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Obesity, Hypertension, and Type-2 Diabetes Mellitus: The Interrelationships and the Determinants among Adults in Gaza City, Palestine

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ABSTRACT

Objectives: To describe the distribution of social factors, lifestyle habits and anthropometric measurements according to hypertension and Type-2 diabetes.
Methods: A cross-sectional study was conducted in Gaza City, Palestine that included 379 patients (20-60 years) who had hypertension and/or diabetes. Three groups of patients were involved; 106 hypertensive (HT), 109 diabetic (T2DM) and 164 hypertensive diabetics (HT + T2DM).
Results: The HT + T2DM group were older and had a higher body mass index compared to HT and T2DM groups. There were 62.3% patients who were female, 49.2% were highly educated HT patients, and 49.3% patients had a low level of education and were HT + T2DM. There were 55.8% patients who lived in large families. Patients who were passive smokers or never smoked before were mostly HT + T2DM, while active smokers and past smokers had T2DM. There were 48.2% patients who were highly physically active who had HT, 40.9% whom were moderately active had T2DM, and 53.8% of patients who had a low level of activity were HT + T2DM. Multivariate linear regression showed that having a diseased mother, living in a large family, being a past or passive smoker, or never having smoked, having a low or moderate level of activity, and having HT or HT + T2DM, were significantly associated with an increased body mass index.
Conclusion: Parental health/disease conditions and environmental factors (social network and lifestyle habits) played the greatest role in the development of obesity and disease.

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Introduction

In the last 3 decades, no country has significantly decreased the rates of overweight and obese people in the population [1]. In the past, excessive consumption of calories was associated with developed countries, but this is now a worldwide problem with a health burden emerging in developing countries [2]. According to the World Health Organization (WHO) 2014 report, there were 1.9 billion overweight adults in the world, and over 600 million were obese [3]. Obesity has well-known associations with all-cause mortality [4], morbidity [5], and disability, resulting in unhealthy life-years with poor quality of life [6], and increased healthcare costs [7]. A Prospective Studies Collaboration report, presented data from 900,000 participants and 57 prospective studies, and found that obesity was associated with an increased mortality of vascular diseases, diabetes, renal, hepatic, respiratory diseases and cancer [8]. Obesity has also been linked to higher rates of cardiovascular diseases (CVDs), hypertension, osteoarthritis, gallbladder disease and certain psychological disorders such as

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depression [9].

Obesity and its consequences like CVDs, metabolic syndrome, hypertension and diabetes have been strongly linked to environmental factors including social factors, and lifestyle habits such as excessive calorific intake, smoking and physical inactivity [10]. In addition to causing illness, obesity reduces functional capacity (described as “disability”), which is defined as impaired activities of daily living and/or functional impairment [11]. Furthermore, the prevalence of obesity and its consequences have increased in the last decade irrespective of socio-economic status, income and education levels [12]. In the USA, obesity and associated non-communicable diseases (NCDs) have a major impact on economic and social states; about 120 billion USD was the estimated cost, with two thirds accounting for the cost of treatment plans and one third for the cost of disability [13]. The rates of obesity have tripled in the last 20 years in the developing world, where the Middle East and Asia-Pacific regions are facing the greatest challenges [14]. Dramatic increases in the prevalence of obesity raises serious concerns about a future characterized by increasing rates of diabetes and other obesity-associated disorders around the globe [15].

It was reported that in Palestine, the prevalence of overweight adults in the total study population was 62.4%, and 24.4% were obese; CVDs were higher among obese adults at this time [16]. In addition, the rates of NCDs in urban and rural areas are progressively increasing amongst Palestinian adults in the Gaza Strip [17]. Irrespective of social factors and lifestyle habits conditions such as insulin resistance, hypertension and metabolic syndrome are escalating in the Gaza Strip [18]. However, a comprehensive study of the associations of NCDs like hypertension and Type-2 diabetes mellitus (T2DM), with obesity, social factors and lifestyle habits needs more attention [19]. Due to increased challenges to health in the Palestinian population, national health plans have recognized the need to tackle the existence of obesity-related diabetes and CVDs [16]. This study aimed to describe the distribution of social factors, lifestyle habits and anthropometric measurements according to hypertension and T2DM amongst adults in Gaza City, Palestine, to predict the factors associated with a higher body mass index (BMI).

Materials and Methods

1. Geography and demography of Palestinian Territories

The total area of the Palestinian Territories is 6,165 km^2 that is divided into the West Bank, a 5,800 km^2 area located along the northwest border of Jordan, and Gaza, a 365 km^2 strip of land on the Mediterranean coast, northeast of Egypt [20]. According to the Palestinian Central Bureau of Statistics [21], the total population of Palestinian Territories was 4,550,368 individuals; the natural increase of population in Palestine was 2.9%, in the West Bank 2.59% and in the Gaza Strip 3.41%. The Ministry of Health (MOH) estimated the gender distribution was 49.2% females and 50.8% male in the year ending 2013 [22].

2. Primary healthcare service

At the end of 2013, there were 5 main health service providers in the Gaza Strip: (MOH), United Nations Relief and Works Agency, non-governmental organizations, Palestinian Military Medical Services, and private for-profit bodies. MOH bears the heaviest burden as it holds the main responsibility with 54 primary healthcare centers. The United Nations Relief and Works Agency operates 20 primary healthcare centers distributed across 8 refugee camps. The non-governmental organizations operate 66 primary healthcare centers and general clinics, while the Palestinian Medical Military Services operates 7 primary healthcare centers and clinics [22].

3. Study design, setting and population

A cross-sectional design was used to find associations between social factors, lifestyle habits, anthropometric measurements, and health status as shown in the Conceptual Framework (Figure 1). Health status includes hypertension (HT) and/or T2DM. Data were collected over 7 months, from November 2013 to May 2014. The patients were recruited from 7 Primary Healthcare centers under MOH in 3 regions of Gaza City (East: 1 center, Middle: 4 centers and West: 2 centers). The selection of primary healthcare centers was a simple random approach.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. The study was ethically approved by the Helsinki Committee for Ethical Approval of Gaza (No.: PHRC/HC/11/13).

4. Sample size calculation

The sample size required for the study was calculated by Epi-Info™ (version 7.0.8.3; 2011). It depended on a confidence interval of 95% and a power of 80%. Based on a study that took place in the Palestinian Territories by Abdeen et al [16], the prevalence of obese adults in the total population was 24.4% and the prevalence of normal weight adults was 36.1%. The ratio for control to case was 1.0, risk ratio was 0.6759, and the odds ratio was 0.5713. Based on the previous data of sample size calculation, the sample size required for this study was 484 patients. From the 504 patients in this study, 20 patients were excluded during the pilot phase, and 105 subjects were excluded due to ineligibility. The final sample consisted of 379 patients with HT and/or T2DM who were selected by location stratification from 3 regions in Gaza City, which subdivided into 7 primary healthcare centers.

5. Data collection and study instruments

A structured questionnaire was used to collect data through interview sessions. Four public health nutrition experts in Palestine and Malaysia approved the validity of the questionnaire parts. In order to check the psychometric properties, the designed valid questionnaire was pre-tested and verified for reliability in primary healthcare centres of MOH, Gaza City. The questionnaire was translated into Arabic from the original English version (forward and backward translations were performed by English and Arabic, mother tongue speakers). The time needed for completing the questionnaire for each case was about 30 minutes including the introduction, explanation of the study objective and writing the informed consent form. The questionnaire collected social information data: age, gender, marital status (married, and unmarried: single, divorced and widowed), family size (small: ≤ 5 members, medium: 6-9 members, and large: ≥ 10 members), and level of education (low: secondary school or less, moderate: diploma or 2 years after secondary school, and high: bachelor degree and above). The second section of the questionnaire involved self-reported information about the patient's NCDs history (diseased by HT, T2DM, or HT + T2DM) and parent's medical history that usually related to NCDs of metabolic disorders like CVDs, HT, and DM. HT and T2DM are widely distributed in Palestine and are strongly linked to being overweight and having diabetes [16-19].

The third section of the questionnaire provided the information about lifestyle habits. Smoking habits grouped patients into active smokers, past smokers, passive smokers, and patients who had never smoked according to CDC, Behavioral Risk Factor Surveillance System Survey Questionnaire [23]. Active smokers included all smokers, irrespective of the number of cigarettes they smoked daily or the duration of their smoking habit. A "past smoker" was defined as a person who had stopped smoking over 1 year ago or had more than 100 cigarettes in the past. A "passive smoker" was a person who was closely in contact with smokers for more than 1 hour weekly. Meanwhile, a "never smoker" was a person who had never smoked. In addition, an adopted version-2 of Global Physical Activity Questionnaire (GPAQ) was used to determine physical activity patterns. The GPAQ was developed and approved by the WHO in 2002 as a surveillance tool for physical activity [24]. Physical activity was grouped into 3 levels; high, moderate, and low physically active patients.

Anthropometric measurements included BMI and waist circumference (WC). Standard techniques were adopted to obtain anthropometric measurements. The BMI was calculated using height and weight based on the BMI formula [BMI (kg/m^2) = Weight (kg) / Height squared (m^2)] [25]. A Seca Stadiometer was used by trained field staff to measure both weight and height according to the WHO standardized protocols, patients weighed in light cloths to the nearest 0.1 kg, while the height measured after instruction of participants to stand barefooted with their heads in an upright position, and the reading will be taken to the nearest 0.1cm. Seca 201 non-elastic tape was used to assess WC to the nearest 1.0 cm at the top of the iliac crest according to the protocol of National Institutes of Health [26].

6. Quality control

Quality control was performed to check the validity and reliability of the main questionnaire and data collection method. The composed questionnaire was carried out on 20 participants as a pilot study to enable the researcher to examine the tools of the study in terms of acceptability, applicability and time frame. The data collection process was modified according to the results of the pilot study. All main parts of the questionnaire are valid as they were adopted from previous data [16,17,23-25]. To assess the reliability of the questionnaire, the participants of the study were asked to comment on the appropriateness and clarity of the questionnaire. After the pilot study and collection of participants' feedback on the questionnaire, changes were made. The revised questionnaire was verified and reviewed by experts to reconfirm the acceptability and suitability of the instruments used to achieve the objectives. The final form of the revised questionnaire was used in the data collection process.

7. Outcomes

The outcomes of interest were the associations and the distribution of selected social factors, lifestyle habits and anthropometric measurements according to health status of HT and/or T2DM. In addition, the outcomes of this study aimed to predict the factors associated with higher BMI (kg/m^2) as the main indicator of total obesity. The interrelationships between the variables are explained in the Conceptual Framework (Figure 1).

8. Statistical analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0 software (IBM Corp., Armonk, NY,

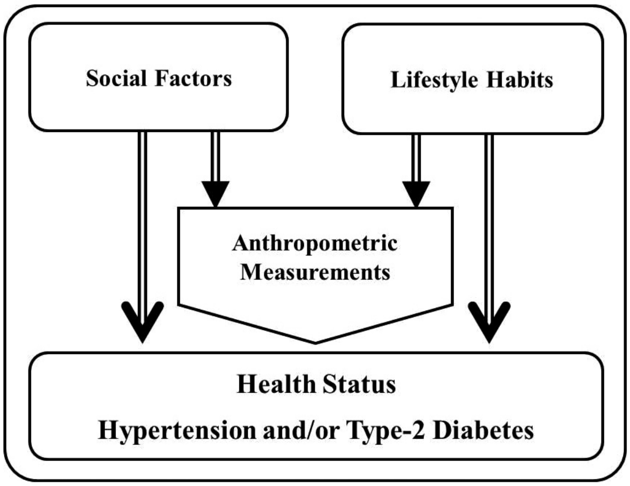

Figure 1 Conceptual framework of the study.

USA). Chi-square test (χ^2) compared the categorical variables of social factors and lifestyle habits with health status (HT, T2DM and HT + T2DM). Univariate analysis of One-Way ANOVA test (F) was used to detect the differences on the continuous variables of age, BMI and WC according to changed health status. Continuous variables were presented as mean ± SD. Multiple Linear Regression model analysis was performed to detect the predictors of increased BMI and to control confounding social factors, lifestyle habits and health status (the dependent variable being BMI). Dummy variables were created for categorical variables with more than 2 levels, and the least influencing level was excluded from the model. A $p \leq 0.05$ was considered statistically significant and the level of confidence was 95% when the power was equal to 80%.

Results

A total of 379 patients with HT and/or T2DM were selected from 7 primary healthcare centers in 3 regions of Gaza City. As detailed in Table 1, the distribution of patients indicated that 106 (28.0%) were HT patients, 109 (28.8%) were T2DM, and 164 (43.2%) were HT + 2DM. The mean age for all patients was 51.35 ± 8.06 years. Although there was no difference between the HT and T2DM groups, the mean age of the HT + T2DM group was higher than the HT and T2DM groups (53.70 ± 5.9 vs. 49.26 ± 8.5 years, $p < 0.001$; 53.70 ± 5.9 vs. 49.86 ± 9.3 years, $p = 0.001$; respectively). Female patients account for 62.3% of the total population; 50.0% of them had HT + T2DM, while male patients was balanced distrusted for all health groups. From the total population, 84.4% were married, whilst the rest were unmarried patients (single, divorced and widowed). Unmarried patients had higher percentages of HT + T2DM (52.5%) compared to married patients (41.6%), while married patients had higher percentages of HT compared to unmarried patients (30.6% vs. 13.6%). Meanwhile, 280 (73.8%) patients were lowly educated according to Palestinian classification, 34 (9.0%) were moderate and 65 (17.2%) were highly educated. The distribution of patients revealed that highly educated patients had a higher percentage of HT (49.2%) and lowly educated patients had a higher percentage of HT + T2DM (49.3%). Furthermore, 109 (28.8%) patients lived in small families, 184 (48.5%) lived in medium families, and 86 (22.7%) lived in large families. There were 55.8% of patients that lived in large families and 42.2% of patients who lived in small families that were affected by HT + T2DM.

Moreover, 163 (43.0%) patients indicated that their father was affected with 1 or more NCDs and 250 (66.0%) of them indicated that their mother was affected with 1 or more NCDs; patients whose father was affected with NCDs had a higher percentage of HT + T2DM (51.0%), while no difference was obtained based on the changed health status of the mother.

The distribution of smoking habits showed there were 57 (15.0%) active smokers, 44 (11.6%) past smokers, 111 (29.3%) passive smokers, and 167 (44.1%) who had never smoked. As detailed in Table 1, there was no difference in the distribution of health status in active smokers. In past smokers, there was a higher proportion of patients with T2DM (43.2%), than HT (29.5%), or HT + T2DM (27.3%). In those patients that had never smoked, 45.5% had HT + T2DM, compared with 26.3% with HT, and 28.2% with T2DM. The distribution of patients with HT, T2DM, and HT + T2DM according to physical activity, and anthropometric measurements are presented in Table 1.

A significant difference in BMI was observed between patients with T2DM (32.01 ± 6.57 kg/m^2) and HT + T2DM (35.44 ± 6.38 kg/m^2, $p < 0.001$). There was also a significant difference observed in WC between patients with T2DM and those with HT + T2DM (109.72±13.96 vs. 117.47±12.29 cm, $p = 0.001$).

In order to predict the factors that are associated with higher BMI (kg/m^2) from social factors, lifestyle habits and health status, a model of multiple linear regression analysis was used after excluding the least effective dummy variables (Table 2). The overall model was significant (F = 8.244, $p < 0.001$) and the adjusted R^2 was 22.3%. After checking multi-colinearity, the model did not have dubious variables among the inserted independent variables that may have confounding effects. Results from model analysis showed significant positive relationships between independent variables and BMI (given the same age). Patients who live in large families have on average 1.53 (95% CI: 1.006-3.054) higher BMI values than patients who live in medium or small families. Also, patients whose mothers had a history of 1 or more NCDs have 1.72 (95% CI: 1.418-3.028) higher BMI compared to patients whose mothers had no history of NCDs. Regarding smoking

Table 1. Distribution of selected social factors, lifestyle habits and anthropometric measurements according to HT and/or T2DM.

Variables (N = 379)		Health status HT	T2DM	HT + T2DM	Test value	p
Socio-demographic factors						
Age (y)		49.26 ± 8.5	49.86 ± 9.3	53.70 ± 5.9	F = 13.126	< 0.001*
Gender	Male	46 (32.2)	51 (35.6)	46 (32.2)	x^2 = 11.78	0.003*
	Female	60 (25.4)	58 (24.6)	118 (50.0)		
Marital status	Married	98 (30.6)	89 (27.8)	133 (41.6)	x^2 = 7.217	0.027*
	Unmarried	8 (13.6)	20 (33.9)	31 (52.5)		
Level of education	Low	63 (22.5)	79 (28.2)	138 (49.3)	x^2 = 23.69	< 0.001*
	Moderate	11 (32.4)	12 (35.2)	11 (32.4)		
	High	32 (49.2)	18 (27.7)	15 (23.1)		
Family size	Small	27 (24.8)	36 (33.0)	46 (42.2)	x^2 = 10.12	0.037*
	Medium	62 (33.7)	52 (28.3)	70 (38.0)		
	Large	17 (19.8)	21 (24.4)	48 (55.8)		
Parent's history of NCDs						
Father had ≥ 1 NCDs	Yes	53 (32.5)	56 (34.4)	54 (33.1)	x^2 = 12.02	0.002*
	No	53 (24.5)	53 (24.5)	110 (51.0)		
Mother had ≥ 1 NCDs	Yes	75 (30.0)	67 (26.8)	108 (43.2)	x^2 = 2.066	0.356
	No	31 (24.0)	42 (32.6)	56 (43.4)		
Lifestyle habits						
Smoking	Active	18 (31.6)	21 (36.8)	18 (31.6)	x^2 = 14.71	0.023*
	Past	13 (29.5)	19 (43.2)	12 (27.3)		
	Passive	31 (27.9)	22 (19.8)	58 (52.3)		
	Never	44 (26.3)	47 (28.2)	76 (45.5)		
Physical activity	High	13 (48.2)	8 (29.6)	6 (22.2)	x^2 = 32.46	< 0.001*
	Moderate	37 (33.6)	45 (40.9)	28 (25.5)		
	Low	56 (23.1)	56 (23.1)	130 (53.8)		
Anthropometric measurements						
BMI (kg/m^2)		33.87 ± 6.85	32.01 ± 6.57	35.44 ± 6.38	F = 8.982	< 0.001*
WC (cm)	Male	110.29 ± 14.23	107.49 ± 12.62	117.98 ± 14.62	F = 3.598	0.030*
	Female	110.88 ± 13.16	109.72 ± 13.96	117.47±12.29	F = 9.147	< 0.001*
F calculated by One-way ANOVA, x^2 calculated by Pearson Chi-Square Test						

Data are presented as mean ± SD or n (%).
* Significant level at $p \leq 0.05$.
BMI = body mass index; HT = hypertension; NCD = non-communicable disease; T2DM = Type 2 diabetes mellitus; WC = waist circumference.

habits, past smokers, passive smokers and never smokers had higher BMI than others; 2.94 (95% CI: 1.563-5.334), 3.52 (95% CI: 2.056-6.099), and 2.74 (95% CI: 1.489-4.997); respectively. According to physical activity, moderate and low physical activities have distinctive influencing effects with higher BMI; 3.71 (95% CI: 1.086-6.339) and 6.43 (95% CI: 2.575-9.103), respectively. Finally, patients with HT have an average of 1.73 (95% CI: 1.090-3.375) higher BMI compared to other diabetic patients, and patients of HT + T2DM have 1.80 (95% CI: 1.270-3.333) higher BMI compared to other patients.

Table 2 Prediction factors associated with a higher BMI.

Variables	B coefficient	95% Confidence Interval for B		*p*
		Lower Bound	Upper Bound	
Constant	22.867	17.248	28.486	< 0.001*
Age (y)	-0.004	-0.094	0.085	0.923
Female	1.710	-0.312	3.733	0.097
Married	0.390	-1.372	2.152	0.664
Education level$_0$	-0.801	-3.074	1.473	0.489
Education level$_1$	-1.204	-3.764	1.356	0.356
Large family	1.530	1.006	3.054	0.049*
Father had ≥ 1 of NCDs	0.617	-0.710	1.944	0.361
Mother had ≥ 1 of NCDs	1.723	1.418	3.028	0.010*
Smoking habit$_0$	2.949	1.563	5.334	0.016*
Smoking habit$_1$	3.528	2.056	6.099	0.007*
Smoking habit$_2$	2.743	1.489	4.997	0.017*
Physical activity$_0$	3.712	1.086	6.339	0.006*
Physical activity$_1$	6.430	2.575	9.103	< 0.001*
Health status$_0$	1.733	1.090	3.375	0.039*
Health status$_1$	1.802	1.270	3.333	0.021*
Enter linear regression method applied. There were no interactions amongst independent variables (VIF < 4)				

* Association significant at $p \leq 0.05$.
B = regression coefficient; NCD = non-communicable disease.
Education level$_0$ is low level to moderate and high level.
Education level$_1$ is high to moderate and low level.
Smoking habits$_0$ is past smokers to active smokers, passive smokers and never smokers.
Smoking habits$_1$ is passive smokers to active smokers, past smokers and never smokers.
Smoking habits$_2$ is never smokers to active smokers, past smokers and passive smokers.
Physical activity$_0$ is moderate to high and low level.
Physical activity$_1$ is low to high and moderate level.
Health status$_0$ is HT to T2DM and HT + 2DM.
Health status$_1$ is HT + 2DM to HT and T2DM.

Discussion

Hypertension and diabetes have major impacts on quality of life and health [27]. They may result in a longer period of illness with the disease leading to associated complications and increased patient suffering [28]. The major cause of acquired HT and T2DM is obesity [4,5,10], which is developed due to unmanaged lifestyle habits including smoking, sedentary behavior and bad dietary habits [29]. Indeed, the acquired HT and T2DM as well as other NCDs have been linked directly to stress and social factors [30]. Hence, this study aimed to investigate the distribution of social factors, lifestyle habits and anthropometric measurements according to the state of HT and/or T2DM.

In a sample of Palestinian adults in this study, younger patients had either HT or T2DM, whereas older patients more commonly acquired both HT and T2DM. This result was consistent with previous results which described the association of age with poor health outcomes, and increased morbidity rate with high blood pressure and glycemic state [31-33]. There was a higher percentage of female patients in the HT + T2DM group, whereas there was no marked association of male patients with HT, T2DM, or HT + T2DM. This result suggested that females were at a higher risk of HT and T2DM than males. Similarly, Moradi-Lakeh et al [31] found that female subjects from Saudi Arabia had worse self-reported poor/fair health than male adults, while Shivpuri et al [34] and Ishii et al [35] concluded that female subjects were more susceptible to inflammation which may lead to them being more susceptible to diabetes and metabolic syndrome. Obesity in the female population may increase the risk of disease, as reported in the study by Abdeen et al [16], who observed double the incidence of obesity among females compared to male subjects in Palestine.

Moreover, there was a higher incidence of HT in married subjects compared to unmarried patients. In contrast, married subjects had a lower incidence of T2DM and HT + T2DM compared to unmarried subjects. Schoenborn [36] estimated that health status among US adults is due to changed marital status, and they support that married individuals irrespective of race, gender, age, or income, had better health conditions compared to other groups (the unmarried group included separated, divorced, single, or widowed subjects). In addition, Robards et al [37] agreed that being married improved health and helped to reduce mortality, especially in middle-aged and elderly individuals. Similarly, Lai et al [38] found that unmarried cancer patients had a poor outcome compared to married patients. The difference in health outcome as a result of marriage could be attributed to economic and psychological support to promote a healthy lifestyle, and the social networks built from the union of married partners, while the increased hypertension among married subjects may be attributed to increased responsibilities and stress factors [36,37].

In this current study, that highly educated patients had a higher incidence of HT, whereas low educated patients had a higher incidence of HT + T2DM. Fonseca and Zheng [39] collected data from 15 countries and showed that people who had more years of education had better health, which was explained by the limited number of metabolic and disease markers. In addition, Brunello et al [40] found that education of subjects aged ≥ 50 years was a protective factor, with 1 additional year of education reducing self-reported poor health by 7.1% for women and by 3.1% for men taking account of smoking, physical activity and BMI. Likewise, Clark and Royer [41] and Cutler and Lleras-Muney [42] identified that better-educated people had lower morbidity rates from the most common acute and chronic diseases, and had the best health outcomes and life quality, whilst at the same time, these individuals bear higher responsibilities and are exposed to more life-stress factors.

Furthermore, the effect of large family size was associated with HT + T2DM. Family size may have a socio-economic impact on health outcome, affecting the adherence to treatment, fertility in women, disease consequences (because it is related to psychological improvement), and quality of life [43]. In another explanation, larger families might have lower social and economic values [44].

Parents' health history had a strong influence on the development of HT and/or T2DM among their sons or daughters, with 43.0% and 66.0% of study subjects reporting that their fathers and mothers had one or more of NCDs, respectively. Abukhdeir et al [45] stated that prevalence of T2DM increased among individuals whose mother had a history of DM in Palestine, while Mühlenbruch et al [46] explained that the risk in getting future diabetes is increased if 1 or both parents have or had diabetes in Germany. Meanwhile, Mamtani et al [47] concluded that obesity as a predictor of future T2DM in the Mexican-American population was supported by the finding that they share common genetic influences. In addition to genetic disposition, it is well-known that environmental factors and social networks are likely to be major contributors of perinatal influences of the obesity epidemic and its consequences [48,49]. However, environmental factors and social networks are major factors influencing complex food-related behaviour. This may be determined by the interplay of many factors, including physiological and socio-demographic factors such as income, education, occupation, behavioural and lifestyle factors such as physical activity, smoking, and knowledge, and attitudes related to diet and health [10].

Higher percentages of passive smokers and never smokers have HT + T2DM, which may be attributed to higher female involvement compared to male subjects. However, smoking is the most preventable behavior that causes death [50]. According to the WHO report, about 30% of cancer deaths, 20% of stroke and CHD deaths, and 80% of chronic obstructive lung disease deaths are attributed to smoking [51]. The mortality rate among the middle-aged population (30 to 70 years) has increased by 2- to 3- fold compared to the same group, leading to a reduction of about 10 years of a healthy life [52]. The pathological mechanism of smoking arises from about 4800 chemical compounds, including oxidants and free radicals in the vapor and particulate, which initiate and promote oxidative stress damages [53].

The majority of highly physically active subjects were in the HT group (48.2%), the majority of moderately physically active subjects were in the T2DM group (40.9%), and the majority of low physically active subjects were in the HT + T2DM group (53.8%). As evidenced before, the subjects with HT or T2DM were significantly younger compared to subjects with HT + T2DM, which might explain the distribution observed for physical activity. The HT + T2DM patients in this study had higher obesity indices irrespective of gender. These results are similar to previous results that found that regular physical activity and exercise were accompanied with major health benefits, including decreased risks of T2DM, cancer, depression, CVDs, and premature death [54]. At the time, obesity and its consequences are linked inversely with energy imbalance evidenced by unhealthy dietary habits and declined energy expenditure [55].

The overall BMI and WC for both males and females revealed that the HT + T2DM group had significantly higher BMI and WC values than the groups with HT and T2DM. These results are consistent with previous studies. Adams et al [56] showed that a modest increase in weight and obesity indices might reduce lifespan and increase substantial associated costs among Americans aged between 50-71 years due to associated NCD. In addition, it would also lead to about a 20%–40% increase in mortality in all subjects who were overweight and a 2- to 3-fold increased risk of mortality among obese individuals.

Subjects whose mother had one or more NCDs (obesity-related diseases) were susceptible to higher BMI. The percentage of variability due to genetic factors was about 75%, indicating that genetics plays a clear role in vulnerability to increased obesity [57]. There is growing evidence that common genetic variants or single-nucleotide polymorphisms (SNPs) may play an important role in the obesity epidemic. These SNPs have modest effects on an individual's susceptibility to common forms of obesity, but due to their high frequency, they can have a large contribution to obesity at the population level [58]. Kral et al [49] reported that children are more likely to be obese if their mothers had severe obesity; this fact highlights the significance of gene-environment interactions. In addition, subjects are influenced by living in a large family, because sharing and accepting social network lifestyle behaviours includes eating habits [44]. In the Framingham Heart Study, a person's risk of becoming obese was increased by 57% if colleagues became obese, and the risk of becoming obese was increased by 40% and 37% if a person had a sibling or spouse who became obese, respectively [48].

Smoking habits are considered an environmental risk factor which are directly affected by social network influences [50]. Smoking and obesity represent the current leading preventable health risks, increasing endothelial dysfunction and high CVDs morbidity and mortality among diabetic or insulin resistant subjects [59]. An active smoking habit has the potential to increase the risk of obesity 10-fold [59]. It is reported that smokers have a lower BMI than non-smokers matched by age, with the cessation of smoking followed by weight gain [60]. In this study, past smokers, passive smokers and never smokers compared to active smokers were significant predictors of increased BMI by regression analysis.

Regular physical activity and exercise provide major health benefits, including decreased risks of T2DM, CVDs, and premature death [54]. Obesity results from energy imbalance, excessive input, and little output that is influenced by age, body size and gene disposition [55]. The evaluation of physical activity is accomplished by estimating all of the travelling, working, and recreational activities [61]. In the present study, obesity was associated inversely to the intensity of physical activity, with low and moderate physical activities significant predictors of increased BMI among HT and/or T2DM patients compared to high physical activity. Consistently, intensity of physical activity has been linked inversely with obesity in elderly subjects [62]. Meanwhile, Ekelund et al [63] found that a little increase in physical activity was associated with reduced mortality risks of abdominal obesity in both European men and women, through a prospective study of cancer and nutrition. Furthermore, Fox and Hillsdon [64] stated that the reasons of obesity were due to physical inactivity in both developing and developed countries; firstly, the majority of ativities was based on service pattern; secondly, motorized transportation and changing shopping patterns affected activity; thirdly, increased self-sufficiency and convenience in food and home equipment; finally, losing the motivation for recreational activities.

There is a consensual agreement on the direct link between HT and obesity. El Bcheraoui et al [32] and Abd Elaziz et al [65] found a strong association between hypertension and obesity among Saudis and Egyptian adults. Likewise, Bener et al [66] stated that high BMI was associated significantly to HT. Furthermore, Hsu et al [67] directly linked increased weight and BMI to diabetes in different ethnic groups for Asian populations. However, diabetes, especially uncontrolled, can lead to fluctuations of weight due to caloric loss by frequent sugar urination [68]. The results of this study are consistent with previous literature and evidence, showing that HT and HT + T2DM are associated directly with increased BMI via linear regression model analysis.

1. Limitation of the study

The data are from a cross-sectional study, and therefore, we cannot assess causality, because the data collection of the study ran in a short time, or gathered at only one point in time. In addition, a cross-sectional study evaluates prevalent rather than incident outcomes, so it limits the interpretation of the findings. Second, the socio-demographic information was self-reported and subject to recall and social desirability biases. The majority of the study population were female patients because they were the most accessible and available subjects in the Primary Healthcare centers.

Conclusion

This study aimed to identify the interrelationships between selected social factors, lifestyle habits, anthropometric measurements and health status of HT and/or T2DM. The results have shown strong interaction and association between all factors. Obesity and HT and T2DM were strongly related, and the effects of parents' health influenced their sons' and daughters' health/disease conditions. Indeed, the health/disease conditions were not only influenced by family history, but also by environmental contributions such as social network, level of physical activity, lifestyle habits, stress, and awareness, all of which play an important role in developing obesity or NCDs. In summary, increasing awareness and knowledge about the environmental and social networks, and following a healthy lifestyle can help against increased BMI and its contribution to hypertension and diabetes.

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Conflicts of Interest

Author MSE declares that he has no conflicts of interest.

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