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Original Article

Epidemiologic study of type 2 diabetes mellitus and metabolic syndrome in rural population of kurdistan province, Iran, in 2011–2017

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ABSTRACT

Background: Metabolic syndrome is a serious health problem and is associated with an increased risk of type 2 diabetes and cardiovascular disease. The aim of this study was to determine the status of these two diseases in the rural population of Kurdistan province, west of Iran.
Methods: In this cross sectional study, 10,496 villagers of Kurdistan province during the period from March 2011 to February 2017 were selected through randomized systematic sampling. Required information was collected using pre-made check list and the examinations were performed. The data were analyzed with SPSS v22 software using chi-square test.
Results: In the present study, the mean age of the population was 46.0 ± 14.13 y/o and 49.2% people were male and 50.8% were female. The prevalence of metabolic syndrome was 22.1% and for type 2 diabetes the prevalence was 19.6%. Hypertension was significantly higher in women ($p < 0.001$). There was a significant difference between the two sexes in terms of waist circumference, type 2 diabetes and metabolic syndrome. There was a significant difference between age groups with hypertension, waist circumference, type 2 diabetes and metabolic syndrome ($p < 0.001$) and a significant relationship between educational status with hypertention, waist circumference, type 2 diabetes and metabolic syndrome ($p < 0.001$). The results also showed that the relationships between age group and gender with BMI was significant ($P < 0.001$).
Conclusion: The prevalence of diabetes in the rural population of Kordestan province is moderate but it has a high prevalence in metabolic syndrome. Educational and healthcare interventions seem to be necessary to reduce these prevalences, especially among women and in older ages.

1. Introduction

Diet and life style, all over the world, are changing from a healthy, traditional, high-fiber, low-fat, low-calorie diet with exercise and daily physical activity, to increase carbohydrate intake, high fat, high red meat consumption, low fiber gain and low activity. These diet and wrong habits are associated with an increased risk for obesity, metabolic syndrome, and type 2 diabetes mellitus [1]. Evidences suggest that specific fatty acids are effective on cell metabolism, and changes in the quantity and quality of dietary fats can affect insulin sensitivity [2]. High total fat intake is associated with fasting hyperinsulinemia and low insulin sensitivity index. Epidemiological studies have shown that fat intake in patients with type 2 diabetes is higher than normoglycemic subjects [1].

Metabolic syndrome, also known as X syndrome and insulin resistance syndrome, is a complex of metabolic risk factors including central obesity, glucose intolerance, hyperinsulinemia, low HDL cholesterol, high triglyceride and hypertension [3,4]. Metabolic syndrome is a multiplex risk factor for atherosclerotic cardiovascular disease [5]. The mortality rate of people with this syndrome due to myocardial infarction and cardiac arrest is two times more than general population [6]. Many patients with

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metabolic syndrome have insulin resistance that predisposes them to prediabetes or type 2 diabetes. Obesity and physical inactivity are factors that drive the patients towards the metabolic syndrome, but metabolic susceptibility is also needed for occuring this syndrome, which these factors are the adipose tissue disorder that is commonly diagnosed as abdominal obesity, genetic and racial factors, aging and endocrine disorders [5,7]. The prevalence of metabolic syndrome varies greatly between different countries and races, but it is expected to be higher in Asian countries, especially in the Middle East [8]. There are ample evidences that the prevalence of cardiovascular disease in Iran as a developing country, is increasing. While the mortality rate of these diseases in developed countries has decreased over the past 20 years, age-adjusted mortality has increased in Iran by 20–45% [9]. Although according to studies the prevalence of this syndrome should be higher in modern societies, the prevalence of this disease in Iran in 2011 was 30.1% in men and 55.0% in women, while the prevalence in France in the same year in men and women was 13.7% And 6.6%, respectively [10,11].

One of the diseases that is more associated with metabolic syndrome is type 2 diabetes mellitus [5]. Type 2 diabetes mellitus is characterized by a relative lack of insulin due to pancreatic β-cell dysfunction and insulin resistance in target organs [12]. Over the past 30 years, the face of diabetes has changed from a mild disorder related to old ages to a major cause of morbidity and mortality affecting young and middle-aged people [13]. Although the prevalence of type 1 diabetes is also increasing, the most common type of diabetes is type 2, which accounts for about 90% of all cases of diabetes [14]. In 2000, around 171 million people in all ages and around the world had glucose levels within the diabetes range, and researchers were estimating that the global prevalence of diabetes mellitus would increase by 100% over the next 30 years and increase the global burden of the disease to 366 million people in 2030 [13,15]. But the importance of the topic is so great which the World Health Organization (WHO) reported that in 2014, 422 million people were diabetic. The global pravalence of this disease is 8.5%, which is higher in lower and middle income countries. It was estimated in 2015 that about 1.6 million deaths were directly caused by diabetes, and WHO's prediction is that in 2030, diabetes will be the seventh factor caused death [16]. The prevalence of diabetes in rural areas is often less than urban areas [15]. For example, in a study conducted in India in 2002, the pravalence of this disease in urban areas was 5.6–12.4%, but in rural areas it was 2.4–2.7% [17]. This urban-rural difference in the prevalence of diabetes mellitus in the first place has attributed to the difference in modern lifestyle in urban communities compared to traditional lifestyle in rural areas, which include factors such as differences in diet, physical activity and mental stress [15].

Estimating the current and future burden of diabetes is important in order to allocate health and social resources and to confront the increasing prevalence of diabetes. Since there is no accurate information about the prevalence of metabolic syndrome and diabetes in Kurdistan province, especially in the rural population, the aim of this study was to determine the status of these two diseases in the rural population of Kurdistan province, west of Iran.

2. Subjects, materials and methods

For this cross sectional study, after obtaining permission from the Ethics Committee of Kurdistan University of Medical Sciences, residents of the villages of Kurdistan Province, which is located in west of Iran, with the age of 30 and older were considered as the population of the study. Based on data collected using the Family Physician Program in villages in Kurdistan province during the period from March 2011 to February 2017, the residents of the villages of Kurdistan province were estimated as 58,019, of whom 25,668 were over 30 years old. Among them, 10,496 people were selected for our study through randomized systematic sampling. After explaining all of the stages of the study for patients, some of required data including age, sex, blood pressure, type 2 diabetes and metabolic syndrome and etc. were collected through a premade check list. Then The following procedures were done in the same way for all of the patients:

1. Systolic and diastolic blood pressure (BP) for each person was measured using a standard and calibrated mercury sphygmomanometer by a physician. The first and fifth Korotkoff Sounds were considered as systolic and diastolic blood pressure, respectively, and blood pressure was measured for each patient in sitting position when the patient was resting for at least 15 min. For more accuracy, blood pressure was measured twice for each patient, and then the mean value was considered as the final BP.
2. The weight of patients was measured when they were fast, with light clothing, without shoe, after bowel movements with Digital Scale Seca co. with an accuracy of 100 g.
3. The height was measured with a stable stadiometer of Seca co., which the patients should stand tall without shoes with an accuracy of 0.5 cm.
4. The waist circumference was measured by sewing meter at the narrowest part and in the area between the last rib and the iliac bone in a standing position in the state in which the person did not compress the abdomen. The hip circumference was measured by tape measure at the highest hip circumference, and the waist to hip ratio was calculated by dividing the waist circumference into the hip circumference.
5. 15 ml of venous blood was taken after 12 h of fasting and at 8–9 in the morning and in a sitting position with a 20 ml syringe by an experienced nurse and the blood samples were divided in tubes containing anticoagulant EDTA, tubes without anticoagulant and tubes for storing whole blood samples, and were sent to the reeferal lab in each city. Serum levels of triglyceride, total cholesterol and fasting blood sugar (FBS) were measured by enzymatic method using autoanalyzer Ependorf co., Germany. Low-density lipoprotein cholesterol (LDL) serum levels were measured using the Friedwald formula. Of course, this formula was used if the serum triglyceride level was less than 400 mg/dL. Hemoglobin glycosylated percentage and high density lipoprotein cholesterol (HDL) serum levels were measured by enzymatic method.
6. If the FBS was greater than 100 and less than 126 mg/dL, it was considered as pre-diabetes (FBS disorder), and, if it was more than 126 mg/dL, was considered as a person with diabetes. People with FBS less than 126 mg/dl were tested to standard glucose tolerance test (75 g glucose in 2 h) and venous blood samples were collected at 0, 60 and 120 min after glucose administration. The plasma samples were measured after centrifuging on the same day. Diabetes was diagnosed as having a plasma glucose level of 2 h higher than 200 mg/dL.

The metabolic syndrome cases were determined based on National Cholesterol Education Program-Adult Treatment Panel III, NCEP-ATPIII, and with having three of these five criteria, metabolic syndrome was diagnosed for a person: 1) The waist circumference higher than or equal to 102 cm in men and 88 cm in women, 2) Serum triglycerides (TG) higher than or equal to 150 mg/dL, 3) HDL less than 40 mg/dl in men and less than 50 mg/dL in women, 4) BP higher than or equal to 130/85 mmHg, 5) FBS higher than or equal to 100 Mg/dl.

Finally, the data were analyzed with SPSS v22 software. For

Table 1
Education and Marital status in the studied population.

Variable		Frequency	Relative Percentage (%)
Marital status	Divorced	77	0.7
	Married	9314	88.7
	Single	307	2.9
	Widow	798	7.7
Educational status	Illiterate	5330	50.8
	Elementary	3702	35.3
	Middle School	558	5.3
	High School	818	7.8
	Academic	88	0.8

Table 2
Mean and Standard Deviation of metabolic indexes.

Variable	Mean	Standard Deviation
Waist Circumference	90.0	12.1
BMI	26.3	4.7
Cholesterol	178.0	38.7
Triglyceride	128.0	76.9
HDL (mg/dl)	46.0	15.9
LDL (mg/dl)	99.1	31.2
FBS (mg/dl)	89.1	23.9

descriptive variables, descriptive statistics, mean, standard deviation and frequency were used and chi-square test was used to analyze the hypothesis.

3. Results

In the present study, the mean age of the population was 46.0 ± 14.13 y/o and 5161 people (49.2%) were male and 5335 (50.8%) were female. The marital and educational status are shown in Table 1 and BMI, and the level of cholesterol, TG, LDL, HDL, and FBS are presented in Table 2. In the studied population, the prevalence of metabolic syndrome was 22.1% (Table 3) and for type 2 diabetes the prevalence was 19.6%, pre-diabetes 12.32% and 81.48% had not diabetes.

Hypertension was significantly different between men and women ($p < 0.001$) and its prevalence was higher in women. Also, there was a significant difference between the two sexes in terms of waist circumference, type 2 diabetes and metabolic syndrome (Table 4). Our results also showed that there was a significant difference between age groups with hypertension, waist circumference, type 2 diabetes and metabolic syndrome ($p < 0.001$) (Table 5). There was a significant relationship between educational statu with hypertention, waist circumference, type 2 diabetes and metabolic syndrome ($p < 0.001$) (Table 6). The results also showed that the relationships between age group and gender with BMI was significant ($P < 0.001$) (Table 7). The maps showed the prevalence of variables by the rural population of each countise of kurdistan province (Map 1–7).

4. Discussion

Metabolic syndrome is one of the serious health problems that is increasing today. This syndrome is associated with an increased risk of type 2 diabetes and cardiovascular disease. However, the cause of the metabolic syndrome is complex and multiple factors as well as genetic factors can play important roles in the development of this syndrome [18]. In this study, the prevalence of metabolic syndrome and type 2 diabetes in rural population was investigated. According to the results of this study, the prevalence of metabolic syndrome and diabetes in the female population was higher than that of men. In a review study, Ranasinghe et al. (2017) have investigated the prevalence of metabolic syndrome among young people in South Asia and Oceania [18]. In that study, the results showed that metabolic syndrome in women is much more than men and these results are consistent with the present study. Also a study by Zhou B et al. (2017) that evaluated the effective factors of diabetes among men and women has shown that the incidence of diabetes in women was more than that of men and these results also were consistent with the present study [19]. In general, the mass of fat is higher in women's body physiology, and the fat content in the body of women is much higher in the flank and in the abdominal region. In fatty tissue, cytokines produced by fat cells cause inflammation and insulin resistance, and diabetes is far more seen in them. Also, the hormonal differences in female gender in comparison with male gender is one of the other factors that causes differences in the prevalence of metabolic syndrome between both genders. Evidences suggest that estradiol, as the main female gender hormone, has protective effects on cardiovascular disease,

Table 3
Prevalence of some metabolic indexes.

Waist Circumference (%)		HTN (%)		TG (%)		Metabolic Syndrome	
Normal	Abnormal	Have Not	Have	Normal	Abnormal	Yes	No
61.7	38.3	78.5	21.5	65.3	34.7	22.1	77.9

Table 4
The relationship between HTN, waist circumference, diabetes, metabolic syndrome and HDL with gender.

Gender Variable		Men		Women		X2	P value
		Frequency	%	Frequency	%		
HTN	Have	3884	80.4	3913	76.7	20.09	0.000
	Have Not	949	19.6	1191	23.3		
Waist Circumference	Normal	4027	87.9	1809	37.1	2582.1	0.000
	Abnormal	553	12.1	3067	62.9		
Diabetes Status	Normal	3902	84.3	3859	78.8	59.8	0.000
	Pre-diabetes	519	11.2	655	13.4		
	Diabetes	208	4.5	382	7.8		
Metabolic syndrome	Have	3535	90.3	2753	67.3	627.9	0.000
	Have Not	380	9.7	1340	32.6		
HDL	Normal	2867	68.2	1526	34.8	956.9	0.000
	Abnormal	1337	31.8	2857	65.2		

Table 5
The relationship between HTN, TG, waist circumference, diabetes, metabolic syndrome and HDL with age group.

Age Group (Y/O)Variable		≤39		40–49		50–59		60–69		≥70		X2	P value
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%		
HTN	Have	208	6.9	346	13.1	529	27.5	572	40.2	485	51.3	1320.2	0.000
	Have Not	2790	93.1	2301	86.9	1395	72.5	851	59.8	460	48.7		
TG	Normal	1870	66.8	1589	62.9	1187	64.5	891	65.9	600	67.8	12.17	0.000
	Abnormal	930	33.2	936	37.1	654	35.5	461	34.1	285	32.2		
Waist Circumference	Normal	1859	64.9	1483	58.7	1037	57.2	823	60.7	634	61.7	68.1	0.000
	Abnormal	1005	35.1	1042	41.3	776	42.8	533	39.3	264	38.3		
Diabetes Status	Normal	2496	87.8	2066	81.2	1427	76.3	1049	76.4	723	80.9	168.8	0.000
	Pre-diabetes	276	9.7	318	12.5	289	15.5	184	13.4	107	12.0		
	Diabetes	71	2.5	161	6.3	154	8.2	140	10.2	64	7.1		
Metabolic Syndrome	Have	319	13.3	460	21.2	408	26.1	341	29.7	192	25.9	169.5	0.000
	Have Not	2077	86.7	1705	78.8	1155	73.9	806	70.3	550	74.1		
HDL	Normal	1268	49.8	1146	49.9	889	52.9	616	50.5	447	57.1	16.57	0.002
	Abnormal	1278	50.2	1152	50.1	792	47.1	604	49.5	336	42.9		

Table 6
The Relationship Between HTN, TG, Waist Circumference, Diabetes, Metabolic Syndrome and HDL with Educational status.

Educational Status Variable		Illiterate		Elementary		Middle School and High school		Academic		X2	P value
		Frequency	%	Frequency	%	Frequency	%	Frequency	%		
Hypertension	Have	3545	69.0	3023	87.89	1148	89.9	81	97.6	565.5	0.000
	Have Not	1590	31.0	419	12.2	129	10.1	2	2.4		
Waist Circumference	Normal	2638	54.1	2170	66.3	962	78.3	66	83.5	309.6	0.000
	Abnormal	2240	45.9	1101	33.7	266	21.7	13	16.5		
Diabetes Status	Normal	3884	87.8	2758	83.4	1049	86.3	70	90.9	78.5	0.000
	Pre-diabetes	648	13.2	396	12.0	126	10.4	4	5.2		
	Diabetes	396	8.0	151	4.6	40	3.3	3	3.9		
Metabolic Syndrome	Have	3015	72.3	2311	83.6	919	89.1	48	96.0	214.4	0.000
	Have Not	1153	27.7	452	16.4	113	10.9	2	4.0		
TG	Normal	3232	66.2	2129	65.5	728	60.8	47	63.5	12.64	0.005
	Abnormal	1648	33.8	1122	34.5	469	39.2	27	36.5		
HDL	Normal	2075	47.0	1600	53.9	658	60.3	32	59.3	76.55	0.005
	Abnormal	2336	53.0	1371	46.1	433	39.7	22	40.7		

metabolic syndrome and diabetes, and its mechanism of action is to reduce the expression of inflammatory proteins. As the age increases in female, the level of secretion of this hormone decreases, which can be a risk factor for the high incidence of metabolic syndrome and diabetes in female as compared to that of the male. But in the study of Yang et al. (2010) it seems that the variation in nutritional status, cultural conditions and geographical area is the main cause of the difference [20].

In this study, three indicators of high blood pressure, waist circumference, type 2 diabetes in the subjects were examined for metabolic syndrome. The results showed a significant difference between age groups and high blood pressure, waist circumference, type 2 diabetes and metabolic syndrome ($p < 0.001$) (Table 5). So that with the age elevation, the values of these variables increased. This association was more prevalent in women than men.Yang et al. (2010) with the aim of investigating the prevalence of diabetes among Chinese women and men showed that in the age group of 40–59 years old the prevalence of diabetes was 11.5% and in the age group of 60 years and above was 20.4% Which is similar to the present study [20]. Also, in the study of Delpisheh et al. (2016) on type 2 diabetic patients in rural regions of Malekan, the results indicated an increased prevalence of diabetes in older women [21], which is consistent with the results of the present study. It seems that the higher incidence of abdominal obesity in this age group, the higher incidence of abdominal obesity among women, the increased incidence of diabetes and metabolic syndrome in them, as well as decreased mobility and physical activity, the type of nutrition, the incidence of menopause and hormonal disorders (estrogen reduction), are the related factors.

Other findings of this study indicated that there is a significant relationship between educational level with blood pressure, waist circumference, type 2 diabetes and metabolic syndrome

Table 7
The relationship between age group and gender with BMI.

BMI Variable		Normal		Overweight		Obesity Grade 1		Obesity Grade 2		Severe Obesity		X2	P value
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%		
Age Group	≤39	1132	37.9	1189	39.8	534	17.9	101	3.4	30	1.0	221.9	0.000
	40–49	815	30.9	1093	41.4	546	20.7	143	4.5	40	1.5		
	50–59	671	34.9	740	38.5	397	20.7	94	4.9	19	1.0		
	60–69	581	41.0	553	39.0	210	14.8	55	3.9	18	1.3		
	≥70	504	53.8	327	34.9	72	7.7	28	3.0	6	0.6		
Gender	Men	2213	45.9	1973	41.0	532	11.0	77	1.6	22	0.5	621.2	0.000
	Women	1490	29.3	1929	38.0	1227	24.1	344	6.8	91	1.8		

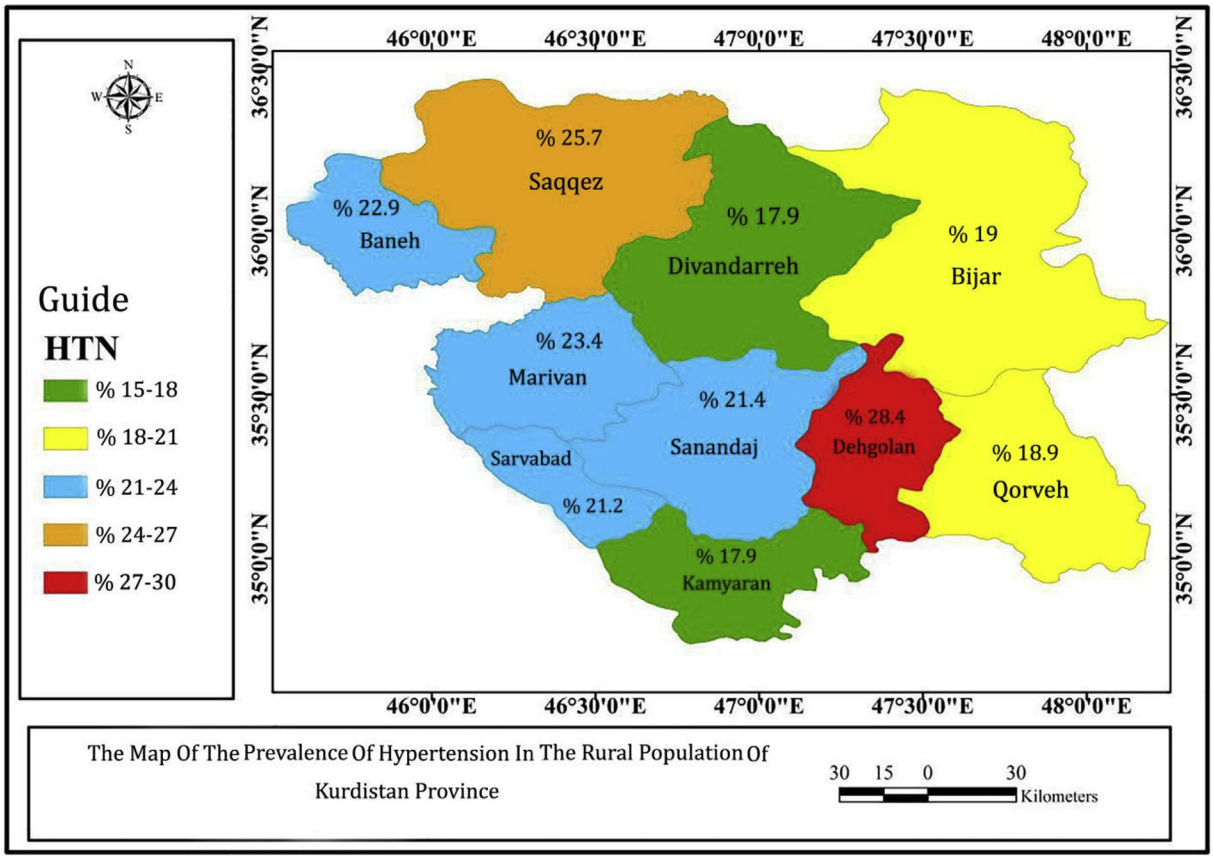

Fig. 1. Prevalence of hypertention in the rural population of Kurdistan province.

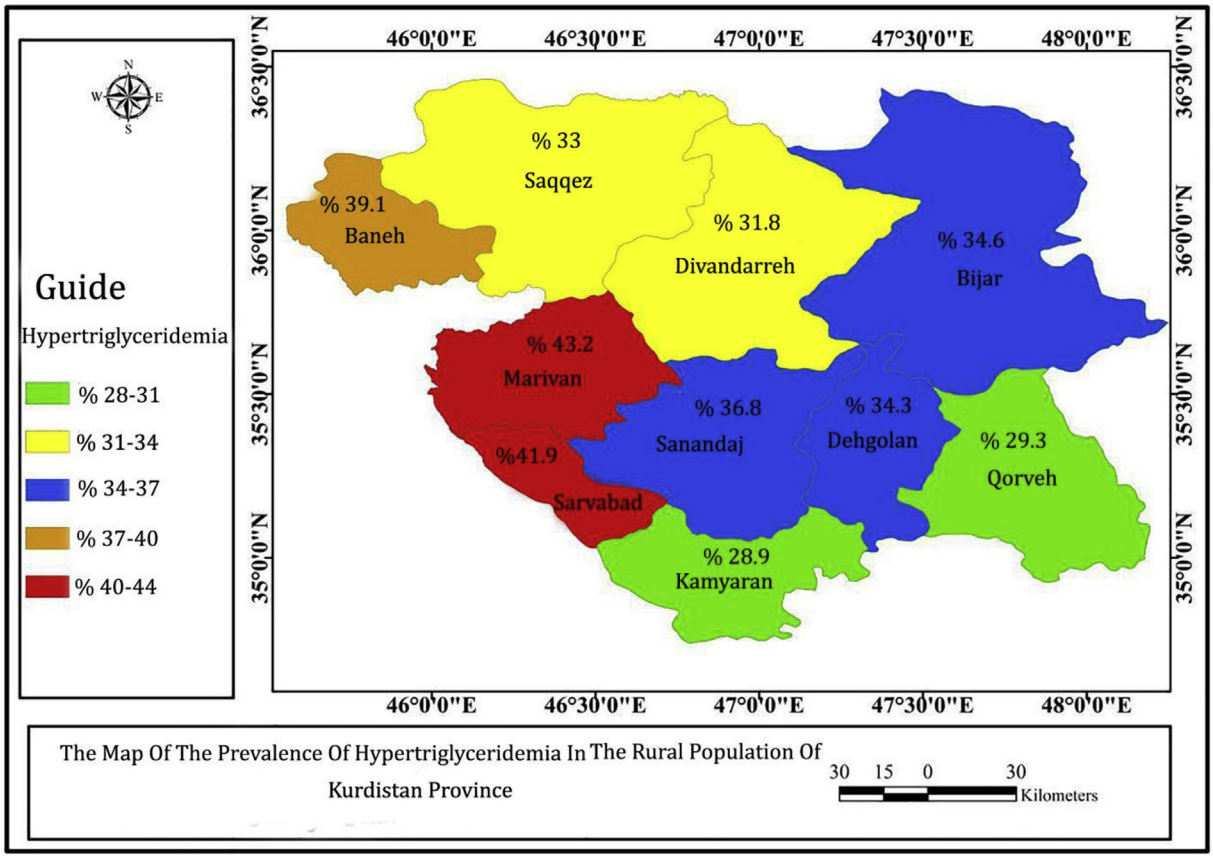

Fig. 2. Prevalence of hypertriglyceridemia in the rural population of Kurdistan province.

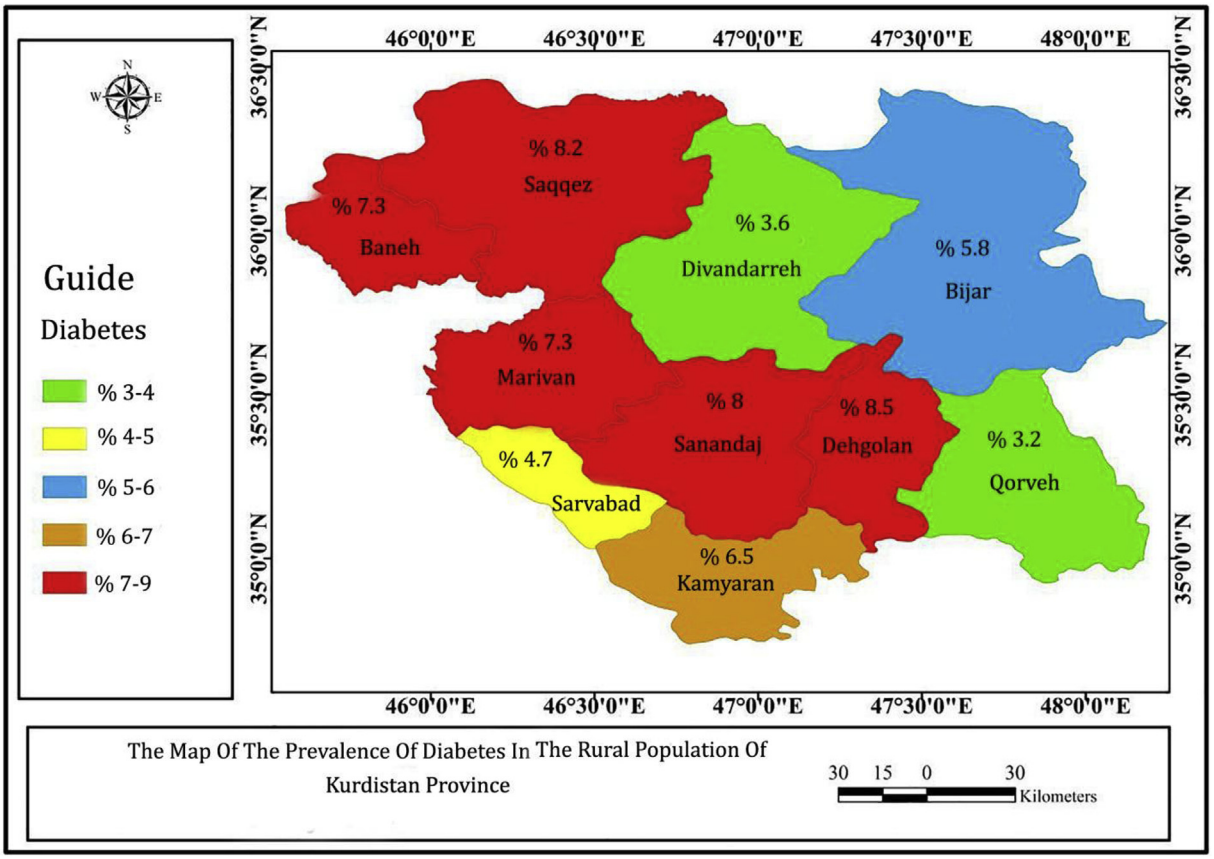

Fig. 3. Prevalence of diabetes in the rural population of Kurdistan province.

($p < 0.001$). Increasing the level of education increases the awareness of individuals. Educated people seem to be more aware about their lifestyle and also detects and prevents the symptoms of the disease faster. In general, people with higher levels of education are at a better social and economic condition. Therefore, lower carbohydrate intake and higher protein intake may be prevalent and this will reduce the incidence of diabetes.

In this study, the highest mean of blood pressure was reported in Dehgolan and the lowest in Divandarreh and Kamyaran. Geographic conditions can be a reason for people to be prone to hypertention. But genetics and life style seem to be a major factor in hypertention. Also, the highest hypertriglyceridemia prevalence was reported in Marivan and Sarvabad and the lowest in Kamyaran and Qorveh. Hypertriglyceridemia is associated with the type of nutrition and lifestyle. The consumption of animal oils in Kurdistan province is roughly high. In some cities, consumption is more than other cities in the province, which this difference in consumption is shown in the reported statistics.

According to the results, the highest frequency of diabetes was reported in the cities of Sanandaj, Dehgolan, Marivan, Saqqez, Baneh and the lowest levels of diabetes in Qorveh and Divandarreh. Also the most prevalence of metabolic syndrome was reported in Marivan and Sarvabad and the lowest in Qorveh and Kamyaran. Somewhat genetic can explain these results. But lifestyle is a major contributor to type 2 diabetes. Also, exercise, socioeconomic level, educational level can be important factors and contributing to the difference in statistics in the cities of Kurdistan province.

In the present study, the prevalence of metabolic syndrome and diabetes in rural areas was higher than urban areas. A study by Teddy et al. (2013) aimed at investigating the prevalence of metabolic syndrome in urban and rural areas in the United States. The results showed that the prevalence of metabolic syndrome in the villages was higher than the urban population [22], which the results are consistent with the present study. But our study is in contrast with the study of Lee et al. (2016) with the aim of evaluation of the prevalence of metabolic syndrome in China, as the researchers concluded that the prevalence of this syndrome was higher in urban areas [23]. In this regard, the results of Yang et al. (2010) study to determine the prevalence of type 2 diabetes among urban and rural men and women indicate high prevalence of type 2 diabetes in urban residents compared with villagers (11.4% vs. 8.2%) [20]. These results are contradictory with the present study. According to Zhou et al. (2015), the prevalence of diabetes in rural areas is higher than urban areas, which is consistent with the present study [24]. An increase in the prevalence of diabetes in rural areas can be due to undesirable nutritional habits, geographical conditions, as well as a lack of awareness about proper nutrition, timely diagnosis of diabetes and genetic differences in rural and urban populations. For example, polymorphisms of lipoprotein genes, cholesterol ester-transferor protein (CETP), and etc. can change the genetic predisposition to diabetes in different individuals.

According to the present study, a significant correlation was observed between the increase in body mass index and the increase in age with the incidence of metabolic syndrome. A study by Kashani et al. (2016) in Mazandaran showed that there is a significant correlation between increasing BMI and increasing age with metabolic syndrome. The results of this study are consistent with the present study [25]. A meta-analysis study was also conducted by Ray Lee et al. (2016) to determine the prevalence of metabolic

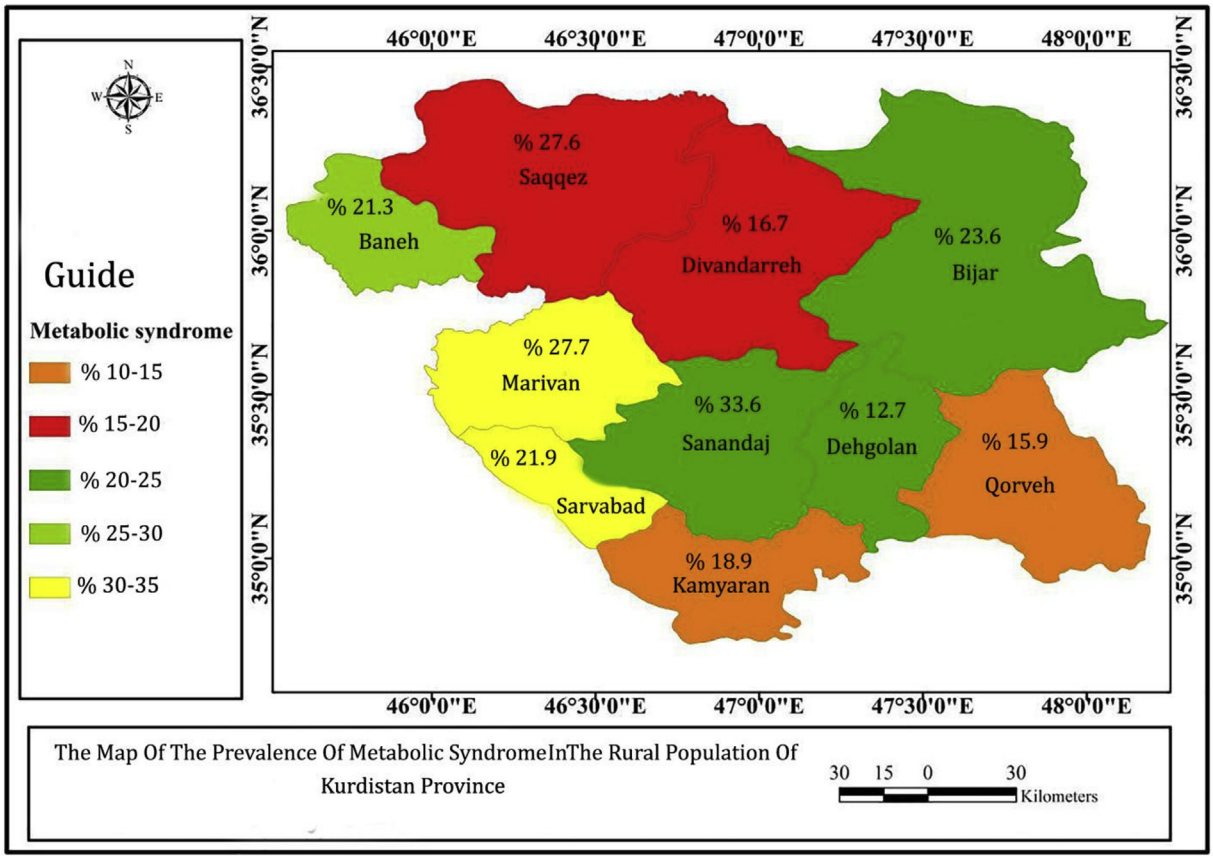

Fig. 4. Prevalence of metabolic syndrome in the rural population of Kurdistan province.

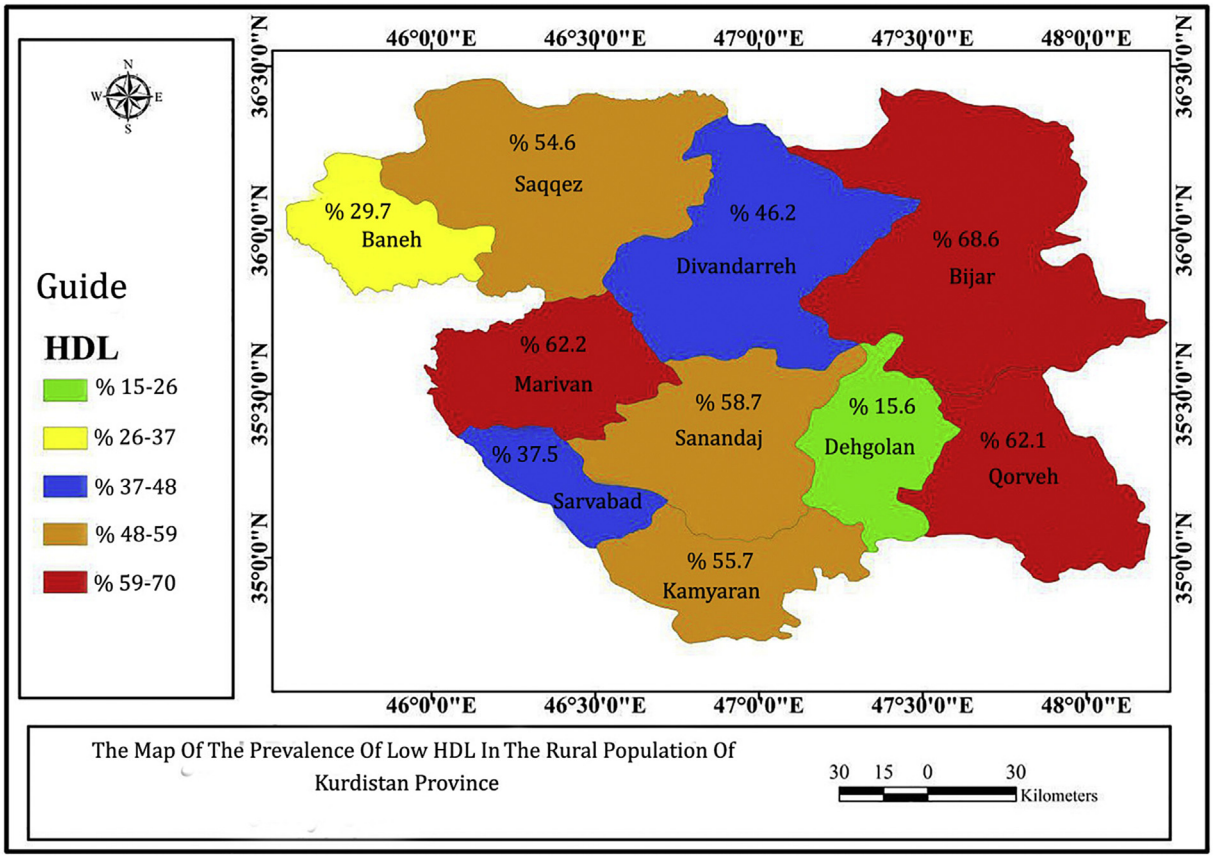

Fig. 5. Prevalence of loe HDL in the rural population of Kurdistan province.

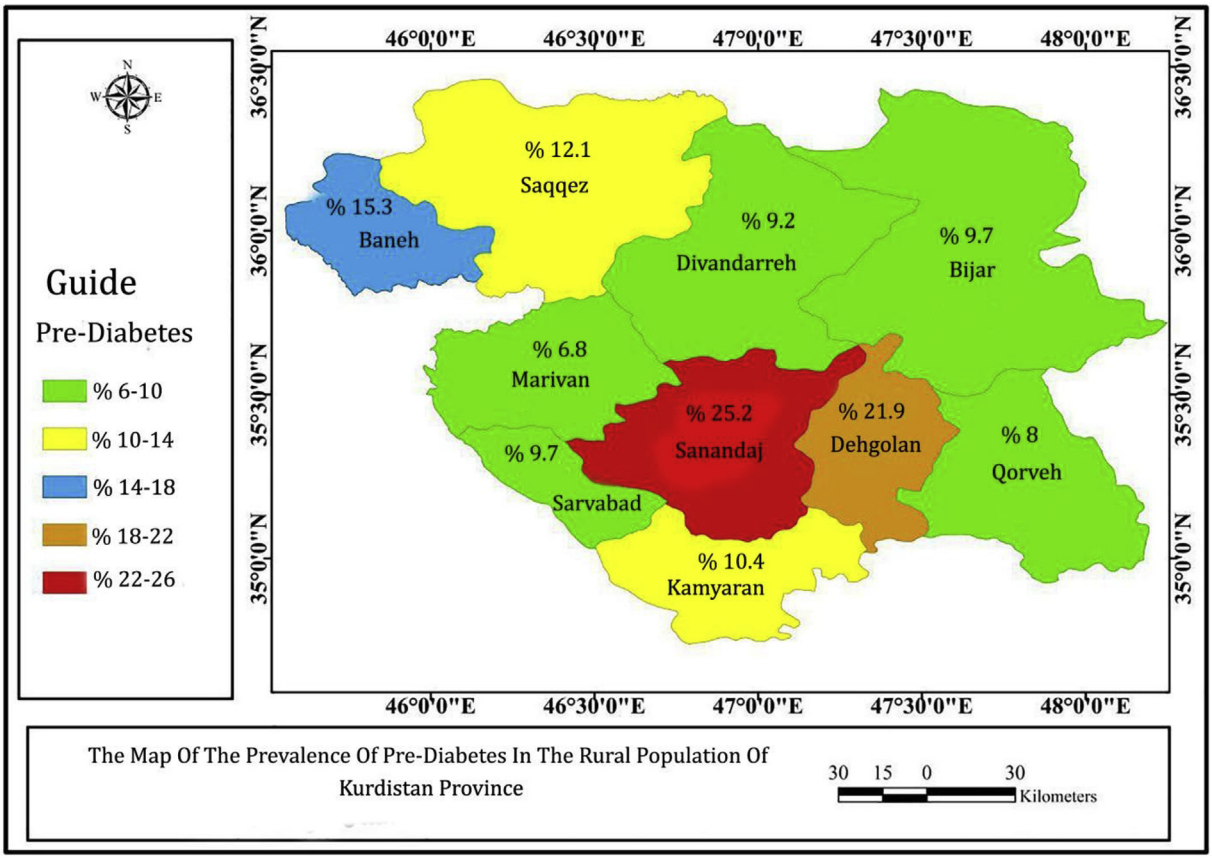

Fig. 6. Prevalence of pre-diabetes in the rural population of Kurdistan province.

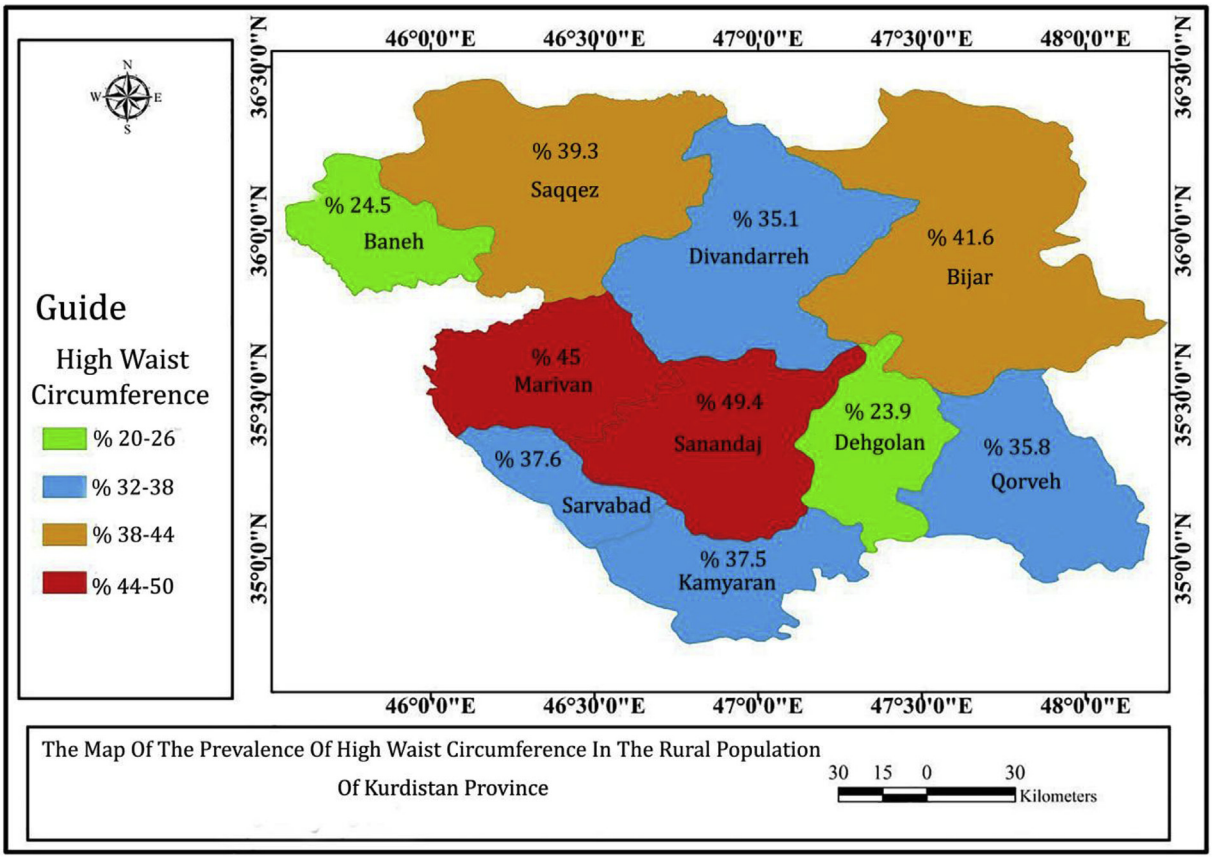

Fig. 7. Prevalence of high waist circumference in the rural population of Kurdistan province.

syndrome in China. In this meta-analysis, the overall prevalence of metabolic syndrome was 24.5%, which was 19.2% in men and 27.0% in women [23]. The results of this study were consistent with the present study. It seems that as the age increases and the base metabolism and mobility decreases, the amount of obesity increases, followed by the increase in the risk factors of the metabolic syndrome, namely increased blood lipids, inflammatory factors, and etc. and the highest prevalence of this syndrome has seen in women with high body mass index.

5. Conclusion

The results of this study showed that the prevalence of diabetes in the villagers of Kordestan province is moderate compared to the situation in Iran, but it has a high prevalence in metabolic syndrome (22.1% in our study as compared to 23.8% in Iran). This can be due to an increase in obesity, aging and lack of mobility, genetic differences, poor nutritional status, and lifestyle. Educational and healthcare interventions seem to be necessary to reduce these prevalences, especially among women and in older ages.

Conflicts of interest

The authors declare that they have no conflict of interest.

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