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ORIGINAL RESEARCH

Determinants of Overweight Among Type Two Diabetes Mellitus Patients Attending Public Hospitals At Awusi Resu Zone of Afar Region: Unmatched Case–Control Study

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Background: Diabetes is a major cause of morbidity and mortality; affecting More than 415 million people.

Objective: The primary aim of this study was to assess the determinants of being overweight among Type 2 Diabetic patients attending diabetic clinics of public Hospitals in the Awusi resu zone of Afar region, Northeast Ethiopia.

Methods: A hospital-based unmatched case–control study design was conducted from May 5 to June 5/2021 by systematic random sampling 286 study participants were involved in the study (96 cases and 190 controls); Logistic regression analysis was performed to identify the best model of factors leading to overweight. The odds ratio and 95% confidence interval were used as a measure of association.

Results: Those who have attended college and above have an AOR; of 10.30 CI: (4.16–25.50) ten times higher odds of being overweight when compared to those unable/able to read. Only those who have a family history of diabetes AOR: 3.10 CI (1.04–9.30) have three folds of being overweight when compared to their counterparts. Of those who use insulin for controlling blood glucose (AOR: 0.14 CI (0.03–0.74) 96% at less likely to be overweight compared to those who use exercise.

Conclusion and Recommendation: In this study, educational level, Family History, and type of blood glucose controlling mechanism were important predictors of overweight on T2DM. Moreover the diabetes patients were recommended to use insulin for controlling blood glucose.

Keywords: overweight, diabetes mellitus type 2, public hospitals

Introduction

Background

In 1999, WHO defined diabetes mellitus as "a metabolic disorder of multiple etiology, characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.[1] Obesity – is medically defined as a body mass index (BMI) of 30 kg/m or more – is a major independent risk factor for developing the disease – about 90% of people with type 2 diabetes have obesity or are overweight (BMI of at least 25).[2]

The ADA/WHO classification of Diabetes Mellitus includes four clinical classes: A. Type 1 Diabetes Mellitus – results from β-cell destruction due to immune-mediated or idiopathic, causing absolute insulin deficiency. B. Type 2 Diabetes Mellitus – due to a progressive insulin secretory defect on the background of insulin resistance. C. Other specific types of Diabetes Mellitus – eg, Diseases of the exocrine pancreas, drug-induced diabetes (long-term steroid use), and some endocrine diseases like thyrotoxicosis. D. Gestational Diabetes Mellitus (GDM).[3] Hyperglycemia diagnosed during pregnancy in previously non-diabetic women according to the Economic Report, which is published every five years, found that the total

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annual cost of diabetes in 2022 is $412.9 billion, including $306.6 billion in direct medical costs and $106.3 billion in indirect costs.[4] People with diagnosed diabetes now account for one of every four healthcare dollars spent in the US.[5]

To date, the International Diabetes Federation (IDF) has estimated that 451 million adults live with diabetes worldwide in 2017 with a projected increase to 693 million by 2045 if no effective prevention methods are adopted.[6] The prevalence of both type 1 and type 2 diabetes among children and adolescents has also increased, and the estimates of children and adolescents below age 20 with type 1 diabetes now exceed one million,[7] among the complications of T2DM, Diabetic nephropathy was the most common complication, accounting for 91.0%, followed by neuropathy 54.4%, retinopathy 39.3%, and macro vascular complications (17.5%).[8]

A controlled diet plays a major role in delaying disease progression among diabetes patients. Diabetes patients often have difficulty identifying the recommended type, quality, and quantity of diet. Knowledge of a recommended diet for diabetes patients influences patient's food selection and dietary practice.[9]

Globally, more than 1.9 billion adults aged 18 years and above were overweight in 2016. Of these, over 650 million adults were obese.[10] In Sub-Saharan African, countries the magnitude of overweight is increasing at an alarming rate. Overweight people with diabetes could induce increased thrombogenic factors, cardiovascular disease, and raised blood pressure. It also interferes with the treatment of hyperglycemia and diabetes-related complications.[11]

Being overweight is the most important risk factor for T2DM and has been proven the major contributor to the current epidemics of T2DM,[12] therefore, the study identified determinants of being overweight among T2DM patients attended in Dubti and Aysaita hospitals, Afar region, Ethiopia, and which would be a base for further research and investigations

Methods and Materials

Study Area and Period

This study was conducted among patients with T2DM attending public Hospitals in the Afar Regional State of Ethiopia. There were 5 primary hospitals and one General Hospital in the Region. Afar region is one of the tenth regions of the FDRE which is located in Northeast Ethiopia, and comprises 72,053 km^2, according to CSA 2013 EFY projection the region has 1,989,674 populations which are subdivided into five administrative zones, 34 woredas, and 5 city administrations, one primary Hospital evenly distributed in each administrative Zone towns and one general hospital found in Dubti district. The study was conducted at the Dubti and Aysaita hospitals in the Afar region.

Study Design

A hospital-based case–control study was conducted among patients with diabetes mellitus attending public hospitals in Awusi Resu, Afar Region, Northeast Ethiopia.

Source Population

All Diabetic patients visited Dubti and Aysaita Hospital during the study period.

Study Population

Cases: The study population included all patients with T2DM and BMI ≥ 25 kilograms per meter square (kg/m^2).
Controls: The study population included all patients with T2DM with a BMI between 18.5 kg/m^2 and 25 kg/m^2.

Inclusion and Exclusion Criteria

Inclusion Criteria

All T2DM patients who fulfill cases and controls definition.

Exclusion Criteria

All critically ill patients and pregnant diabetic mothers excluded from the study.

Sample Size Determination

EPI Info online stat calculator was used to calculate the sample size with the following parameters: Significance=95%, Power=80%, AOR=2.3 (the odds of study subjects who did not walk regularly). The Odds ratio was obtained from a cross-sectional study conducted to identify the magnitude of overweight and associated factors among patients with type 2 diabetes mellitus at Mekelle Public Hospitals, Tigray, Ethiopia. Case-to-control ratio=1:2; the proportion of controls with exposure was 23.5%, and the proportion of cases with exposure was 41.4%. Assuming a nonresponse rate of 10%, the sample size for cases will be 96, while the sample size for controls will be 190. The total sample size was 286.[13]

Sampling Procedures and Techniques

A systematic random sampling technique was used to select the study participants. K For cases and controls, total cases and controls were divided by the total sample size (n) of cases and controls in each hospital, respectively. The calculated sample size was allocated proportionally to the selected hospitals, based on the number of patients attending hospitals. The study participants were selected using a systematic sampling technique at every kth interval. The Kth interval was calculated by dividing the total number of cases and controls (N) by the total sample size (n) of cases and controls using the K value. The patients were selected in every other interval for cases, and controls were selected for every three patients; therefore, the value of K was 1 for cases and 3 for controls for both hospitals. The first study participant was selected by using the lottery method. Two controls were selected for each case. The procedure was continued in both selected health facilities throughout the data collection period until the required sample size was achieved.

Data Collection

Data Collection Instruments

Anthropometric measurements and structured questionnaires were used for the data collection. The questionnaire consists of variables significantly associated with overweight from similar literature was used.[14] The questionnaire was prepared in English and translated into Amharic and Afar languages. The questionnaire was pre-tested in 5% of the sample size at Aba'ala Hospital. Trained health professionals (nurses and health officers) collected the data. The collected data were reviewed and checked for completeness and consistency by the supervisor and principal investigator daily during the data collection time.

Data Collectors

Three diploma nurses as data collectors and one-degree nurse as supervisors were involved in data collection. Data collectors and supervisors were listed at a health facility in the district.

Data Collection Procedure

Training was provided to the data collectors and supervisors, and data related to weight, height, and blood pressure were obtained by measuring each study participant. Weight was measured in light clothing and without shoes in kilograms (kg), using a calibrated UNICEF Seca digital weighing scale, and was checked every six patients using another calibrated UNICEF Seca digital weighing scale. Height will be measured using a stadiometer in centimeters (cm), and measurements will be checked every six patients using another stadiometer. While measuring height, the study subjects will be kept in an erect position such that the back of the head, shoulder blades, buttocks, and heels make contact with the backboard of the stadiometer. Blood pressure was measured using a mercury sphygmomanometer with a cuff deflation rate of 2 mm Hg. The average of two 5-minute measurements of BP from the left arm in the sitting position was recorded, and each record was checked using another mercury sphygmomanometer. Informed consent was obtained from all participants.

Data Quality Control

Data quality was ensured using a different approach. First, the Questionnaire prepared in English was translated into the Amharic and Afar languages and then back to English to check for consistency. The questionnaire was pre-tested at Aba'ala Hospital and was not included in the actual study. The purpose of the pre-test was to ensure that the questionnaire was

sufficiently efficient to carry out the actual study and estimate the time required. Intensive training for three days was given to the data collectors and supervisors on how to interview diabetic clients to fill out questionnaires and take anthropometric measurements. The selection of cases and controls was based on a previously defined case definition. Measurements were taken using standard instruments of weighing scale and height board and were routinely checked and adjusted to maintain accuracy. The weighing scales were regularly calibrated with objects of known weight. The scale indicators were checked against zero readings after each participant had been weighed. Continuous supervision was performed during all data collection periods. The collected information was reviewed daily, and possible errors were returned to the data collection for correction after checking by the supervisors together with the principal investigator. The information collected from the key informant interviews was transcribed in English and kept every day, immediately after the field.

Method of Data Processing and Analysis

Data were entered into Epi Data version 3.1 and analyzed using SPSS version 23 software. Variables with a p-value of <0.1 in the bi-variable analysis were entered into the multivariable analysis. With all regression assumptions fulfilled ie, constant for variables in the equation is significant (p<0.05), model prediction of variables would be checked, better prediction of variables than the constant-only model (omnibus test of coefficients at p<0.000), and goodness-of-fit test with the Hosmer and Lemeshow test model was constructed using the entry method. The crude odds ratio (OR) was calculated, and a p-value <0.1, was considered as a cut-off point to select variables for the final model. The adjusted odds ratio with 95% CI) was computed to determine the strength of the association. Statistical significance was set at $p < 0.05$.[15]

Results

Socio-demographic and economic characteristics of study participant, among the study participants, 163 (57.0%) were male and 123 (43.0) were female, of which 112 (53.1) were cases from male and 45 (46.9%) were female. Of the study participants, 195 (68.2%) were Muslims, of whom 66 (68.8%) were cases the remaining were controls. Most of the participants were 185 (64.7%), 117 (40.9%), 86 (30.1%) married, above average income, and civil servants in occupation, respectively (Table 1).

Table 1 Socio-Demographic Characteristics of Study Cases and Controls of Study Participants Attending Public Hospitals at Awusi Resu Zone of Afar Region, Northeast Ethiopia, 2021 (n=286)

Variable	Responses	Study Participants		COR	P value
		Cases (%)	Controls (%)		
Sex	Male	51 (53.1%)	112 (58.9%)	0.78	0.35
	Female	45 (46.9%)	78 (41.1%)	0.60	0.00
Religion	Muslim	66 (68.8%)	129 (67.9%)	0.95	0.56
	Orthodox	28 (29.2%)	59 (31.1%)	0.17	0.76
	Protestant	2(2.1%)	2(1.1%)	0.12	0.01
Marital status	Married	63 (65.6%)	122 (64.2%)	0.45	0.54
	Single	22 (22.9%)	37 (19.5%)	0.02	0.34
	Others	11 (11.5%)	31 (16.3%)	0.07	0.92
Monthly income	Below average	8(8.3%)	73 (38.4%)	0.04	0.00
	Above average	23 (24.0%)	94 (49.5%)	0.09	0.00
	High Income	65 (67.7%)	23 (12.1%)	2.82	0.00
Occupation Category	Pastoral	27 (28.1%)	54 (28.4 1.02)	1.02	1.0
	Civil Servant	29 (30.2%)	57 (30.0%) 0.94	0.94	1.0
	Merchant	22 (22.9%)	47 (24.7%) 1.13	1.13	0.75
	Others	18 (18.8%)	32 (16.8%) 0.50	0.5	0.00

Notes: Below Average (<3100ETB), Above Average (3100–6000), High income (6000–10,000) Others (Daily laborer and Housewife), others (Widowed and divorced.

Abbreviations: COR, Crude odds ratio; AOR, adjusted odds ratio.

Health Profile of Study Participants

Most of the participants had no family history of T2DM (259), of which 80 (83.3) were cases and the remaining 179 (94.2%) were controls. More than halves 265 (92.7%) greater number of the participants were members of the DM Association of which 92 were cases and 173 controls) (Table 2).

Dietary Knowledge

Concerning knowledge of the recommended diet, most of the patients (59.4%) had good dietary knowledge. However, 116 (40.6%) had poor dietary knowledge of the recommended diet. The Mean ± SD knowledge score was 12.80 ± 3.2. The study participants were asked about the lifestyle modification they knew to control glycemia levels so; one hundred twenty-five (78.7%) mentioned dietary modification as one of the ways to control blood glucose levels and 61 (21.3%) did not know any lifestyle modification. Two hundred and five (71.7%) patients knew that the consumption of carbohydrates had an immediate effect on blood glucose levels, while 81 (28.3%) did not know a specific food group that had an immediate effect on blood glucose levels. Only 42% of participants identified food types that increased their blood glucose levels. When the patients were asked about which preparation of food decreased or maintained blood sugar levels one Hundred sixty-three (57%) correctly answered while the rest did not know. Two Hundred and seven (89.9%) did not think skipping meal time would help control blood sugar levels, while 29 (10%) thought that skipping meal time would help control blood sugar levels (Table 3).

Dietary Practice

The response of the patients about dietary practice and the majority of the patients 197 (68.9%) had a meal frequency of three a day. Two hundred thirteen (74.5%) took their meal during appropriate meal time, while the remaining 73 (25.5%) took their meal at inappropriate meal time. Most of the participants do not take sweet and soda drinks regularly 192 (67.1%) while the remaining 94 (32.9%) take sweet and soda drinks regularly. More than half of the participants did not consume fatty meat regularly. One hundred twenty-four (43.4%) of the patients consumed vegetables more than week 3 times a week, whereas 162 (56.6%) did not eat that amount. More than half of the participants 199 (69.6%) consumed juices while they consumed fruit, the other hand the remaining 87 (30.4%) consumed the whole fruit. The average dietary score was 11, and most of the participants had good dietary practices (Table 4).

Table 2 Health Profile of Cases and Controls of T2DM Patients Attending Follow-Up at Awusi Resu Zone Public Hospitals, Northeast Ethiopia. August 2021

Variable	Responses	Study Participants		COR	P-value
		Case (%)	Controls (%)		
Other Comorbidity	Yes	22 (22.9%)	42 (22.1%)	1.05	0.88
	No	74 (77.1%)	148 (77.9%)	0.50	0.00
Comorbidity Type	Hyperlipidemia	42 (43.8%)	12 (6.3%)	1.0	1.0
	Hypertension	2(2.1%)	9(4.7%)	1.0	1.0
Family History of DM	Yes	16 (16.7%)	11 (5.8%)	3.2	0.04
	No	80 (83.3%)	179 (94.2%)	0.48	0.00
Dietary habits changed after DM Diagnosis	Yes	73 (76.0%)	142 (74.7%)	0.93	0.80
	No	23 (24.0%)	48 (25.3%)	0.51	0.00
Information Source for DM	Doctors	77 (80.2%)	134 (70.5%)	0.59	0.81
	Others	19 (19.8%)	56 (29.5%)	0.97	0.94
Diet Advice from a Physician	Yes	70 (72.9%)	75 (26.2%)	0.91	0.71
	No	26 (27.1%)	55 (28.9%)	0.51	0.00
Regular Exercise	Yes	20 (20.8%)	40 (21.1%)	1.01	1.0
	No	76 (79.2%)	150 (78.9%)	0.50	0.21
Member of DM Association	Yes	92 (95.8%)	173 (91.1%)	2.26	1.15
	No	4(4.2%)	17 (8.9%)	0.24	0.00
RBS Level	Below, 180,	62 (64.6%)	111 (58.4%)	1.05	0.84
	Above, 180	34 (35.4%)	79 (41.6%)	0.50	0.00

Abbreviation: COR, Crude odds ratio.

Table 3 Diabetic Nutritional Knowledge of Study Participants Attending Public Hospitals at Awusi Resu Zone Afar Region, Unmatched Case–Control Study 2021

Questions	Responses	Yes	Percent	No	Percent
Lifestyle Modification	Yes/No	225	78.7	61	21.3
Blood Glucose Controlling Mechanism	Yes/No	120	42.0	166	58.0
Types of food that increase Blood glucose	Yes/No	64	22.4	222	77.6
Source of carbohydrate	Yes/No	205	71.7	81	28.3
Achieve good Glycemic Level	Yes/No	163	57.0	123	43.0
Mostly eaten foods by DM patients	Yes/No	141	49.3	145	50.7
Raises Blood Glucose Level	Yes /No	193	67.5	93	32.5
Fruit and Vegetable Taking Composition	Yes/No	107	37.4	179	62.6
Meals skipping	Yes/No	257	89.9	29	10.1
Mean Knowledge Score	12.8±				
Knowledge Level	Poor/Good	170	59.4	116	40.6

Table 4 Dietary Practice of T2DM Attending Dubti and Aysaita Hospitals at Afar Region, Unmatched Case–Control Study 2021

Questions	Responses	Yes	Percent	No	Percent
Frequency of Eating	Yes/No	89	31.1	197	68.9
Appropriate meal Time	Yes/No	213	74.5	73	25.5
Do you take Fatty meal regularly?	Yes/No	123	43.0	163	57.0
Do you Soda and Sweet drinks regularly	Yes/No	94	32.9	192	67.1
Do you take fruit regularly?	Yes/No	96	33.6	190	66.4
Do you take vegetables regularly?	Yes/No	124	43.4	162	56.6
How do you take to fruit?	Yes /No	87	30.4	199	69.6
Mean Dietary Score	11.11±				
Dietary Score Level	Poor/Good	181	63.3	105	36.7

Multivariable Logistic Regression Analysis

Logistic regression analysis showed that Educational Level, Family, and type of blood glucose control mechanism were important predictors of overweight in T2DM. Those who attended college and above had an AOR; of 10.30 CI:4.16–25.50) ten times higher odds of being overweight when compared to those who were unable/able to read only. Those who had a family of DM AOR:3.10 CI (1.04–9.30) were three times more likely to be overweight than their counterparts with no family history. Of those who used insulin to control blood glucose (AOR: 0.14 CI (0.03–0.74) 96% were at low risk of being overweight compared to those who used exercise/diet (Table 5).

Note: Even though five variables were recruited for multivariable regression after 16 variables were checked for bi-variable.

Table 5 Multivariable Analysis of Cases and Controls Attending DM Clinics of Aysaita and Dubti Hospitals, Afar, Northern East Ethiopia, 2021. (n=286)

Variable		Study Participants		COR (95% CI)	P-value	AOR (95% CI)
		Cases	Controls			
Educational Category	Unable/able to read and write	16	69	1		1
	Primary school	13	65	0.09 (0.04-0.0.20)	0.83	0.90 (0.35–2.35)
	Secondary school	9	34	0.08 (0.04–0.20)	0.88	1.01 (0.36–3.40)
	College & Above	58	22	0.10 (0.04–0.24)	0.00	10.30 (4.16–25.50)
	Below average	8	73	1		1

(*Continued*)

Table 5 (Continued).

Variable		Study Participants		COR (95% CI)	P-value	AOR (95% CI)
		Cases	Controls			
Monthly income	Above, average	23	94	0.04 (0.01-0.02)	0.20	1.91 (0.73–5.01)
	High income	65	23	0.09 (0.05–0.17)	0.00	1.20 (0.73–5.01)
Family hx of DM	Yes	16	11	3.26 (1.50–7.33)	0.04	21.90 (8.20–58.60)
	No	80	179	1		1
Control mechanism for DM	Insulin	19	60	0.27 (0.08–0.91)	0.02	0.14 (0.03–0.74)
	Tablet	70	124	0.50 (0.15–1.50)	0.07	0.25 (0.05–1.12)
	Others	7	6	1	0.06	1
Information source for DM	Doctors	134	77	1	0.30	1
	Other	56	19	0.60 (0.33–1.07)	0.05	1.51 (0.70–3.35)

Note: *Significant at p-value of 0.05.

Discussion

In this study, educational status, positive family history, and blood glucose control mechanisms were the statistically significant determinant variables. Positive family history of T2DM was found to be associated with being overweight with AOR: 3.10 CI (1.04–9.30) which is triple the odds of being overweight as compared to those who have no family history of T2DM, this is consistent with the study done on Prevalence of Diabetes Mellitus, Prediabetes and Its Associated Factors in Dessie Town, Northeast Ethiopia:[16] A Community-Based Study which revealed: Positive family history of diabetes mellitus with AOR: 20.24, 95% CI 4.74–86.43). Another study done at India on Determinants of gestational diabetes mellitus showed that family history of diabetes (P = 0.001, OR = 4.5).[17] The differences in strength and confidence interval could result from in the study design, sample size, and study area. Educational status those who attended college and above had an AOR: of 10.30 (4.16–25.50), which is ten times the odds of being overweight as compared to those who can read only is consistent with the study done on the Prevalence of Diabetes Mellitus, Prediabetes, and its Associated Factors in Dessie Town, Northeast Ethiopia,[16] which showed educational status (illiterate) (AOR: 2.35, 95% CI 1.04–5.35) the difference could be the design, sample size, and study area. This could be a result of the fact that those who attend college and above occasionally work at an office and are not liable for physical activity which leads to being overweight. Another predictor variable for the determinants of overweight was insulin usage for controlling blood glucose level: those who used insulin (AOR: 0.14 CI (0.03–0.74) for controlling blood glucose had 96% less risk of developing overweight as compared to those who used exercise/diet for controlling blood glucose, which is consistent with the study conducted in Jimma Hospital[18] on Determinants of poor glycemic control showed being on metformin plus insulin [AOR=9.22, 95% CI=2.90–29.35] and being on insulin [AOR=4.48, 95% CI=1.52–13.16], moreover this could be explained by the fact that as it is known insulin facilitates gluconeogenesis and inhibits fat synthesis. In general, the remaining literatures[19–24] did not showed that family history, educational status as well as blood glucose controlling mechanism as statistically associated independent variable in their results these could be resulted from the study design, setting, community living structure and time of the study.

Recommendations

Based on the findings of this study, specific recommendations are outlined below;

- Health education and counseling focusing on the identified determinant factors should be provided to clients with T2DM in both hospitals' DM Clinics
- Assess the determinant factors with a better determinant assessment mechanism and design
- Encourage the clients to follow fruit and vegetable-based diets rather than carbohydrate diets

Limitations

This study provides timely information on this issue using primary data from two hospitals. Both the cases and controls were from hospitals, and the findings were generalizable to hospitals. Another strength of this study is that it is better to identify multiple risk factors that affect the outcome variable than a cross-sectional study. However, this study has some limitations.

- Recall bias and inaccurate responses in variables are expected
- Therefore, measurement bias is likely to occur. However, the measurement materials
- Patients or controls who did not visit the hospital at the time of data collection were excluded from the study
- However, maximum effort was made to decrease the effect of these limitations on the validity of the findings during the pre-survey and data-collection periods

Ethical Considerations

Before beginning data collection, official letters were obtained from Samara University, College of Health Sciences Public Health Department Ethical Committee. The letter was then submitted to both the administrative office and responsible bodies to ensure smooth and effective participation of the respondent, and the objective of the study was explained. Data collectors were strictly oriented to confidentiality, and the names of the respondents were never used throughout the research All the methods were conducted following the Declaration of Helsinki and written informed consent was taken from each participant.

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Disclosure

The authors report no conflicts of interest in this work.

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