HUE UNIVERSITY
UNIVERSITY OF MEDICINE AND PHARMACY

NGUYEN THI HUONG

STUDY OF EPIDEMIOLOGICAL CHARACTERISTICS, RISK FACTORS AND PREDICTIVE VALUES OF METABOLIC SYNDROME IN THE POPULATION OF THUA THIEN HUE PROVINCE

DOCTORAL THESIS SUMMARY

HUE, 2022

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BACKGROUND

In the world and Vietnam, the metabolic syndrome is increasingly popular, being topical and associated with socio-economic development as well as human lifestyle. In recent years, the socio-economic development of Thua Thien Hue province has increased and people's lives have been gradually enhanced. Therefore, non-communicable diseases are also increasingly common, including diseases caused by cardiovascular disease and type 2 diabetes. The consequences of metabolic syndrome have put huge burdens on the economy and society and lead to high mortality risk. Hence, it is of great importance to providing effective prevention strategies.

To control non-communicable diseases in general, the World Health Organization calls for a variety of remedies, including the control of risk factors for non-communicable diseases. At once, it is recommended to use the STEPS toolkit (STEPwise Approach for Noncommunicable Disease Risk Factor Surveillance) is standardized to assess and monitor trends in NCDs risk factors in the country, which all nations can be not only used to follow trends in countries but also make the comparison between nations. In Thua Thien Hue province, a study by Doan Phuoc Thuoc showed that the prevalence of non-communicable diseases among the population in Thua Thien Hue province was being increased. Prevalence of people with hypertension, diabetes and lipid disorders is 44.1%, 8.1% and 62.9% respectively. Among them, the proportion of people who did not treat and treated irregularly was high. Meanwhile, grassroots health care is still not invested in and equipped to respond to the rapid increase of diabetes and cardiovascular disease in the community. Therefore, determining the value of some predictive indices of metabolic syndrome, especially in terms of simple indices, easy implementation, non-invasive, cheap price and effectiveness is to allow people to easily get access to those tests, simultaneously doctors at the grassroots levels can apply and implement to save costs for local people.

As a result of the above issues, to provide information for giving effective and appropriate strategies in the current context and be easy to make specific recommendations to prevent metabolic syndrome and identify the predictive indices of metabolic syndrome that can be applied at the primary healthcare level, we carried out this study with three following objectives:

1. To describe the epidemiological characteristics of metabolic syndrome in people aged 25 years and older in some regions of Thua Thien Hue province.

2. To the analysis of some risk factors of metabolic syndrome in research subjects

3. To estimate the value of some applied metabolic syndrome predictive indices in individuals and at primary health care levels

The scientific significance of the project:

This study helped us have a better understanding of the trends and epidemiological characteristics of metabolic syndrome in recent years. The risk factors of metabolic syndrome were specifically assessed according to a laddered approach in risk factor surveillance for non-communicable diseases (STEPS) and proved by case-control study design. The study provided the scientific basis for building predictive indices, referring to the value of several indices that have been studied in Vietnam and throughout the world.

The practical significance of the project:

The study helped to update the epidemiology of metabolic syndrome. This is a describing study in terms of the epidemiological characteristics of metabolic syndrome after 14 years compared with that of author Huynh Van Minh (2008) conducted in Thua Thien Hue province. From there, we can see the tendency to sustain metabolic syndrome among people and provide effective and appropriate strategies in the current context.

The results of the dissertation identify combinations of the metabolic syndrome components, especially the presence of the abdominal component combined with increased blood pressure, allowing grassroots health staff to decide on referrals on time so that people can detect risks early.

Risk factors for metabolic syndrome were specifically assessed according to a laddered approach in risk factor surveillance for noncommunicable diseases (STEPS) and were proved by a case-control study design. Therefore, it is easy to make specific recommendations for metabolic syndrome precautions.

Determining the value of some predictive indices of metabolic syndrome; in which anthropometric indices are simple, easy to implement, non-invasive, inexpensive and effective for people to have easy access, doctors on the baseline can apply.

Chapter 1
BACKGROUND

1.1. EPIDEMIOLOGICAL CHARACTERISTICS OF METABOLIC SYNDROME

1.1.1. The distribution of incidence of metabolic syndrome by space

The incidence of metabolic syndrome is increasing throughout the world. It is estimated that one-third of American adults suffered from metabolic syndrome. In some American countries, the prevalence of metabolic syndrome ranged from 23% to 50.3% depending on the study age and diagnostic criteria. In Europe, the prevalence of metabolic syndrome among the population was relatively high. In the Netherlands, the prevalence of people aged 45 to 65 was 29.2% and in France, the figure for people aged 16 years and over was 36. 0%.

In Asia, although Body Mass Index was often lower than that of Europeans, this did not mean that the prevalence of metabolic syndrome was low. The incidence of metabolic syndrome varied from nation to nation, the highest proportion was found in Saudi Arabia (39.8%) while the opposite pattern was true for Philippines (11.9%)

In Africa, metabolic syndrome prevalence ranged from 9.6% to 32.45% according to diagnostic criteria.

In Vietnam, the incidence of metabolic syndrome has varied in terms of the regions, diagnostic criteria and study subjects. In the northern provinces, the authors' study showed that the prevalence of metabolic syndrome ranged from 12.5% to 16.3%. In the central provinces and the central highlands and southern provinces, the figures ranged from 12.4% to 40.8% and 16.5% to 17.7%, respectively.

1.1.2. The distribution of metabolic syndrome prevalence by time

The studies based on data from national surveys conducted in countries such as the US, Korea, Taiwan, China and Sri Lanka all showed an increasing trend in metabolic syndrome. In Vietnam, for 10 years, the Ho Chi Minh City’s Nutrition Center conducted two epidemiological surveys on nutritional status and metabolic disorders in the year 2001 and 2008 showing that the prevalence of metabolic syndrome (IDF-2005) increased from 12.0% to 17.7%.

1.1.3. The distribution of metabolic syndrome prevalence by human characteristics

Age: Many studies showed that the tendency of sustaining metabolic syndrome has increased with age and become younger.

Gender: A variety of studies showed that the incidence of metabolic syndrome in women was higher than that in men.

1.1. RISK FACTORS OF METABOLIC SYNDROME

According to the risk factor approach for non-communicable diseases, risk behavioral factors are the main risk factors of metabolic syndrome. Obesity is a factor that plays a role in the pathogenes of metabolic syndrome. Other biometabolic factors act as components of metabolic syndrome.

1.2.1. Smoking

Smoking increases the risk of metabolic syndrome through the increase in insulin resistance, obesity and dyslipidemia. In the world, many studies have shown there was a relationship between smoking at different levels and risks of metabolic syndrome and smoking increases the risk of metabolic syndrome from 1.4 to 2.56 times compared with no smoking.

1.2.2. Inadequate physical activity

Inadequate physical activity promotes the development of obesity and decreases muscle insulin sensitivity, leading to an increased risk of metabolic syndrome. Studies throughout the world have shown that physical inactivity increases the risks of metabolic syndrome at different levels.

1.2.3. Harmful alcohol consumption

Several studies have found that there was a relationship between alcohol consumption and components of metabolic syndrome.

1.2.4. Unhealthy diet

- Insufficient vegetables/fruits: Low consumption of vegetables and fruits is a risk factor for non-communicable diseases. Many studies have found that there was a close relationship between the consumption of vegetables and fruits and metabolic syndrome prevalence.

- Salt consumption: Consuming a diet with high salt level contributes to hypertension and increases the risk of heart disease and stroke.

1.2.5. Being overweight, obesity

Many studies have shown that there was a relationship between being overweight and obesity and metabolic syndrome. Studies in India, China, Korea and Cambodia... showed the relationship between body mass index and metabolic syndrome. Studies in Vietnam by authors Do Van Luong and Nguyen Thi Nga indicated that the incidence of suffering from metabolic syndrome increases gradually with body mass index level.

1.3. SOME PREDICTIVE INDICATORS OF METABOLIC SYNDROME

In this research, we determined the value of some predictive indices of metabolic syndrome; in which anthropometric indices are simple, easy to implement, non-invasive, inexpensive and effective for people to have easy access, doctors on the baseline can apply.

1.3.1. Waist circumference

Many studies have been conducted to determine the predictive value of waist circumference for metabolic syndrome among ethnic groups. In some nations, studies showed that waist circumference values depended on ethnicity as shown in Table 1.1.

Table 1.1. Waist circumference threshold in predicting metabolic syndrome in some Asian countries across several studies

Nations	n	Metabolic syndrome prevalence	Waist circumference threshold in males (cm)	Waist circumference threshold in females (cm)
Japan	5972	32.8	84	80
Singapore	4723	17.9	90	80
India	640	29.9	90	80
Korea	31076	-	83	76
Iran	5332	30.4	89	86
China	47325	24.2	90	85
Saudi Arabia	12126	-	92	87

In Vietnam, Tran Huu Dang's study suggested that the waist circumference threshold to predict metabolic syndrome in Hue city was 89 cm for males (sensitivity was 100% and specificity was 90.99%) and 80 cm for females (sensitivity was 96.77% and specificity was 66.67%).

1.3.2. Waist-Hip Ratio

To assess visceral obesity, a computer cirglitar or resume resonance imaging can be used. However, there is an indirect approach by measuring the ratio of waist-hip ratio. The waist-hip ratio varies according to race. Some studies throughout the world showed that the waist-hip ratio had good value in terms of metabolic syndrome prediction.

1.3.3. Body Mass Index (BMI)

BMI has been widely used to measure obesity. However, the BMI does not reflect the distribution of fat in the body. Many authors around the world have studied and shown that at the appropriate cutting threshold, BMI had good value in metabolic syndrome prediction among local people.

1.3.4. Waist circumference/height ratio

Some studies in China and Iran showed that the WHtR index had good value in metabolic syndrome prediction in both males and females.

Chapter 2
SUBJECTS AND RESEARCH METHODOLOGY

2.1. Subjects of study

2.1.1. Subjects for a cross-sectional study

People aged 25 years and over in Thua Thien Hue province agree to participate in the study, except for those who are dumb, deaf, mental disorders affecting the mind and mental retardation or do not agree to participate in the study.

2.1.2. Subjects for a case-control study

People with MetS (Consensus 2009) were matched with people without MetS.

2.2. Research time

Cross-sectional study: From 5/2018 to 12/2018.

Case-control study: From 1/2019 to 3/2019.

2.3. Research methods

Study Design: A combination between a cross-sectional study and a case-control study

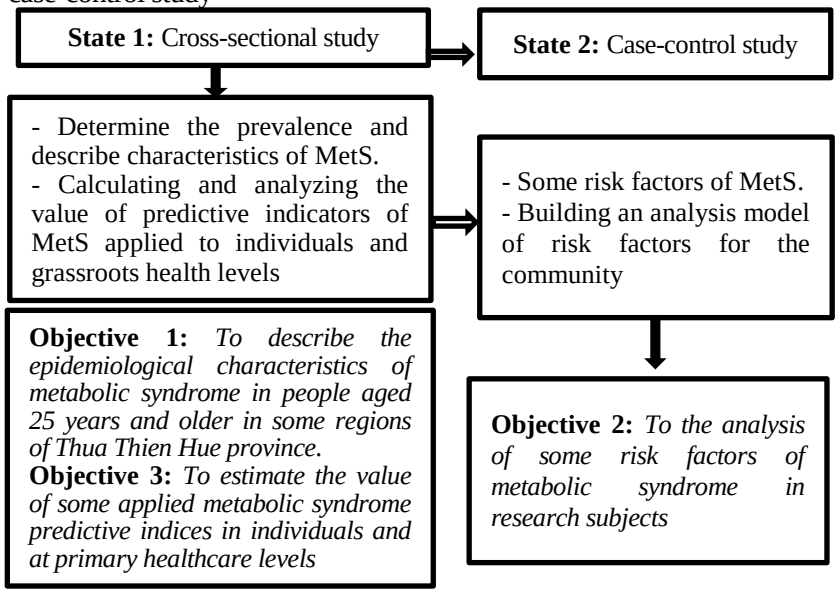

Figure 2.1. Two phases of study design

Sample size: The sample size in the cross-sectional descriptive study was 1600 people and in the case-control study was 154 pairs.

Sampling method:

In the cross-sectional descriptive study, a multi-stage randomized method was applied:

- Stage 1: Selecting 4 ecological zones.
- Stage 2: Selecting communes/wards in each ecological zone.
- Stage 3: Selecting research object.

In the case-control study, we conducted group pairing who are diagnosed with metabolic syndrome based on the consensus statement of IDF, AHA/NHLBI, WHF, IAS and IASO in 2009; the control group included subjects without components of metabolic syndrome and was paired with a disease group based on criteria including: the same age group (no more than 5 years difference), sex and geographical location.

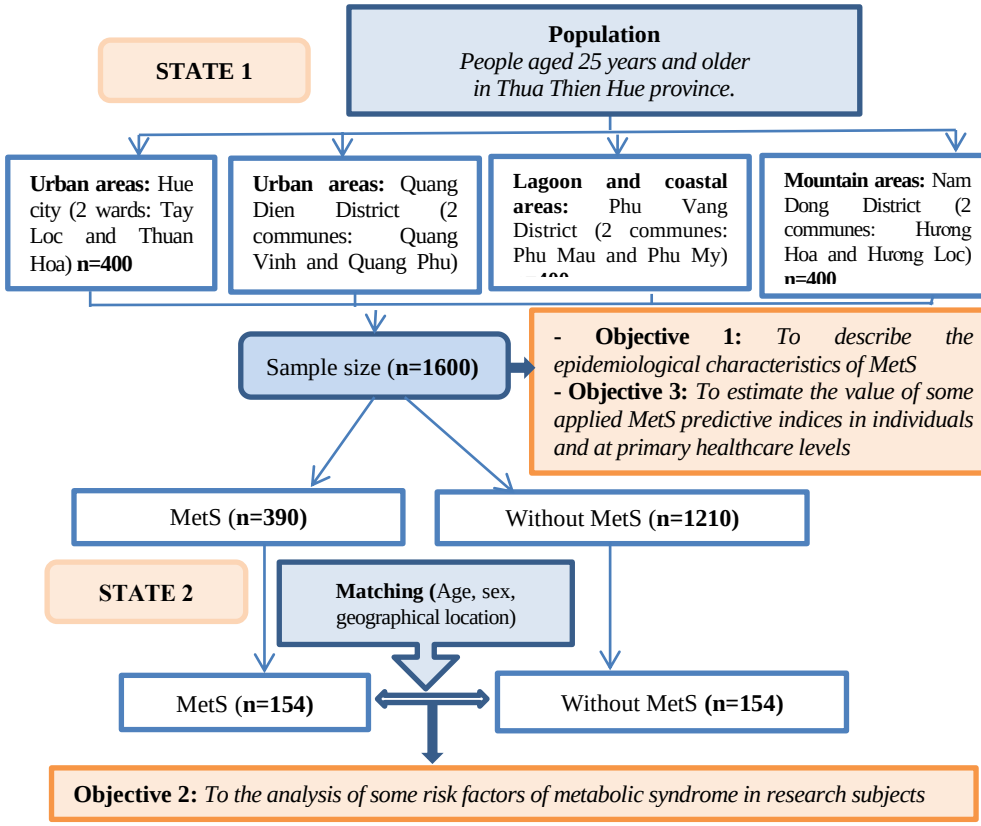

Figure 2.2. Summary of sample size and sampling method in two-stage of study design

Information collection: We arranged to collect information according to the following points: Administrative desk, blood sampling room, weighing and measuring, measuring blood pressure and interviewing people participating in the study.

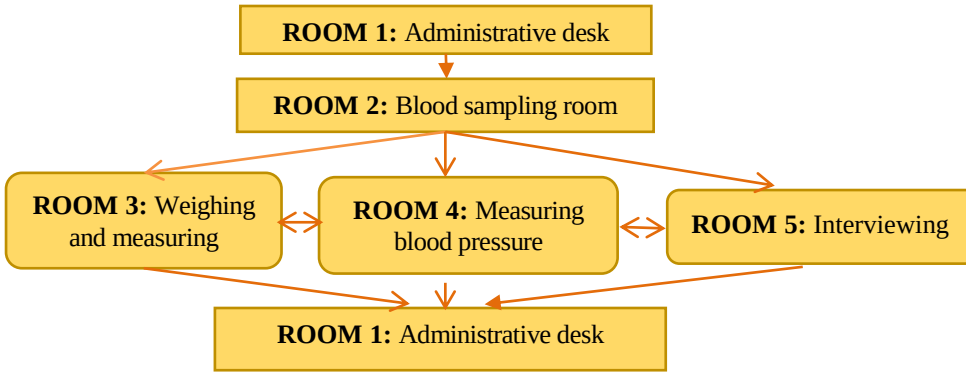

Figure 2.3. Arrangement of data collection

Evaluation methods:

- The diagnosis of metabolic syndrome was based on diagnostic criteria of the consensus statement of IDF, AHA/NHLBI, WHF, IAS and IASO in 2009:

+ Waist circumference ≥ 90 cm for males and ≥ 80 cm for females.

+ Hypertriglyceridemia: ≥ 1.7 mmol/L (150 mg/dL), or being treated with a triglyceride-lowering drug.

+ Decrease HDL-Cholesterol: < 1.03mmol/l (40mg/dl) for males and < 1.29mmol/l (50mg/dl) for females or being treated with drugs that increase HDL-Cholesterol.

+ Hypertension: Systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85 mm Hg, or previously diagnosed and treated hypertension.

+ Fasting plasma glucose increase to ≥ 5.6 mmol/l (100 mg/dl), or previously diagnosed with type 2 diabetes.

People were diagnosed of suffering from metabolic syndrome if having three or more three criteria mentioned-above.

- BMI = [Weight (kg)]/[Height (m)]^2
- Waist to Hip Ratio (WHR) = [Waist (cm)]/[Hip (cm)].
- Waist – to - Height Ratio (WHtR) = [Waist (cm)]/[Height (m)].

- The factors associated with metabolic syndrome were assessed according to World Health Organization regulations in investigating risk factors for non-communicable diseases.

2.4. Data processing and analysis

SPSS 20.0 and MedCalc software were used to analyze the data. In the cross-sectional descriptive study, we calculated the number, percentage, age-standardized prevalence estimated by the direct method using the 2020 Vietnam census population as the standard and analyzed ROC curve through the AUC parameter to evaluate the screening value of indicators in predicting metabolic syndrome. In the case-control study analyzed paired OR, McNemar's $\chi 2$ test was used for statistical testing. Factors in univariate analysis with $p < 0.25$ will be included into the conditional logistic regression model. Then we built a predictive model based on the results of multivariate regression analysis.

2.5. Ethics in research

The study was approved by the local people and authority and approved by the Medical Council of Hue University of Medicine and Pharmacy (No. H2018/350b) before conducting the study.

Chapter 3
RESEARCH RESULTS

3.1. Characteristics of the study subjects

The study was conducted among 1600 people aged 25 and over in Thua Thien Hue province, of which males accounted for 36.1% and the figure for females was 6.9%. The average age of respondents was 54.09. The education level of local people was mainly below high school (accounting for 90.04%). 48.6% of people were farmers and general lalorers. Most of the study subjects were living with their spouses (85.2%). There was 10.8% of local people with poor and near-poor household economies.

3.2. Epidemiological characteristics of metabolic syndrome among people in Thua Thien Hue province

3.2.1. Characteristics of suffering metabolic syndrome among people

The prevalence of metabolic syndrome was 24.4%.

The prevalence of people in Thua Thien Hue province is 19.4% (95% CI: 17.3 - 21.5).

There are 16 combinations to form MetS, of which there are 10 ways of combining 3 components, 5 ways of combining 4 components and 1 way of combining 5 components. MetS combined from 3 to account for 59.5%; in which the highest proportion is the combination of triglycerides, HDL-C, blood pressure (14.1%). MetS combines from 4 components accounting for 30.2%; in which the highest proportion is the combination of waist circumference, triglycerides, HDL-C, blood pressure accounting for 13.3%. MetS includes all 5 components, accounting for 10.3%. Abdominal circumference and blood pressure were present in 53.8% of MetS combinations.

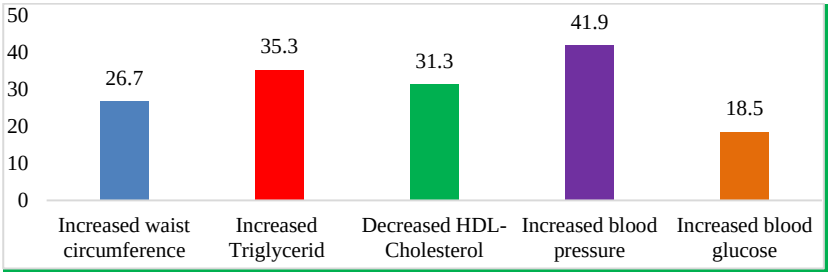

Figure 3.1. The component proportion distribution of metabolic syndrome among local people

Among components of metabolic syndrome, increased blood pressure accounted for the highest proportion (41.9%), increased blood glucose made up the lowest proportion (18.5%).

3.2.2. Epidemiological features of metabolic syndrome

Table 3.1. Epidemiological features of metabolic syndrome

Features \ MetS		Yes		No	
		n	**%**	**n**	**%**
Gender	Males	127	22.0	451	78.0
	Females	263	25.7	759	74.3
Age group (Year)	25-34	13	6.7	180	93.3
	35-44	35	14.6	204	85.4
	45-54	79	21.6	287	78.4
	55-64	128	33.0	260	67.0
	≥ 65	135	32.6	279	67.4
Education level	Illiteracy and primary education	190	27.5	500	72.5
	Secondary and high education	163	21.6	593	78.4
	Intermediate, college, tertiary and postgraduate education	37	24.0	117	76.0
Profession	Farmers and general labors	140	18.0	638	82.0
	Business	50	27.3	133	72.7
	Civil servants	36	19.8	146	80.2
	At home/ Housewife	94	33.5	187	66.5
	Retirement/ Loss of working capacity	70	39.8	106	60.2
Marriage	Unmarried	11	18.6	48	81.4
	Got married	321	23.6	1042	76.4
	Divorced, separated, widowed	58	32.6	120	67.4
Economic status	Poverty and near poverty	43	24.9	130	75.1
	Normal	347	24.3	1080	75.6
Ecology	Urban areas	119	29.8	281	70.2
	Rural areas	79	19.8	321	80.2
	Lagoon and coastal areas	116	29.0	284	71.0
	Mountain areas	76	19.0	324	81.0
	Total	**390**	**24.4**	**1210**	**75.6**

The prevalence of suffering from metabolic syndrome was 22.0% in males and 25.7% in females. The metabolic syndrome prevalence increased by age group, the lowest aged group was from 25- to 34-year-olds (6.7%). Meanwhile, groups aged 55-64 and ≥ 65 accounted for high proportion, with 33.0% and 32.6%, respectively. People with general

labor occupation suffering from metabolic syndrome were lower than other groups (18.0%); primary school education and illiteracy suffering from metabolic syndrome (27.5%) were higher than other groups; divorced/separated/widowed groups consists of high prevalence in terms of suffering from metabolic syndrome (32.6%). The metabolic syndrome prevalence in urban and lagoon/coastal areas was higher than that of rural and mountainous areas (29.8% and 29.0% compared with 19.8% and 19.0%, respectively).

3.3. Risk factors for metabolic syndrome

3.3.1. Pairing characteristics of research subjects

The disease and control groups were matched with the same sex, ecological region and the difference in age was not more than 5 years. Education levels, marriage and economic status in disease and control groups were incomparable (p>0.05).

3.3.2. Risk factors for metabolic syndrome

3.3.2.1. Univariate analysis

Table 3.2. The relationship between smoking habits and metabolic syndrome

Smoking habit		Control		Total	95% CI	p
		Yes	No			
Disease	Yes	6	42	**48**	2.6 1.5 – 4.7	< 0.001
	No	16	90	**106**		
Total		**22**	**132**	**154**		

There was a relationship between smoking habit and metabolic syndrome (p < 0.001). Smoking increased the risk of suffering from metabolic syndrome by 2.6 times (95% CI: 1.5 – 4.7).

Table 3. 3. The relationship between physical activity and metabolic syndrome

Physical activity at low level		Control group		Total	95% CI	p
		Yes	No			
Disease	Yes	9	28	**37**	2.8 1.4 -5.8	0.0035
	No	10	107	**117**		
Total		**19**	**135**	**154**		

There was a relationship between physical activity at low level and metabolic syndrome (p < 0.01). Physical activity at low level

increased the risk of suffering from metabolic syndrome by 2.8 times (95% CI: 1.4 – 5.8).

Table 3.4. The relationship between alcohol consumption habit and metabolic syndrome

Alcohol consumption at harmful and risky levels		**Control**		**Total**	**95% CI**	**p**
		Yes	**No**			
Disease	**Yes**	2	22	**24**	22.0 3.0 – 163.2	<0.001
	No	1	129	**130**		
Total		**3**	**151**	**154**		

The table showed that out of 154 pairs of disease - control, 129 pairs of both disease and control did not consume alcohol at harmful and risky levels, 2 pairs of both disease and control intaked alcohol at harmful and risky levels. Meanwhile, there were 22 pairs of disease groups consuming alcohol at harmful and risky levels compared with control group using alcohol at an acceptable level and only 1 pair of disease group did not consume alcohol at harmful and risky levels, while control group consumed alcohol. Therefore, 95% CI had extremely significant value (95% CI = 22.0, p<0.001).

Table 3.5. The relationship between vegetable/fruit consumption and metabolic syndrome

Inadequate vegetables /fruits intake		**Control**		**Total**	**95% CI**	**p**
		Yes	**No**			
Disease	**Yes**	80	47	**127**	2.4 1.4 – 4.0	0.00097
	No	20	7	**27**		
Total		**100**	**54**	**152**		

There was a relationship between inadquate vegetable/fruit consumption and metabolic syndrome prevalence (p < 0.001). Lacking of vegetable/fruit consumption increased the risk of suffering from metabolic syndrome by 2.4 times (OR: 2.4; 95% CI: 1.4 – 4.0).

Table 3.6. The relationship between salty eating habit and metabolic syndrome

Salty eating habit		Control		Total	95% CI	p
		Yes	No			
Disease	Yes	4	21	**25**	1.1 0.6 – 2.1	0.7518
	No	19	110	**129**		
Total		**23**	**131**	**154**		

The table showed that there was not a relationship between salty eating habits and metabolic syndrome prevalence ($p > 0.05$).

Table 3. 7. The relationship between being overweight/obese and metabolic syndrome

Being overweight/obese		Control		Total	95% CI	p
		Yes	No			
Disease	Yes	12	84	**96**	28 8.9 – 88.6	< 0.001
	No	3	55	**58**		
Total		**15**	**139**	**154**		

There was a relationship between being overweight/obese and suffering from metabolic syndrome ($p<0.001$). Being overweight/obese increased metabolic syndrome prevalence by 28 times (95% CI: 8.9 - 88.6).

3.3.2.2. Multi-variable logistic regression model and predictive model - Multivariate regression analysis

Table 3.8. Factors associated with metabolic syndrome according to multivariate analysis

Elements	OR	95% CI	p
Smoking	2.1	1.04 – 4.25	**0.039**
Physical activity at low level	2.2	1.02 – 4.57	**0.046**
Inadequate vegetables/fruits consumption	2.2	1.11 – 4.19	**0.023**
Alcohol consumption at harmful and risky levels	4.3	1.09 – 17.03	**0.037**
Being overweight/obese	14.7	7.64 – 28.28	**< 0.001**

Smoking increased the risk of metabolic syndrome by 2.1 times (95% CI: 1.04 – 4.25) compared with no smoking ($p < 0.05$).

Physical activity ay low level increased the risk of suffering from metabolic syndrome by 2.2 times (95% CI: 1.02 – 4.57) compared with physical activity at moderate and high levels ($p < 0.05$).

A diet lacking of vegetables/fruits increased the risk of suffering from metabolic syndrome by 2.2 times (95% CI: 1.11 – 4.19) compared with sufficient consumption group ($p < 0.05$)).

Alcohol consumption at harmful and risk levels increased risk of suffering from metabolic syndrome were 4.3 times (95% CI: 1.09 - 17.03) higher compared with acceptance level ($p < 0.05$).

Being overweight/obese increased risk of suffering from metabolic syndrome by 14.7 times (95% CI: 7.64–28.28) compared with being non overweight/obese group ($p < 0.001$).

- Predictive model based on risk factors

According to results of multi-variate regression analysis, we have built a predictive model of metabolic syndrome was based on the following risk factors:

Ln (p/(1-p)) = 0.74 * Smoking (a) + 0.77 * Physical activity at low level (b) + 0.77 * Insufficient intake of vegetables/fruits (c) + 1.46* Alcohol consumption at harmful and risky levels (d) + 2.7 * Overweight/obesity (e) – 1.82. Or p/(1-p) = e0.74a + 0.77b + 0.77c + 1.46d + 2.7e – 1.82

The predictive model for metabolic syndrome was based on factors such: Smoking, physical activity at low level, diet lacking of vegetables/fruits, alcohol consumption at harmful levels and risk and BMI, in which, BMI was a key factor.

3.4. Predictive indices for metabolic syndrome

3.4.1. The indices to assess obesity

Table 3.9. The value of obesity indices in predicting metabolic syndrome in males

Indices	Cut-off point	Sensitivity	Specificity	AUC
Waist circumference	> 82	78.6 63.2 – 89.7	88.3 84.9 – 91.1	0.85 0.80 – 0.90
BMI	> 22.76	67.7 58.8 – 75.7	84.0 80.3 – 87.3	0.81 0.78 – 0.84
WHR	> 0.88	73.8 58.0 – 86.1	76.5 72.3 – 80.3	0.799 0.735 – 0.863
WHtR	> 0.54	69.3 60.5 – 77.2	83.4 79.6 – 86.7	0.82 0.78 – 0.85

For men:

- Cut-off waist circumference > 82 cm has good value (AUC = 0.85; 95% CI: 0.80–0.90) in predicting MetS with sensitivity and specificity of 78.6% (CI95%: 63.2 – 89.7) and 88.3% (95% CI: 84.9 – 91.1) respectively.

- BMI is the index with good value (AUC = 0.81) in predicting MetS with cut-off > 22.76 kg/m2 (95% CI: 0.78 – 0.84) with the most sensitivity. and specificity was 66.7% (95% CI: 58.8 - 75.7) and 84.0% (95% CI: 80.3 - 87.3), respectively.

- WHR had a mean value (AUC = 0.799; 95% CI: 0.735 - 0.863) in predicting MetS at cut-off > 0.88 with a sensitivity of 73.8% (95% CI: 58.0 - 86.1).), specificity 76.5% (95% CI: 72.3 – 80.3).

- WHtR has a good value (AUC=0.82; 95% CI: 0.78 – 0.85) in predicting MetS at cut-off > 0.54 with sensitivity 69.3% (95% CI: 60, 5 – 77.2); specificity 83.4% (95% CI: 79.6 – 86.7).

Table 3.10. The value of obesity indicators in predicting metabolic syndrome in females

Index	**Cut-off point**	**Sensitivity**	**Specificity**	**AUC**
Waist circumference	> 73	91.3 82.0 – 96.7	80.1 77.1 – 82.9	0.844 0.81 – 0.88
BMI	> 22.72	64.3 58.1 – 70.1	75.2 72.0 – 78.3	0.76 0.73 – 0.79
WHR	> 0.83	84.1 73.3 – 91.8	68.0 64.5 – 71.3	0.792 0.744 – 0.839
WHtR	> 0.51	76.1 70.4 – 81.1	78.8 75.7 – 81.6	0.85 0.82 – 0.87

For women:

- Cut-off waist circumference >73 cm has a good value (AUC = 0.84; 95% CI: 0.81 - 0.88) in predicting MetS with sensitivity and specificity of 91.3% (CI 95%: 82.0 – 96.7) and 80.1% (95% CI: 77.1 – 82.9) respectively.

- WHtR has a good value (AUC = 0.85; 95% CI: 0.82 - 0.87) in predicting MetS at cut-off > 0.51 with a sensitivity of 76.1% (95% CI: 70, 4 – 81.6), specificity 78.8% (95% CI: 75.7% - 81.6%).

- WHR has a mean value (AUC = 0.792; 95% CI: 0.744 - 0.839) in predicting MetS at cut-off > 0.83 with sensitivity 84.1% (95% CI: 73.3 - 91.8)), specificity 68.0% (95% CI: 64.5 – 71.3).

- BMI is the index with the average value (AUC = 0.76, 95% CI: 0.73 - 0.79) in predicting HCC with cut-off of 22.72 with the most valuable sensitivity and specificity were 64.3% (95% CI: 58.1 – 70.1) and 75.2% (95% CI: 72.0 – 78.3), respectively.

Chapter 4
DISCUSSION

4.1. EPIDEMIOLOGICAL CHARACTERISTICS OF METABOLIC SYNDROME

4.1.1. The prevalence of metabolic syndrome among people in Thua Thien Hue province

Along with the socio-economic development, in recent years, the incidence of MetS is increasingly popular. Although the MetS prevalence depends on many factors such as: age, gender, geography and diagnostic criteria... However, in all regions of the world as well as Vietnam, the MetS prevalence is increasing. According to our research results, the proportion of people suffering from MetS (Consensus 2009) accounted for 24.4%. Several studies throughout the world with the same diagnostic criteria showed a higher incidence compared with our study such as Sigit F. S in the Netherlands (29.2%), Colombet Z. in France (36.0%).), Klongthalay S. in Thailand (32.7%), Harikrishnan S. in India (33.0%), Wang X. in China (30.0%). However, our research results were higher than some authors namely Harikrishnan S. in Indonesia (21.66%) or Huh J. H. in Korea (20.3%). In Vietnam, our research results were higher than those of authors Tran Quang Binh and Vo Thi De. Thus, not only in Vietnam but also in countries throughout the world are facing an increase in MetS. This might lead to the fact that it should have appropriate preventive strategies.

Regarding the results of our study, among the components of metabolic syndrome, increased blood pressure accounted for the highest proportion (41.9%), the lowest one was increased blood glucose (18.5%). In different studies, the incidence of components is incomparable. Research by author Do Van Luong (2015) in Thai Binh showed that the proportion of belly fat was the lowest, accounting for

5.5%; increased blood glucose made up 9.1%; increased triglycerides accounted for 28.5%; Hypertension accounted for 36.9% and the highest one was decrease in HDL-C, consisting of 49.8%. Author Tran Quang Binh (2015) in Ha Nam showed that among the components of metabolic syndrome, the most common index was dyslipidemia (with 47.2% of decrease in HDL-C and 39.9% of increase in triglycerides), followed by hypertension (26.7%), the figures for hyperglycemia and belly fat were 13.2% 4.2%, respectively despite of normal BMI index. The study by author Huynh Van Minh (2008) demonstrated that among the components of metabolic syndrome, HDL-C accounted for the highest percentage (52.1%), followed by increased blood pressure (34.0%), increased triglycerides consisted of 15%, and belly fat made up 13.7%. The study by author Nguyen Thi Nga (2017) found that the most common components were an decrease in HDL-C and an increase in triglycerides, with 39.3% and 31.7%, respectively.

4.1.2. Epidemiological characteristics of the metabolic syndrome among people in Thua Thien Hue province

Age: Our study results indicated an increasing trend in MetS by age group. These were similar to many studies in Vietnam and around the world. In Qatar, a study by M. H. Al-Thani was conducted among 2496 people from 18 to 64 years showed that the risk of MetS raised with age group, MetS prevalence was 3.4; 5.66; 10.25 and 18.24 times higher, respectively among people aged 30-39, 40-49, 50-59 and 40-64 compared to group aged 18-29 years. In Sri Lanka, the study of author Sivarathy Amarasinghe (2015) also showed that the prevalence of MetS increased gradually by age groups, group aged 18-34 increased by 9%, the figures for groups aged 35-49 and 50-64 rose by 14.8%; 36.6%, respectively. In China, Zhi Du's study among 10926 people aged 40 years and over showed that years of age increase to 10 years, the MetS increases 1.33 times. In India, the study of S. Harikrishnan showed that the older the age, the higher the prevalence of metabolic syndrome. The figure for 20-29 age group was 11.4%; group aged 30-39 was 16.5%, group aged 50-59 was 37% and groups aged 60-69 and 70-79 were 37.6%. In Ethiopia, a study by S. Kerie displayed that group aged 18-28 suffering from MetS was 0.36 times compared with other groups. In Vietnam, a study by authors Do Thi Ngoc Diep (2012) and Nguyen Thi Nga (2017) showed that the prevalence of metabolic syndrome increased

with age group. Nguyen Van Luong'study also showed the same result. Therefore, it is of great importance to provide appropriate prevention strategies for young people.

Gender: Our study results showed that the prevalence of metabolic syndrome in females was higher than males. Many studies around the world also found that the metabolic syndrome prevalence in females was higher than males such as Aguilar M. in the US, Wong-McClure R. A. in Central American countries, Harikrishnan S. in India... In Vietnam, the results were similar to our study as Do Van Luong's study (2015) in Thai Binh showed that the incidence of metabolic syndrome in men was 9.3%, the figure for women was 15.7%. Huynh Van Minh's study (2008) gave similar results, the incidences in females and males were 14.1% and 8.4%, respectively. The metabolic syndrome prevalence in women was more common than that of men, this can be also seen in the study by authors Vo Thi Easy and Do Thi Ngoc Diep.

Education: Our study results showed the percentage of suffering from metabolic syndrome was 27.5% among people with illiteracy and primary education group, higher than that of author groups such as middle and high school education (with 21.6%), and tertiary and postgraduate (with 24.0%) with $p<0.05$. This result was similar to S. Harikrishnan's study in India showing that those who completed grade 10 or higher were less likely to suffer from metabolic syndrome than those who were illiteracy. In Canada, study by Wiliane J. T. Marbou among 604 people aged 20 years and over found that primary and secondary education had a higher incidence than college or higher.

Occupation: Occupation had associated with energy consumption level during labor. Morgagni described the MetS as common among people with working characteristics such as reading books, having a quiet life, having working time more than physical activity, consuming excess energy meals – this means no manual workers and heavy physical activity. Our results showed that farmer and general labor groups had lower incidence compared to other groups. These results were comparable with some studies in Vietnam and around the world.

Marriage: Mental trauma, the combination of biological reactions in terms of perception and attitude between the individuals and the habitat, the effects of neuro secretion promote fat development, especially

visceral fat and cause insulin resistance. In personal circumstances such as good quality of life and happy marriage, there is less risk of suffering from metabolic syndrome and its elements. Our study results showed a high incidence of MetS among people with divorced, separated and widowed marriages (32.6%). Our results were similar to those of some authors in Vietnam and around the world.

Economy: The development of the economy and society makes the disease model has changed. In many studies, the economy has been associated with metabolic syndrome prevalence. However, the relationship between economic status and metabolic syndrome prevalence has not been found in our study.

Geography: Along with the development of globalization, and urbanization, the incidence of non-communicable diseases is increasingly popular. Besides, the prevalence of MetS in urban areas is higher than that in rural areas. In most studies, MetS prevalence in urban areas is higher than in rural areas. The study by Sivarathy Amarasinghe (2015) conducted among 544 people aged 18 and over in Sri Lanka showed the metabolic syndrome prevalence in rural and urban areas was 21.6% and 32.5, respectively. In Vietnam, this trend has also shown. This reflects the effects of urbanization on metabolic syndrome including disorders associated with sedentary lifestyles and imbalanced eating habits. The study by Tran Quang Binh (2015) found that the incidence of metabolic syndrome was associated with residential area. In Huynh Van Minh's study (2008), people living in the city had a higher incidence of metabolic syndrome than that in other areas. The study by Do Thi Ngoc Diep in Ho Chi Minh City showed that people living in the inner city had a higher incidence compared with suburban areas. Our study results also showed a high prevalence of metabolic syndrome in urban and coastal areas. Therefore, it is necessary to provide appropriate policies with a local context.

4.2. RISK FACTORS OF METABOLIC SYNDROME

Smoking: Our study results found that there was a relationship between smoking and metabolic syndrome. Many studies in different regions of the world have shown similar results to our sample. In Europe, a meta-analysis of 13 studies among 56691 participants demonstrated that active smokers increased risk of suffering from metabolic syndrome to 26% compared with non-smokers. In Asia, studies in Thailand, Saudi Arabia, Sri-Lanca showed that smoking

increased the risk of suffering from metabolic syndrome by 1.4 to 2.65 times compared with non-smokers. In South America, a study by Bermudez et al in Venezuela showed that smoking increased the risk of suffering from metabolic syndrome by 1.54 times compared with no smoking (95% CI: 1.11 – 2.14; p = 0.010). In Vietnam, a study by author Do Van Luong et al (2013) in Thai Binh showed that smoking increased the risk of suffering from metabolic syndrome.

Alcohol consumption: There were significant differences in terms of the effects of alcohol consumption on individuals. The process of metabolizing alcohol in the body varies up to 2-3 times, depending on factors such as age, sex, genetics, the level of metabolism in livers. This affects differently on each individual based on the amount of consumption. Therefore, many studies throughout the world showed the influence of different levels of alcohol consumption on MetS. In Europe and the US, many studies indicated the association between alcohol consumption and MetS.

Physical activity: Lacking of physical activity promotes the development of obesity and decreases muscle insulin sensitivity, leading to an increase in suffering from risks of MetS. Many studies have shown that lacking of physical activity was a risk factor of MetS. Our study results showed that there was a relationship between the level of physical activity and MetS. The study by author Do Van Luong et al in 2015 found that people with moderate physical activity were 2.4 times higher incidence of MetS than individuals with a high level of physical activity ($p < 0.05$). The MetS prevalence among individuals with mild level of physical activity were 13.9 times higher compared with those who had severe physical activity ($p < 0.01$). The study by Sitotaw Kerie et al (2017) demonstrated that inadequate exercisers increased 2.61 times to suffer from MetS compared with adequate exercisers. In Ethiopia, a study by author S. Kerie showed that physical inactivity can raise the risks of suffering from MetS to 2.61 times. A study by author Sivarathy Amarasinghe (2015) conducted in Sri Lanka found that MetS prevalence among people with a sedentary lifestyle was 29.9% higher than those with moderate and vigorous physical activity (23.7%). In Korea, Yun Jin Kim's study indicated that women without doing exercise was related to the incidence of suffering from MetS.

Inadequate vegetable/fruit consumption: According to WHO recommendations, people should consume at least 400g of vegetables and fruits per day, equivalent to 5 servings of vegetables/fruits. Our study results showed that there was a relationship between insufficient vegetable/fruit consumption and MetS prevalence ($p< 0.05$). Many studies in the world and Vietnam showed the association between the intake of vegetables/fruits and MetS. In Taiwan, a study by author C. M. Liao et al showed that a diet rich in vegetables reduced the risk of suffering from MetS by 1.8 times. In Korea, Miso Lim et al conducted a 8-year follow-up study showed that people consuming regularly fruit (4 servings/day) had a lower incidence of MetS (2009 consensus) compared with those who consumed less fruit (1 serving/day), with HR=0.55, $p < 0.0001$ for men and HR = 0.57, $p < 0.0001$ for women. In Vietnam, the study by author Tran Kim Phung in 2011 showed that people who intaked adequate vegetables suffered from MetS 4.3% lower than those who consumed less vegetables by 22.3%, with $p < 0.05$. Therefore, the relationship between vegetable/fruit consumption and MetS was shown in our study as well as other studies in Vietnam and throughout the world.

Being overweight/obesity: Being overweight/obesity is directly associated with MetS. According to our study results, there was a relationship between being overweight/obesity and MetS ($p < 0.001$). Many studies showed the association between being overweight as well as obesity and MetS. In India, a study by author S. Harikrishnan demonstrated that the prevalence of MetS (ATP III) among overweight and obese people was 2.73 and 6.26 times higher than that of people with normal BMI ($p < 0.001$). In China, Zhi Du's study showed that BMI increased to one unit, the risk of MetS would increase to 1.4 times. In Cameroon, the study by author Williane J. T. Marbou found that there was a relationship between BMI and MetS with $p < 0.001$. In Korea, a follow-up study by author Yoon Hye Lee et al indicated that both obesity and visceral obesity were associated with an increase in developing risk of metabolic syndrome. In Vietnam, many studies showed that there was a relationship between being overweight as well as obesity and MetS. The research by author Do Van Luong showed that being overweight increased risk of suffering from MetS to 3.3 times compared with normal people. This risk increased up to 30-fold (OR = 31.2; $p < 0.001$) in obese subjects.

Predictive model: The combination of various risk factors often increases the prevalence of metabolic syndrome. Our study results showed that the predictive model of the risk factors for metabolic syndrome had the form: Ln (p/(1-p)) = 0.74 * Smoking (a) + 0.77 * Physical activity at a low level; (b) + 0.77 * Inadequate intake of vegetables/fruits (c) + 1.46* Alcohol consumption at harmful and risky (d) + 2.7 * Being overweight/ obesity (e) – 1.82. Or p/(1-p) = e0.74a + 0.77b + 0.77c + 1.46d + 2.7e – 1.82. Thus, the predictive model of metabolic syndrome was based on the following factors: Smoking, physical activity at low level, inadequate intake of vegetables/fruits, alcohol consumption at harmful and risky levels and BMI. In which, BMI was a key factor in the predictive model. Several studies throughout the world found that the combination of risk factors increased the prevalence of metabolic syndrome compared with individual factors. A meta-analysis of 11 interventional studies demonstrated that a lifestyle modification intervention (a combination of diet and exercise) was effective in alleviate the prevalence of metabolic syndrome and the severity of associated abnormalities among people suffering from metabolic syndrome. In China, Xin-Tong Li's study among 7424 Chinese adults found that compared with those who lacked physical activity and consumed less fruit and vegetables, people doing physical activity and consuming adequate fruit mitigated the risk of suffering from metabolic syndrome to the lowest level (OR = 0.69, 95% CI: 0.59-0.82), followed by adequate physical activity and insufficient consumption of vegetables (OR = 0, 74, 95% CI: 0.65 – 0.83).

4.3. PREDICTIVE INDICES OF METABOLIC SYNDROME

Obesity is a risk factor closely associated with insulin resistance and metabolic syndrome. Many studies in the world have focused on anthropometric and biochemical indices among people to detect metabolic syndrome. Among the analyzed indices, the anthropometric index can be performed easily, efficiently and non-invasively; however, central and visceral fat cannot be distinguished. Anthropometric indices are often applied in areas where medical resources are restricted.

4.3.1. Waist circumference

Waist circumference is the simplest and most common way to assess central obesity. Waist circumference is an easy, simple,

inexpensive indicator that is closely related to body fat. However, waist circumference also has certain limitations such as: Lack of a gold standard for comparison in assessing waist circumference in children, being difficult to measure and being inaccurate in people with BMI of 35 or more. But in the context that the physical conditions of primary health care facilities in Thua Thien Hue province are still difficult, waist circumference is an indicator that health workers can use to advise and people can self-monitor health to change behavior and go to higher medical facilities.

4.3.2. Body mass index

The results of our study show that BMI is a good index in men (AUC = 0.81) and average in women (AUC = 0.76) in predicting MetS. In men, the cut-off > 22.76 was the most valuable with sensitivity and specificity of 66.7% and 84.0%, respectively, and the Youden index 0.44. In women, the cut-off of 22.72 was the most valuable with sensitivity and specificity of 70.3% and 75.5%, respectively, and the Youden index of 0.39. BMI has been widely used to measure obesity. However, BMI does not reflect body fat distribution, which is an important limit of BMI because MetS is more closely related to visceral obesity than obesity.

4.3.3. Waist-to-hip ratio (WHR)

Like waist circumference, the waist-to-hip ratio is also a central obesity indicator. There is a correlation between central obesity and the distribution of visceral fat. To evaluate people can use computed tomography or magnetic resonance imaging. However, indirectly by measuring the waist-to-hip ratio. Thus, it will save costs for people, especially where economic conditions are limited.

However, the waist-to-hip ratio also has limitations such as: Inability to distinguish fat from lean mass around the hips. Difficult to measure (especially buttock) and less accurate in people with a BMI of 35 or higher.

4.3.4. Waist circumference/height ratio (WHtR)

The results of our study show that the waist circumference/height ratio has a good value in predicting MetS in men (AUC = 0.82) and women (AUC = 0.85). In men, the cut-off > 0.54 was the most valuable with a sensitivity of 69.3%; specificity of 83.4%, the Youden index 0.53. In women, the cut-off > 0.51 was the most

valuable with sensitivity of 76.1%, specificity of 78.8%, the Youden index 0.55. Several studies around the world show that waist circumference/height ratio (WHtR) is the best predictor for detecting risk factors related to cardiovascular diseases. According to the results of the study Xiang-Hui Zhang, the WHtR index has a predictive value of MetS in men and women (with AUC of 0.872 and 0.804 respectively) with the optimal cutoff of 0.53 and 0.52 respectively. For Iranian elderly, the waist circumference/height ratio is the anthropometric index with the highest value in predicting MetS (AUC: 0.786, 95% CI: 0.76 – 0.81). In Thailand, Siwarom's study showed that WHtR had very good value in predicting MetS in male and female adolescents with a cutoff of 0.5. Research by Swainson M. G shows that compared to other obesity indicators, the waist circumference to height ratio is the most accurate indicator of the ratio of body fat and visceral adipose tissue. Cut-off WHtR > 0.53 in men and WHtR > 0.54 in women were valid for obesity and WHtR > 0.59 was valid for visceral obesity in both sexes.

In Thua Thien Hue province, non-communicable diseases increased rapidly. Meanwhile, grassroots health care is still not invested and equipped to respond to the rapid increase of diabetes and cardiovascular disease in the community. The results of our study provide more evidence that using the WHtR index has a good predictive value for MetS and can be applied at primary healthcare levels. Ashwell's proposal for a threshold > 0.5 and using Ashwell's shape chart for people in Thua Thien Hue province is scientifically based, feasible and cost-effective for people. At the same time, staff at the grassroots health levels can use it to give appropriate advice to the people.

CONCLUSION

Through the study of 1600 people in Thua Thien Hue province, we had the following conclusions:

1. Epidemiological characteristics of metabolic syndrome among people in Thua Thien Hue province

The prevalence of metabolic syndrome among local people was 24.4%. The prevalence of people in Thua Thien Hue province is 19.4% (95% CI: 17.3 - 21.5). In terms of the disorder components,

increased blood pressure accounted for the highest proportion (41.9%), increased blood glucose (18.5%) was the lowest one.

The prevalence of metabolic syndrome accounted for 22.0% in men and 25.7% in women. The incidence of metabolic syndrome increased with age group. People with general labor occupation suffering from metabolic syndrome was higher than other occupational groups, the percentage of suffering from metabolic syndrome among people with primary education and illiteracy was more common than other groups, and divorced/separated/ married/widowed groups suffering from metabolic syndrome accounted for a high proportion. The prevalence of metabolic syndrome in cities and lagoons/coastal areas was higher compared with plain and mountainous areas.

2. Risk factors of metabolic syndrome

Risk factors of metabolic syndrome included: smoking, physical activity at a low level, inadequate dietary intake of vegetables/fruits, alcohol consumption at harmful and risky levels, being overweight, obesity.

The predictive model for metabolic syndrome was based on factors: smoking, physical activity at a low level, inadequate dietary intake of vegetables/fruits, alcohol consumption at harmful and risky levels, and BMI. In which, BMI was a major factor. This model had the form: Ln (p/(1-p)) = 0.74 * Smoking (a) + 0.77 * Physical activity at low level (b) + 0.77 * Inadequate dietary intake of vegetables/fruits (c) + 1.46* Alcohol consumption at harmful and risky levels (d) + 2.7 * Being overweight/obese (e) – 1.82. Or $p/(1-p) = e^{0,74a + 0,77b + 0,77c + 1,46d + 2,7e – 1,82}$

3. Estimating the value of some applied metabolic syndrome predictive indices in individuals and at primary health care levels

Indicators with the good predictive value of metabolic syndrome are: waist circumference in men and women, waist-to-height ratio in men and women, and body mass index in men. The cut-off for waist circumference in men was > 82 cm with a sensitivity and specificity of 78.6% (95% CI: 63.2 – 89.7) and 88.3% (CI 95%: 84.9 – 91.1) respectively. The cut-off for waist circumference in women is > 73 cm with a sensitivity and specificity of 91.3% (95% CI: 82.0 – 96.7) and 80.1% (95% CI: 77.1 – 82.9), respectively. In men, the cut-off waist-to-height ratio > 0.54 had a sensitivity of 69.3% (95% CI: 60.5

– 77.2); specificity of 83.4% (95% CI: 79.6 – 86.7). In women, the cut-off > 0.51 with a sensitivity of 76.1% (95% CI: 70.4 – 81.6); specificity 78.8% (95% CI: 75.7% - 81.6%). Body mass index has good value in predicting metabolic syndrome in men with cutoff > 22.76 kg/m2 (95% CI: 0.78 – 0.84); sensitivity 66.7% (95% CI: 58.8 – 75.7) and specificity 84.0% (95% CI: 80.3 – 87.3).

Indicators with average values in predicting metabolic syndrome are body mass index in women, waist-to-hip ratio in men and women.

RECOMMENDATIONS

It is of great importance to promoting effective communication activities to enhance health, guiding local people to change lifestyle behaviors, diets, self-care behaviors and proactively have access to health services to be consulted for treatment in the best condition.

Healthcare workers at health stations and the public can use anthropometric indices in metabolic syndrome screening. These indices are simple assessment, easy implementation, non-invasive, cheap price and efficiency.

PUBLICATIONS AND PRESENTATIONS

A. Publications

1. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2018), Cut-off values of waist circumference and waist-to-hip ratio for predicting metabolic syndrome among the population in two communes, Quang Dien district, Thua Thien Hue province, *Journal of Medicine and Pharmacy*, 8(6), pp. 27-33.
2. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi, Doan Pham Phuoc Long, Nguyen Thi Huyen (2019), Cut off values of lipid accumulation product and visceral adiposity index for predicting Metabolic Syndrome among the population in two communes, Quang Dien district, Thua Thien Hue province, *Journal of Vietnamese Cardiology*, no. 88, pp. 292-298.
3. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2019), Comparisons of some obesity indices in the prediction of Metabolic Syndrome among the population in Quang Dien district, Thua Thien Hue province, *Ho Chi Minh City Journal of Medicine*, Supplement of Vol. 23, No. 5, pp. 154-160.
4. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2021), Studying on the epidemiological characteristics of metabolic syndrome among people in Thua Thien Hue province, *Journal of Vietnamese Cardiology*, No. 88, pp. 292-298.
5. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2022), Value of the waist-to-height ratio in the prediction of metabolic syndrome in a population of Thua Thien Hue province, *Journal of Medicine and Pharmacy*, 12 (3), pp. 121-125.

B. Presentations

1. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2018), Cut off values of waist circumference and waist-to-hip ratio for predicting metabolic syndrome among the population in two communes, Quang Dien district, Thua Thien Hue province. Oral presentation at the 10th postgraduate workshop of Hue University of Medicine and Pharmacy, November 17th, 2018.

2. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi, Doan Pham Phuoc Long, Nguyen Thi Huyen (2019), Cut-off values of lipid accumulation product and visceral adiposity index for predicting Metabolic Syndrome among the population in two communes, Quang Dien district, Thua Thien Hue province. Oral presentation at The 10th Central Vietnam Open Congress of Cardiology, July 13th, 2019.
3. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2019), Comparisons of some obesity indices in the prediction of Metabolic Syndrome among the population in Quang Dien district, Thua Thien Hue province. Oral presentation at the 20th Youth Science and Technology Conference of Hue University of Medicine and Pharmacy, December 28th, 2019.
4. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2019), Clinical surrogate marker for predicting metabolic syndrome among the population in two communes, Quang Dien district, Thua Thien Hue province. Oral presentation at the 3rd National and International Conference on Health Challenge in Sustainable Development Goals (SDGs): "Health Screening and Surveillance: PM2.5, Cancer and Suicide", Khon Kaen, Thailand, July 22-23th, 2019.
5. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi (2019), Comparison of some obesity indices in the prediction of Metabolic Syndrome among population in two communes of central Viet Nam. Oral presentation at the 11th International Conference on Public Health among Greater Mekong Sub-Region Countries "Improving Health Equity among Greater Mekong Sub-Region Counties: A Public Health Challenge", Vientiane Capital, Lao PDR, October 18-19th, 2019.
6. Nguyen Thi Huong, Doan Phuoc Thuoc, Le Van Chi, Doan Pham Phuoc Long, Nguyen Thi Thuy Hang (2021), Value of obesity indices in the prediction of metabolic syndrome in the population of Thua Thien Hue province. Oral presentation at the 20th Youth Science and Technology Conference of the Ministry of Health, November 25-27th 2021

C. Awards

1. Second prize at the 10th postgraduate workshop of Hue University of Medicine and Pharmacy, November 17th, 2018.
2. First prize at the 20th Youth Science and Technology Conference of Hue University of Medicine and Pharmacy, December 28th, 2019.
3. Outstanding Oral Presentation Award at the 3rd National and International Conference on Health Challenge in Sustainable Development Goals (SDGs): "Health Screening and Surveillance: PM2.5, Cancer and Suicide", Khon Kaen, Thailand, July 22-23th, 2019
4. First prize at the 20th Youth Science and Technology Conference of the Ministry of Health, November 25-27th 2021.
5. The publications of research belonging to the cluster of works are recognized for the 4th Ancient Capital Award for Science and Technology in 2021.