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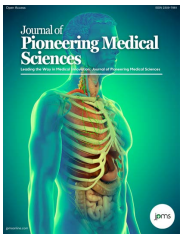

Associations Between Cardiovascular Risk, Obesity and Thyroid Dysfunction in Diabetic Population a Cross-sectional Study in Northern Border in Saudi Arabia

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Abstract **Objectives:** Saudi Arabia has the fourth highest incidence of diabetes mellitus in the world. It is important to ensure that the community has sufficient knowledge of this disease to enable further promotion of health interventions to control its prevalence. This study aims to analyze the knowledge of participants about cardiovascular risk factors, obesity and thyroid disorders in Diabetes patients. **Methods:** A survey was conducted. The data was collected through an online questionnaire and analyzed using descriptive and inferential statistics. **Results:** The study found that most participants recognized a significant relation between cardiovascular disease risk and diabetes, with statistically significant associations noted for factors such as age, city, education level, occupation and the presence of chronic diseases (p value <0.05). However, demographics like gender, nationality and marital status did not show significant relationships. Additionally, 61.8% acknowledged the link between thyroid dysfunction and obesity and a large majority (84.9%) were unaware of the relationship between thyroid disorders and diabetes mellitus. **Conclusion:** This study highlights a critical gap in knowledge regarding the interrelationships between cardiovascular risk factors, obesity and thyroid disorders among diabetes mellitus patients in Arar, Saudi Arabia. While participants demonstrated some awareness of the link between diabetes and cardiovascular diseases

Key Words Cardiovascular diseases, obesity, thyroid disorders, diabetes mellitus, awareness, Saudi Arabia, endocrine comorbidities, public health interventions

INTRODUCTION

Background

Generally, the prevalence of obesity has grown significantly worldwide and is considered a major cardiovascular risk factor among type II diabetes mellitus (DM) [1]. Cardiovascular disease (CVD) remains a leading cause of morbidity and mortality among individuals with diabetes. Evidence suggests that both obesity and thyroid dysfunction are significant risk factors for CVD, yet their interactions within diabetic populations are not well understood. Specifically, the relationships between obesity, thyroid dysfunction and cardiovascular risk factors in diabetic patients remain underexplored [2]. The two most common endocrine disorders found in clinical practice are thyroid disorders and DM. Thyroid dysfunction has become more prevalent throughout the world in recent decades [3]. It can have severe consequences if left undiagnosed or untreated and significantly impacts health outcomes, including cardiovascular and metabolic disorders, mental health and bone health [4]. One of the most common causes of primary thyroid problems is immune system damage, thyroiditis caused by radiation, hypothyroidism following surgery and antithyroid medications [5]. Hypothyroidism commonly manifests as weariness, depression, cold intolerance, hoarseness, dry skin, constipation and bradycardia. The common symptoms and signs of hypothyroidism include fatigue, depression, cold intolerance, hoarseness, dry skin, constipation, bradycardia [6]. Diabetes mellitus (DM) is a

widely prevalent disease that may affect any individual at any age [7]. Thyroid disorders are the most common endocrine diseases among diabetic patients, especially autoimmune thyroid disorders [8]. Early-onset type 2 diabetes mellitus is linked to a number of illnesses and risk factors, such as advanced age, obesity or overweight, lifestyle choices, family history, race or ethnic origin, hypertension, elevated cholesterol, malnourishment and autoimmune, genetic and environmental factors [9].

Many studies have indicated a correlation between T2DM and thyroid dysfunction and may have a reciprocal effect on one another, according to certain research [10]. It has been shown that thyroid hormone controls pancreatic function and the metabolism of carbohydrates [11]. On the other hand, diabetes can affect thyroid function in several ways. For instance, it has been demonstrated that diabetes affects the way TSH responds to thyrotropin-releasing hormone, which causes hypothyroidism and thus reduces T3 levels [12].

Research on the hepatic concentration of thyroxin and the hyperglycemia-induced reversible reduction to deiodinase activity has led to the hypothesis that reduced T3 levels in diabetes may also be due to a lower amount of conversion of T3 from T4 [13].

Rationale and Knowledge Gap

Most studies focus on obesity or thyroid dysfunction independently, without examining how these factors may interact to influence cardiovascular risk in individuals with diabetes. In addition, there is a lack of research focusing on different types of diabetes (Type 1 vs. Type 2) and their unique associations with obesity and thyroid dysfunctions. Moreover, The biological mechanisms underpinning the associations between obesity, thyroid dysfunction and cardiovascular risk in diabetes are not fully elucidated, leaving a gap in understanding how these factors contribute to disease progression.

Objective

Our study aimed analyze the knowledge of participants about prevalence of cardiovascular risk factors, obesity and thyroid disorders in Diabetes mellitus and association between them. Our study may encourage the establishment of integrated care models that simultaneously address cardiovascular risk, obesity and thyroid dysfunction in diabetic patients. This could involve multidisciplinary teams, including endocrinologists, cardiologists, dietitians and diabetes educators and help to develop standardized care pathways that ensure comprehensive assessments for patients with diabetes, incorporating evaluations for obesity and thyroid health as part of routine check-ups.

METHODS

Study Design and Participants

It was a prospective correctional study and a simple random convenient sampling method was chosen for our study. Through convenience selection, individuals with diabetes mellitus who were over the age of eighteen and resided in Saudi Arabia's Northern Border region were chosen. Accepting to finish the survey was an inclusion criterion; declining to participate was an exclusion criterion.

Ethics Approval of Research

Data protection and participant anonymity were given top priority in this investigation. To ensure anonymity, each participant was given a unique code and DE-identified patient information was used. Prior to the study's start, ethical clearance was granted by Northern Border University's decision no. 45-24-H and the College of Medicine's ethics committee (HAP-09-A-043).

Data Collection and Sample Size

A structured self-designed pre-validated questionnaire based on previous studies [3,13] was used to collect the data. The pilot study was done and not calculated in our results. The questionnaire was pre-validated and sent to the Diabetic population Arar, Saudi Arabia, in the Google form both in English and Arabic version via email and social media like WhatsApp, Twitter and Snapchat. There were three primary sections of the questionnaire: (1) Personal information: Nine questions on age, nationality, marital status, level of education, occupation, height, weight and city of residence were included in this part. (2) Parameters related to chronic diseases and risk factors affecting the participants: Participants were asked if they are obese, have chronic diseases (heart problems, hypertension, hyperlipidemia), or if they are smokers.(3) Participants knowledge regarding cardiovascular diseases and other risk factors: Participants were asked if there is a relationship between thyroid disorders and obesity, family history of thyroid, have thyroid disorders with diabetes and their knowledge about thyroid disorders symptoms, treatment and their relation with diabetes treatment. Sample size was estimated to using the Raosoft® calculator, with a 5% level of significance, 5% margin of error, 95% confidence and expected response distribution of 50% [14].

Statistical Analysis

Data was analyzed using SPSS (version 26). Testing the association was done by Chi Square test (The chi-square test is used to determine if there is a significant association between categorical variables. For example, it can help assess whether education level is related to the prevalence of obesity among diabetic patients.

Interpretation of Chi-Square Value: A higher value indicates a stronger association between the variables). Qualitative variables were represented as percentage and numbers (mean, Frequency…etc) and showing them in the figures. A 0.05 level of significance was used in all tests used in the study.

RESULTS

Table 1 displays various demographic profiles of total numbers of participants (385). Notably, the age distribution indicates a predominance of younger adults, with the majority falling within the 26-35 age range 114 (29.6%), followed by the 18-25 age group 97 (25.2%). Gender representation in the sample leans heavily towards females, who constitute 66.8% (257) of the participants, indicating potential gender dynamics that may influence the study's outcomes. Furthermore, national identity is overwhelmingly Saudi constituting 367 (95.3%) of participants, underscoring the culturally specific context of the findings. The height and weight distributions reflect a wide range of physical measurements, with the most significant clusters observed in the 151-160 cm height category 170 (44.2%) and the 61-70 kg weight category 106 (27.5%). Interestingly, the data also reveals a concerning trend regarding the employment status of participants, where nearly half (49.4%) identify as unemployed, presenting a potential area for further socio-economic analysis and interventional focus. Marital status exhibits a near balance between single constituting 153 (39.7%) and married lie around 186 (48.3%) individuals, which might correlate with social support systems and lifestyle choices. The educational level shows that a substantial majority are well-educated, with 63.6% (245) holding a bachelor's degree, indicating a highly literate population with possible implications for health literacy and engagement with health services.

Table 1: Sociodemographic characteristics of participants (n = 385)

Parameter	No.	Percent (%)
Age		
18-25	97	25.2
26-35	114	29.6
36-45	80	20.8
46-55	62	16.1
More than 55	32	8.3
Gender		
Female	257	66.8
Male	128	33.2
Nationality		
Saudi	367	95.3
Non-Saudi	18	4.7
Height (cm)		
Less than 140	5	1.3
141-150	43	11.2
151-160	170	44.2
161-170	112	29.1
More than 170	55	14.3
Weight (kg)		
Less than 40	3	.8
40-50	37	9.6
51-60	92	23.9
61-70	106	27.5
71-80	87	22.6
More than 80	60	15.6
City		
Rafha	34	8.8
Tarif	26	6.8
Arar	258	67.0
Other	67	17.4
Educational level		
Primary school	12	3.1
Middle school	20	5.2
High school	64	16.6
Bachelor's degree	245	63.6
Others	44	11.4
Occupation		
Government employee	144	37.4
Private sector employee	51	13.2
Unemployed	190	49.4
Marital status		
Single	153	39.7
Married	186	48.3
Divorced	29	7.5
Widowed	17	4.4

As shown in Figure 1, The data indicates that a significant proportion of participants, numbering (262,68.1%), have As shown in Figure 1, notably, the majority of respondents, 336 individuals, reported not suffering from diabetes, which underscores a significant segment of the population potentially at lower risk for associated complications. Conversely, those identifying as having diabetes comprised 49 individuals collectively, with 27 (7.0%) diagnosed with Type 1 diabetes and 22 (5.7%) with Type 2 diabetes. This distribution indicates a relatively low incidence of diabetes within the study group, allowing for a nuanced exploration of the relationships between cardiovascular risk factors, levels of obesity and thyroid dysfunction among the diabetic subset.

The data presented in Table 2 provides a comprehensive overview of various chronic diseases and risk factors affecting a sample of 385 participants. A significant portion of the cohort, specifically 261 (67.8%), reported not suffering from any chronic diseases.

Figure 2 provides compelling statistical insights into the perceived relationship between thyroid disorders and obesity within the studied population. According to the data, a significant majority of respondents, 238 (61.8%) participants,

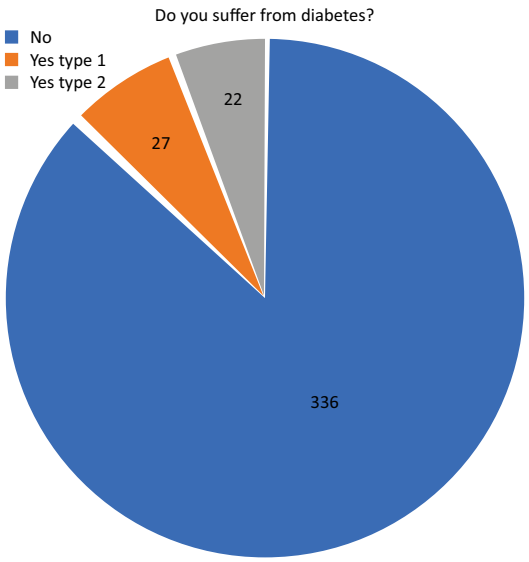

Figure 1: Illustrates whether participants suffer from diabetes mellitus

Table 2: Parameters related to chronic diseases and risk factors affecting the participants (n = 385)

Parameter	No.	Percent (%)
Do you suffer from any chronic disease?		
No	261	67.8
Yes	124	32.2
If yes, what is the disease? * (n = 124)		
Hyperlipidemia	6	4.8
High blood pressure	34	27.4
Diabetes	49	39.5
Thyroid cancer	1	0.8
Iron deficiency anemia	20	16.1
Metabolic syndrome	2	1.6
Vitamin B12 deficiency	25	20.2
Did you think you were overweight or obese?		
No	207	53.8
Yes	178	46.2
Do you suffer from diabetes?		
No	336	87.3
Yes Type 1	27	7.0
Yes Type 2	22	5.7
Do you think there is a relationship between cardiovascular risk factors and diabetes?		
No	173	44.9
Yes	212	55.1
Do you think there is a relationship between obesity and diabetes?		
No	130	33.8
Yes	255	66.2
Do you have any heart problems with diabetes?		
No	342	88.8
Yes	43	11.2
Is there a family history of any heart problem?		
No	278	72.2
Yes	107	27.8
Are you a smoker?		
No	329	85.5
Yes	56	14.5
Are you an ex-smoker?		
No	327	84.9
Yes	58	15.1
Do you suffer from high blood pressure?		
No	322	83.6
Yes	63	16.4
Do you currently take any drugs to treat high blood pressure?		
No	342	88.8
Yes	43	11.2
Do you suffer from hyperlipidaemia?		
No	351	91.2
Yes	34	8.8

*Results may overlap

affirmatively associate thyroid dysfunction with obesity, whereas 147 (38.2%) respondents disagree with this correlation.

Table 3 reveals an understanding of participants' perceptions regarding the interrelation between cardiovascular diseases, thyroid disorders and various risk factors, highlighting a complex interplay between these medical conditions. Notably, a significant majority, 238 (61.8%), acknowledged a relationship between thyroid disorders and obesity, suggesting an awareness of the potential metabolic implications of thyroid dysfunction.

Table 4 shows that the belief that there is a relationship between cardiovascular risk factors and diabetes has statistically significant relation to age (p-value = 0.002), city (p-value = 0.001), education level (p-value = 0.013), occupation (p-value = 0.015) and if participants suffer from chronic diseases (p value=0.033). It also shows statistically insignificant relation to gender, nationality, height, weight and marital status.

Table 5 shows that the relationship between obesity and diabetes has statistically significant relation to gender (p-value = 0.0001), age (p-value = 0.023), city (p-value = 0.0001), marital status (p-value = 0.047) and if the participants suffer from any chronic diseases (p-value = 0.041). It also shows statistically insignificant relation to nationality, height, education level, occupation and if the participants suffer from any other chronic diseases.

Table 3: Participants' knowledge regarding relations between cardiovascular diseases and other risk factors (n = 385)

Parameter	No.	Percent (%)
Do you think there is a relationship between thyroid disorders and obesity?		
No	147	38.2
Yes	238	61.8
Do you have thyroid disorders with diabetes?		
No	327	84.9
Yes	58	15.1
Is there a family history of thyroid dysfunction?		
No	268	69.6
Yes	117	30.4
Is sudden weight gain a symptom of thyroid disorders?		
No	315	81.8
Yes	70	18.2
Are you suffering from fatigue and drowsiness?		
No	209	54.3
Yes	176	45.7
Do you suffer from dry skin and hair?		
No	220	57.1
Yes	165	42.9
Is thyroid disorder related to iodine deficiency?		
No	225	58.4
Yes	160	41.6
Are you taking any medication for thyroid disorders?		
No	334	86.8
Yes	51	13.2
Were you aware that edema, lethargy, pallor and weight gain are common indicators or symptoms of both thyroid illness and diabetes?		
No	218	56.6
Yes	167	43.4
Did you know that, if left untreated, thyroid issues can have major effects on both the mother and the fetus?		
No	206	53.5
Yes	179	46.5
Did you know that following surgery or while taking specific drugs might cause thyroid disorders?		
No	229	59.5
Yes	156	40.5
Did you know that diabetes can affect thyroid hormone and thyroid can prevent early complications of diabetes?		
No	223	57.9
Yes	162	42.1
Did you know that there is an increased incidence of thyroid cancer among women with diabetes?		
No	245	63.6
Yes	140	36.4
Did you know that diabetes treatment can affect thyroid function?		
No	223	57.9
Yes	162	42.1
Did you know that hypothyroid patients with diabetes, the effectiveness of thyroid hormone therapy may be affected?		
No	228	59.2
Yes	157	40.8
Were you aware that drugs used to treat diabetes, hypothyroidism and other comorbidities can affect blood sugar regulation or thyroid function in individuals with type 2 diabetes and hypothyroidism?		
No	235	61.0
Yes	150	39.0
Did you know that unrecognized hypothyroidism can lead to poor blood sugar control and high blood sugar?		
No	239	62.1
Yes	146	37.9
Do you do any activities?		
No	179	46.5
Yes	206	53.5
Are you on any diet?		
No	238	61.8
Yes	147	38.2

DISCUSSION

Cardiovascular diseases (CVDs) are the leading cause of illness and death among people with diabetes [15]. The likelihood of developing CVDs is two to four times greater in those diagnosed with diabetes compared to the general population [16]. A lack of understanding regarding the risk of CVDs in diabetes can hinder early detection and prevention efforts [17]. Therefore, it is crucial for diabetes patients to

Table 4: Relation between the belief that cardiovascular risk factors and diabetes are related and sociodemographic characteristics

Parameters	Do you think there is a relationship between cardiovascular risk factors and diabetes? No	Yes	Total (N = 385)	p-value*
Gender				
Female	109	148	257	0.159
	63.0%	69.8%	66.8%	
Male	64	64	128	
	37.0%	30.2%	33.2%	
Age				
18-25	42	55	97	0.002
	24.3%	25.9%	25.2%	
26-35	42	72	114	
	24.3%	34.0%	29.6%	
36-45	36	44	80	
	20.8%	20.8%	20.8%	
46-55	28	34	62	
	16.2%	16.0%	16.1%	
More than 55	25	7	32	
	14.5%	3.3%	8.3%	
Nationality				
Saudi	163	204	367	0.354
	94.2%	96.2%	95.3%	
Non-Saudi	10	8	18	
	5.8%	3.8%	4.7%	
Height				
Less than 140	3	2	5	0.289
	1.7%	0.9%	1.3%	
141-150	17	26	43	
	9.8%	12.3%	11.2%	
151-160	77	93	170	
	44.5%	43.9%	44.2%	
161-170	57	55	112	
	32.9%	25.9%	29.1%	
More than 170	19	36	55	
	11.0%	17.0%	14.3%	
Weight				
Less than 40	2	1	3	0.591
	1.2%	0.5%	0.8%	
40-50	17	20	37	
	9.8%	9.4%	9.6%	
51-60	42	50	92	
	24.3%	23.6%	23.9%	
61-70	48	58	106	
	27.7%	27.4%	27.5%	
71-80	43	44	87	
	24.9%	20.8%	22.6%	
More than 80	21	39	60	
	12.1%	18.4%	15.6%	
City				
Rafha	21	13	34	0.001
	12.1%	6.1%	8.8%	
Tarif	19	7	26	
	11.0%	3.3%	6.8%	
Arar	110	148	258	
	63.6%	69.8%	67.0%	
Other	23	44	67	
	13.3%	20.8%	17.4%	
Education level				
Primary	10	2	12	0.013
	5.8%	0.9%	3.1%	
Middle	9	11	20	
	5.2%	5.2%	5.2%	
Secondary	29	35	64	
	16.8%	16.5%	16.6%	
Bachelor's	99	146	245	
	57.2%	68.9%	63.6%	
Others	26	18	44	
	15.0%	8.5%	11.4%	
Occupation				
Government employee	52	92	144	0.015
	30.1%	43.4%	37.4%	
Private sector employee	29	22	51	
	16.8%	10.4%	13.2%	
Unemployed	92	98	190	
	53.2%	46.2%	49.4%	
Marital status				
Single	66	87	153	0.548
	38.2%	41.0%	39.7%	
Married	82	104	186	
	47.4%	49.1%	48.3%	
Divorced	15	14	29	
	8.7%	6.6%	7.5%	
Widowed	10	7	17	
	5.8%	3.3%	4.4%	
Do you suffer from any chronic disease?				
No	127	134	261	0.033
	73.4%	63.2%	67.8%	
Yes	46	78	124	
	26.6%	36.8%	32.2%	

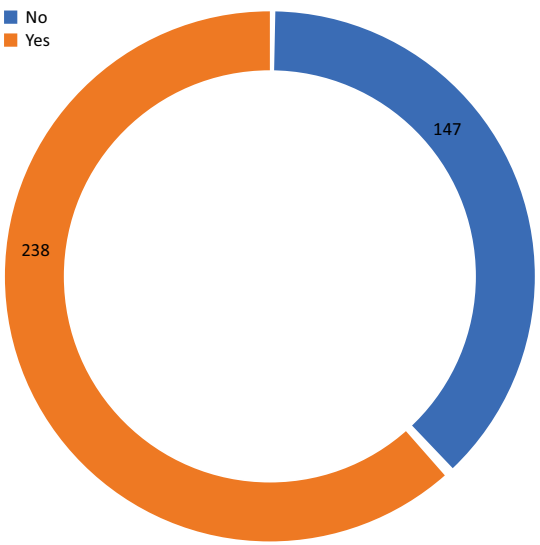

Figure 2: Illustrates if there is a relationship between thyroid diseases and obesity

possess an adequate knowledge about CVD risk factors [18]. Additionally, the rise of obesity in developing countries poses a significant global health challenge. The World Health Organization (WHO) now categorizes both obesity and

Table 5: Belief that obesity and diabetes are related in association with sociodemographic characteristics

Parameters	Do you think there is a relationship between obesity and diabetes? No	Yes	Total (N = 385)	p-value*
Gender				
Female	71	186	257	0.0001
	54.6%	72.9%	66.8%	
Male	59	69	128	
	45.4%	27.1%	33.2%	
Age				
18-25	30	67	97	0.023
	23.1%	26.3%	25.2%	
26-35	34	80	114	
	26.2%	31.4%	29.6%	
36-45	24	56	80	
	18.5%	22.0%	20.8%	
46-55	23	39	62	
	17.7%	15.3%	16.1%	
More than 55	19	13	32	
	14.6%	5.1%	8.3%	
Nationality				
Saudi	122	245	367	0.327
	93.8%	96.1%	95.3%	
Non-Saudi	8	10	18	
	6.2%	3.9%	4.7%	
Height				
Less than 140	2	3	5	0.348
	1.5%	1.2%	1.3%	
141-150	13	30	43	
	10.0%	11.8%	11.2%	
151-160	50	120	170	
	38.5%	47.1%	44.2%	
161-170	46	66	112	
	35.4%	25.9%	29.1%	
More than 170	19	36	55	
	14.6%	14.1%	14.3%	
Weight				
Less than 40	0	3	3	N/A
	0.0%	1.2%	0.8%	
40-50	11	26	37	
	8.5%	10.2%	9.6%	
51-60	35	57	92	
	26.9%	22.4%	23.9%	
61-70	42	64	106	
	32.3%	25.1%	27.5%	
71-80	31	56	87	
	23.8%	22.0%	22.6%	
More than 80	11	49	60	
	8.5%	19.2%	15.6%	
City				
Rafha	20	14	34	0.0001
	15.4%	5.5%	8.8%	
Tarif	16	10	26	
	12.3%	3.9%	6.8%	
Arar	78	180	258	
	60.0%	70.6%	67.0%	
Other	16	51	67	
	12.3%	20.0%	17.4%	
Education level				
Primary	6	6	12	0.284
	4.6%	2.4%	3.1%	
Middle	8	12	20	
	6.2%	4.7%	5.2%	
Secondary	23	41	64	
	17.7%	16.1%	16.6%	
Bachelor's	74	171	245	
	56.9%	67.1%	63.6%	
Others	19	25	44	
	14.6%	9.8%	11.4%	
Occupation				
Government employee	41	103	144	0.228
	31.5%	40.4%	37.4%	
Private sector employee	18	33	51	
	13.8%	12.9%	13.2%	
Unemployed	71	119	190	
	54.6%	46.7%	49.4%	
Marital status				
Single	56	97	153	0.047
	43.1%	38.0%	39.7%	
Married	52	134	186	
	40.0%	52.5%	48.3%	
Divorced	15	14	29	
	11.5%	5.5%	7.5%	
Widowed	7	10	17	
	5.4%	3.9%	4.4%	
Do you suffer from any chronic disease?				
No	97	164	261	0.041
	74.6%	64.3%	67.8%	
Yes	33	91	124	
	25.4%	35.7%	32.2%	

*p-value was considered significant if ≤0.05

diabetes mellitus (DM) as epidemics due to their increasing rates of incidence and prevalence [19]. Those with obesity face a heightened risk of various health conditions, including type 2 diabetes (T2D). Research has indicated that while some individuals acknowledge that thyroid disorders can lead to weight gain, there is often a lack of awareness regarding how obesity may also impact thyroid function. Thus, the results of our study may help to assess the knowledge of the general population about cardiovascular risk factors, obesity and thyroid dysfunction in diabetic patients and help to create awareness about them.

Regarding the participants' knowledge about cardiovascular risk factors, most participants believe that there is a strong relation between CVD risk and diabetes. Additionally, the relationship between cardiovascular risk factors and diabetes has shown statistically significant relation in the present study to age (p-value = 0.002), city (p-value = 0.001), education level (p-value = 0.013), occupation (p-value = 0.015) and whether participants suffer from any other chronic diseases (p-value = 0.033). It also showed statistically insignificant relation to gender, nationality, height, weight and marital status. On the other hand, a study carried out in India in 2014 indicated that merely 44% of respondents acknowledged heart disease as a potential complication associated with diabetes. In addition, research

from Ghana [20] showed that 80% of participants were unaware of the risks of heart disease related to diabetes. However, other studies have reported that knowledge about cardiovascular disease (CVD) risks was notably high (≥50%) among certain populations. Another Indian study [21] revealed that 89% of diabetes patients were aware of macro-vascular complications, creating a contrast with the earliest mentioned study from India [22]. These conflicting results may stem from significant differences in sample size, study population and research design. A 2018 study in Makkah, Saudi Arabia [23], found that while there was a general awareness of diabetic complications at 80%, specific knowledge regarding heart disease risk in diabetes was only 40.1%. However, the participants in our study revealed a relatively low recognition of the coexistence of thyroid disorders with diabetes, as reflected by the 327 (84.9%) who reported not having such comorbidities. This may point to a gap in education concerning the interconnected nature of endocrine disorders. Furthermore, the presence of a family history of thyroid dysfunction in the present study was noted in (117) 30.4% of participants, indicating a potential genetic predisposition that warrants further investigation. The responses regarding symptomatic awareness in our study revealed that a large proportion, 315 (81.8%), do not associate sudden weight gain with thyroid issues, indicating a critical area for public health education. Symptoms such as fatigue and skin changes were acknowledged by 176 (45.7%) and 165 (42.9%), respectively in this present study, which suggests that participants may recognize some implications of thyroid disorders but lack comprehensive knowledge. Additionally, it is concerning that the knowledge about the serious implications of untreated thyroid disorders on maternal and fetal health was not fully recognized, with about 206 (53.5%) unaware of these risks.

Furthermore, research in Pakistan [24] also indicated lower levels of awareness concerning CVD risks, with figures between 50% and 60%. In Nigeria [25], another study showed high general awareness of diabetic complications at 90.5%, yet specific knowledge of cardiac complications was only 61.9%. These findings align with a study conducted in Turkey, where approximately 62.81% of the population knew about CVD risks [26]. A more recent study from Ethiopia in 2019 reported that 63.2% of participants had awareness of heart complications related to diabetes. According to our data, a significant majority of respondents, totaling 238 (61.8%) participants, affirmatively associate thyroid dysfunction with obesity, whereas 147 (38.2%) respondents disagree with this correlation. This disparity in responses underscores an intriguing aspect of clinical perception and knowledge surrounding endocrinological and metabolic interrelations, suggesting that a considerable portion of the population acknowledges the potential impact of thyroid health on weight modulation.

As regarding the participants' knowledge of thyroid dysfunction in relation to both diabetes and obesity, a significant majority (61.8%) recognized a connection between thyroid disorders and obesity, demonstrating some understanding of thyroid dysfunction's metabolic effects. However, there was a notable lack of awareness about the relationship between thyroid disorders and diabetes, with 84.9% reporting no knowledge of such coexistence. This contrasts with prior literature [27,28] that highlights the complex interactions between thyroid function and obesity, where even minor changes in thyroid hormone levels can significantly influence body weight. Moreover, the analysis of weight management post-thyroid treatment suggests a need for further exploration of these metabolic relationships, particularly regarding their implications for diabetes [29]. In our study, the 32.2% (124) who do have chronic conditions reveal important insights into prevalent health issues; diabetes and high blood pressure emerge as the most common, affecting 39.9% (49) and 27.4% (34) of those with reported chronic diseases, respectively. Interestingly, among participants with diabetes in the present study, the majority did not perceive a correlation between cardiovascular risk factors and diabetes, highlighting a potential gap in understanding that could have implications for health education and preventive measures. Additionally, the high percentage of respondents (66.2%) (255) acknowledging a link between obesity and diabetes accentuates the pressing need for awareness and intervention strategies aimed at addressing weight management within this demographic. The relatively low rate of smoking (14.5% current smokers) (56) and high reporting of not suffering from hyperlipidemia (91.2%) in our study further suggest that these participants may engage in health-conscious behaviors, yet the presence of high blood pressure (63) (16.4%) and its treatment adherence (43) (11.2% taking medications) raises concerns about the management of cardiovascular health. The discovery that 107 (27.8%) have a family history of heart problems could indicate a genetic predisposition that necessitates ongoing monitoring and potential lifestyle adjustments.

Regarding the relation between obesity and diabetes, 66.2% of the studied participants linked obesity to diabetes. In a comparative analysis of our findings with previous research, we found that our results were higher than the 29% co-occurrence of obesity among diabetic individuals reported in the Saudi study [30]. While the latter indicated a high awareness of obesity and diabetes, with 94.8% recognizing obesity as a disease, the absence of understanding regarding effective weight management practices was evident. This disparity highlights a gap in practical knowledge despite awareness, emphasizing the need for educational initiatives focused on the preventative measures and management strategies that can mitigate the risks associated with obesity and diabetes. We recommended integrated care approach to address cardiovascular health, obesity and thyroid dysfunction simultaneously. This could involve multidisciplinary teams including endocrinologists,

cardiologists, dietitians and diabetes educators. Creating personalized management plans that may consider individual patient factors such as education level, lifestyle and comorbid conditions. Tailoring interventions can improve adherence and outcomes. Implementing routine screening for thyroid dysfunction and cardiovascular risk factors in diabetic patients. Early identification can facilitate timely interventions to prevent complications. Health Literacy Initiatives: Launching programs aimed at improving health literacy among diabetic patients. Education focused on understanding the interconnections between obesity, thyroid health and cardiovascular risks. Workshops and Support Groups: Organizing workshops that focus on lifestyle modifications, stress management and coping strategies. Support groups fostering community engagement and provide shared learning experiences. Awareness of Risk Factors: Conducting campaigns to raise awareness about the links between diabetes, obesity, thyroid dysfunction and cardiovascular risk. Utilizing various media platforms (social media, television, radio) to reach diverse audiences.

CONCLUSIONS

In conclusion, this study underscores a critical gap in knowledge regarding the interrelationships between cardiovascular risk factors, obesity and thyroid disorders among patients with diabetes in Northern Border region of Saudi Arabia. While participants demonstrated some awareness of the links between diabetes and cardiovascular diseases, awareness of the connections between thyroid dysfunction and both diabetes and obesity remains alarmingly low. With 84.9% of respondents unaware of the coexistence of diabetes and thyroid disorders, targeted educational interventions are essential to improve understanding and promote the prevention and management of these prevalent conditions. Increasing participants' awareness of the metabolic implications of thyroid dysfunction, alongside emphasizing the importance of weight management, could significantly enhance health outcomes for the diabetic population, ultimately reducing the burden of associated cardiovascular risks. It highlights the need for further research with improved methodologies to better delineate the complex relationships among cardiovascular risk, obesity and thyroid dysfunction in diabetic populations.

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