Original Research Article

ASSESSMENT OF NUTRITIONAL STATUS AND DIETARY PATTERN OF DIABETES PATIENTS ATTENDING OUT- PATIENT CLINICS IN ABUJA METROPOLIS, FEDERAL CAPITAL TERRITORY

ABSTRACT

PURPOSE: Nutritional status and dietary pattern of 120 randomly selected type-2 diabetic patients of both sexes (age range 18 and 65 years) attending medical outpatient clinics within Abuja metropolis were assessed. **METHODS:** A cross-sectional survey involving pre-tested and semi-structured questionnaires was used. Socio-demographic characteristics, anthropometric measurements, nutritional status and dietary pattern of the subjects were computed using standard methods. **RESULTS:** The result of socio-demographic characteristics indicates that 52% are males and 48% are females. Subjects with primary education constitute 4.2%, about half of them having either secondary (48.3%) or tertiary (47.5%) education. Most (80.8%) of them are married, 32.5% fell within a monthly income range of ₦50,000 - ₦100,000 (US $139.07 - $278.14). Anthropometric indices showed that the height of 75% of the respondents was 159.9 ± 7.0 cm, 100% of the respondents' weight, hip circumference, waist-hip ratio and waist-height ratio are 72.69 ± 16.88 cm, 104.6 ± 12.4 cm, 0.94 ± 0.1 and 0.61 ± 0.1 respectively. The nutritional status of the subjects revealed that only 25% fell within the normal BMI range, with 1.7% being underweight, 20.8% overweight and half of them (52.5%) obese and out of which 27% are morbid. Their dietary patterns showed that the food mostly consumed include cereals, processed cereals, legumes, vegetables, fruits and meat. More than a quarter of the respondents totally avoid sugar in their diet, while 33.33% rarely eat sugar. Eggs (48.33%) have a moderate frequency of consumption.

CONCLUSION: This study concludes that the dietary practices of the respondents contribute to their poor nutritional status.

Keywords: Nutritional status, Dietary pattern, Semi-structured, Anthropometric, Morbid

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism ensuing from deficiencies in insulin secretion, insulin action, or both [1]. Insulin is a hormone manufactured by the

beta cells of the pancreas, which is essential to make use of glucose from digested food as an energy source [2].

The burden of type 2 diabetes mellitus is becoming an epidemic and is a cause of morbidity and mortality, especially in the developing world. As at 2013, Africa and worldwide prevalence of type 2 diabetes mellitus was 20 million and 382 million respectively; also, a projection of two-fold increase and an increase to 592 million by 2035 has been postulated [3]. The diabetes, an epidemic and non-communicable disease, is rapidly increasing as a major health problem in sub-Saharan African and the world. It has been reported that anthropometric parameters such as BMI, waist circumference (WC), waist hip ratio (WHR), and waist height ratio (WHtR) are suitable pointers for envisaging incidence of type 2 diabetes in populaces [5]. Research has indicated that waist circumference or waist-to-hip ratio may be a better indicator of the risk of developing diabetes than BMI. Such data suggest that the distribution of body fat is a crucial determinant of risk as these measures reflect abdominal or visceral obesity [6].

The treatment for diabetes requires a multiple approach that would include medical nutrition therapy, exercise, weight reduction and use of drugs when indicated [7]. Anthropometric parameters are commonly used as research apparatuses to assess the non-communicable disease risk factors in the populations as they are inexpensive and easy to monitor at the community level [5].

Dietary management has been thought cogent in diabetes care. This is based on the principle of healthy eating in the background of social, cultural and psychological influences on food choices [4].

Therefore there is a need to investigate the nutritional status and dietary pattern of diabetes patients attending out-patient clinics in Abuja metropolis, federal capital territory, Nigeria.

MATERIALS AND METHODS

Research design

The study was a cross-sectional survey involving collection of data on socio-demographic, dietary pattern and anthropometric parameters.

Study area

The study was carried out in Abuja city centre comprising of Asokoro, Maitama and Wuse. Abuja lies at latitude 9.07°N and longitude 7.48°E with a land area of 7,753.9 Sq. Km and a population of 3,100,000 (NPC, 2016 projected estimate). The major people include; Gbagi, Hausa and other ethnic nationals.

Study population

The study population comprised of adult male and female (18 - 65 years) with type-2 diabetic patients attending selected diabetic out-patient clinics within Abuja metropolis. They were confirmed to be diabetic by a physician for having fasting blood glucose (FBG) ≥ 126mg/dl or casual plasma glucose (CPG) ≥200mg/dl or glycated haemoglobin (HbA1c) ≥ 6.5%.

Sample size

The sample size was derived using the Dobson's formula [8]

$$n=t^2\frac{(pXq)}{d^2} = 120$$

Where n= sample size,

t= Confidence interval at 95% (1.96)

p= prevalence rate (8.5% of 0.085) [8]

q = 1-p (1-0.085 =0.915)

d = desired level of significance (0.05)

Therefore n $= \frac{1.96^2 X 0.085 X 0.915}{0.05^2}$

$= 119.5$

≈ 120

Calculating using a non-response case of 7.5%, and putting design defect at 1.0,

Sample size ≈ 130

Sampling

All health facilities in the study area were selected. Number of subjects per health facility was selected using probability proportional to size. The diabetic subjects per health facility were selected from all registered diabetic patients using systematic random sampling.

Field data collection

A semi-structured validated questionnaire was used to collect respondents' information on the socio-demographic characteristics as well as their dietary intake [9].

Anthropometric measurements and Nutritional Status Determination (using MUAC and BMI)

Weight (kg) and height (cm) were taken to the nearest 0.1 using SECA UNICEF weighing scale and standiometer respectively as described by Pierce *et al* [10].

Waist and Hip circumference:

Waist measurement was taken using a non-stretchy tape at the level of the umblicus, to the nearest 0.1cm. Hip measurement was taken using a non-stretchy tape at the highest point along the hip

Mid upper arm circumference (MUAC)

MUAC measured using a shakir strip to the nearest 0.1cm. The left upper arm was measured at the mid-point between the tip of the shoulder and the elbow.

Determination of Body Mass index (BMI)

$$\text{BMI} = \frac{Weight\ (Kg)}{Height\ (m^2)}$$

Waist to Hip ratio

$$\text{WHR} = \frac{Waist\ circumference}{Hip\ circumference}$$

Waist to height ratio

$$\text{WHtR} = \frac{Waist\ circumference\ (cm)}{Height\ (cm)}$$

The BMI, WHR, WHtR, WC and MUAC were compared to WHO reference standards to determine the nutritional status of the patients.

Statistical Analysis

All data were analysed using SPSS version 20 and presented as absolute numbers and percentages and as mean ± standard deviation. They were subjected to one way analysis

of variance (ANOVA), followed by Duncan Multiple Range Test was used for post hoc test. Pearson Correlation was carried out for association test. P-value less than 0.05 ($p<0.05$) was taken as significance.

RESULTS

Socio-Demographic Characteristics of Type-2 Diabetic Patients Attending Medical Outpatient Department (MOPD) within Abuja Metropolis

The result for the socio-demographic characteristics of Type-2 Diabetic patients attending Medical Outpatient Department (MOPD) within Abuja Metropolis presented in Table 1 indicates that 40% of respondents are within the age range of 41 and 45 years; 52% are males and 48% are females; the majority are educated with 95% above primary education level; 80% are married with 25% each from Hausa/Fulani and Gwari ethnic groups forming the majority.

Table 1: Socio-Demographic Characteristics of Type-2 Diabetic patients Attending Medical Outpatient Department (MOPD) within Abuja Metropolis

Socio-Demographic Characteristics	Frequency	Percentages (%)
Age (Years)		
Below 30	11	9.20
31-40	24	20.00
41-50	48	40.00
51-60	23	19.20
61 & above	14	11.70
Sex		
Male	62	51.70
Female	58	48.30
Occupational status		
Civil servants	52	43.30
Trader/Farmer/Artisan	35	29.20
House wife	17	14.20
Others	16	13.30
Educational Level		
Primary	5	4.20
Secondary	58	48.30
Tertiary	57	47.50
Marital Status		
Single	11	9.20
Married	97	80.80
Divorced	5	4.20
Widow/Widower	7	5.80
Ethnic group		
Hausa/Fulani	30	25.00
Gwari	30	25.00
Igbo	18	15.00
Yoruba	10	8.30
Idoma	7	33.00
Others	25	20.80
Monthly income (₦)		
<20000 (< $55.63)	28	23.30
20000-49999 ($55.63-139.07)	27	22.50
50000-99999 ($139.07-278.14)	39	32.50
100000-199999 ($278.14-556.28)	19	15.80
≥200000 ($556.28)	4	3.30
Undisclosed	3	2.50

Anthropometric parameters of Type-2 Diabetic Patients attending MOPD within Abuja Metropolis

The anthropometric parameters of the participants showed that average height for 75.0% of the patients who are not stunted was 159.90 ± 7.03 (cm); all of them had normal weight and hip circumference of 72.69 ± 16.88 (kg) 104.62 ± 12.35 9 (cm) respectively; WHR revealed 66.67% of them at high risk of being overweight (0.94 ± 0.07). Using the student's t-test to check for significance, only hip circumference and waist-hip ratio showed significance (Table 2 a&b).

Nutritional Status of Type-2 Diabetic Patients attending MOPD within Abuja Metropolis

From Table 3, only 30.65% of the diabetic male patients fall within the normal BMI range, 22.58% are overweight with the rest of them suffering from obesity. Eight (27.6%) of the obese are in the morbid class of obesity. The female patients that have normal BMI accounts for 18.97% of the female population (n=58). 3.45% are underweight, 18.97% are overweight while the remaining 58.62% are obese. Morbid obese class among the female patients are 27.0%.

Table 2a: Anthropometric Parameters of Type-2 Diabetic Patients attending MOPD within Abuja Metropolis

Anthropometric indices	Male			Female			All		
	Freq.	%	Mean ± SD	Freq.	%	Mean ± SD	Freq.	%	Mean ± SD
Height (cm)									
< 148	15	24.19	136.60 ± 8.75	15	25.86	130.87 ± 11.88	30	25.0	133.73 ± 10.66
≥ 148	47	75.81	159.70 ± 6.61	43	74.14	160.12 ± 7.54	90	75.0	159.90 ± 7.03
Weight (kg)									
< 45	0	0.00	0	0	0.00	0	0	0.00	0
≥ 45	62	100.00	70.90 ± 16.69	58	100.00	74.60 ± 17.02	120	100.00	72.69 ± 16.88
Waist circ. (cm)									
Normal	33	53.23	84.45 ± 9.24	11	18.97	73.82 ± 4.69	44	36.67	81.80 ± 9.50
Class I	18	29.03	98.21 ± 2.54	8	13.79	83.75 ± 2.76	26	21.67	93.76 ± 7.27
Class II	11	17.74	111.27 ± 11.45	39	67.24	100.95 ± 9.06	50	41.67	102.22 ± 10.45
Hip circ. (cm)									
	62	100.0	102.0 ± 13.1	58	100.00	107.5 ± 10.9	120	100.0	104.6 ± 12.4
Waist/Hip ratio									
Low risk	29	46.77	0.84 ± 0.06	11	18.97	0.77 ± 0.03	40	33.33	0.81 ± 0.05
High risk	33	53.23	0.98 ± 0.08	47	81.03	0.89 ± 0.05	80	66.67	0.94 ± 0.07

171 **Table 2b: Student's t-test to check for Significance at 0.05 Level**

Anthropometric indices	t	Sig. (2-tailed)
Height (cm)	0.612	0.542
Weight (kg)	-1.202	0.232
Waist circ. (cm)	-0.091	0.927
Hip circ. (cm)	-2.499	0.014
Waist/Hip ratio	3.245	0.002
Waist Height Ratio	-0.404	0.867

172 Degree of freedom (df) = 118

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Table 3: Nutritional Status of Type-2 Diabetic Patients attending MOPD in Abuja Metropolis

Nutritional Status Indicators		Male (n=62)	Female (n=58)	All (n=120)
		F (%)	F (%)	F (%)
BMI (kg/m^2)	**Underweight**	0 (0.0)	2 (3.45)	2 (1.7)
	Normal	19 (30.65)	11 (18.97)	30 (25.0)
	Overweight	14 (22.58)	11 (18.97)	25 (20.8)
	Obese	29 (46.8)	34 (58.62)	63 (52.5)
	Obesity Class I	12 (41.4)	13 (38.2)	25 (39.7)
	Obesity Class II	9 (31.0)	12 (35.3)	21 (33.3)
	Morbid Obesity	8 (27.6)	9 (26.4)	17 (27.0)

Dietary Patterns of Type-2 Diabetic Patients attending MOPD in Abuja Metropolis

The dietary pattern of type-2 diabetic patients attending MOPD within Abuja is presented in Table 4. Foods mostly consumed by the respondents include cereals, processed cereals, legumes, vegetables, fruits, meat. Eggs have a moderate frequency of consumption as 48.33% of the respondents rarely consume it. The results revealed that more than a quarter of the respondents totally avoid sugar in their diet, while 33.33% rarely eat sugar.

Pearson's Correlation between Socio-demographic, Anthropometric and Dietary Practices of the Respondents Attending MOPD in Abuja Metropolis

The result showing the correlation between socio-demographic, anthropometric parameters and dietary practices of the respondents is presented in the Table 5. Analysis showed some weak associations between gender and hip circumference ($r = 0.224$, $p = 0.014$), MUAC and WHR ($r = 0.214$, $p = 0.019$). Weight has a relatively strong association with BMI ($r = 0.690$, $p = 0.000$).

Table 4: Dietary Patterns of Type-2 Diabetic Patients attending MOPD in Abuja Metropolis

DIETS		Male (n=62)		Female (n=58)		All (n=120)	
		Freq.	%	Freq.	%	Freq.	%
Cereals	Daily	24	38.71	24	41.38	48	40.00
	Often	28	45.16	26	44.83	54	45.00
	Rarely	9	14.52	8	13.79	17	14.17
	Never	1	0.83	0	0.00	1	0.83
Processed cereals	Daily	9	14.52	9	15.52	18	15.00
	Often	41	66.13	34	58.62	75	62.50
	Rarely	6	9.68	12	20.68	18	15.00
	Never	6	9.68	3	5.17	9	7.50
Beverages	Daily	11	17.74	6	10.34	17	14.17
	Often	22	35.48	29	50.00	51	42.50
	Rarely	22	35.48	20	34.48	42	35.00
	Never	7	11.29	3	5.17	10	8.33
Sugar	Daily	5	8.06	5	8.62	10	8.33
	Often	8	12.90	10	17.24	18	15.00
	Rarely	23	37.10	29	50.00	52	43.33
	Never	26	41.94	14	24.14	40	33.33
Legumes	Daily	15	24.19	16	27.59	31	25.83
	Often	39	62.90	35	60.34	74	61.67
	Rarely	8	12.90	7	12.07	15	12.50
	Never	0	0.00	0	0.00	0	0.00
Vegetables	Daily	27	43.55	24	41.38	51	42.50
	Often	33	53.23	32	55.17	65	54.17
	Rarely	2	3.23	2	3.45	4	3.33
	Never	0	0.00	0	0.00	0	0.00
Fruits	Daily	26	41.94	23	39.66	49	40.83
	Often	30	48.39	28	48.28	58	48.33
	Rarely	6	9.68	7	12.07	13	10.83
	Never	0	0.00	0	0.00	0	0.00
Meat	Daily	19	30.65	25	43.10	44	36.67
	Often	36	58.06	29	50.00	65	54.17
	Rarely	7	11.29	4	6.90	11	9.17
	Never	0	0.00	0	0.00	0	0.00
Milk	Daily	6	9.68	7	12.07	13	10.83
	Often	36	58.09	38	65.52	74	61.67
	Rarely	20	32.26	12	20.69	32	26.67
	Never	0	0.00	1	1.72	1	0.83
Eggs	Daily	9	14.52	10	17.24	19	15.83
	Often	26	41.94	33	56.90	58	48.33
	Rarely	26	41.94	14	24.14	40	33.33
	Never	1	0.83	1	1.72	2	1.67

Table 5: Pearson's Correlation between Socio-demographic, Anthropometric parameters and Dietary Practices of the Respondents Attending MOPD in Abuja Metropolis

Parameter	Correlation (PC)	Significance
Age/Household size	0.222	0.020*
Gender/Hip Circum.	0.224	0.014*
MUAC/WHR	0.214	0.019*

*** Correlation is significant at the 0.05 level**

DISCUSSION

Diabetes, an important public health problem, has been listed as one of the four priority non-communicable diseases (NCDs) targeted for action by world leaders due to the number of cases and its prevalence being on steady increase over the past few decades [11]; with Type-2 diabetes mellitus (T2DM) reported to be one of the most common endocrine disorders, affecting almost 6% of the world's population [12].

The result of this study showed that majority of these participants (85, 70.83%) are of ages 41 years and above because diabetes affect people mostly as they are aging due to some factors even though the diabetes is affecting the youths in recent times [4]; Majority are married; fifty-two (52) of them are civil servants which may be attributed to sedentary lifestyle like sitting down at a spot for hours and those that are housewives (17) probably stay at home, eat several times, take more sweets, do not exercise which could lead to an increase in their blood sugar level and eventually diabetes. Most of them also (115) had at least secondary and or tertiary level of education, showing that they are learned, literate, able to read and write and as well answer questions being asked during the data collection via the questionnaire.

The number of respondents who are Hausa/Fulanis and Gwari were greater than those who are of other ethnic group because of the hospitals are located in their environment. The average monthly income for the respondents fell in medium class with 39 of them earning between #50,000.00 and #100,000.00 (139.07 and 278.14 US Dollar equivalent).

Studies have reported that the management of diabetes mellitus (DM) largely depends on patients' capability to self-care in their daily lives, and therefore, patient education is always considered an essential element of DM management [13, 14].

Anthropometry is a simple, inexpensive and non-invasive marker of obesity [15]. All of the respondents have WC and WHR above normal range. High WHRs may increase the risk of developing conditions associated with being overweight, including heart disease and T2DM. This may be the case even if other measures of being overweight, such as BMI are in normal range [16]. Central obesity, as measured by WHR, is significantly and independently associated with T2DM. Results for WHR showed that 33.3% were at low risk and 66.7% high risk. A genetic predisposition to higher WHR has been shown to be associated with increased risk of T2DM and coronary heart disease [17].

Obesity is an established risk factor for T2DM and cardiovascular disease (CVD) [18, 19]. Increasing prevalence of obesity is parallel to increasing number of persons with T2DM [20-22]. Measures of obesity (BMI, WC, and WHR) are associated with the risk of developing T2DM [23]. In this study, respondents that are either overweight or obese constitute 73.3% of the population of type-2 diabetic patients assessed. In obesity classification, 27.0% of the obese individuals are in the morbid obese class. Obese persons with T2DM are at greater risk for diabetic complications than their non-obese counterparts [24]. Obesity has been shown from a recent study to be associated with the presence of cardiovascular complications, particularly among T2DM women [25]. The WC measurements showed that 21.7% and

41.7% of the diabetic patients were in Class I and Class II respectively. Abdominal fat is more associated with the risk of developing type-2 diabetes than BMI. This is founded on the rationale that increased visceral adipose tissue is linked with a variety of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and dyslipidemia, which are risk factors for type-2 diabetes and CVD [26].

Nutritional status has gained significant usage in assessment of health status of diabetic patients. Food consumption can be greatly influenced by economic status of an individual and/or the environment. Although genes play an important role in determining food intake and energy metabolism, lifestyle and environmental factors may play a principal role in pathophysiology of obesity. Poor and unregulated diet consumption can cause increased weight high BMI which have been independently associated with increased diabetes risk. Therefore preventing weight gain and/or reducing body weight may be important in reducing risk of developing diabetes [27].

Diet is one of the lifestyle interventions in the management and treatment of persons diagnosed with diabetes mellitus [28]. A healthy and adequate diet must meet the body's energy need provide a minimum of all the required nutrients. Individuals suffering from T2DM may sometimes be restricted from certain foods. Diet can significantly impact on health. Foods often consumed by majority of the diabetic patients in our study include whole cereals, processed cereals, beverages, legumes, vegetables, fruits, meat, milk, eggs. Sugar is rarely consumed among them.

CONCLUSION

This study concludes that the present dietary practices of the diabetic patients contribute to poor nutritional status of the diabetic patients.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

Ethical approval obtained from Federal Capital Development Authority (FCDA) Health Secretariat after following their procedure. Health facility approval was sought from the head of each HFs involved after obtaining ethical approval

Informed consent

Informed consent was obtained from the type-2 diabetic patients willing to participate in the study.

References

1. WHO, *Screening for type 2 diabetes: report of a World Health Organization and International Diabetes Federation meeting*. 2003, Geneva: World Health Organization.
2. Itoh, Y., *et al.*, *Free fatty acids regulate insulin secretion from pancreatic β cells through GPR40.* Nature, 2003. **422**(6928): p. 173.
3. IDF, *IDF diabetes atlas.* Brussels: International Diabetes Federation, 2013.
4. Worku, A., S.M. Abebe, and M.M. Wassie, *Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia.* SpringerPlus, 2015. **4**(1): p. 15.
5. Himabindu, Y., *et al.*, *Correlations between anthropometry and lipid profile in type 2 diabetics.* Indian journal of endocrinology and metabolism, 2013. **17**(4): p. 727.
6. Steyn, N.P., *et al.*, *Diet, nutrition and the prevention of type 2 diabetes.* Public health nutrition, 2004. **7**(1a): p. 147-165.
7. ADA, *American Diabetes Association: Standards of medical care in diabetes-2013.* Diabetes care, 2013. **36**(Supplement 1): p. S11-S66.
8. Ehiaghe, A.F., *et al.*, *Socio-Economic Status and Hemoglobin Concentration of Type 2 Diabetes Mellitus Patients Attending Diabetic Clinic in Benin City, Nigeria.* Open Journal of Pathology, 2013. **3**(04): p. 139.
9. Jacques PF, Tucker KL. Are dietary patterns useful for understanding the role of diet in chronic disease. The American journal of clinical nutrition. 2001.
10. Pierce, B.L., *et al.*, *Elevated biomarkers of inflammation are associated with reduced survival among breast cancer patients.* Journal of Clinical Oncology, 2009. **27**(21): p. 3437.
11. WHO, *Global report on diabetes.* 2016.
12. Firouzi, S., M.Y. Barakatun-Nisak, and K.N. Azmi, *Nutritional status, glycemic control and its associated risk factors among a sample of type 2 diabetic individuals, a pilot study.* Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences, 2015. **20**(1): p. 40.
13. Duke, S.A.S., S. Colagiuri, and R. Colagiuri, *Individual patient education for people with type 2 diabetes mellitus.* Cochrane database of systematic reviews, 2009(1).
14. McPherson, M.L., *et al.*, *Association between diabetes patients' knowledge about medications and their blood glucose control.* Research in Social and Administrative Pharmacy, 2008. **4**(1): p. 37-45.
15. Adamu, L.H., *et al.*, *Neck circumference: An upcoming tool of adiposity indices.* Nigerian Journal of Basic and Clinical Sciences, 2013. **10**(2): p. 82.

16. Schmidt, M.I., *et al.*, *Association of waist-hip ratio with diabetes mellitus: strength and possible modifiers.* Diabetes care, 1992. **15**(7): p. 912-914.
17. Emdin, C.A., *et al.*, *Genetic association of waist-to-hip ratio with cardiometabolic traits, type 2 diabetes, and coronary heart disease.* Jama, 2017. **317**(6): p. 626-634.
18. Haffner, S.M., *Abdominal obesity, insulin resistance, and cardiovascular risk in pre-diabetes and type 2 diabetes.* European Heart Journal Supplements, 2006. **8**(suppl_B): p. B20-B25.
19. Pearson-Stuttard, J., *et al.*, *Worldwide burden of cancer attributable to diabetes and high body-mass index: a comparative risk assessment.* The Lancet Diabetes & Endocrinology, 2018. **6**(6): p. e6-e15.
20. Hu, L., *et al.*, *Prevalence of overweight, obesity, abdominal obesity and obesity-related risk factors in southern China.* PloS one, 2017. **12**(9): p. e0183934.
21. Scheen, A.J. and L.F. Van Gaal, *Combating the dual burden: therapeutic targeting of common pathways in obesity and type 2 diabetes.* The lancet Diabetes & endocrinology, 2014. **2**(11): p. 911-922.
22. Bhupathiraju, S.N. and F.B. Hu, *Epidemiology of obesity and diabetes and their cardiovascular complications.* Circulation research, 2016. **118**(11): p. 1723-1735.
23. Anjana, M., *et al.*, *Visceral and central abdominal fat and anthropometry in relation to diabetes in Asian Indians.* Diabetes care, 2004. **27**(12): p. 2948-2953.
24. Riobó Serván, P., *Obesity and diabetes.* Nutricion hospitalaria, 2013. **28**(5).
25. Sallam, R.M., *et al.*, *Gender-Specific profiles of cardiovascular disease in type 2 diabetes mellitus: A cross-sectional study.* Journal of Nature and Science of Medicine, 2018. **1**(2): p. 74.
26. Bello-Sani, F., A. Bakari, and F. Anumah, *Dyslipidaemia in persons with type 2 diabetes mellitus in Kaduna, Nigeria.* International Journal of Diabetes and Metabolism, 2007. **15**(1): p. 9.
27. Kuwahara, K., *et al.*, *Body mass index trajectory patterns and changes in visceral fat and glucose metabolism before the onset of type 2 diabetes.* Scientific reports, 2017. **7**: p. 43521.
28. Whittaker, A., *et al.*, *A khorasan wheat-based replacement diet improves risk profile of patients with type 2 diabetes mellitus (T2DM): a randomized crossover trial.* European journal of nutrition, 2017. **56**(3): p. 1191-1200.