prevalence of diagnosed cases of type 2 diabetes mellitus found in this study was 4.7%. The prevalence below the age of 40 years was 35%, and it was 66.7% for the ages 50 and above. Thus, the occurrence of diabetes mellitus increased with age, which was found to be statistically significant ($P < 0.05$). Similar findings were noted by Patil and Gothankar (2019). Almost a three-fold increase in the prevalence of diabetes mellitus after the age of 60 years was found by Ahmad *et al.* (2011).

Low educational status was found to be statistically significant to diabetes mellitus occurrence in this study ($P < 0.05$). Gikas *et al.* (2004), Arora *et al.* (2010), and Acemoglu *et al.* (2005) also found the highest prevalence in those who were illiterate and decreasing trends in better-educated people. Ramachandran *et al.* (2008) and Satman *et al.* (2002) reported a positive association of education with diabetes mellitus similar to this study; however, Ravikumar *et al*. (2011) found a negative association between education and diabetes mellitus.

In this study, although total prevalence of diabetes was found to be maximum among students, occupation wise, businesspeople showed a higher prevalence of diabetes mellitus than any other occupation. This could be due to an imbalance in the diet and lifestyle of businesspeople due to frequent travelling and eating outside. Al Mansour (2020) found a higher prevalence of DMT2 among married and divorced or widowed respondents compared with single respondents ($p<0.001$). Marriage affects lifestyle; couples may increase food intake and become less active after marriage, leading to increased body weight and risk of developing the disease.

The association of family history of diabetes mellitus and diagnosed cases of diabetes mellitus was proved highly significant ($P < 0.001$). Many studies noted similar findings like our study (Ahmad *et al.*, 2011; Gikas *et al.*, 2004; Arora *et al.*, 2010; Ramachandran *et al.*, 2008; Satman *et al.*, 2002; Rao *et al.*, 2010 and Menon *et al.*, 2006). Doing less physical activity is one of the risk factors for diabetes mellitus which was reported in the current study. Tiwari *et al*. (2008), Shah *et al*. (2009), Ahmad *et al*. (2011), and Mohan *et al.* (2003) reported similar findings where less physical activity was significantly associated with diabetes mellitus, and those subjects who performed moderate to light grade physical activity were more likely to have diabetes mellitus than those who performed heavy physical activity. The association between obesity and diabetes mellitus was found to be significant in the present study ($P < 0.05$). This was supported by other studies conducted in India and other countries (Ahmad *et al.*, 2011; Gikas *et al.*, 2004; Arora *et al.*, 2010; Acemoglu *et al.*, 2005; Satman *et al.*, 2002; Ravikumar *et al*., 2011; Rao *et al.*, 2010; Menon *et al.*, 2006 and Mohan *et al.*, 2003) while Shah *et al.* (2009) and Tiwari *et al*. (2008) did not find any association between BMI and diabetes mellitus.

Abdominal obesity, commonly found in India, was more prevalent in our diabetic subjects as well. In a study by Shobha *et al.* (2009), 94% of the study population had WHR ≥0.85, which is a risk factor for development of diabetes. In the non-obese South Indian population, android pattern of body fat measured by WHR was found to be a greater risk factor for Type-II diabetes than general obesity (Ramachandran *et al.*, 2002 and Misra *et al.*, 1998). A genetics study done by Cassell *et al*. (1999) in South India showed that, an UCP-2 (Uncoupling Protein-2 gene variant) gene association may affect the susceptibility of weight gain in Indians. WHR is strongly associated with insulin resistance and diabetes, and this might explain the shift towards female predominance in the prevalence of diabetes as less physical contributes to it. A study done by Zunt *et al.* (2018) suggested BMI as one of the factors that increased the incidence of diabetes in almost all countries. The study findings are also comparable to a report by

Bahendeka *et al.* (2019) wherein it was reported that personal lifestyle and eating habits leads to overweightness and obesity, which were the primary causes of Type 2 diabetes.

DM is usually a hereditary disease. In addition, there are many causal and confounding factors that contribute to the development of DM, such as obesity. Obesity may result in diabetes which is well documented in different studies (Al-Goblan *et al.,* 2014; Eckel *et al.,* 2011 and Conway *et al.,* 2018). Hypertension is common among patients with diabetes, and DM helps facilitate hypertension (Song *et al.,* 2016; Petrie *et al.,* 2018; Ferrannini and Cushman, 2012; Cryer *et al.,* 2016). Diabetes and high blood pressure complement each other due to the fact that they both contain common physiological traits (Anwer *et al.,* 2011). Diabetic patients experience increased peripheral artery resistance causing elevated systemic blood pressure.

Summary and Conclusion

Diabetes in most women was seen below 40 years of age, and it was prevalent in all categories of workers, *i.e.*, heavy, moderate, and sedentary. Most of the detected diabetes cases had BMI >25 and WHR > 0.85 which is a risk factor for the development of diabetes. Most of those with diabetes had a positive family history, and most did not practice any exercises or dietary restrictions; there was need for lifestyle modifications among the working women. This study significantly associates various risk factors among diagnosed cases of type 2 diabetes mellitus. The association between increasing age, low educational status, obesity, waist circumference, and diabetes mellitus was found to be significant. It was observed that the association between family history of diabetes and WHR in females and diabetes mellitus was highly significant, while there was no significant association found between smoking and drinking and diabetes mellitus. The study highlights the fact that DMT2 is no longer a disease of urban communities. The study concludes that non-modifiable risk factors such as rising age, family history of diabetes mellitus, and modifiable risk factors such as a sedentary lifestyle and obesity are significant contributors in diagnosed cases of diabetes mellitus. This calls for an impending need to conduct regular screening programs for early identification of high-risk groups for diabetes mellitus and intensive health education programs to the women population in India. Although working women often remain busy throughout the day, their physical activity is still very limited. Factors like physical inactivity, family history, lack of knowledge on dietary restrictions, lifestyle modifications, and stress in managing both professional work and family among working women cannot be ignored when it comes to the development of diabetes. Stress management in work environments, regular physical activity, periodic health checkups after 35 years, and lifestyle modifications for persons with a positive family history are recommendations that could drastically control diabetes among working women in the coming years. Further extensive and prospective longitudinal studies need to be conducted to explore the root causes of this shift at the community level and to explore risk factors and their association or causation effects on the prevalence of DMT2 in every sphere of the women population. Also, the study can be further extended through physical surveys and in low socioeconomic populations.

Acknowledgement

The authors acknowledge the financial support provided by the management of Kristu Jayanti College, Bangalore, India for carrying out this work.

References

Acemoglu, H., Ceylan, A., Saka, G., Palanca, Y., Ertem, M., Iicin, E. (2005). Risk factors of Type-2 diabetes in South-Eastern anatolia of Turkey. *Internet Journal of Epidemiology,* 3, 1.

Agrawal, S. (2015). Frequency of food consumption and self-reported diabetes among adult men and women in India: a large scale nationally representative cross-sectional study. *Journal of Diabetes & Metabolism,* 6(1), 474.

Ahmad, J., Masoodi, M.A., Ashraf, M., Rashid, R., Ahmad, R., Ahmed, A. (2011). Prevalence of diabetes mellitus and its risk factors in age group of 20 years and above in Kashmir, India. *Al Ameen J. Med. Sci.,* 4, 38-44.

Al Mansour, M.A. (2020). The prevalence and risk factors of type 2 diabetes mellitus (DMT2) in a semi-urban Saudi population. *International Journal of Environmental Research and Public Health,* 17(1), 7.

Al-Goblan, A.S., Al-Alfi, M.A., Khan, M.Z. (2014). Mechanism linking diabetes mellitus and obesity. *Diabetes Metab Syndr Obes.,* 7, 587-591.

Anwer, Z., Sharma, P.K., Garg, V.K., Kumar, N., Kumari, A. (2011). Hypertension management in diabetic patients. *Eur. Rev. Med. Pharmacol. Sci.,* 15(11), 1256–1263.

Arora, V., Singh, M.J., Khanna, P., Goyal, N., Kumar, N., Singh, M. (2010). Prevalence of diabetes in urban Haryana. *Aust. Med. J.,* 3, 488-494.

Arun, N., Ma, R.C.W., Ramachandran, A., Chamukuttan, S. (2016). Diabetes in Asia and the Pacific: Implications for the Global Epidemic, *Diabetes Care,* 39, 472–485.

Bahendeka, S., Wesonga, R., Mutungi, G., Muwonge, J., Neema, S., Guwatudde, D. (2019). Prevalence and correlates of diabetes mellitus in Uganda: a population-based national survey. *Tropical Medicine and International Health,* 21(3), 405–416.

Billionnet, C., Mitanchez, D., Weill, A., Nizard, J., Alla, F., Hartemann, A. (2017). Gestational diabetes and adverse perinatal outcomes from 716,152 births in France in 2012. *Diabetologia,* 60, 636–644.

Cassell, P.G., Neverova, M., Janmohamed, S., Uwakwe, N., Qureshi, A., McCarthy, M.I. (1999). An un-couplingprotine-2 gene variant associated with raised Body Mass Index. *Diabetologia,* 42, 688–692.

Chopra, S.M., Misra, A., Gulati, S., Gupta, R. (2013). Overweight, obesity and related non-communicable diseases in Asian Indian girls and women. *European Journal of Clinical Nutrition,* 67(7), 688-696.

Colditz, G.A., Willett, W.C., Stampfer, M.J., Manson, J.E., Hennekens, C.H., Arky, R.A., Speizer, F.E. (1990). Weight as a risk factor for clinical diabetes in women. *American Journal of Epidemiology,* 132(3), 501-513.

Conway, B.N., Xijing, H., Heather, M.M., Amy, L.G., Xiao-Ou, S., Margaret, K. H., Wei, Z., Alvin, C.P., William, J.B. (2018). The obesity epidemic and rising diabetes incidence in a low income racially diverse southern US cohort. *PLoS ONE.* 13(1), 1-18.

Cryer, M.J., Horani, T., Di Pette, D.J. (2016). Diabetes and hypertension: a comparative review of current guidelines. *J. Clin. Hypertens.* 18(2), 95–100.

Dabelea, D., Mayer-Davis, E.J., Saydah, S., Imperatore, G., Linder, B., Divers, J., Bell, R., Badaru, A., Talton, J.W., Crume, T., Liese, A.D., Merchant, A.T., Lawrence, J.M., Reynolds, K., Dolan, L., Liu, L.L., Hamman, R.F. (2014). Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. *JAMA.* 311, 1778-1786.

Devendra, D., Liu, E., Eisenbarth, G.S. (2004). Type 1 diabetes: recent developments. *BMJ,* 328, 750-754.

Eckel, R.H., Steven, E.K., Ele, F., Allison, B.G., David, M.N., Michael W.S., Robert, J.S., Steven, R.S. (2011). Obesity and type 2 diabetes: what can be unified and what needs to be individualized? *Journal of Clinical Endocrinology Metabolism,* 6, 1654–1663.

Ferrannini, E., Cushman, W.C. Diabetes and hypertension: the bad companions. (2012). *The Lancet,* 380(9841), 601–610.

Gikas, A., Sotiropoulos, A., Panagiotakos, D., Peppas, T., Skliros, E., Pappas, S. (2004). Prevalence, and associated risk factors, of self-reported diabetes mellitus in a sample of adult urban population in Greece: MEDICAL exit poll research in salamis (MEDICAL EXPRESS 2002). *BMC Public Health*, 4(1), 1-9.

Kharroubi, A.T., Darwish, H.M. (2015). *Diabetes mellitus*: The epidemic of the century. *World Journal of Diabetes,* 6(6), 860-67.

Maahs, D.M., West, N.A., Lawrence, J.M., Mayer-Davis, E.J. (2010). Epidemiology of type 1 diabetes. *Endocrinology & Metabolism Clinics of North America, 39*, 481-497.

Mehta, S.R., VSM, Col AS Kashyap, Lt Col S Das. 2009, *Diabetes Mellitus* in India: The Modern Scourge, *Med. J. Armed Forces India*, 65(1):50-54.

Menon, V.U., Kumar, K.V., Gilchrist, A., Sugathan, T.N., Sundaram, K.R., Nair, V., (2006). Prevalence of known and undetected diabetes and associated risk factors in central Kerala ADEPS. *Diabetes Res. Clin. Pract.*, 74, 289-94.

Metzger, B.E., Lowe, L.P., Dyer, A.R., Trimble, E.R., Chaovarindr, U., Coustan, D.R., (2008). Hyperglycemia and adverse pregnancy outcomes. *New England Journal of Medicine,* 358, 1991–2002.

Misra, A., Kathpalia, R., Lall, S.B., Peshin, S. (1998). Hyperinsulinemia in non-obese, non-diabetic subjects with isolated systolic hypertension. *Indian Heart Journal*, *50,* 49–54.

Mitra, S. (2019). Diabetes Research, Prevalence, and Intervention in India. *European Journal of Environment and Public Health*, 3(1), 1-5.

Mohan, V. (2004). Why are Indians more prone to diabetes? *Journal of Association of Physicians of India*, 52, 468–74.

Mohan, V., Shanthirani, C.S., Deepa, R. (2003). Glucose intolerance (diabetes and IGT) in a selected South Indian population with special reference to family history, obesity and lifestyle factors the Chennai urban population study (CUPS 14). *Journal of Association of Physicians of India,* 51, 771-777.

Patil, R., & Gothankar, J. (2019). Risk factors for type 2 diabetes mellitus: An urban perspective. *Indian Journal of Medical Sciences,* 71(1), 16-21.

Petrie, J.R., Guzik, T.J., Touyz, R.M. (2018). Diabetes, hypertension, and cardiovascular disease: clinical insights and vascular mechanisms. *Canadian Journal of Cardiology.* 34(5), 575–584.

Ramachandran, A., Mary, S., Yamuna, A., Murugesan, N., Snehalatha, C. (2008). High prevalence of diabetes and cardiovascular risk factors associated with urbanization in India. *Diabetes Care,* 31, 893-98.

Ramachandran, A., Snehalatha, C., Viswanathan, V. (2002). Burden of type 2 diabetes and its complications – The Indian scenario. *Current Science,* 83, 1471–1476.

Rao, C.R., Kamath, V.G, Shetty, A., Kamath, A. (2010). A study on the prevalence of Type 2 diabetes in coastal Karnataka. *International Journal of Diabetes in Developing. Countries,* 30, 80-85.

Ravikumar, P., Bhansali, A., Ravikiran, M., Bhansali, S., Walia, R., Shanmugasundar G. (2011). Prevalence and risk factors of diabetes in a community-based study in North India: The Chandigarh urban diabetes study (CUDS). *Diabetes Metab*., 37, 216-21.

Rimm, E.B., Manson, J.E., Stampfer, M.J., Colditz, G.A., Willett, W.C., Rosner, B., Speizer, F.E. (1993). Cigarette smoking and the risk of diabetes in women. *American Journal of Public Health,* 83(2), 211-214.

Satman, I., Yilmaz, T., Sengül, A., Salman, S., Salman, F., Uygur, S. (2002). Population-based study of diabetes and risk characteristics in turkey: Results of the Turkish diabetes epidemiology study (TURDEP). *Diabetes Care*, 25, 1551-1556.

Shah, S. K., Msaikaka N. N., Burman, C., Snehlata, A. C., Ramachandran, A. (2009). High prevalence of Type 2 diabetes in urban population in North Eastern India. *International Journal of Diabetes in Developing. Countries*, 19, 144-146.

Shobha, D.M., Sahu, A., Swapna, M., Tripathy, R.M. (2009). Assessment of Risk Factors for Development of Type-II Diabetes Mellitus among Working Women in Berhampur, Orissa. *Indian Journal of Community Medicine*, 34(3), 232–236.

Song, J., Chang-Sheng, S., Qi –Fang, H., Li-Hua, L., Chang-Sheng, M., Xiao- Huo, G., Li-Nong, J., Ji-Guang, W. (2016). Management of hypertension and diabetes mellitus by cardiovascular and endocrine physicians: a China registry. *Journal of Hypertension.* 34(8), 1648-1653.

Talukder, A., Hossain, M.Z. (2020). Prevalence of Diabetes Mellitus and its associated factors in Bangladesh: Application of two-level Logistic Regression Model. *Scientific Reports*, 10(1), 1-7.

Tiwari, R.R., Deb, P.K., Debbarma, A., Chaudhuri, R., Chakraborti, A., Lepcha, M. (2008). Risk factor analysis in self-reported diabetes in a rural Kerala population. *International Journal of Diabetes in Developing. Countries*, 28, 91-94.

Tripathy, J. P., Thakur, J. S., Jeet, G., Chawla, S., Jain, S., Pal, A., Prasad, R., Saran, R. (2017). Prevalence and risk factors of diabetes in a large community-based study in North India: results from a STEPS survey in Punjab, India. *Diabetology & Metabolic Syndr*ome, 9(1), 1-8.

Unnikrishnan, R., Anjana, R. M., Mohan, V. (2016). Diabetes mellitus and its complications in India. *Nature Reviews Endocrinology*, 12(6), 357-370.

Zunt, J.R., Kassebaum, N. J., Blake, N. (2018). "Global, regional, and national burden of meningitis, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016". *The Lancet Neurology*, 17(12), 1061–1082.