MINISTRY OF EDUCATION AND TRAINING MINISTRY OF HEALTH
THAIBINH UNIVERSITY OF MEDICINE AND PHARMACY

PHAM THI VAN ANH

THE PREVALENCE OF METABOLIC SYNDROME, SOME RELATED FACTORS AND EFFECT OF INTERVENTION AMONG ADULTS FROM 25-64 YEARS OLD IN THAI BINH PROVINCE

PHD DISSERTATION IN PUBLIC HEALTH

Code: 9720701

THAIBINH, 2023

THE COMPLETED DISSERTATION

AT THAIBINH UNIVERSITY OF MEDICINE AND PHARMACY

Supervisors: **1. Dr. Le Duc Cuong MD, PhD**

2. Assoc.Prof.Dr. Ninh Thi Nhung

Reviewer 1: Prof. Dr. Pham Duy Tuong

Reviewer 2: Assoc.Prof.Dr. Truong Tuyet Mai

Reviewer 3: Assoc.Prof.Dr. Nguyen Thi Thuy Duong

The thesis will be presented to the University Dissertation Evaluation Commitees of the Thaibinh University of Medicine and Pharmacy

At …….hour, date 2023

The thesis may be found at:

- National Library
- Library of Thaibinh University of Medicine and Pharmacy

LIST OF RELATED PUBLICATIONS

1. Pham Thi Van Anh, Le Duc Cuong, Ninh Thi Nhung (2022), Effectiveness of some dietary and lifestyle interventions for metabolic syndrome in people aged 25-64 years old in Thai Binh province. *Vietnam Journal of Science and Technology,* 12 (64), page 19 – 23.

2. Pham Thi Van Anh, Le Duc Cuong, Ninh Thi Nhung (2023), Factors related Metabolic Syndrome among adults from 25-64 years old in Thai Binh Province, *Journal of Comuunity Medicine*, 1 (64), page 71 – 78.

3. Pham Thi Van Anh, Le Duc Cuong, Ninh Thi Nhung (2023), The Prevalance of Metabolic Syndrome among adults from 25-64 years old in Thai Binh Province, *Journal of Comuunity Medicine*, 1 (64), page 186 – 193.

INTRODUCTION

Metabolic Syndrome (MS) is a cluster of conditions that occur together, These conditions include increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels [1]. MS tends to increase yearly and becomes the biggest community health issue today [2]. These metabolic disorders increase the risk of cardiovascular, diabetes, vascular, and neurological complications [3]. MS and its complication can be prevented and treated by a healthy lifestyle, suitable nutrition and physical activities.

In Vietnam, the prevalence of MS in the urban is higher than in the rural and tends to increase continuously in almost research. This reflects the effect of urbanization on MS, the syndrome includes disorders that related unbalanced eating habit and less activities. The prevalence of MS among people from 40-64 years old living in Red River Delta areas was 16.3% [4]. Thai Binh is an agricultural land area, living standards is improving, urbanization has been increasing rapidly, the lifestyle of people is changing, leading to change in the prevalence of MS. The prevalence of MS in Vu Thu District, Thai Binh province was 12.6% based on Do Van Luong [5]. This rate in 2018 was 40.4% according to Nguyen Viet Kinh [6]. Therefore, community comprehensive interventions are needed to control the components of MS, including improving knowledge of how people change their lifestyles and healthy eating habits to reduce the prevalence and mortality rate associated with MS.

From current situations, the questions are: what is the prevalence of MS among people from 25-64 years old in Thai Binh? What are factors related with MS and which comprehensive interventions that guide how people change their lifestyles an eating habits are effective in community to reduce the prevalence of MS in Thai Binh. These results suggest that building strategies and policies to prevent MS not only in Thai Binh but also in whole country is necessary. We conduct a study titled ***"The prevalence of Metabolic Syndrome, some related factors and effect of intervention among adults from 25-64 years old in Thai Binh province"*** with two objectives:

1. To describe the prevalence and related factors among adults aged 25-64 in Thai Binh province in 2019.

2. To evaluate the lifestyle and eating habits interventions on components of MS among adults aged 25-64 in Thai Binh province

Hypothesis

Metabolic syndrome tends to be more frequent. There are many components that make up MS, some components cannot be changed but some of which can be changed. Assume that interventions are implemented to control the components of MS with comprehensive solutions such as improving people's knowledge of how to change their lifestyle and healthy eating habits, and suitable physical activities to reduce the morbidity and mortality associated with MS.

Finding of the thesis

This research helps to better understand the recent trends in the prevalence of metabolic syndrome. The risk factors of metabolic syndrome are specifically evaluated using a stepwise approach in monitoring the risk factors of non-communicable diseases (STEPS). The study proposes comprehensive community interventions, thereby providing preventive solutions for metabolic syndrome for the people in Thái Bình province specifically, and Vietnam in general.

This is the first study on MS with adults aged 25-64 in Thai Binh, it updated the prevalence and found related factors affecting MS. The thesis found the tendency of MS in adults in agricultural province which are in the process of urbanization, to build effective strategies and suitable current context. Thesis also found the comprehensive interventions are low-cost and effective and easy to get to people not only in Thai Binh province but also in whole country.

Structure of the thesis

The thesis consists of 128 pages, 32 tables, 7 charts and 151 references, of which 108 references are foreign references. It includes 2 pages for the introduction, 32 pages for literature review, 23 pages for the object and methodology, 35 pages for the research findings, 32 pages for discussion and 3 pages for the conclusions and the recommendations

Chapter 1
LITERATURE RIVEW

1.1. Definition of Metabolic syndrome

1.1.1. Definition

The first international workshop about Insulin resistance was held on 21-22/11/2003 in Los Angeles, California, United States was recognized the syndrome and had a disease code in the international Classification of Diseases (ICD-9), which was 277.7 under the name Metabolic Syndrome. WHO definition was the first definition that tie together the main components, including insulin resistance, obesity, dislipidemia and hypertesion, at which, insulin resistance is the most important. A person, who must have insulin resistance and above components could be MS. However, this definition was not easy to apply to clinical and not suitable with large epidemiological studies [7].

Metabolic syndrome was described as a group of metabolic disorders that were associated with cardiovascular risks and predicted development of diabetes (if diabetes was not at that time)

1.1.2. Diagnosis standards for Metabolic Syndrome

- *WHO standard:* In 1998, World Health Organization (WHO) was the first organization who provided a diagnosis standard for MS. Insulin resistance was the compulsory component. Definite diagnosis was confirmed when person had an insulin resistance along with two of the risk factors (sub-criteria) [8].
- *European Group for the Study of Insulin Resistance (EGIR) standard:* to definite diagnosis must be hyperinsulinemia (criteria A) with at least two components of criterion B. EGIR used fasting insulin levels to assess insulin resistance and applied impaired fasting glucose (IFG) as an alternative to impaired glucose tolerance (IGT) [9].
- *National Cholesterol Education Program (NCEP/ATP III) standard:* Metabolic syndrome is present if three or more of the following five criteria are met: abdominal obesity, blood pressure, fasting triglyceride, fasting high-density lipoprotein (HDL) cholesterol and fasting blood sugar. This standard was widely used in epidemiological studies because it used routine tests and simple measuments [10].
- *International Diabetes Federation (IDF) standard:*

The IDF uses central obesity as a prerequisite for diagnosis. IDF provided cut off points for different ethnicities, ensures higher accuracy when applying this standard to worldwide. This method uses fasting blood glucose tests instead of hyperglycemia [11].

- *Metabolic syndrome defined by IDF and AHA/NHLBI, 2009*

The MS is present if three of more of following five components: abdominal obesity; Elevated triglycerides (drug treatment for elevated triglycerides is an alternate indicator); Reduced HDL-C (drug treatment for reduced HDL-C is an alternate indicator); Elevated blood pressure (antihypertensive drug treatment in a patient with a history of hypertension is an alternate indicator); Elevated fasting glucose (drug treatment of elevated glucose is an alternate indicator)

1.2. The current situation of metabolic syndrome

1.2.1. In the world

The prevalence of MS was determined in different populations, different continents, and in different subjects in many studies. The prevalence of MS was different between genders and working conditions. In the United Kingdom, United States and developed countries, it is estimated that 1 in 3-5 adults aged over 50 have MS [12]. Because of differing criteria and diagnosis standards, there is no worldwide prevalence of MS. The prevalence of MS in Middle America was 30.3% [13]. Azad Fatahi reviewed 125 studies in Iran up to 2017, and found that the prevalence of MS was 10.26% and the ratio was higher in women and in urban areas [14].

Study of Jamkhandi in South India in 2019 found that the 5-year cumulative prevalence of MS was 32.5% in women aged 38-45 (95% CI= 25,9–39,1%). Those with BMI $\geq$ 23 kg/m^2 had a higher risk of getting MS (OR =10,38; 95% CI= 3,50–30,80) [15]. Studies in the Netherlands and Indonesia in 2020 showed that the prevalence of MS was 26% in men and 46% in women in Indonesia and 36% in men and 24% in women in the Netherlands. Components of MS in the Netherlands were 62% high blood pressure, 40% abdominal obesity in the Dutch population, 61% high blood pressure and 51% high blood glucose in Indonesia [16]. According to Manaf the prevalence of MS in Malaysia in 2021 was 20.6%; risk factors were BMI index, hypertension, diabetes and physical activity [17].

1.2.2. In Vietnam

Vietnam is a developing country, with rapidly increasing rates of non-infectious diseases such as diabetes and cardiovascular disease. Studies of the prevalence of MS concentrated on patients who were examined in hospitals, who were at high risks for hypertension, diabetes … and lack of community research.

In the National hospital of Endocrinology in 2019-2020, the rate of metabolic syndrome in inpatient diabetes treated at the hospital was 71.6%

[18]. A study conducted on 1039 people aged 18 and over at Ko Tum General Hospital found that the prevalence of MS was 21.75% [19]. Nguyen Trong Hung study conducted on 117 people aged between 20-60 at the National Institute of Nutrition in 2020 found that the rate of metabolic syndrome was 14.5% [20]. Another community study conducted by Doan Phuoc Thuoc in 2019 on 360 people aged 25 and over in Phu Vang District, Thua Thien Hue showed that 25% of people had metabolic syndrome [21]. Pham Ngoc Oanh conducted a study in Ho Chi Minh City in 2019 which found that the prevalence of MS was 36.2% (95% CI = 34,0 – 39,0) [22]. The result of Do Van Luong research in 2019 in rural Thai Binh province was 12.6% [5].

1.3. Some risk factors of metabolic syndrome

- The group of risk factors cannot be changed: Studies have found that some risk factors for metabolic syndrome cannot be changed including age, gender, genes, race, living areas, level of social-economic development

- The group of risk factors can be changed: Studies have shown that some risk factors for metabolic syndrome such as smoking, alcohol consumption, eating habits, physical activity are related with MS. These are factors that can be changed and can be prevented by by lifestyle changes and nutrient changes.

1.4. Metabolic syndrome interventions

There are two ways to treat metabolic syndrome. The first one is to treat the causes of metabolic syndrome: overweight/obesity, less physical activity and insulin resistance. Reduce body weight and improve physical activity will decrease insulin resistance and directly reduce the risk of MS. The second way is directly to treat risk factors such as dyslipidaemia, high blood pressure, inflammation and insulin resistance. In a clinical setting, using drugs to treat these factors is emphasized. For communities to achieve optimal and long-term goals, the need to change relative factors is determined the high-risk group and recommended solutions to control MS, such as lifestyle changes, healthy eating habits and more physical activity … These solutions became a part of daily life and integrated to social life into be effective.

In Vietnam and throughout the world, there have been many interventions designed to adjust lifestyle and diet to prevent metabolic syndrome and slow progression to hypertension, diabetes and cardiovascular disease. These interventions focused on increasing physical activity, giving up unhealthy habits such as smoking, alcohol consumption and changing healthy eating habits. Intervention models included propaganda, counselling, group education or direct intervention, monitoring for each individual for a fixed time and evaluation before and after the intervention with or without control groups. However, most interventions

focused on hospitals, offices and people with chronic diseases such as cardiovascular disease, diabetes, hypertension and other conditions. Studies to screen out community and intervention applications in this field are few, especially for people aged 25-64 who are the main workers

Chapter 2. OBJECT AND METHODOLOGY

2.1. Subjects, locations and study times

2.1.1. Subjects of the research

***Phase 1*: Subjects regarding to objective 1**

Adults from 25 - 64 years old belong to 6 commune/ward in Thai Binh province.

Choosing standards:

- People lived in research locations for least 12 months and over, were able to answer questions and agree to attend the study

Exclusion criteria:

- People were diagnosed with acute diseases, mental diseases, and physical deformities at time of investigation; pregnant and breastfeeding for less than 12 months

Phase 2: Subjects regarding objective 2

- People from 25-64 years old who were diagnosed with metabolic syndrome based on IDF&AHA/NHLBI (2009) criteria

Choosing standards

- Attended the research in phase 1.
- Did not have acute diseases, mental diseases at time of investigation;
- Agreed to attend phase 2.

Exclusion criteria

- Pregnant and breastfeeding for less than 12 months.
- People with systolic blood pressure ≥160 mmHg or/and diastolic blood pressure ≥95 mmHg.
- People with fasting blood glucose ≥ 6,5 mmol/L
- People who have taken medication for dyslipidemia in the last 3 months

2.1.2. Research sites

***- Phase 1*: Investigation before intervention was conducted in 6 commune/wards including: Tran Hung Dao ward, An Ninh commune, Quynh Trang, Minh Lang, Phong Chau, Binh Nguyen commune in 6 district/city in Thai Binh province.

***- Phase 2*: Intervention was conducted in 4 communes in 4 districts

+ Intervention commune: Minh Lang commune in Vu Thu district and Phong Chau commune in Dong Hung District

+ Control cummune: Quynh Trang commune in Quynh Phu district and Binh Nguyen commune in Kien Xuong district

2.1.3. Timeline: Divided in two phases

+ *Phase 1 pre - intervention:* From 8/2019 to 11/2019: cross -sectional study to investigate the prevalence of metabolic syndrome and identify related factors

+ *Phase 2 intervention:*

- From 8/2020 to 1/2021 conducted interventions within 6 months with a two point evaluation có đánh giá tại các thời điểm:

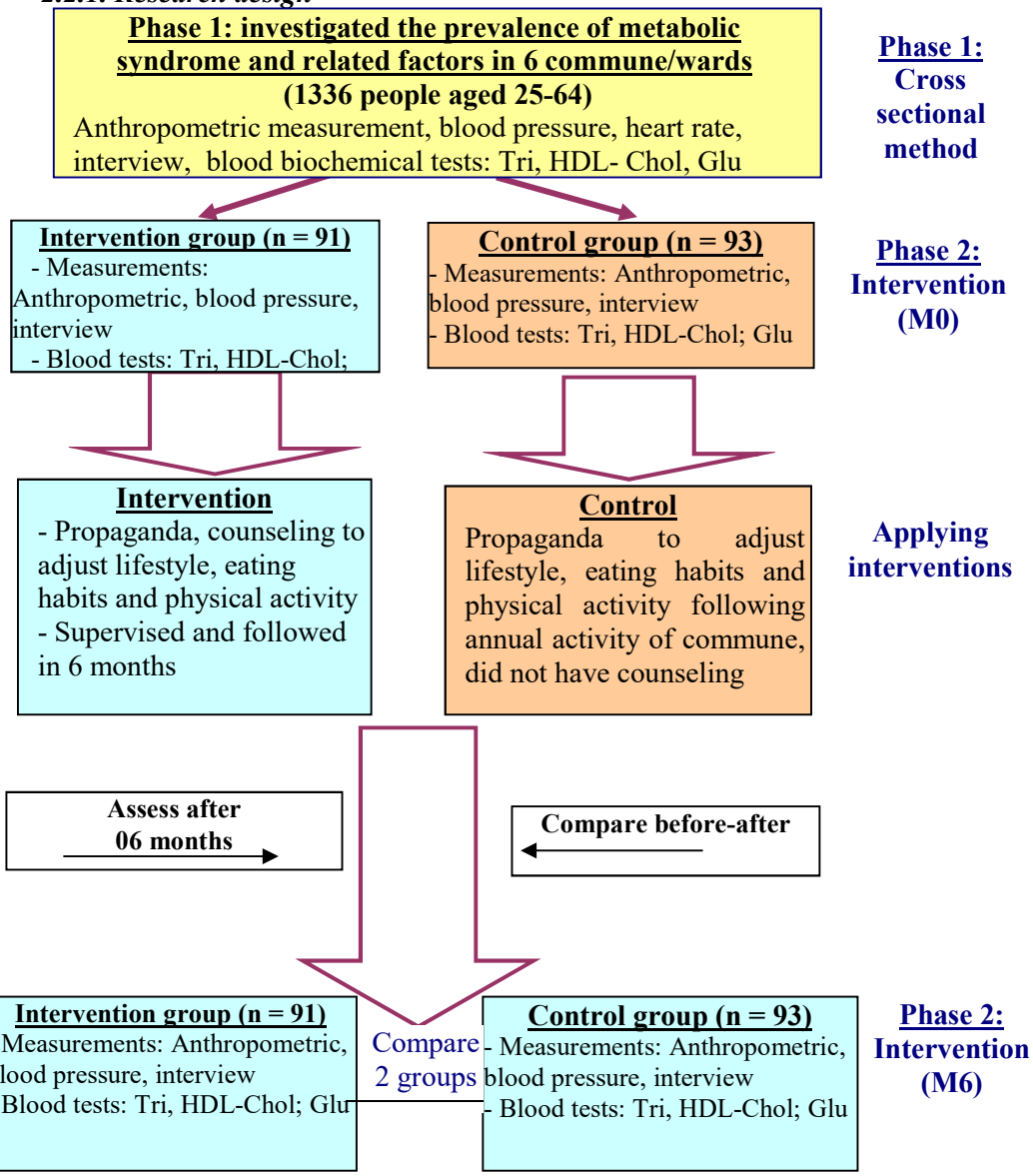
M0 was the initial intervention: 8/2020

From 8/2020 to 1/2021 conducted continous propaganda, counseling and supervision

M6 was the final six- month intervention: 1/2021

2.2. Methodology

2.2.1. Research design



Hình 2.2. Research diagram

2.2.2. Sample size

2.2.2.1. Sample size for objective 1

Using sample size calulation for estimating a population proportion with specified relative precision

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

Given that 1324. We chose 1336 subjects

Sampling methods are a combination of purposive sampling, stratified sampling, random sampling and full sampling .

Chose subjects: Lists everyone from 25-64 years old in the family in 6 commune/wards, divided into 4 age groups (from 25 to under 35 years old, from 35 to under 45 years old, from 45 to under 55 years old, from 55 to 64 years old) and gender. Depending on the population of each commune we randomly selected 25-28 people from each gender/age group in one commune/ward. Each family chose 1 person.

The total number of chosen people was: Tran Hung Dao ward 241 people, Quynh Trang commune 206 people, Phong Chau commune 210 people, Binh Nguyen commune 207 people, An Ninh commune 209 people and Minh Lang commune 263 people

2.2.2.2. Sample size for objective 2

Using sample size calulation for hypothesis tests for two population proportion (two sided tests)

$$n = \frac{\left\{z_{1-\alpha/2}\sqrt{2\overline{p}(1-\overline{p})} + z_{1-\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)}\right\}^2}{(p_1-p_2)^2}$$

Given that n = 88 for each group. We chose 93 people for the intervention group and 93 people for the control group. After 6 months, the intervention group lost 2 people, the control group remained 93 people

Location: chose purposive 4 communes with relatively similar economic, cultural and social characteristics among 6 communes in phase 1, divided into 2 groups:

- The control group: ramdomly chose Binh Nguyen commune in Kien Xuong district and Quynh Trang commune in Quynh Phu district.
- The intervention group: ramdomly chose Minh Lang commune in Vu Thu district and Phong Chau commune in Dong Hung district.

2.2.3. Variables and indicators in the research

2.2.3.1. Variables for objective 1

a/ General variables: Demographic characteristics, Nutrition classified by BMI, waist circumference, smoking, alcohol consumption, use of salt, oil and physical activity

b/ The prevalence and related factors of metabolic syndrome

- The prevalence of metabolic syndrome by location, gender, age group, area, BMI and waist circumference
- Related factors with demographic characteristics, anthropometric indexes, nutrition, lifestyle and physical activity

2.2.3.2. Variables for objective 2

- Effect of intervention on changes in nutrition: eat vegetables, fruits, salty
- Effect of intervention on changes in lifestyle, physical activity
- Effect of intervention on changes in blood pressure and blood biochemical tests
- Effect of intervention on changes in the prevalence of MS

2.2.4. Steps and process of the research

** Steps of the research*

- Activity before intervention

+ Directly interviewed subjects in the household by an interviewer using a pre-prepared questionnaire

+ Invited subjects to the commune health center to take blood tests, anthropometric measurements, blood pressure measurement in the early morning

- Activity during intervention time

+ Intervention 1: Direct and indirect propaganda and to improve knowledge of people with MS

+ Intervention 2: Directly organized guidelines for each subject for sampling the menu to change eating habits

+ Intervention 3: Counseled, trained in physical activity

+ Intervention 4: Supervision in Minh Lang and Phong Chau communes

2.2.5. Data collection methods

- *Anthropometric measurements:* measuring weight, height, waist, and hip circumference
- *Blood pressure and heart rate measurements*
- *Blood biochemical tests.*

Blood biochemical tests were done by doctors and technical nurses in Labo in Thai Binh Centre for disease control and prevention which achieved ISO 15189:2012. All blood tests were run in automatic immunohistochemistry system (Cobas 6000 (Model: Cobas C501 and Cobas E601) that made by Roche. The equipment is regularly serviced every three months by Roche engineers.

- *Interview technique:* Directly interviewed subjects in the household by an interviewer using a pre-prepared questionnaire. The questionnaire was build based on research objectives and Steps questionnaire of WHO

2.2.6. Standards and agreements using in the research

- *Metabolic syndrome diagnosis criteria:* IDF&AHA/NHLBI (2009) criteria .
- *Body Mass Index (BMI):* based on WHO guidelines 1998.
- *Blood biochemical tests:* based on WHO guideline 1998
- *Vegetables and fruits consumption:* 1 standard unit equals 80 grams of fruits and vegetables. According to WHO, adults should eat at least 400 grams (5 standard units) per day

- *Regulation on the intensity of physical activity:*

+ Moderate physical activity: increase in breath and heart rate slightly such as walking, cycling (10km/h), dancing, playing table tennis, playing badminton, swimming and yoga ….

+ Intensive physical activity: activities that require rapid breathing and faster heart rate than normal such as: running (10-15 km/h), cycling, aerobics, playing football, basketball, tennis, swimming, weight training …

+ According to WHO, adults should have moderate physical activity at least 30 minutes per day, 5 days a week or 60 minutes a day throughout the week. If the physical activity is intense, it should take at least half the time as above.

- *Regulations on salt consumption:* According to the Ministry of Health, the recommendation amount of salt in adults in 2016 is less than 6 grams per day

2.2.7. Statistics

Data was checked for completeness before entering the analysis, using SPSS 22 software to analyze. Compare the proportions used test χ^2. The significant level in the study was 95% (α=0,05). A logistic regression was used to find related factors, the relation was assessed by Odd ratio (OR) and Confident Interval (CI): 95%.

* Effectiveness Index:

$$\text{CSHQ}(\%) = \frac{|\text{P1} - \text{P2}|}{\text{P1}} \text{ x } 100$$

* Intervention effectiveness: HQCT (%) = CSHQ_{NCT} - $\text{CSHQ}_{\text{NĐC}}$

* ARR Index: ARR% = p0 – p1

* NNT Index: (number needed to treat): NNT = 1/(p0 – p1)

In which: p0 was the prevalence in the control group, p1 was the prevalence in the intervention group.

2.2.8. Ethics issue in the research

The research was complied with the regulation of the Approval Committee and Ethics Committee of Thai Binh University of Medicine an Pharmacy under Decision No. 1883/QD – YDTB dated October 22, 2019

Research ensures the right to "voluntarily participate" in research. Results are fully communicated to the subject. Prepare a plan and be ready for emergencies when there are adverse events during the examination and blood collection.

Research results are used for healthcare to help treat and prevent metabolic syndrome in the community

Chapter 3. RESEARCH RESULTS

3.1. The prevalence and related factors of metabolic syndrome in adults aged 25-64 in Thai Binh province in 2019

Table 3. 1. The prevalence of metabolic syndrome by gender, Region

Gender, Location		n	Metabolic syndrome	
			n	%
Gender	Male	667	181	**27.1**
	Female	669	199	**29.7**
	p	>0.05		
Region	Urban	241	71	**29.5**
	Rural	1095	309	**28.2**
	p	>0.05		
Total		**1336**	**380**	**28.4**

p: compered the proportions between male and female, urban and rural, χ^2 test

The prevalence of metabolic syndrome was 28.4%, the female rate was not significantly higher than the male and the urban rate was higher than the rural (p>0.05)

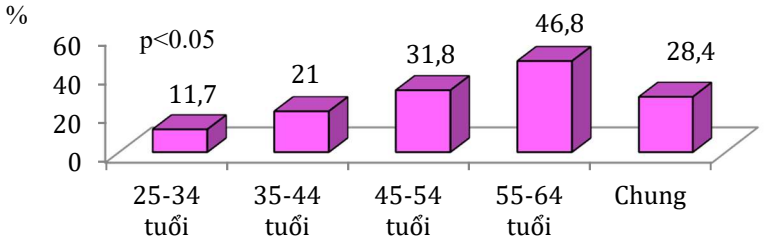


Chart 3. 1. The prevalence of metabolic syndrome by aged group

Different age groups had different rates of metabolic syndrome (p<0.05), of which age from 55-64 years old was the highest prevalence, with 46.8%.

Table 3. 2. The proportion of MS components by gender

Gender / Components of MS	Male (n = 667)		Female (n =669)		Total (n = 1336)		p
	Number	%	Number	%	Number	%	
Abnormal central Obesity	66	9.9	176	23.6	242	18.1	<0,05
Impaired glucose Tolerance	124	18.6	195	29.1	319	23.9	<0,05
Hypertriglyceridem	412	61.8	263	39.3	675	50.5	<0,05

ia							
High blood pressure	295	44.2	185	27.7	480	35.9	<0,05
Low level of HDL	192	28.8	451	67.4	643	48.1	<0,05

The proportions of abnormal central obesity, low levels of HDL and impaired glucose tolerance in males were lower than female ($p<0.05$). The proportion of hypertriglyceridemia and high blood pressure in males were lower than females ($p<0.05$)

Table 3. 3. The proportion of MS components by gender, age group

Number of componets / Variable	n	0		1		1		≥ 3	
		n	%	n	%	n	%	n	%
Gender									
Male	667	122	18.3	164	24.6	200	30.0	181	27.1
Female	669	114	17.0	208	31.1	148	22.1	199	29.7
p		<0.05							
Age group									
25 – 34	300	84	28.0	110	36.7	71	23.7	35	11.7
35 – 44	329	62	18.8	120	36.5	78	23.7	69	21.0
45 – 54	365	60	16.4	81	22.2	108	29.6	116	31.8
55 – 64	342	30	8.8	61	17.8	91	26.6	160	46.8
p		<0.05							
Total	**1336**	236	17.7	372	27.8	348	26.1	380	28.4

17.7% of subjects did not have any MS components, the rate of people with 1 component was 27.8% and 2 components was 26.1%. 38.4% of subjects had 3 MS components

Table 3. 4. Related between metabolic syndrome and demographic characteristics

Variables		n	No MS (n = 956)		MS (n = 380)		OR *(95% CI)*
			n	%	n	%	
Age group	25-34	300	265	88.3	35	11.7	1
	35-44	329	260	79.0	69	21.0	2,01 *(1,29-3,12)*
	45-54	365	249	68.2	116	31.8	3,53 *(2,33-5,34)*

	55-64	342	182	53.2	160	46.8	6,66 *(4,41-10,05)*
Gender	Female	669	470	70.3	199	29.7	0,88 *(0,69-1,12)*
	Male	667	486	72.9	181	27.1	
Region	Urban	241	170	70.5	71	29.5	0,94 *(0,69-1,28)*
	Rural	1095	786	71.8	309	28.2	

The table showed that those aged from 55-64 had a significant risk of MS 6.66 times higher than those aged from 25-34, ages from 45-54 were 3.53 times higher and those aged from 35-44 were 2.01 times higher than those aged from 25-34 (p<0,05).

Table 3. 5. Related between metabolic syndrome and anthropometric, lifestyle and nutrition

Anthropometric		n	MS (n=380)		Single regression
			SL	%	OR *(95% CI)*
BMI	Normal	1063	275	25,8	1
	Underweight	107	9	8,4	0,3 (0,1-0,5)
	Overweight, obesity	166	96	57,8	3,9 (2,8-5,7)
Waist	Normal	1094	199	18,2	13,4 (9,6-18,5)
	High	242	181	74,8	
Fruit consumption	5 units	999	270	27,0	1,31 (1,00-1,71)
	< 5 units	337	110	32,6	
Vegetable consumption	5 units	846	220	26,0	1,38 (1,08-1,76)
	< 5 units	490	160	32,7	
Alcohol consumption	No	568	145	25,5	1,29 (1,01-1,64)
	Yes	768	235	30,6	
Moderate physical activity	Yes	234	54	23,1	1,4 (1,0-1,99)
	No	1102	326	29,6	

Those were overweight and obesity had a significant risk of MS 3.9 times and 13.4 times higher than with a normal BMI (p<0,05). Subjects that ate less than 5 standard units of fruit and vegetables had a significant risk of MS 1.31 and 1.38 times greater than those ate 5 standard units (p<0,05). Those who drank alcohol, did not exercise, and had a significant risk of MS 1.29 and 1.4 times higher than those who had no alcohol and moderate physical activity (p<0,05).

Table 3.6. Related between metabolic syndrome and salt consumption

Salt consumption		n	MS		Single regression
			SL	%	OR (*95% CI)*
Dip, add salt sauce to food	No/seldom	143	19	13,3	1
	Normal	149	30	20,1	1,65(*0,88-3,08)*
	Regular	1044	331	31,7	3,03*(1,84-4,99)*
Add salt when cooking	No/seldom	787	189	24,0	1
	Normal	454	150	33,0	1,56 *(1,21-2,02)*
	Regular	95	41	43,2	2,40 *(1,55-3,72)*
Salty fast food	No/seldom	471	97	20,6	1
	Normal	478	143	29,9	1,65 (*1,22-2,22)*
	Regular	387	140	36,2	2,19 (*1,61- 2,96)*

Using salt or salty sauce to cook, dip and eat salty foods had a significantly higher risk of MS than those who did not dip, add and eat salt or salty foods (p<0,05).

Table 3. 7. Factors associated with metabolic syndrome with logistic multiple regression

Dependent veriables		**OR (Adjusted)**	**95% CI**
Age group	25-<35*	1	
	35-<45	1,86	1,16 – 2,97
	45-<55	3,81	2,44 -5,95
	55-<65	7,67	4,91-11,98
BMI	Normal	1	
	Underweight	0,20	0,13 - 0,57
	Overweight, obesity	4,49	3,05 – 6,61
Alcohol consumption	No*	1	
	Yes	1,40	1,06-1,85
Vegetable	5 units *	1	
	< 5 units	1,34	1,01-1,77
Dip, add salt sauce to food	No/seldom *	1	
	Normal	1,59	0,82-3,15
	Regular	2,59	1,49-4,48
Add salt when cooking	No/seldom *	1	
	Normal	1,57	1,17-2,10

	Regular	2,67	1,61-4,43
Eat less fat	Yes *	1	
	No	1,55	1,16-2,06

*(n) = 1336 * = compared group*

The results from logistic multiple regression showed that age, BMI, alcohol consumption, eating less than 5 standard units of vegetable oil, salty eating habits and eating more fat were related factors to metabolic syndrome (p<0,05).

3.2. Effectiveness of interventions on components of metabolic syndrome

Table 3.8. Effectiveness of changing fruit and vegetable consumption before and after intervention

Fruit, vegetable 5 units/day	Time	Control group (n=93)		Intervention group (n=91)		p (χ^2 test)
		SL	%	SL	%	
Fruit	Before	77	82,8	64	70,3	> 0,05
	After 6 months	87	93,5	91	100	< 0,05
Effective index (%)		10,9		29,7		
Effective Intervention (%)		**18,8**				
Vegetable	Before	53	57,0	66	72,5	< 0,05
	After 6 months	57	61,3	86	94,5	< 0,05
Effective index (%)		7,0		23,3		
Effective Intervention (%)		**16,3**				

The table showed that after 6 months intervention, in the intervention group, the proportion of eating 5 units of fruit increased from 70.3% to 100%, in the control group increased from 82.8% to 93.5%. The different was significant and the effectiveness of the intervention was 18.8%. The proportion of eating 5 units of vegetable in the intervention group increased from 72.5% to 94.5%, from 57% to 61.3% in the control group, the different was significant and the effectiveness of the intervention was 16.3%

Table 3. 9. Effectiveness of changing salty eating habits before and after intervention

Regular	Time	Control group (n=93)		Intervention group (n=91)		p (χ^2 test)
		SL	%	SL	%	
Dip, add salt sauce to food	Before	84	90,3	74	81,3	>0,05
	After 6 months	71	76,3	35	38,5	<0,05

Effective index (%)		15,5		52,6		
Effective Intervention (%)		37,1				
Add salt when cooking	Before	15	16,1	6	6,6	>0,05
	After 6 months	14	15,1	0	0	<0,05
Effective index (%)		6,2		100		
Effective Intervention (%)		93,8				

Before intervention, the rate of dipping and adding salt sauce to food regularly was not different in both groups. After intervention, the proportion in the intervention group reduced significantly from 81.3% to 38.5% and the effectiveness of the intervention was 37.1%. The rate of subjects who added salt when cooking regularly decreased and the effectiveness of the intervention was 93.8%

Table 3. 10. Effectiveness of changing lifestyle before and after intervention

Lifestyle	Time	Control group (n=93)		Intervention group (n=91)		p (χ^2 test)
		SL	%	SL	%	
Smoking	Before	22	23,7	15	16,5	> 0,05
	After 6 months	17	18,3	8	8,8	< 0,05
Effective index (%)		22,8		46,7		
Effective Intervention (%)		**23,9**				
Alcohol consumption	Before	54	58,1	46	50,5	> 0,05
	After 6 months	50	53,8	36	39,6	< 0,05
Effective index (%)		7,4		21,6		
Effective Intervention (%)		**14,2**				
Moderate physical activity	Before	25	26,9	28	30,8	> 0,05
	After 6 months	28	30,1	46	50,5	< 0,05
Effective index (%)		10,6		38,8		
Effective Intervention (%)		**28,2**				

After intervention, the rate of smoking in the intervention group reduced from 16.5% to 8,8%, in the control group was down from 23.7% to 18.3%, the different was significant and the effectiveness intervention was 23.9%. The proportion of alcohol consumption in the intervention group decreased from 50.5% to 39.6%, this result in the control group reduced from 58,1% to 53,8%, the significant the effectiveness of the intervention was 14.2%. The proportion of physical activity was increased in both groups, the rate in the intervention group was the significantly higher than the control group with the effectiveness of the intervention was 28.2%.

Table 3. 11. Effectiveness of changing the proportion of high blood pressure and impaired glucose tolerance

Indexs		Control group (n=93)		Intervention group (n=91)		p
		SL	%	SL	%	
High blood pressure	Before	62	66,7	74	81,3	> 0,05
	After 6 months	63	67,7	54	59,3	< 0,05
	Effective index (%)	1,5		27,1		
	Effective Intervention (%)	25,6				
	ARR%	**8,4**				
	NNT	**11,9**				
Impaired glucose Tolerance	Before	57	61,3	43	47,3	<0,05
	After 6 months	50	53,8	34	37,4	<0,05
	Effective index (%)	12,2		20,9		
	Effective Intervention (%)	8,7				
	ARR%	**16,4**				
	NNT	**6,1**				

The results in the table showed that after 6 months intervention, the rate of high blood pressure in the intervention group reduced from 81.3% to 59,3% with the effectiveness of the intervention was 25.6%. Absolute risk reduction was 8.4% and 1 out of every 12 subjects in the intervention groups became normal blood pressure after intervention (NNT≈ 11,9). After intervention, 1 out of every 6 subjects with high blood glucose had stable levels (NNT ≈ 6,1).

Table 3. 12. Compared mean of MS component before and after intervention

Index	Time	Control group (n = 93) $\overline{X}$ ± SD	Intervention group (n = 91) $\overline{X}$ ± SD	p1
Mean components	Before	3,46±0,69	3,29±0,54	>0,05
	After 6 months	3,14±1,15	2,66±1,04	<0,05
	Different	**0,32±0,13**	**0,63±0,10**	<0,05
	p2	<0,05	<0,05	

This table showed that the mean components of metabolic syndrome in the intervention that decreased were significantly higher than the mean in the control group, which was 0,63±0,10 and 0,32±0,13 components.

Table 3. 13. Effectiveness of changing the prevalence of metabolic syndrome before and after intervention

Metabolic syndrome	Control group (n = 93)	Intervention group (n = 91)	P (χ^2test)

		SL	%	SL	%	
Time	Before	93	100	91	100	> 0,05
	After 6 months	72	77,4	58	63,7	< 0,05
Effective index (%)		22,6		36,3		
Effective Intervention (%)		13,7				
ARR%		**13,7**				
NNT		**7,3**				

The study found that after intervention, the prevalence of metabolic syndrome fell from 100% to 63.7% in the intervention group and 77.4% in the control group. The effectiveness of the intervention was 13.7%. 1 out of every 7 subjects with metabolic syndrome did not have MS.

CHAPTER 4. DISSCUSSTION

4.1. The prevalence and related factors of metabolic syndrome

In 1336 subjects aged from 25-64, the prevalence of metabolic syndrome was 28.4%. The result is similar to the results of Doan Phuoc Thuoc (2019), with the prevalence of metabolic syndrome in 360 people aged from 25 and over in Phu Vang district, Thua Thien Hue province was 25% [21]. The results of the prevelance of metabolic syndrome according to Le Huu Loi (2017) who conducted the study in 95 patients in Kom Tum province was 27.36% [23].

It differs from Trinh Kien Trung who conducted on 1.185 people aged 40 years old and over in Can Tho city, with the prevalence of metabolic syndrome was 16.5% [24], Tran Quang Bình found that the prevalence of metabolic syndrome was 12.3% [25]. Nguyen Trong Hung study conducted on 117 people aged between 20-60 at the National Institute of Nutrition in 2020 found that the rate of metabolic syndrome was 14.5% [20]. The different of the prevalance in each studies may be caused by different locations, subject, sample size.

Some research found the prevalance of MS is higher than this study. A study of Nguyen The Hoang who conducted on 300 hypertention patients in Gio Linh district, Quang Tri province found the prevalence of MS was 62% [26]. In the National hospital of Endocrinology in 2019-2020, the rate of metabolic syndrome in inpatient diabetes treated at the hospital was 71.6% [18]. Franca studied on 787 adults showed that the prevalence of MS was 34.1% [27]. Mahmoud done a research in United Arab Emirates found the prevalence of MS was 37.4% [28]. The results of these studies are higher than this study because the subjects of these studies were patients who had diseases such as diabetes, hypertention ... Subjects in our study were people in the community

Among the 5 components of MS, the proportion of hypertriglyceridemia accounted for the highest (50.5%), the result is similar to the result of Pham Ngoc Oanh in Ho Chi Minh city with the proportion was 51.0% [22]. This may represent an increasing trend of dyslipidemia not only in urban areas, but also in rural areas. This rate is also tending to increase very rapidly, especially among those aged 35 - 44, it is noticeable that many of them do not know they have the disease until they have a general examination and most of them do not anticipate the complications of the disease.

This study found that the proportion of people had low level of HDL and high blood pressure was 48.1% and 35.9%, while other components had a lower proportion. Compared with some of the other studies, the proportion of components in metabolic syndrome varies by study. In Brazil, a Franca study on 787 adults found that the prevalence of MS was 31.4%, the component of MS was low of HDL (56.2%), abnormal central obesity (55.3%), high blood pressure (47.6%), and impaired glucose tolerance (24.3%), hypertriglyceridemia (19.9%) [27]. According to Jayant in India, the highest MS components was low of HDL with 77.88%, hypertriglyceridemia (71.2%), high blood pressure (70.2%) and impaired glucose tolerance (51.0%) [29].

The results of the study showed that the percentage of subjects who had 1 component was 27.8%, while the rate of subjects who had 3 to 5 components was 28.4%. The rate for the two components was 26.1%, this is a very high-risk group that could get HCC if they hadn't intervened and adjusted in time. The prevalence of 3 and 4 components in this study was higher than that of subjects with normal BMI, the incidence of 3 components was 10.2%, 4 factors was 1.8%, The result was that because the subjects had a normal BMI, the anthropometric component of the study had a lower risk. [25]. The study in diabetic patients found higher results compared with our study, the percentage of 3, 4, 5 components was 38.7%, 23.3%, 5.7% [5], the rate is higher because the subjects are people with diabetes who already have a factor that makes up metabolic syndrome .. Other studies also showed similar results [26], [30].

4.1.3. Factors related with metabolic syndrome

Metabolic syndrome is caused by a combination of factors: age, race, genes, lifestyle (smoking, alcohol consumption, nonhealthy eating,), overweight and obesity … The risk of MS increases with age. Our results showed that age is significantly related with MS. Aged from 55-64 had a higher risk of MS than the 25–34-year-old with OR = 6.66 (95%CI= 4.41 – 10.05), aged from 45-54 had a higher risk of MS than the 25–34-year-old with OR = 3.53 (95% CI= 2.33 – 5.34), aged from 35-44 had a higher risk of MS than the 25–34-year-old with OR = 2.01 (95% CI= 1.29 – 3.12). Other

studies also showed similar results [31], [32], [33].

There is no significant differences in prevalence of metabolic syndrome between males and females, urban and rural areas, this can explain that Thai Binh province is a delta province, with a small area, a large population, and most of the agricultural production. Nowadays, life in the countryside is increasing, urbanization is rapid, small industry and commerce develop, so the difference between urban and rural areas is not too different. Therefore, there was no regional difference in the incidence of MS.

Overweight and obesity are risk factors for metabolic syndrome. Fat accumulation, especially visceral fat, is associated with insulin resistance, which is a very important mechanism of MS. In our studies, overweight and obese subjects had 3.9 times higher risk of metabolic syndrome than those with normal BMI ($p<0.05$). Other studies also showed similar results [34], [35], [36]. The results of the study also showed that that people with high waist circumference had a 13.4 times higher risk of HCC than people with normal waist circumference ($p<0.05$). The accumulation of too much fat around the waist and hips is considered a risk factor for diseases such as diabetes and cardiovascular disease. In the study on 3056 subjects aged from 30-70 in Iran found that as the waist-hip ratio increased, the risk of HCC increased with OR = 1.93, (95% CI = 1.30-2.09) [37].

Our study found that people who used alcohol or beer had 1.29 times higher risk of MS than those who do not use ($p<0.05$). The result is similar to the result of Kim, people who drink wine had 2.11 times risk of MS than those who do not drink (OR = 2,11; 95%CI=1,25-3,56) [38]. It can be seen that alcohol consumption related to HCCH depends on the level, frequency and duration of the subject's alcohol consumption.

In our study, there was a relationship between MS and the use of vegetables and fruits. People who ate fruits and vegetables that did not meet the recommended intake requirements were1.31 times and 1.38 times more likely to have MS compared with those who eat fruits and vegetables that meet the recommended intake requirements ($p<0.05$). Research by Doan Phuoc Thuoc also showed that people who did not eat enough fruits and vegetables in their diets have a 1.7 times higher risk of developing MS than those who ate enough (95% CI= 1.1-3.3) [21].

Studies around the world have shown an association between a high-salt diet and obesity and metabolic syndrome [39]. Our study results showed that a high-salt, salty diet increases the risk of MS. People who frequently add, dip salt into food, add salt when cooking, eating salty processed food have have a higher risk of HCCH than those who do not with OR>1 and $p<0,05$.

People with older age groups, alcohol use habits, inadequate intake of

fruits and vegetables, low levels of physical activity, overweight and obesity need to implement screening programs to prevent metabolic syndrome and implementing prevention programs. The role of health education is very important to encourage people to exercise regularly, change healthy lifestyles, contribute to reducing the obesity rate and reduce the risk of hypertension that are components of MS in the community.

4.2. Effectiveness of dietary and lifestyle intervention to MS

The intervention selected 93 subjects with MS in 02 communes: Minh Lang commune, Vu Thu district and Phong Chau commune, Dong Hung district. The control group consisted of 93 subjects from 02 communes: Binh Nguyen commune, Kien Xuong district and Quynh Trang commune, Quynh Phu district. During the intervention, 2 subjects moved to live with their family in another locality, did not follow up the intervention, the remaining 91 subjects evaluated after intervention. In the control group, 93 subjects followed the instructions and collected all data after the intervention.

The results of our study showed that the mean components of metabolic syndrome in the intervention that decreased were significantly higher than the mean in the control group, which was 0,63±0,10 and 0,32±0,13 components. The result is similar to the results of Do Van Luong, mean components of MS in the intervention group before intervention was 3,46 ± 0,61 components, after intervention 3,10 ± 0,72 components ($p<0.05$). In the control group, mean of MS components decreases no significant. Changing of mean MS component before and after intervention in the intervention group and the control group was 0,37 ±0,60 and 0,08±0,53 components) ($p<0,05$) [5].

The results of our study have shown that interventions are effective in reducing the incidence of components of the metabolic syndrome, thereby reducing the incidence of MS. The study found that after intervention, the prevalence of metabolic syndrome fell from 100% to 63.7% in the intervention group and 77.4% in the control group. The effectiveness of the intervention was 13.7%. 1 out of every 7 subjects with metabolic syndrome did not have MS. It differs from Do Van Luong who used pre-germinated brown rice in 16 weeks for diabetic patients who had metabolic syndrome, the results showed that the intervention reduced the incidence of MS from 100% to 82,7% and 1 out of every 17 subjects with metabolic syndrome did not have MS [5]. Because the subject of the two studies are different. In Do Van Luong study, subjects are patients with diabetes who already has 1 of the 5 components of MS and our study, subjects are people in the community. Other reasons is we combined many interventions, so the effectiveness of reducing the incidence of MS will be higher.

Nguyen Duc Cong conducted an intervention on 683 patients with MS in Bac Lieu showing that after the intervention, the rate of subjects with MS

decreased by 21% [40]. Research by Truong Tuyet Mai on 30 overweight and obese adults aged 40-59 years with MS, interventions by diet and exercise counseling once a week for 12 weeks. After 12 weeks of intervention showed the rate of patients with MS decreased by 30% [41]. Simona Bo conducted an intervention to change diet and lifestyle in 335 subjects with MS, and after 12 months of intervention, the intervention group's incidence rate decreased from 70.4% to 34.9% (p<0,001) [42].

CONCLUSION

1. The prevalence and related factors of metabolic syndrome

- The prevalenc of metabolic syndrome in adults aged from 25-64 in Thai Binh province in 2019 was 28.4%, of which trong đó nhóm từ 55-64 tuổi có tỷ lệ mắc cao nhất với 46,8%. Tỷ lệ mắc ở nữ cao hơn ở nam, thành thị cao hơn nông thôn nhưng sự khác biệt không có ý nghĩa thống kê với p>0,05.

- Among the components of metabolic syndrome, the highest proportion was hypertriglyceridemia with 50.5%, the proportion of low levels of HDL, high blood pressure, impaired glucose tolerance and abnormal central obesity was 48.1%, 35.9%, 29.3% and và 18.1%.

- 17.7% of subjects had no components of metabolic syndrome, the proportion of subjects who had 1, 2 components was 27.8% and 26.1%. 28.4% of subjects had 3 and more components

- Age, BMI, alcohol consumption, eating less than 5 standard units of vegetable oil, salty eating habits and eating more fat were related factors to metabolic syndrome (p<0,05).

2. Hiệu quả biện pháp can thiệp chế độ ăn, lối sống HCCH

- After 6 months intervention, the prevalence of metabolic syndrome fell from 100% to 63.7% in the intervention group and 77.4% in the control group. The effectiveness of the intervention was 13.7%. 1 out of every 7 subjects with metabolic syndrome did not have MS

- The intervention efficacy of eating 5 units of fruit and vegetables; reducing dipping; adding salt sauce; reducing added salt when cooking regularly; reducing smoking and reducing alcohol consumption was 29.3%; 22.8%; 37.1%; 93.8%; 20.8% and 14.2%.

KIẾN NGHỊ

1. Should plan to screen and detect early components of metabolic syndrome for people aged 45 and over to prevent metabolic syndrome for Thai Binh people in particular and the whole country in general.

2. Should apply these intervention models regularly and periodically for adults in Thai Binh province to reduce the risk of metabolic syndrome. Thereby reducing non-communicable chronic diseases such as hypertension,

diabetes, obesity, and cardiovascular diseases in order to improve people's quality of life.