

# Metabolic Disorder: Diabetes in Kanpur District, U.P.

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## Abstract

*The present study entitled with "Metabolic Disorder: Diabetes in Kanpur District, U.P." was carried out with the objective to find out Diabetes in Kanpur district. In this research select the 30 respondents (40- 70 years) were selected through the random sampling method from Kanpur District (U.P.). Diabetes and dietary pattern were assessed by gathering information on the BMI, Dietary intake, Food frequency, like and dislike and RDA was used in order to collect data from the selected respondents. It was found that 30 percent respondents have diabetic. In 30 respondents, 16.66 percent respondents have insulin dependent and 83.33 percent respondent have non-insulin respondent. It was found that 56.66 percent respondents were vegetarian, 26.66 percent respondents were non-vegetarian and 16.66 percent respondents were ovo-vegetarian. Maximum respondents' 30 percent of the respondents followed the dietary pattern Breakfast + Lunch + Dinner. 70 percent respondent dislike non-veg and 63.3 percent respondent like dairy products. Nutrient intake by the female protein, calcium and iron were less than the RDA whereas, energy and fat intake was higher than the RDA and energy, protein, calcium and iron were less than the RDA whereas, fat intake was higher than the RDA by the male.*

**Keywords:** Assessment, Frequency, Consumption, dietary pattern, insulin and RDA.

## 1. Introduction:

Diabetes Mellitus is a group of heterogeneous metabolic disorder characterized by high blood glucose levels result from defect in insulin secretion and/or action. Accordingly, there are two types and treatment varieties according to the cause of Diabetes Mellitus (WHO, 2013). Globally diabetes mellitus is an emerging common chronic illness with an estimated number of 220 million people in year 2010. Of these approximately 12.1 million were living in Africa. In Sub Saharan Africa Type 2 Diabetes accounts for over 90 per cent of diabetes (Hall *et al.*, 2011). In Ethiopia, the estimated prevalence of diabetes mellitus in adult population was 1.9 per cent (Feleke and Enquesselassie, 2005) and the total diabetic cases were estimated to be 2.6 million by the year 2025 (Watkins and Alemu, 2003).

Insulin, a polypeptide hormone synthesized in humans and other mammals within the beta cells of the islets of Langerhans in the pancreas. The islets of Langerhans form the endocrine part of pancreas, accounting for 2 per cent of the total mass of the pancreas, with beta cells constituting 60-80 per of all the cells of islets of Langerhans (Anon, 2004).

According to WHO report, that was published on their website on 1<sup>st</sup> June 2018, non-communicable diseases have become an issue of global concern with about 41 million deaths per year and 1.6 million deaths occurring as a results of Diabetes alone. In addition, over 85 per cent of the deaths occur in the low and middle income countries/developing countries. Thus the aim is to reduce premature deaths from NCDs globally by one third by the year 2030 (WHO, 2018). As a matter of fact, Diabetes Type 1 (T1DM) is becoming a disease of public health importance in Africa that is affecting mostly children and teenagers. Currently there is insufficient impeccable epidemiological data from sub-Saharan Africa on T1DM in children and adolescents. However, incidence in Tanzania was estimated to be 1.5/100,000, and an increase in incidence in Sudan from 9.5/100,000 in 1991 to 10.3/100,000 in 1995 has been reported (Majaliwa *et al.*, 2007).

Typical symptoms include excessive fluid intake, rapid weight loss, frequent urination, fruity odor breath, increased appetite, drowsiness, abrupt vision change (noticeable often first in the classroom), and mood

changes causing behavior problems in school. Untreated and/or unmanaged condition has some immediate complications such as hypoglycemia, hyperglycemia and long term complications such as eye disease (retinopathy), nerve disease (neuropathy), and kidney disease (nephropathy). All these can affect the school child inevitably reducing school attendance, sub-optimal class performance and in the long term negative socio-economic consequences (Persson *et al.*, 2019).

Children with Type 1 Diabetes Mellitus usually may classically present with symptoms such as polyuria, polydipsia, polyphagia and weight loss. However, in about 19 per cent of younger children below age of 5 years parents or guardians may report non-classical symptoms such as nocturnal enuresis, 10.5 per cent of the under-five may also present with constipation and 25 per cent of the children inclusively, may present with diabetic ketoacidosis (Roche *et al.*, 2005).

Diabetes imposes a large economic or financial burden on the health care system and health spending on diabetes accounted 11.6 per cent of total health expenditure worldwide in 2015 (Zhang *et al.*, 2010; International Diabetes Federation, 2015). In Latin America and the Caribbean countries the annual estimated number of deaths was 339,035 accounted a loss of 757,096 and United States Dollar (USD) 3 billion discounted years of productive life and cost among persons younger than 65 years respectively in 2000 (Barceló *et al.*, 2003). The medical cost of diabetes depends on its prevalence, types of drug used, and presence of comorbidity, compliance of patient and development as well as progression of complication (Suleiman *et al.*, 2006).

The debilitating effects of diabetes mellitus include various organ failures, progressive metabolic complications such as nephropathy, retinopathy, and/or neuropathy (Piero, 2006). Diabetics are accompanied by risk of cardiovascular, peripheral vascular and cerebrovascular diseases. Several pathogenetic processes are involved in the development of diabetes, including destruction of pancreatic  $\beta$ -cells that lead to lowered sensitivity of insulin action (WHO, 1999; Votey and Peters, 2004).

Environmental factors also play a significant role in aetiology of Type 1 Diabetes Mellitus. Thus, there is strong evidence that is derived from the study of monozygotic twins, where occurrence of the disease in both siblings varies around 50 per cent and never reaches 100 per cent. The environmental factors involved include viruses (rubella, coxsackievirus B or enteroviruses), toxins and nutrients (cow's milk, cereals). The precise effect of these factors remains unclear, but it is important to be identified, since these factors can be modified and possibly lead to prevention or treatment interventions (Beyan *et al.*, 2012; Redondo *et al.*, 1999).

Life style management is apparently the cornerstone of management of diabetes mellitus. It is recognized as being an essential part of diabetes and cardiovascular disease prevention. Meta-analyses demonstrate that lifestyle interventions, including diet and physical activity, led to a 63% reduction in diabetes incidence in those at high risk. Lifestyle modification programs have demonstrated encouraging improvement in risk factors for diabetes; however, the effect on diabetes incidence has not been reported (Rebecca *et al.*, 2009).

Unhealthy diet and insufficient physical activity due to poor attitude, non-adherence, and poor management by the health care professionals and patients were common cause of diabetic complication (Abdelaziz *et al.*, 2015). The dietary management of diabetes mellitus is a complement of lifestyle management. It has a positive effect on long term health and quality of life. Dietary management aims at optimal metabolic control by establishing a balance between food intake, physical activity, and medication to avoid complications. In type 2 diabetes, the dietary objective is for improved glycemic and lipid levels and weight loss as appropriate (Piero *et al.*, 2006).

## 2. Materials and Methods:

A cross-sectional and descriptive design was used in this study among adult to older age 40-70 of diabetic patients belongs to Kanpur District, U.P. were selected for the study. The selection of the respondents was based on the random sampling in the study.

Total number of 30 respondents was selected for study purpose. Presented schedule was used in order to collect data from respondents. The schedule was including aspects which were led to the fulfillment of the objective of this study. The selected respondent filled Google form with the help of schedule that contained questions related to general information, anthropometric measurement and dietary information. 24 hours dietary recall method and food frequency table method were used for the nutritional assessment of the diabetic respondents described by (Swaminathan, 2010). Calculation of nutrient intake will be done with the help of the food composition tables (Gopalan *et al.*, 2018). The data were tabulated and analyzed statically (Gupta, 2011).

### 3. Result and Discussion:

The present study pertaining to the topic “**Metabolic Disorder: Diabetes in Kanpur District, U.P.**” was done by the survey method and result obtained were analyzed and discussed as follows:

- 3.1. Socio-demographic information of the selected respondents
- 3.2. Anthropometric measurement of the selected respondents
- 3.3. Dietary pattern of the respondents.

**Table 3.1: Distribution of Diabetic Patients by Socio-Demographic Profile**

S. No.	Different Demography		Total No. 30	Percentage
1.	Age (Year)	40-55	12	40
		55-70	18	60
2.	Religion	Hindu	30	100
		Muslim	0	0
		Christian	0	0
		Sikh	0	0
3.	Gender	Male	12	40
		Female	18	60
4.	Type of Family	Joint	20	66.66
		Nuclear	10	33.33
5.	No. of Family Member	<5	10	33.33
		=5	8	26.66
		>5	12	40
6.	Education	Fifth Pass	0	0
		Tenth Pass	2	6.66
		Twelfth Pass	10	33.33
		Graduate	9	30
		Post Graduate	9	30
7.	Occupation	Service	9	30
		Business	9	30
		Agriculture	1	3.33
		Housewife	11	36.66
8.	Exercise	Yes	18	60
		No	12	40
9.	Harmful Substances Intake	Alcohol	5	16.66
		Cigarette	0	0
		Betel Leaves	0	0
		Tobacco	4	13.33
		No	21	70
10.	Sleeping Time	5 hours	2	6.66
		6 hours	9	30
		7 hours	10	33.33
		More than that	9	30

The data pertaining in Table-3.1 shows that total of 30 respondents participated in this study. The respondent 40 per cent belonged to 40-55 years, 60 per cent belonged to 55-70 years of age group. Above mentioned data revealed that 100 per cent respondents were Hindu and 40 per cent respondents were male and 60 per cent respondents were female. As per data collected 66.66 per cent respondents belonged to joint family and 33.33 per cent respondents belonged to nuclear family. Family size of the respondents was 40 per cent in more than 5 members followed by 33.33 per cent in less than 5 members and 26.66 per cent in 5 members.

According to presented data educational status of maximum respondents was twelfth pass i.e. 33.33 per cent followed by graduated (30%), post-graduated (30%) and tenth pass (6.66%). Occupation of the respondents was maximum in housewife i.e. 36.66 percent followed by service, business and agriculture with respected value 30 per cent, 30 per cent and 3.33 per cent. 60 per cent respondents agreed to do exercise daily and 40 per cent denied doing such. 70 per cent respondents denied to intake of harmful substances whereas, 16.66 per cent and 13.33 per cent respondents agreed to intake of alcohol and tobacco, respectively. As the above mentioned data it was found that 33.33 per cent respondents take sleep for 7 hours followed by, more than 7 hours (30%), 6 hours (30%) and 5 hours (6.66%), respectively.

**According to WHO (1994)**, this problem has been aggravated by rapid cultural and social dynamics, ageing populations, increasing urbanization, dietary changes, reduced physical activity and other unhealthy lifestyle and behavioral patterns.

**Table 3.2: Specific Questions Related to Diabetes Mellitus**

S. No.	Parameters		Total No. 30	Percentage
1.	Having Diabetes	Yes	9	30
		No	21	70
2.	Type of diabetes	Insulin Dependent	5	16.66
		Non-insulin Dependent	4	13.33
		Non-Diabetic	21	70
3.	Period of Diabetes	<5 Years	12	40
		>5 Years	18	60
4.	History of diabetes	Yes	17	56.66
		No	13	43.33
5.	Health Problems	Poor Vision	11	36.66
		Swelling in Body	19	63.33
6.	Medication	Yes	23	76.66
		No	7	23.33
7.	Diet Restriction	Yes	11	36.66
		No	19	63.33
8.	Awareness Regarding Diabetic Diet	Yes	22	73.33
		No	8	26.66
9.	Exclude Sugar in Diet	Yes	12	40
		No	5	16.66
		Sometimes Difficult to Avoid	13	43.33
10.	Have Always High Sugar Level	Yes	4	13.33
		No	20	66.66
		Sometimes	6	20
11.	Diabetes can Make Blind	Yes	20	66.66
		No	10	33.33
12.	Diabetes can affect Kidney Too	Yes	20	66.66
		No	10	33.33
13.	Diabetes can Controlled by Cinnamon and Herbal Remedies	Yes	9	30
		No	3	10
		Maybe	18	60

Data regarding specific questions related to diabetes mellitus presented in Table 3.2. The presented data illustrated that 30 per cent respondents were suffering from diabetes and 70 per cent respondents did not had diabetes, in which 16.66 per cent respondents had insulin dependent diabetes followed by 13.33 per cent had non-insulin dependent diabetes and 70 per respondents were non-diabetic. Result revealed that 40 per cent respondents had diabetes since less than 5 years and 60 per cent had diabetes since more than 5 years, 56.66 per cent respondents had family history regarding diabetes and 43.33 per cent had no family history, 36.66 per cent respondents had poor vision and 63.33 per cent respondents had swelling in their body. 76.66 per cent respondents used to take medication for diabetes whereas, 23.33 per cent respondents denied to take medication, 36.66 per cent respondents had diet restriction and 63.33 per cent respondents did not had any diet restriction. Data showed that 73.33 per cent respondents were aware regarding diabetic diet whereas, 26.66 per cent respondents were not aware regarding diabetic diet, 40 per cent respondents agreed that they exclude sugar in

their diet, 16.66 per cent respondents denied to exclude sugar in their diet and 43.33 per cent respondents revealed that sometimes it is difficult to avoid sugar in their diet, 13.33 per cent respondents had always high blood glucose level, 66.66 had no high blood glucose level whereas, 20 per cent respondents agreed that they have sometimes high blood glucose level. As above mentioned data 66.66 per cent respondents replied in yes that diabetes can make them blind and can affect their kidney too whereas, 33.33 per cent respondents replied in no that diabetes cannot make blind and also can not affect kidney, 60 per cent respondents said that may be cinnamon and herbal remedies can control diabetes followed by 30 per cent respondents said that cinnamon and herbal remedies can control diabetes and 10 per cent responded in no that cinnamon and herbal remedies cannot control diabetes.

**Table 3.3: BMI Classification for Diabetic Respondents**

S. No.	BMI Classes	Presumptive Diagnosis	Respondents N = 30	%= 30
1.	< 18.5	Under weight	6	20
2.	18.5 – 24.9	Normal weight	8	26.66
3.	25.0 – 29.9	Overweight	10	30
4.	30 – 34.9	Obese Grade I	4	13.33
5.	>35	Obese Grade II	2	6.66

The data presented in Table-3.3 shows that the BMI classification of diabetic respondents. Maximum respondents were overweight i.e. 30 per cent followed by normal weight (26.66%), underweight (20%), obese grade I (13.33%) and obese grade II (6.66%).

**Park et al. (2003)** observed prevalence of the MetS in National Health and Nutrition Examination Survey (NHANES) was 5% among the subjects of normal weight, 22% among the overweight, and 60% among the obese.

**Table 3.4: Likes and Dislikes of Food Products of Respondents**

S. No.	Food Products	Like/Dislike	Total No. 30	Percentage
1.	Dairy Products	Like	19	63.3
		Dislike	11	37.7
2.	Green Vegetables	Like	22	73.3
		Dislike	8	27.7
3.	Dry Fruits	Like	18	60
		Dislike	12	40
4.	Fruits	Like	22	73.3
		Dislike	8	27.7
5.	Fried Foods	Like	9	30
		Dislike	21	70
6.	Non-Veg	Like	9	30
		Dislike	21	70

The result regarding likes and dislikes of diabetic respondents are presented in Table 3.4. The data revealed that maximum respondents like green vegetables and fruits i.e. 73.3 per cent followed by dairy products (63.3%), dry fruits (60%), fried foods (30%) and non-veg (30%). Whereas, maximum respondents disliked non-veg and fried foods i.e. 70 per cent followed by dry fruits (40%), dairy products (37.7%), green vegetables and fruits (27.7%).

**Table 3.5: Distribution of study participants according to their food pattern**

S. No.	Particulars	N=30	Percentage
1.	<b>Food Habits</b>		
a.	Vegetarian	17	56.66
b.	non vegetarian	8	26.66

c.	Ovo-vegetarian	5	16.66
<b>2.</b>	<b>Fast Food Consumption</b>		
a.	once a week	5	16.66
b.	twice a week	3	10
c.	once in a month	7	23.33
d.	Occasionally	8	26.66
e.	Never	7	23.33
<b>3.</b>	<b>Fasting Pattern</b>		
a.	once a week	2	6.66
b.	twice a week	1	3.33
c.	once in a month	0	0
d.	Occasionally	9	30
e.	Never	18	60
<b>4.</b>	<b>Dietary Pattern</b>		
a.	Brunch + dinner	2	6.66
b.	Breakfast + lunch + dinner	9	30
c.	Breakfast + lunch + evening tea + dinner	8	26.66
d.	Breakfast + lunch + evening tea + dinner + bed time	6	20
e.	Breakfast + midmorning + lunch + evening tea + dinner + bed time	5	16.66

The Table 3.5 shows the distribution of the respondents according to the food habits and dietary pattern. Food habits in selected respondents, 56.66 per cent respondents were vegetarian followed by 26.66 per cent were non-vegetarian and 16.66 per cent were ovo-vegetarians. Fast food consumption in selected respondents, 16.66 per cent respondents consumed fast food once in a week, 10 percent respondents consumed fast food twice a week, 23.33 per cent respondents consumed fast food once in a month, 26.66 per cent respondents consumed fast food occasionally, and 23.33 per cent respondents never consumed fast food. Fasting pattern in selected respondents, 6.66 per cent respondents kept fast once a week, 3.33 per cent respondents kept fast twice a week, 30 percent respondents kept fast occasionally and 60 per cent respondents never kept fast. In a dietary pattern 30 per cent respondent adopted three meal pattern (Breakfast + lunch + dinner) followed by 26.66 per cent adopted four meal pattern (Breakfast + lunch+ evening tea + dinner), 20 per cent respondents adopted five meal pattern (Breakfast + lunch + evening tea + dinner + bed time), 16.66 per cent respondent adopted six meal and two meal pattern (Breakfast + midmorning + lunch + evening tea + dinner + bed time) and 6.66 per cent adopted two meal pattern (Brunch + dinner) respectively.

**Table 3.6: Distribution of the Respondents according to their Food Consumption Frequency**

Food Groups	Daily		Weekly		Monthly		Occasionally		Never	
	N=30	%	N=30	%	N=30	%	N=30	%	N=30	%

Cereals	30	100	-	-	-	-	-	-	-	-
Pulses	26	86.66	4	13.33	-	-	-	-	-	-
Milk & milk products	22	73.33	8	26.66	-	-	-	-	-	-
Green leafy vegetables	10	33.33	7	23.33	8	26.66	5	16.66	-	-
Egg	-	-	6	20	10	33.33	5	16.66	9	30
Roots & Tubers	11	37.7	4	13.33	8	26.66	-	-	7	23.33
Fruits	5	16.66	5	16.66	9	30	11	37.7	-	-
Meat & Poultry	-	-	3	10	6	20	8	26.66	13	43.33
Fats & Oil	30	100	-	-	-	-	-	-	-	-
Sugar & Jaggery	10	33.33	2	6.66	5	16.66	2	6.66	11	37.7

Data presented in Table 3.6 illustrated that the food consumed daily by all respondents included cereals, pulses, milk and milk products, green leafy vegetables, egg, roots and tubers, fruits, meat and poultry, fats and oil and sugar. The above mentioned data revealed that all respondents consumed cereals daily. The pulses were consumed daily by 86.66 per cent respondents, and 13.33 per cent weekly. Milk and milk products were consumed daily by 73.33 per cent respondents and 26.66 per cent respondents consumed weekly. Consumption of green vegetables was maximum in daily i.e. 33.33 per cent followed by 26.66 per cent, 23.33 per cent and 16.66 per cent in monthly, weekly and occasionally, respectively. 33.33 per cent respondents had consumed egg monthly, 30 per cent respondents had never consumed egg, 20 per cent respondents had consumed egg weekly and 16.66 per cent consumed occasionally. Regarding root and tubers, they consumed daily by 37.7 per cent, 26.66 per cent respondents had consumed monthly and 23.33 per cent never consumed and 13.33 per cent consumed weekly. 37.7 per cent respondents consumed fruits occasionally followed by monthly (30%), weekly (16.66%) and daily (16.66%). As per data presented in table consumption of meat and poultry were high in never consumed i.e. 43.33 per cent followed by 26.66 per cent occasionally, 20 per cent monthly and 10 per cent weekly. Fats and oils were consumed by all respondents daily. Sugar and jiggery consumption was higher in never consumed i.e. 37.7 per cent followed by 33.33 per cent daily, 16.66 per cent respondents consumed monthly and 6.66 per cent in weekly and occasionally, respectively.

Similarly, **Bouchard-Mercier et al., (2010)** identified by different statistical methods, a diet rich in fruits and vegetables was inversely associated with BMI and a diet rich in meat and fat was positively associated with BMI.

**Table 3.7: The Mean Nutrient Intake per Day in Selected Sedentary Male Worker Respondents**

Parameters	Energy (Kcal)	Protein (g)	Fat (g)	Calcium (mg/d)	Iron (mg/d)
<b>Intake</b>	1964	55	26	550	15
<b>RDA</b>	2320	60	25	600	17
<b>difference</b>	356	5	-1	50	2

Above mentioned data in Table 3.7 shows that the average value of nutrients intake by the selected male respondents with respect to energy, protein, fat, fiber, calcium, and iron. After comparing all the average nutrients value with ICMR, RDA (2018) it was observed that, energy, protein, calcium and iron were less than the RDA whereas, fat intake was higher than the RDA.

**Table 3.8: The Mean Nutrient Intake per Day in Selected Sedentary Female Worker Respondents**

Parameters	Energy (Kcal)	Protein (g)	Fat (g)	Calcium (mg/d)	Iron (mg/d)
<b>Intake</b>	2000	54	19	480	19
<b>RDA</b>	1900	55	20	600	21
<b>difference</b>	-100	1	1	120	2

Above mentioned data in Table 3.8 shows that the average value of nutrients intake by the selected female respondents with respect to energy, protein, fat, fiber, calcium, and iron. After comparing all the average nutrients value with ICMR, RDA (2018) it was observed that, protein, calcium and iron were less than the RDA whereas, energy and fat intake was higher than the RDA.

**Garg et al., (1994)** recommended that the diet should contain 25% to 35% of calories as total fat for the individuals entering cholesterol management. If the fat content exceeds 35%, it is difficult to sustain the low intakes of saturated fat required to maintain a low LDL-C. On the other hand, if the fat content falls below 25%, TGs can rise and decline in HDL-C levels can be seen.

#### 4. Conclusion:

The survey on “Metabolic Disorder: diabetes in Kanpur District, U.P”. The survey method uses for the data collection and its concluded that out of 30 percent respondent the 30 percent respondents had diabetic. In food frequency consumption of cereals, it was found higher rate that all respondents consumed cereals daily and fruits it was found lower rate consumed by 16.66 percent respondents on daily. 56.66 percent respondent found vegetarian, 70 percent respondent dislike non-veg and most of the respondent 30 follow three meal pattern (breakfast + lunch + dinner). Nutrient intake by the female protein, calcium and iron were less than the RDA whereas, energy and fat intake was higher than the RDA and energy, protein, calcium and iron were less than the RDA whereas, fat intake was higher than the RDA by the male.

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#### References:

1. Abdelaziz MS, Rani SH, Ravindranath S, Shaik R, Kasim M. (2015). Pharmacoeconomic evaluation of oral-hypoglycemic agents at hospital in Bangalore. IOSR Journal of Pharmacy and Biological Sciences 10: 46-50. 12.
2. Anonymous. 2004. Diagnosis and Classification of Diabetes Mellitus – Position Statement.
3. Barceló A, Aedo C, Rajpathak S, Robles S (2003). The cost of diabetes in Latin America and the Caribbean. Bull World Health Organ 81: 19-27.
4. Beyan H, Riese H, Hawa MI, Beretta G, Davidson HW, et al. (2012) Glycotoxin and autoantibodies are additive environmentally determined predictors of type 1 diabetes. Diabetes 61: 1192-1198.
5. Bouchard-Mercier A, Paradis AM, Godin G, et al (2010). Associations between dietary patterns and ldl peak particle diameter: A crosssectional study. J Am Coll Nutr, 29:630-7.
6. Feleke Y, Enquselassie F (2005) An assessment of the health care system for diabetes in Addis Ababa, Ethiopia. Ethiopian Journal of Health Development 19: 203-210.
7. Garg A, Bantle JP, Henry RR, et al. Effects of varying carbohydrate content of diet in patients with non-insulin-dependent diabetes mellitus. Journal of the American Medical Association. 1994;271(18):1421-1428.
8. Gopalan, C.; Rama Sastri, B.V. and Balasubramanian, S.C. (2018). Nutritive Value of Indian Foods. Revised and updated by Narasinga Rao, B.S.; Deosthale, Y.G. and Pant, K.C. National Institute of Nutrition, Hyderabad.

9. Gupta, S.P. (2011). Statistical Methods. *Sultan Chand & Sons*. 4<sup>th</sup> edition.
10. Hall V, Thomsen RW, Henriksen O, Lohse N (2011) Diabetes in Sub Saharan Africa 1999-2011: Epidemiology and public health implications. A systematic review. *BMC public health* 11: 564.
11. <https://www.who.int/ncds/governance>
12. ICMR (2018) Nutritional Requirement and Recommended Dietary Allowances for Indians, NIN, Hyderabad, 9-10.
13. International Diabetes Federation (2015) IDF diabetes atlas. (7th edn), Brussels.
14. Majaliwa ES, Munubhi E, Ramaiya K, Mpembeni R, Sanywa A, et al. (2007) Survey on acute and chronic complications in children and adolescents with type 1 diabetes at Muhimbili National Hospital in Dar es Salaam, Tanzania. *Diabetes Care* 30: 2187-2192.
15. Park Y-W, Zhu S, Palaniappan L, Heshka S, Carnethon MR, Heymsfield SB. The metabolic syndrome: prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988–1994. *Archives of Internal Medicine*. 2003;163(4):427–436.
16. Persson E, Persson S, Gerdtham U-G, Carlsson KS, Swedish Childhood Diabetes Study Group (2019) Effect of type 1 diabetes on school performance in a dynamic world: New analysis exploring Swedish register data. *Appl Econ* 51: 2606-2622.
17. Piero MN. 2006. Hypoglycemic effects of some Kenyan plants traditionally used in management of diabetes mellitus in eastern province, Msc thesis, Kenyatta University.
18. Rebecca, SS, Zimmet PZ, Cameron AJ and Shaw JE. 2009. Lifestyle management: preventing Type 2 diabetes and cardiovascular complications. *Therapy*, Vol. 6, No. 4 , Pages 489-496 (doi:10.2217/thy.09.37)
19. Redondo MJ, Rewers M, Yu L, Garg S, Pilcher CC, et al. (1999) Genetic determination of islet cell autoimmunity in monozygotic twin, dizygotic twin, and non-twin siblings of patients with type 1 diabetes: Prospective twin study. *BMJ* 318: 698-702.
20. Roche EF, Menon A, Gill D, Hoey H (2005) Clinical presentation of type 1 diabetes. *Pediatr Diabetes* 6: 75-78.
21. Suleiman I, Fadeke O, Okubanjo O (2006) Pharmacoeconomic evaluation of anti-diabetic therapy in a Nigerian Tertiary Health Institution. *Annals of African Medicine* 5: 132-137.
22. Swaminathan M. (2010). *Essentials of Food and Nutrition (An Advanced Text Book)* Volume first, fundamental aspects, second Edition; 28:608-611.
23. Votey SR. and Peters AL. 2004. Diabetes mellitus type 2. A review. <http://www.emedicine.com/emerg/topic133.htm> Accessed July, 2006.
24. Watkins P, Alemu S (2003) Delivery of diabetes care in rural Ethiopia: An experience from Gondar. *Ethiop Med J* 41: 9-17.
25. World Health Organization (2013) Definition of diabetes mellitus and prevalence.
26. World Health Organization (1994). Prevention of diabetes mellitus, Technical Report Series no. 844. Geneva: World Health Organization.
27. World Health Organization (1999). Department of Noncommunicable Disease Surveillance. Definition, diagnosis and classification of diabetes mellitus and its complications; Geneva.
28. Zhang P, Zhang X, Brown J, Vistisen D, Sicree R, et al. (2010) Global healthcare expenditure on diabetes for 2010 and 2030. *Diabetes Res Clin Pract* 87: 293-301.