Medical Research Archives

ESMED
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Published: May 31, 2022

Citation: Nguyen HT, Hoang NY, et al., 2022. Associated Factors of Nutritional Status Among Patients with Both Type 2 Diabetes Mellitus and Hypertension: A Cross-Sectional Study, Medical Research Archives, [online] 10(4). https://doi.org/10.18103/mra.v10i5.2771

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DOI: https://doi.org/10.18103/mra.v10i5.2771

ISSN: 2375-1924

RESEARCH ARTICLE

Associated Factors of Nutritional Status Among Patients with Both Type 2 Diabetes Mellitus and Hypertension: A Cross-Sectional Study

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Authors' contributions

We confirm that all authors had access to the data and participated in the writing of the manuscript and have seen and approved the submitted version. HungTrong Nguyen, Nhi Yen Hoang and Hung Xuan Le contributed to the study design, statistical analysis and interpretation of data, manuscript drafting. Van Thao Dam, Mai Anh Nguyen Hoang, Linh Ha Hoang contributed to the inclusion of samples, study design, statistical analysis and interpretation of data, manuscript drafting and critical discussion. Nhung Thi Tuyet Le, Duong Huong Phan, Luong Ngoc Tran contributed to the study design, statistical analysis and interpretation of data, manuscript drafting and critical discussion. HungTrong Nguyen, Nhi Yen Hoang and Hung Xuan Le contributed to the study design, statistical analysis and interpretation of data, manuscript drafting and critical discussion.

ABSTRACT

Background: The growing prevalence of overweight/obesity in patients with diabetes mellitus and hypertension has become a global health concern, which is increasing the risk of deaths. Knowing some factors leading to obesity allows more effective and appropriate prevention.

Aims: To identify some related factors to the nutritional status of patients with both type 2 diabetes mellitus and hypertension at the National hospital of Endocrinology in 2019-2020.

Methods: A cross-sectional study on 228 patients with type 2 Diabetes mellitus and hypertension at the National Hospital of Endocrinology from September 2019 to December 2019.

Results: The results revealed that the elderly group has a higher obesity rate than the middle-aged group ($P<0.05$). Overweight/obesity subjects had higher protein intake than those with Non-overweight/obesity ($P<0.05$). Unsatisfactory anthropometric indexes such as waist circumference (WC), waist-hip ratio (WHR), body fat percentage (BFP) had higher odds of overweight/obesity than those who have satisfactory index (OR=10.3, 18.4 and 13.5, respectively). Besides, 24-hours intake, eating habits and physical activity affected the risk of overweight/obesity. Lower frequency consumption of milk for diabetics and participation in physical activities had higher odds of overweight/obesity (OR=2.2, $P<0.05$). **Conclusion:** The body mass index of patients is associated with the anthropometric indexes, diets and physical activity.

Keywords: Diabetes mellitus; Hypertension; Overweight/obesity; Body mass index; 24-hour dietary recall.

INTRODUCTION

Hypertension and type 2 diabetes are common comorbidities. In the US population, hypertension occurs in approximately 30% of patients with type 1 diabetes and in 50% to 80% of patients with type 2 diabetes [1]. Hypertension and diabetes are the two leading risk factors for atherosclerosis and its complications, including heart attacks and strokes [2,3].

Worldwide diabetes prevalence is projected to increase from 8.3% (382 million adults) in 2013 to 8.8% (592 million adults) by 2035, with more than 80% of cases in low- and middle-income countries [4]. Consistent with this global trend, the estimated prevalence of diabetes in Vietnam has risen from 2.9% in 2010 [5] to 5.4% in 2013 [4]. In 2015, according to the World Health Organization (WHO), there were 1.13 billion people living with high blood pressure worldwide, with the majority of them in low and middle-income countries [6]. In Vietnam, according to a 2015 survey by the Ministry of Health, the prevalence of hypertension was 18.9% [7]. Along with rapid economic growth and urbanization, Vietnam is one of the Asian countries that has experienced dietary changes, including increasing fat and meat intakes [8]. Factors associated with an increased risk of overweight/obesity were female gender, high body fat percentage and visceral adipose index [9]. Significantly correlated factors with hypertension were age, sex, body mass index, and diabetes status [10].

There is considerable evidence for an increased prevalence of hypertension in diabetic persons from other populations [11]. In a study conducted in American Indian and Alaska Native communities to estimate the prevalence of clinical hypertension and assess the coexistence with diabetes mellitus, 37% of diabetic individuals were diagnosed with hypertension [11]. In the same study, the relative risk of hypertension in the diabetic populations compared with the nondiabetic populations varied from 4.7 to 7.7 [12]. It has also been shown that in hypertensive patients ageging 40-59 years, of three different ethnic groups living in South London, are more likely to have diabetes mellitus, and, conversely, patients with both diabetes mellitus have a greater chance of having hypertension. In a large prospective cohort study that included 12550 adults, the development of type 2 diabetes mellitus was almost 2.5 times as likely in persons with hypertension than in their normotensive counterparts [11,13]. Both essential hypertension and diabetes mellitus affect the same major target organs. The common denominator of hypertensive/diabetic target organ-disease is the vascular tree. People with coexisting diabetes mellitus and hypertension are at increased risk of developing atherosclerosis, retinopathy, renal failure and nontraumatic amputations and cardiovascular disease (CVD) [14]. Moreover, it has been shown that lowering BP in high risk patients with both diabetes mellitus can reduce deaths from strokes, overall mortality, and CVD events and can slow the progression of renal disease in patients with both type 2 diabetes mellitus [15]. Left ventricular hypertrophy and coronary artery disease are much more common in diabetic hypertensive patients than in patients suffering from hypertension or diabetes mellitus alone [16]. Hypertension substantially increases the risk of both macrovascular and microvascular complications in diabetes mellitus. In studies such as Systolic hypertension in the Elderly Program (SHEP) and Systolic hypertension in Europe Study (Syst-Eur), those with coexisting diabetes mellitus had an approximate doubling in cardiovascular morbidity and mortality [15,17]. Patients suffering from both diabetes mellitus and hypertension are 2-3 times more likely to experience from strokes or cardiovascular diseases, while that rate for kidney diseases in the final stage is 5-6 times higher [18]. This has become a major health challenge for the world in general and Vietnam in particular. However, for individuals with diabetes, studies by Look AHEAD group have shown that a loss of 5-10% of body weight can improve fitness, reduce HbA1c levels, improve cardiovascular disease risk factors, and decrease the use of diabetes, hypertension, and lipid-lowering medications [19,20]. Besides, the Ministry of Health of Vietnam determined that 70% of type II diabetes mellitus patients can be prevented or kept from showing up early by maintaining a healthy lifestyle, following a balanced diet and exercising regularly [21].

Considering the effectiveness of managing overweight/obesity which plays an important role in improving diabetes as well hypertension outcomes and reducing its burden. A better understanding of the related factors of individuals with overweight/obesity may help public health practitioners, researchers and policymakers to establish tailored and appropriate goals for obesity treatment, and better design interventions and clinical trials around prevention and treatment. The aim of this study was to identify some related factors to the nutritional status of patients with both

type 2 diabetes mellitus and hypertension at the National hospital of Endocrinology in 2019-2020.

METHODS

Research subjects: Study on 228 patients with type 2 Diabetes mellitus (T2DM) and hypertension at the Department of Clinical Nutrition & Dietetics, National hospital of Endocrinology from September, 2019 to June, 2020.

The inclusion criteria: Patients diagnosed with T2DM and hypertension (systolic blood pressure ≥140mmHg, diastolic blood pressure ≥90mmHg) and being hospitalized at the time of research. Subjects above 20 years of age and voluntarily participate in the study; completed hospital records.

The exclusion criteria: Patients were unable to communicate. Unconscious patients, suffering from severe complications such as comma, stroke. Those with type 1 diabetes mellitus patients, gestational diabetes mellitus patients.

Study design: This is a cross-sectional study.

Sample size: Using sample size formula:

$$n = Z^2_{1-\alpha/2}\frac{p(1-p)}{(\varepsilon p)^2}$$

where:

n: sample size (number of subjects);

p: in a 2016 study, 42.2% of T2DM with hypertension patients suffered from overweight/obesity [11];

ε: desired error between research sample and population, take ε = 0.16;

$\mathbf{Z_{1-\alpha/2}}$: The accuracy of the study should be expected to reach 95% by 1.96;

Result: n = 206, adding additional 10% of subjects in case they refuse to participate in the study; therefore, the final sample size is 226. A total of 228 eligible patients matched the selection criteria and agreed to participate in the study.

Variables: The body mass index (BMI) is a commonly simple index to classify overweight and obesity in adults which was calculated as weight in kilograms divided by the square of height in meters, and the nutritional status of adult patients was determined according to the WHO's standards for Asian criteria as normal weight=18.5-22.9; overweight=23-24.9; and obese ≥25 [22]. Waist circumference and the waist-hip ratio is evaluated according to WHO criteria with ≥ 90cm in men or ≥ 80cm in women and ≥ 0.9 in men or ≥ 0.8 in women, respectively [33]. Body fat percentage: there are 4 classifications (under fat, healthy, overfat, obese) according to using a body fat analyzer Tanita BC-343 scale (Tanita, Tokyo, Japan) [24].To assess usual dietary intake, 228 participants completed 24-hour dietary recall- a method consists of precisely recalling, describing, and quantifying the intake of foods and beverages consumed in the 24 hours during the day before the interview, from the first intake in the morning until the last foods or beverages consumed at night [25].

Sampling methods: The sample was selected using a convenient sampling method, all subjects were taken according to the list of patients with complete medical records. Proceed to reach the study subject when the patient is hospitalized for treatment.

Statistical analysis: Data is checked and converted before being entered into the computer by using Excel software. This research has used algorithms for descriptive statistics (percentage, mean, standard deviation) to describe the characteristics of participants. Chi-square test, Fisher's exact test, Mann-Whitney test, t-test, and odds ratio was used to analyze the comparison and correlation between groups or variables. The analysis will be performed by STATA 15.0 software.

RESULTS

Table 1. Demographic characteristic of participants

Characteristics		n	%
Sex	Male	86	37.7
	Female	142	62.3
Residence	Rural	143	62.7
	Urban	85	37.3
Home economics	Poverty	17	7.5
	Non-poverty	211	92.5
People living with	Alone	12	5.3
	Family or friends	216	94.7
Eating with relatives	Yes	216	94.7
	No	12	5.3
Employment status	Retirement	114	50.0
	Farmer	50	21.9
	Housewife	27	11.8
	Business	23	10.1
	Government employees	3	1.3
	Worker	2	0.8
	Others	9	4.0
Age group (years)	40-65	91	39.9
	≥ 65	137	60.1
	Average ± SD (min - max)	66.5±7.9 (43-88)	
Educational level	Illiteracy	10	4.4
	Elementary School	42	18.4
	Secondary School	86	37.7
	High School	50	21.9
	College/University	31	13.6
	After College/University	9	4.0

Table 1 showed the demographic characteristics of the subjects. Overall, the proportion of female subjects (62.3%) was higher than that of males (37.7%). Among the participants, there were 143 subjects (62.7%) living in rural areas and 85 subjects (37.3%) living in urban areas. The rate of people living with family, sharing meals with relatives had the same result, accounting for 94.7%. Regarding employment status, it was shown that half of the respondents have retired (50.0%), followed by farmers (21.9%). Besides, almost the educational attainment of the subjects were secondary school (37.7%), high school (21.9%). The subjects who were illiterate and have graduated from college/ university accounted for 4.4% and 4%, respectively.

Table 2. The relationship between nutritional status and different variables of participants

Characteristics		Non Overweight/ Obesity n (%)	Overweight/ Obesity n (%)	OR (95%CI)	*P*
BFP (n=217)	Satisfactory	66 (30.4)	43 (19.8)	1	<0.0001
	Unsatisfactory	11 (5.1)	97 (44.7)	13.5 (6.2-30.9)	
WC (n=220)	Satisfactory	32 (14.5)	9 (4.1)	1	<0.0001
	Unsatisfactory	46 (20.9)	133 (60.5)	10.3(4.3-26.1)	
WHR (n=220)	Satisfactory	9 (4.1)	1 (0.4)	1	0.0002
	Unsatisfactory	69 (31.4)	141 (64.1)	18.4(2.4-811.5)	
Frequency of using milk for diabetics	≥4-6 times/week	34 (14.9)	36 (15.8)	1	0.0083
	<4-6 times/week	48 (21.0)	110 (48.3)	2.2(1.2-4.0)	
Frequency of physical activities (min/day)	Satisfactory	48 (21.1)	65 (28.5)	1	0.0422
	Unsatisfactory	34 (14.9)	81 (35.5)	2.2 (1.2-4.0)	

***fisher's exact test* ☐*satisfactory: ≥ 30min/day and ≥5days/week*

The results of table 2 showed that the risk of suffering from overweight/obesity of patients with both unsatisfactory body fat percentage had higher odds of overweight/obesity (OR=13.5; 95%CI=6.2-30.9; *P*<0.0001) as compared with those who had satisfactory body fat percentage. Participants with unsatisfactory waist circumference had higher odds of overweight/obesity (OR=10.3; 95%CI=4.3-26.1; *P*<0.0001), as compared with those with satisfactory waist circumference. Patients with both unsatisfactory WHR had higher odds of overweight/obesity (OR=18.4; 95%CI=2.4-811.5; *P*=0.0002), as compared with those with satisfactory WHR. Besides, as compared with patients using milk for diabetics ≥4-6 times/week, patients with both this using <4-6 times/week had higher odds of overweight/obesity (OR=2.2; 95%CI=1.2-4.0; *P*=0.0083). In addition, the patients having unsatisfactory time to practice physical activities had higher odds of overweight/obesity than those engaging in physical activities ≥30 min/day and ≥5 days/week (OR=2.2; 95%CI=1.2-4.0; *P*= 0.0422).

Table 3. Comparisons of daily dietary intake between Non-overweight/obesity patients and Overweight/obesity patients

8	Non-Overweight/Obesity (n=82)	Overweight/Obesity (n=146)	*P*
	$\overline{X}$ ± SD		
Energy (kcal)*	1773.0±384.3	1684.1±406.8	0.2388
Protein (g) **	78.5±23.7	85.4±24.7	0.0414
Lipid (g)*	44.79±18.0	43.9±21.4	0.7784
Carbohydrate (g) **	254.8±59.1	241.6±55.7	0.0991
Fiber(g) **	9.1±5.7	8.9± 4.8	0.8158
Animal protein /total protein(%)*	58.2±27.1	60.4%±29.9	0.3470
Plant Lipid/total lipid(%)**	49.3±16.3	49.2%±17.8	0.9924
Cholesterol (mg)	139.8±17.5	131.5±11.6	0.6829

**Mann-Whitney test*
***t-test*

The results of table 3 showed that according to the 24-hours dietary recall of patients, the protein intake of subjects with overweight/obesity (85.4g) was 6.9g higher than that of patients without both overweight/obesity (78.5g) (*P*=0.0414). In addition, the average intake amount of carbohydrate, lipid, energy, fiber, animal protein /total protein and plant lipid/total lipid, cholesterol was comparable between patients with both overweight/obesity and normal ones (*P*>0.05).

Table 4. The relationship between nutritional status and daily dietary intake of participants

Characteristics (n=228)		Non Overweight/ Obesity n (%)	Overweight/ Obesity n (%)	OR (95%CI)	*P*
Energy (30-35 kcal/kg)	Satisfactory Unsatisfactory	26 (11.4) 56 (24. 5)	43(18.9) 103(45.2)	1 1.1(0.6-2.1)	0.7220
Satisfying all 3 AMDR□	Satisfactory Unsatisfactory	19 (8.4) 63 (27.6)	17(7.4) 129(56.6)	1 2.3 (1.04-5.0)	0.0220
Percentage of calories by Protein (15-20%)	Satisfactory Unsatisfactory	40 (17.5) 42 (18.5)	78(34.2) 68(29.8)	1 0.8 (0.4-1.5)	0.5006
Percentage of calories by Lipid (20-25%)	Satisfactory Unsatisfactory	41 (18.0) 41 (18.0)	51(22.3) 95(41.7)	1 1.9 (1.03-3.4)	0.0260
Percentage of calories by Carbohydrates (55-60%)	Satisfactory Unsatisfactory	36 (15.8) 46 (20.2)	34(14.9) 112(49.1)	1 2.6 (1.4-4.8)	0.0012
Fiber (14g/1000kcal)	Satisfactory Unsatisfactory	2 (0.9) 80 (35.1)	5(2.2) 141(61.8)	1 0.7 (0.1-4.4)	0.6789
Cholesterol (<200mg/day)	Satisfactory Unsatisfactory	72(31.6) 10(4.4)	135(59.2) 11(4.8)	1 0.6 (0.2-1.6)	0.2428

AMDR□: Acceptable macronutrient distribution ranges (carbohydrate: protein: lipid=55-60%: 15-20%: 20-25%)

It can be seen from table 4 that patients eating unsatisfactory all 3 AMDR had higher odds of overweight/obesity (OR=2.3; 95%CI=1.04-5.0; *P*=0.0220), as compared with those eating satisfying all 3 AMDR. As compared to patients eating a satisfactory percentage of calories by lipid, those eating unsatisfactory percentages had higher odds of overweight/obesity (OR=1.9; 95%CI=1.03-3.4; *P*=0.0260). The odds of overweight/obesity were higher for patients consuming unsatisfactory percentage of calories by carbohydrate (OR=2.6; 95%CI=1.4-4.8; *P*=0.0012). The patients eating an unsatisfactory amount of energy, percentage of calories by protein, the amount of cholesterol or fiber had the risk of overweight/obesity were comparable with patients eating satisfactory those variables (*P*>0.05).

DISCUSSION

In our study, the proportion of men was lower than that of women. This result is similar to the results of Doan Thi Thu Huong's study on 264 patients with both diabetes and hypertension, in which the rate of women is more than twice that of men [26]. The average age of subjects in our study was 66.5±7.9 years. The definition of elderly or older is all aged over 65 years and older [27]. Hosik Min's research (2010) shows that the odds of a person having both diabetes and hypertension must be multiplied by 1.07 as being old, which means that the odds increase with age [28]. Besides, according to ADA 2020, diabetes is an important health condition for the aging population. Approximately one-quarter of people over the age of 65 years have diabetes and one-half of older adults have prediabetes, and the number of older adults living with these conditions is expected to increase rapidly in the coming decades [29]. In addition, in this study, subjects living in rural areas were approximately 1.7 times higher than those living in urban areas. This tends to be similar to the study of Nguyen Thuy Dung et al (2019) at the National Hospital of Endocrinology, the results of subjects living in rural areas were 2.6 times higher than those living in urban areas [30]. This result can be explained by the fact that media and education about health knowledge in general and knowledge about T2DM and hypertension diseases in particular was still limited in rural areas of Vietnam, leading to people living in this area not fully understood about health problems.

Our study showed the correlation between waist circumference, body fat percentage, and WHR. Patients with both unsatisfactory waist circumference had higher odds of overweight/obesity, as compared with those with satisfactory waist circumference. To explain this result, it is worth looking at the research by Marcin Gierach et al (2014), which showed a statistically significant positive relationship between waist circumference and BMI in patients with both

metabolic syndrome [31]. In addition, patients with both unsatisfactory WHR will have the risk of overweight/obese, which is 18.4 times higher than patients with both satisfactory WHR. Another study by Shafriani et al (2018) on 200 adults also showed a statistically significant difference for WHR of different BMI groups, the average WHR value of obese people was higher than that of non-obese people [32]. The risk of suffering from overweight/obesity of patients with both unsatisfactory body fat percentage was 5.6 times higher than patients with both satisfactory body fat percentage. Camila Kümmel Duarte et al (2018) also showed the correlation between body fat percentage and waist circumference of 188 patients in which the average BMI value in the low body fat percentage group was lower than that in the high body fat percentage group [33]. There are four factors in the 24h diet of T2DM patients with both hypertension that are correlated with their BMI status. For the distribution of dietary substances in the 24-hour ratio, the risk of suffering from overweight/obesity of patients having unsatisfactory all 3 AMDR intake was 2.3 times higher than the patients having satisfactory all 3 AMDR intake. This indicated that not only eating the recommended amount of energy but also balancing the rate of energy-generating substances is also extremely important to reduce the risk of overweight/obesity. Besides, the research results have found a relationship between the ratio of each substance and the risk of overweight/obese. Patients with an unsatisfactory percentage of calories by lipid intake had higher odds of overweight/obesity compared with those with a satisfactory percentage of calories by lipid intake. This result was similar to that of T2DM patients in Nguyen Thi Dinh's study (2017) [34]. Unbalanced lipid intake leads to not only a risk of fat accumulation but also an increased risk of cardiovascular disease in T2DM patients [35]. Patients with an unsatisfactory percentage of calories by carbohydrate intake had higher odds of overweight/obesity compared with those who ate enough as recommended. Both the quantity and the type or source of carbohydrate in foods influence postprandial glucose level [36], so managing carbohydrate intake is really essential for the patients. The study did not find the association between the percentage of calories by protein intake and the risk of overweight/obesity. However, when comparing the intake between the overweight/obesity group and non-overweight/obesity group, there was a significant difference in the average protein intake. Non-overweight/obese subjects had lower protein intake than subjects with overweight/obese. This is an alarming fact, though our study accounts for nearly two-thirds of total diabetes patients were > 65 years who are at risk of a greater loss of muscle strength and a higher rate of disability and as such may greatly benefit from increased protein intakes as recommended [37]. A previous study indicated obesity as an independent risk factor for the onset, aggravated course, and poor outcomes of chronic kidney disease, even after adjustment for confounding comorbidities, including diabetes and hypertension, which are the two major causes of chronic kidney disease [38]. High protein intake may lead to increased intraglomerular pressure and glomerular hyperfiltration which can cause damage to a glomerular structure leading to or aggravating chronic kidney disease [39]. Therefore, the daily dietary habits of food from protein for T2DM patients with both hypertension and obesity should not be too high and long-term which will influence the risk of kidney disease in patients. Besides, as compared with patients using milk for diabetics > 4-6 times/week, patients with both this using <4-6 times/week had higher odds of overweight/obese. Typically, patients who use milk for diabetics have been diagnosed with T2DM in the past, so these patients will be more aware of the disease than new patients. These diagnosed patients may have been advised on how to maintain a healthy lifestyle to prevent related diseases (including obesity) from their doctors. This experience helps them consciously protect their health and lead a healthier lifestyle. Results showed that the patients having unsatisfactory time to practice physical activities had higher odds of overweight/obesity than those engaging in physical activities >30 min/day and >5 days/week. This indicates that overweight/obesity is associated with the frequency of physical activity.

CONCLUSION

Our study conducted on 228 patients with diabetes mellitus and hypertension showed that: overweight/obesity was prevalent in the study population. The associated factors of overweight/obesity were anthropometric indicators, dietary intake, physical activity. The associated factors of overweight/obesity patients were studied, which provided important evidence for effective screenings and potential interventions

for the treatment and control of overweight/obesity in patients with diabetes mellitus and hypertension.

Acknowledgments

We thank National hospital of Endocrinology for enabling us to complete this study. We also thank all the patients who participated in the study.

Funding

This research did not receive any specific grants from any funding agency in the public, commercial or nonprofit sector.

Availability of data and materials

The data sets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the local Ethics Committee of the Hanoi Medical University, Vietnam (No. 1202/QĐ-ĐHYHN). Written informed consent was provided by each participant before entering the study.

Consent for publication

Not applicable for this section.

Competing interests

The authors declare that there is no conflict of interest that could be perceived as prejudicing the research reported.

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