Original Article

Prevalence and Risk Factors of Overweight and Obesity and Physical Activity Patterns among Elderly Individuals in Southern Thailand: A Community Cross-Sectional Study

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Objective: To investigate the prevalence of overweight and obesity and physical activity (PA) patterns and to assess the factors associated with obesity among elderly individuals in the southernmost province of Thailand.

Materials and Methods: An epidemiological community-based cross-sectional study was conducted among elderly individuals aged 60 years and older. The eligible participants completed a face-to-face inquiry of the study's questionnaire related to personal characteristics and PA. Local assistant researchers collected these data. BMI was categorized according to the Asian-Pacific cut-off points. Statistical computing was performed with RStudio, and a p-value of less than 0.05 was considered significant.

Results: The prevalence of overweight was 20.3%, and that of obesity was 35.2%. The overweight prevalence and obese prevalence among male and female elderly individuals were 22.7% and 30.3%, and 18.6% and 28.6%, respectively. The obesity prevalence was non-significantly high in the female group. The majority of the elderly participants were non-working. The share of non-working participants was the highest among females and increased with age. The prevalence of lack of exercise was the highest among females. Daily physical activity hours (DPAH) and vigorous-intensity exercise decreased among the female group and the elderly group. Only 47.8% of the present study participants met the PA sufficiency criteria. The 70 to 79, and older than 80 years age group were less likely to be obese than the earlier-stage elderly group (adjusted OR 0.56, 0.31). Furthermore, personal income of 4,001 to 6,000 Baht per month and smokers had a lower likelihood of being obese than the poor elderly group and those who were not smokers (adjusted OR 0.55, 0.37).

Conclusion: The prevalence of overweight in these areas was moderate, and that of obesity was quite high. The male overweight and obese prevalence were analogous to those of female elderly individuals. The majority of the elderly participants were non-working. Most were females and increased with age. The majority met PA insufficiency criteria. Personal and health habit factors were associated with obesity among elderly individuals.

Keywords: Elderly; Overweight and obesity; Physical activity patterns

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Overweight and obesity are major public health concerns worldwide. According to a report by the World Health Organization (WHO), the prevalence of overweight and obesity has nearly tripled since 1975. In 2016, more than 1.9 billion (39%) adults were overweight. Of these, over 650 million (13%) were obese[1]. In the United States, 15 million older adult people over the age of 51 are obese[2]. In Europe, by 2016, it was estimated that adults aged 50 years or older accounted for almost 40% of the population[3] and was about 58.7% in South-Asian population[4]. The recent surveys in Thailand, overweight and obese was 39.4% in adult and 48.7%, 45.7%, 35.8% in 60 to 69, 70 to 79, and older than 80 years old[5]. In particular, obesity is a dominant risk factor for non-communicable diseases (NCDs), including hypertension, high cholesterol, diabetes, coronary heart diseases, respiratory problems, and musculoskeletal diseases. It is a contributing factor of cancer[1,2]. For a person living with obesity, obesity is not only affecting his or her health but also affecting his or her daily life.

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The age distribution of the global population has changed. The number and proportion of people aged 60 years and older are increasing and will be increased up to 1.4 billion by 2030 and 2.1 billion by 2050[6,7]. This change has been reported in both developed and developing countries[8]. A recent report estimated that more than 142 million older people or 14% of all people aged 60 years and over globally are unable to meet all of their basic daily needs[9]. Increasing age leads to decreasing physiological function, resulting in serious degradation of health, and factors that underlie the risk of diseases[10]. In addition, elderly individuals have limitations in physical activity (PA) due to reasons, such as individual, interpersonal, perceived environmental, community or organizational and policy factors, leading to overweight and obesity[11].

Proper physical, mental, spiritual, and social activities are considered highly valuable for elderly individuals[12]. According to recommendations by WHO, PA has been linked to health and longevity in elderly individuals, and it is also crucial for successful ageing[13]. PA is a protective factor against NCDs such as cardiovascular disease, stroke, diabetes, and cancer[14]. PA is associated with improved mental health, quality of life, and wellbeing, and delay the onset of dementia in elderly individuals[15-18]. Recent evidence has reported that 1.6 million deaths annually can be attributed to insufficient PA[19]. Nevertheless, the number of elderly individuals who have PA has decreased, regardless of the obvious advantages and benefits of PA[20]. The crude global prevalence of physical inactivity was 21.4%, whereas PA levels among elderly individuals remain below the recommended 150 minutes per week[11,21,22]. The overall prevalence of physical inactivity among elderly people in rural China and Malaysia was 83.7% and 88%, respectively[23,24]. The Thai National Health Examination Survey (NHES VI) reveals that prevalence of physical inactivity was 30.9% in general population and 43.4%, 61.4% in 70 to 79 and older than 80 years old[5].

However, southernmost Thailand has a unique social context in which more than 90% were Muslim and the majority of local people were of low socioeconomic status. The data on PA among elderly individuals in rural southern Thailand are rarely used, and they do not focus on the prevalence and trends of overweight and obesity. Therefore, the main objective of the present study was to investigate the prevalence of overweight and obesity and PA patterns and to assess the factors associated with obesity among the elderly population in the southernmost province of Thailand. The results from the present study could be used by public health policymakers and health practitioners to encourage and improve the PA levels among elderly people in developing areas.

Figure 1. The map of southern provinces of Thailand[a].

[a] https://asiapacific.anu.edu.au/mapsonline/sites/default/files/styles/cartogis_700x700/public/maps/bitmap/standard/2014/02/00-280_SouthThailandProvinces.png?itok=JQSG2cjM

Materials and Methods

Study design and study participants

The present study was an epidemiological community-based cross-sectional study conducted between January and September 2017 and was approved by the Ethics Committee of Princess of Naradhiwas University (PNU 2017-002). The study participants were elderly individuals aged 60 years and older living in the southernmost province of Thailand. All eligible participants were invited and given informed consent, those who were not willing to provide information were excluded. The community administration committee was approved for the data gathering.

Study setting

The probability selection method was used to obtain the study setting. A cluster sampling procedure was used to select one of the three southernmost provinces of Thailand, namely Narathiwat, Yala, Pattani, and Narathiwat, as Figure 1. Then, the selected

cluster was classified into three characteristics, urban, semi-urban, and rural areas, by the distance of the location and population density. Therefore, one municipality and two out of thirteen districts were selected. Narathiwat municipality was selected from two municipalities as an urban area. It was composed of four out of 22 communities located within five kilometers of city hall and with a population density over 112 persons per square kilometer (km^2). The communities of Galaepayae, Samaianajus, Nanakon, and Yaguk were selected as urban areas by a simple random method. The Khokien Sub-district of the Muang district, located within 10 kilometers of city hall and with a population density between 85 and 112 persons per km^2, was selected as a semi-urban area. Additionally, three out of 13 communities were sampled, namely Hutaetuwor, Baerape, and Khopaka. Rural areas were defined as areas located more than 30 kilometers from city hall and with a population density of fewer than 85 persons per km^2. Four out of 16 communities were sampled from the Bang Khun Thong and Praiwan Sub-districts of the Tak Bai district. The communities of Kho ngu, Khochumboe, Saikow, and Torlang were selected as rural areas. In total, eleven communities were included in the present study area. The proportion of the elderly population in the chosen areas was 12% to 17% during the last two years.

Sampling methods

The sample size of the present study was calculated based on the overweight proportion among elderly individuals in southern Thailand[25]. The overweight proportion among elderly individuals was 60.0%, the type I error z was 0.5%, the design effect was 1, the precision was 4%, and the power was 0.8. Based on an estimated 1% incomplete information, the sample size was 640. The proportionate-to-size study method was used for participant recruitment. A chosen community was divided into three groups of elderly individuals with early elderly, aged 60 to 69 years old, middle-aged elderly, aged 70 to 79 years old, and late elderly aged older than 80 years old. Approximately 60 elderly individuals in each community were recruited, the local assistant researchers invited those samples to be study participants.

Inclusion and exclusion criteria

Elderly individuals aged 60 years and older living more than 10 years in the communities of the present study setting were included. Eligible participants could communicate completely and were willing to provide personal and behavioral data. Bedbound elderly individuals or those who did not cooperate were excluded.

Data collection procedure

Project information was conveyed, and permission to collect data was obtained from the community administration committee in the study areas. Two to three local assistant researchers were set up in each study area and completed skills training for community data collection tasks. One day of course training was conducted three times in urban, semi-urban, and rural communities with the aim of informing team members of the purposes, methods, and procedure of the study as well as their tasks and compensation. Elderly individuals in each community were screened and invited to be study participants. Eligible participants were given explanations of the present study's objectives and signed the consent forms. The eligible participants received face-to-face inquiry according to the study's questionnaires that related to personal characteristics and PA. Data collection was conducted through verbal conversation. Regarding physical examination, elderly individuals' body weight and height were measured by using a calibrated weighing scale and tape measure. Readable values were double verified and recorded by a research assistant in the area.

Independent variables

Personal characteristics questionnaire: The uniform study questionnaire was designed by the research team and was used to collect personal characteristics. There were two parts within the two pages of the study questionnaire form. The preface was the project title and provided general guidance on completing the form, the second page was the first part of the questionnaire. Personal information was provided with tick marks, and the text was filled in by the local assistant researchers. The second part was related to the physical examination, which comprised the waist circumference. The study participants were in a standing position, their two feet were approximately 10 centimeters apart, and both arms were extended in front of them. For waist measurement, a measurement tape in centimeters was used at the midpoint between the pelvis and the last rib cage during exhalation. The tape measure was attached to the participant's body, with confidence that it was not tight.

Physical activity: The PA assessment was composed of three main items, the type of exercise,

exercise frequency, and routine work. In the present study, exercise covered using muscle strength to make the body move in a systematic way not less than 30 minutes, having a higher heart rate and feeling tired and sweaty. The type of exercise depended on individual preferences and fitness, including walking, jogging, cycling, and yoga. The exercise frequency was the total number of days per week in which exercise was conducted, and there were four response options, every day, less than 3 days, 3 to 4 days, and other. In cases in which the participant's answer did not match those answers, the average number of days per week in the last two months was recorded. Routine work was recorded among elderly individuals who were able to work. Agriculture, farming, and gardening were classified as hard activity. Housework such as washing, cleaning the house, and cooking was classified as moderate activity, and washing dishes, folding clothes, and making the bed were classified as light activity. The assessor marked a tick in the questionnaire related to the participant's activity and indicated his or her main routine work.

Main outcome measures

Overweight and obesity: Overweight and obesity were the results of the classification of body mass index (BMI) status, which was assigned to abnormal body weight. BMI was calculated as weight in kilograms divided by the square of the height in meters (kg/m²) and was categorized into five groups according to the cut-off points of WHO for the Asian-Pacific region[26] as underweight for less than 18.5 kg/m², normal weight for 18.5 to 22.9 kg/m², overweight for 23 to 24.9 kg/m², obese I for 25 to 29.9 kg/m², and obese II for 30 kg/m² or more.

Statistical analysis

EpiData 3.1 was used for data processing, analysis, input, correction, and completion. The R program and RStudio were used to analyze the study data. Regarding the demographic characteristics of the participants, descriptive statistics were presented as the mean (standard deviation; SD), maximum and minimum values and independent t-test for continuous variables. Categorical variables were presented as proportional data of frequency and percentage. The average daily PA was compared by gender and age and tested by using the chi-square and Fisher's exact test for categorical variables. Logistic regression analysis using backward stepwise selection was used to estimate the effect of individual characteristics and health behavior on obesity. The factors associated with obesity were presented as odds ratios, and statistical significance was set at p-value equal to 0.05.

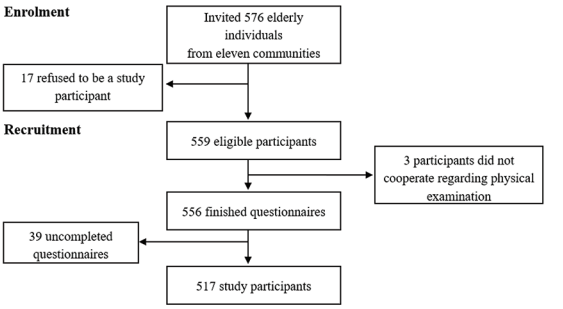

Figure 2. Flow diagram of the screening process and participant recruitment.

Results

Participant characteristics

Five hundred seventy-six elderly individuals in the eleven communities were invited to participate, and 17 elderly individuals refused. Five hundred fifty-nine elderly individuals met the eligibility criteria. Of the 42 who were excluded, three elderly individuals were not willing to undergo physical examination, and 39 had incomplete questionnaires. Five hundred seventeen elderly individuals were included in the present study. The recruited participants are presented in Figure 2. Half of the participants were recruited from rural areas, and two-thirds were females. One-third were aged 70 to 79 years. Half were married, had studied at the primary school level, and individual earned income of less than 4,000 Baht per month. Half of the respondents had a household size of four to six persons, and their offspring were their caregivers. The majority of the participants completed annual health check-ups. Almost all of them were non-smokers and did not drink alcohol with 92.1% and 94.4%, respectively. Two-thirds had a waist circumference in the acceptable range (67.1%). The demographic characteristics of the participants are presented in Table 1.

Overweight and obese prevalence

In the present study population, the prevalence of overweight was 20.3%, and that of obesity was 35.2%. The prevalence of obese I and II was 27.5% and 7.7%, respectively. The overweight prevalence and obese prevalence among male and female elderly individuals were 22.7% and 30.3%, and 18.6% and 28.6%, respectively. The obesity prevalence was high in the female group, but the difference was not statistically significant ($p<0.0669$). The 60 to 69 age

Table 1. Demographic characteristics of the participants

Factors	Male (n=211); n (%)	Female (n=306); n (%)	Total (n=517); n (%)	p-value
Dwelling zone				0.0209*
Urban	81 (38.4)	125 (40.8)	206 (39.8)	
Semi-urban	30 (14.2)	68 (22.2)	98 (19.0)	
Rural	100 (47.4)	113 (36.9)	213 (41.2)	
Age (years), mean 71.6, SD 8.2, min-max 60 to 103				0.3530
60 to 69	107 (50.7)	136 (44.4)	243 (47.0)	
70 to 79	70 (33.2)	111 (36.3)	181 (35.0)	
≥80	34 (16.1)	59 (19.3)	93 (18.0)	
Marital status				<0.001*‡
Single	5 (2.4)	4 (1.3)	9 (1.7)	
Married	181 (85.8)	114 (37.3)	295 (57.1)	
Other	25 (11.8)	188 (61.4)	213 (41.2)	
Education				<0.001***
None	36 (17.1)	99 (32.4)	135 (26.1)	
Primary school	143 (67.8)	176 (57.5)	319 (61.7)	
Secondary/higher	32 (15.2)	31 (10.1)	63 (12.2)	
Family members (persons), mean 4.5, SD 2.3, min-max 1 to 13				0.6975
1 to 3	79 (37.4)	125 (40.8)	204 (39.5)	
4 to 6	94 (44.5)	132 (43.1)	226 (43.7)	
>6	38 (18.0)	49 (16.0)	87 (16.8)	
Individual income (Baht)				<0.001***
≤2,000	52 (24.6)	108 (35.3)	160 (30.9)	
2,001 to 4,000	40 (19.0)	65 (21.2)	105 (20.3)	
4,001 to 6,000	60 (28.4)	89 (29.1)	149 (28.8)	
>6,000	59 (28.0)	44 (14.4)	103 (19.9)	
Care giver				<0.001***
None	26 (12.3)	56 (18.3)	82 (15.9)	
Offspring	69 (32.7)	187 (61.1)	256 (49.5)	
Spouse	108 (51.2)	43 (14.1)	151 (29.2)	
Others	8 (3.8)	20 (6.5)	28 (5.4)	
Annual health check-up				0.0172*
No	65 (30.8)	127 (41.5)	192 (37.1)	
Yes	146 (69.2)	179 (58.5)	325 (62.9)	
Alcohol				<0.001***
No	183 (86.7)	305 (99.7)	488 (94.4)	
Yes	28 (13.3)	1 (0.3)	29 (5.6)	
Smoking				<0.001***
No	176 (83.4)	300 (98.0)	476 (92.1)	
Yes	35 (16.6)	6 (2.0)	41 (7.9)	
Waist (cm)				<0.001***‡‡
Mean [SD]	83.3 [19.4]	82.6 [19.0]	82.9 [19.1]	
Acceptable range (%)	148 (70.1)	199 (65.0)	347 (67.1)	
Weight, min-max 25 to 65				<0.001***‡‡
Mean [SD]	62.0 [12.6]	55.1 [12.3]	57.9 [12.8]	
Height (cm), min-max 112 to 187				<0.001***‡‡
Mean [SD]	162.9 [7.4]	151.0 [8.0]	155.8 [9.7]	
BMI status (kg/m^2)[a]				0.2530
Underweight (<18.5)	24 (11.4)	35 (11.4)	59 (11.4)	
Normal weight (18.5 to 22.9)	75 (35.5)	96 (31.4)	171 (33.1)	
Overweight (23 to 24.9)	48 (22.7)	57 (18.6)	105 (20.3)	
Obese I (25 to 29.9)	53 (25.1)	89 (29.1)	142 (27.5)	
Obese II (>30)	11 (5.2)	29 (9.5)	40 (7.7)	
Obesity				0.0669
Non-obese	147 (69.7)	188 (61.4)	335 (64.8)	
Obese	64 (30.3)	118 (38.6)	182 (35.2)	

SD=standard deviation; BMI=body mass index

* p<0.05, ** p<0.01, *** p<0.001, ‡ Fisher's exact test, ‡‡ t-test

[a] BMI status references the WHO Asian BMI classification

Table 2. The prevalence of BMI status by age

Factors	Total (n=517); n (%)	Age (years); n (%)			
		60 to 69 (n=243)	70 to 79 (n=181)	≥80 (n=93)	p-value
BMI status (kg/m^2)[a]					<0.01**
Underweight (<18.5)	59 (11.4)	15 (6.2)	27 (14.9)	17 (18.3)	
Normal weight (18.5 to 2.9)	171 (33.1)	77 (31.7)	57 (31.5)	37 (39.8)	
Overweight (23 to 24.9)	105 (20.3)	47 (19.3)	39 (21.5)	19 (20.4)	
Obese I (25 to 29.9)	142 (27.5)	77 (31.7)	47 (26.0)	18 (19.4)	
Obese II (>30)	40 (7.7)	27 (11.1)	11 (6.1)	2 (2.2)	
Obesity					<0.001***
Non-obese	335 (64.8)	139 (57.2)	123 (68.0)	73 (78.5)	
Obese	182 (35.2)	104 (42.8)	58 (32.0)	20 (21.5)	

BMI=body mass index

** p<0.01, *** p<0.001

[a] BMI Status references the WHO Asian BMI classification

group was shown the highest obesity prevalence (p<0.001), as shown in Table 2.

Daily physical activity

Approximately half of the elderly individuals were non-working with 46.4%, and 39.8% were still active with a hard activity working level. The female group was shown to have a high proportion of non-working individuals and a significantly lower proportion with a hard activity working level than the male group (p<0.001). There was also a difference in the prevalence of working between the elderly age groups (p<0.001). In particular, the majority of the 60 to 69 age group were still working (65.8%), and almost half belonged to the group with a hard activity working level (47.7%). In addition, the prevalence of non-working individuals increased among the medium and late old age stages. Regarding exercise, the results showed that 52.0% of both genders had moderate-intensity exercise. The prevalence of lack of exercise among males was lower than females. However, the vigorous-intensity exercise level among females was significantly lower than males (p<0.01). The prevalence of exercise with a vigorous-intensity level was low in the older than 80-year age group at 9.7%. The daily physical activity hours (DPAH) mean was 3.0 hours, and among males and females, it was 3.5 and 2.7 hours, respectively. There was a significant difference between genders and age groups (p<0.01). The majority of participants were classified into groups of fewer than three hours per day for PA (55.3%). Males presented a higher mean DPAH than females, and older individuals showed a significant decrease in DPAH (p<0.001). Following the PA sufficiency criteria of at least five days per week, 47.8% of the study participants met the criteria. The PA sufficiency prevalence among males and early-stage elderly individuals was significantly higher than that among the other groups (p<0.01), as presented in Table 3.

Factors associated with obesity

In the initial multiple logistic regression model, eleven factors combining personal and PA variables were assessed. The final regression analysis model identified three factors that were significantly associated with obesity among the participants. Age, personal income, and smoking were the factors associated with obesity among elderly individuals. Regarding participant age, the late-stage elderly group had a lower likelihood of obesity. The 70 to 79 age group was 0.56 times less likely to be obese than the earlier-stage elderly group of 60 to 69 years (95% CI 0.37 to 0.86, p<0.01). Likewise, the 80-year-old and older age group was 0.31 times (95% CI 0.17 to 0.55, p<0.001) less likely to be obese than the earlier-stage elderly of 60 to 69 years group. Regarding socioeconomic factors, elderly individuals who had a personal income of 4,001 to 6,000 Baht per month had a 0.55 times lower likelihood of being obese than the poor elderly group of less than 2,000 Baht per month (95% CI 0.33 to 0.91, p<0.05). In terms of smoking, those who were smokers had a 0.37 times lower likelihood of obesity than those who were not smokers (95% CI 0.16 to 0.84, p<0.05), as presented in Table 4.

Discussion

The prevalence of overweight was 20.3%, and that of obesity was 35.2%. The overweight prevalence

Table 3. The prevalence of average daily physical activity by sex and age

Physical activity	Sex; n (%)			Age (years); n (%)				
	Male (n=211)	Female (n=306)	p-value	Total (n=517)	60 to 69 (n=243)	70 to 79 (n=181)	≥80 (n=93)	p-value
Working			0.0024**					<0.001***‡
None	79 (37.4)	161 (52.6)		240 (46.4)	83 (34.2)	92 (50.8)	65 (69.9)	
Light activity	8 (3.8)	14 (4.6)		22 (4.3)	10 (4.1)	8 (4.4)	4 (4.3)	
Moderate activity	20 (9.5)	29 (9.5)		49 (9.5)	34 (14.0)	11 (6.1)	4 (4.3)	
Hard activity	104 (49.3)	102 (33.3)		206 (39.8)	116 (47.7)	70 (38.7)	20 (21.5)	
Exercise‡			0.0012**					0.4905
None	47 (22.3)	93 (30.4)		140 (27.1)	59 (24.3)	53 (29.3)	28 (30.1)	
Light intensity	10 (4.7)	18 (5.9)		28 (5.4)	16 (6.6)	8 (4.4)	4 (4.3)	
Moderate intensity	106 (50.2)	163 (53.3)		269 (52.0)	127 (52.3)	90 (49.7)	52 (55.9)	
Vigorous intensity	48 (22.7)	32 (10.5)		80 (15.5)	41 (16.9)	30 (16.6)	9 (9.7)	
DPAH †	<0.01**					<0.001***‡		
<1.0	88 (41.7)	168 (54.9)		256 (49.5)	93 (38.3)	97 (53.6)	66 (71.0)	
1.0 to 2.9	14 (6.6)	28 (9.2)		42 (8.1)	11 (4.5)	18 (9.9)	13 (14.0)	
3.0 to 4.9	49 (23.2)	41 (13.4)		90 (17.4)	54 (22.2)	28 (15.5)	8 (8.6)	
5.0 to 6.9	32 (15.2)	42 (13.7)		74 (14.3)	51 (21.0)	18 (9.9)	5 (5.4)	
≥7.0	28 (13.3)	27 (8.8)		55 (10.6)	34 (14.0)	20 (11.0)	1 (1.1)	
DPAH†; mean [SD]	3.5 [2.9]	2.7 [2.8]	<0.001***	3.0 [2.9]	3.9 [3.0]	2.7 [2.8]	1.4 [1.8]	<0.001***
Physical activity sufficiently†			<0.001***					<0.001***
Yes	117 (55.5)	130 (42.5)		247 (47.8)	142 (58.4)	80 (44.2)	25 (26.9)	

DPAH=daily physical activity hours

** p<0.01, *** p<0.001, ‡ Fisher's exact test

† Average of physical activity per week

Table 4. The final model results of obesity among elderly individuals

	Obese			
	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value (Wald's test)	p-value (LR-test)
Age (years)		<0.001***		
60 to 69 (refence)	-	-	-	
70 to 79	0.63 (0.42 to 0.94)	0.56 (0.37 to 0.86)	0.0077**	
≥80	0.36 (0.21 to 0.64)	0.31 (0.17 to 0.55)	<0.001***	
Personal income (Baht)		0.0330*		
≤2,000 (reference)	-	-	-	
2,001 to 4,000	1.37 (0.83 to 2.26)	1.11 (0.65 to 1.88)	0.6878	
4,001 to 6,000	0.69 (0.43 to 1.12)	0.55 (0.33 to 0.91)	0.0210*	
>6,000	0.94 (0.56 to 1.58)	0.69 (0.40 to 1.20)	0.1941	
Smoking				
No (reference)	-	-	-	0.0108**
Yes	0.42 (0.19 to 0.93)	0.37 (0.16 to 0.84)	0.0179*	
Log-likelihood		–320.0798		
AIC		654.159785		

OR=odds ratio; CI=confidence interval; AIC=Akaike information criterion

and obese prevalence among male and female elderly individuals were 22.7% and 30.3%, and 18.6% and 28.6%, respectively. The obesity prevalence was non-significantly high in the female group. The majority of elderly participants were non-working; the share of non-working participants was the highest among females and increased with age. The prevalence of lack of exercise was the highest among females. The DPAH and vigorous-intensity exercise decreased among the female group and the elderly group of

older individuals. Half of the study participants met PA sufficiency criteria. Age, personal income, and smoking were the factors associated with obesity among elderly individuals.

The prevalence of overweight was 20.3%. The present study results are different from those studies conducted among elderly individuals in Asia, South America, and Europe, which claimed that the prevalence of overweight was approximately 31.2%, 41.8%, and 31.5%, respectively[26-28]. There are reasons for the contrast in the overweight prevalence distribution. In the Chinese study, even though it was based on the Asian-Pacific cut-off points, the participants included middle-aged and elderly individuals. In the Brazilian and Spanish studies, the difference in the prevalence distribution might be due to a difference in the BMI criteria, in which overweight was 25 to 29.9 kg/m². In addition, the overweight prevalence of the present study is lower than that of a study conducted in ten European countries, where the general prevalence of overweight at BMI of 25 kg/m² or more was 60.1%. These extreme opposite results may be explained by the difference in BMI cut-off points, and eligible study participants aged 50 years or older were included[3].

The obesity prevalence of the present study is similar to that of a study conducted in Spain, in which the prevalence was 36.1%[27]. Nevertheless, the obesity prevalence is homogeneous, and the results are based on differences in the BMI criteria. The present study also shows a difference compared to the studies conducted in China and Brazil, in which the prevalence of obesity was 12.2% and 23.4%, respectively[27,28]. In addition to the BMI criteria and study participants, the dissimilarity is due to data collection. In the Spanish study, height and weight were self-reported. In the Chinese study, trained staff collected the data. In the Brazilian study, weight was measured to the nearest 100 grams using a digital personal scale.

The present study reveals that the prevalence of overweight and obesity are not different among male and female elderly individuals. The present study result is dissimilar to those of studies conducted in India, Spain, and European countries, but the prevalence of overweight is high among females, and the prevalence of obesity is high among males in another study conducted in Spain[3,27,29,30]. This could explain that overweight and obesity are diseases of personal health behavior. Therefore, regardless of nationality, elderly individuals can become overweight and obese without proper diet and exercise management[31]. Pathophysiology is another reason for obesity in elderly people. Ageing is associated with changes in body composition and metabolism. After age 70, fat-free mass and fat mass decreased in parallel[32].

The majority of elderly participants were non-working; the share of non-working participants was the highest among females and increased with age. This result is consistent with a study conducted in northern China that found 51.7% engaged in non-work-related activities[33]. However, the previous result might not be parallel because the study was conducted in rural areas and its participants were over 40 years old. The prevalence of lack of exercise was the highest among females. The majority met PA insufficiency criteria. The present study finding is similar to the study conducted in Iran[34], in which 80% of participants reported no PA and 14.8% reported low and moderate PA levels. Males were more likely to be moderately or extremely physically active than women. In addition, according to a study in the Republic of Slovenia[35], 39.5% of the participants reported insufficient PA levels.

Age, personal income, and smoking were the factors associated with obesity among elderly individuals. The present study is congruent with two studies conducted in Iran and Brazil and confirmed that increasing age is less likely to lead to obesity[36,37]. A low educational level also influenced obesity in Iran, and low grip strength, cognitive impairment, physical inactivity, and chronic diseases influenced obesity in Brazil. However, educational level is also representative of personal income. The present study findings are completely different from those of studies conducted in Latin America and the Caribbean[38], in which being female, having a poor health status, and the frequency of dietary intake were associated with obesity. Regarding smoking, it is not surprising that smoking in elderly individuals promotes a decrease in body weight[39]. Nevertheless, studies have shown that weight gain is induced. Heavy smokers tend to have drinking habits, which affect the distribution of body fat and is associated with an increased BMI[40].

The present community-based cross-sectional study had designed cluster areas sampling into three groups, urban, semi-urban, and rural. However, those of the study participants were limited because the recruitment was the one province in southernmost Thailand. The influence factors on obesity are varied, and the present study could not cover all aspects such as individual genetics, nutritional status, and food habit. Therefore, the results would be biased due to

these factors.

Conclusion

The prevalence of overweight in these areas was moderate, and that of obesity was quite high. The prevalence of overweight and obesity in males was analogous to that of female elderly individuals. The majority of elderly participants were non-working; highest among females and increased with age. The prevalence of lack of exercise was the highest among females. The majority met PA insufficiency criteria. Personal and health habit factors are associated with obesity among elderly individuals. To promote the health of elderly individuals in these areas, they should be encouraged to have proper weight control and exercise.

What is already known on this topic?

Overweight and obesity are major public health concerns worldwide, related to NCDs and affected patients' daily life. PA has been linked to health and longevity in elderly individuals, and protective factor against NCDs. The global prevalence of physical inactivity was high and PA levels among elderly individuals remain below the recommended standard.

What this study adds?

Overweight and obesity among the elderly in the southernmost provinces of Thailand were quite serious. The overweight prevalence was moderate, whereas obesity prevalence was quite high, and the highest prevalence occurred in female group and increased with age. The majority of elderly individual in this area does not meet PA sufficiency criteria. Female elderly individuals were the special group that should be interested on the health campaign to control body weight and prevent obesity.

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Authors' contributions

PS conceived the study concept, design, data collection, analysis of the research, interpretation of the analysis, manuscript write-up, and submission. DMW and WC supervised data collection and contributed to edit the manuscript. All authors reviewed and approved the final version of the manuscript. The corresponding author attests that all listed authors meet authorship criteria.

Availability of data and material

The data that support the findings of the present study are available from the corresponding author upon reasonable request

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Conflicts of interest

The authors declare that they have no competing interests.

References

1. World Health Organization. Factsheet on obesity and overweight [Internet]. 2018 [cited 2019 Dec 3]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
2. U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General. The surgeon general's call to action to prevent and decrease overweight and obesity. Washington, DC: US General Printing Office; 2001.
3. Peralta M, Ramos M, Lipert A, Martins J, Marques A. Prevalence and trends of overweight and obesity in older adults from 10 European countries from 2005 to 2013. Scand J Public Health 2018;46:522-9.
4. Amin F, Fatima SS, Islam N, Gilani AH. Prevalence of obesity and overweight, its clinical markers and associated factors in a high risk South-Asian population. BMC Obes 2015;2:16.
5. Aekpalakorn W, Puckcharern H, Satheannoppakao W. The sixth national health examination survey 2019-2020. Nonthaburi: The National Health Examination Survey Office, Health System Research Institute; 2021. [in Thai]
6. United Nations Population Fund and HelpAge International. Ageing in the twenty-first century: A challenge and a celebration [Internet]. 2012 [cited 2019 Dec 3]. Available from: https://www.unfpa.org/publications/ageing-twenty-first-century.
7. World Health Organization. Ageing and health [Internet]. Geneva: WHO; 2018 [cited 2019 Dec 3]. Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health.
8. World Health Organization. 10 facts on ageing and health [Internet]. Geneva: WHO; 2018 [cited 2019 Dec 3]. Available from: https://www.who.int/news-room/fact-sheets/detail/10-facts-on-ageing-and-health#.
9. World Health Organization. The United Nations decade of healthy ageing (2021-2030) [Internet]. Geneva: WHO; 2020 [cited 2020 Dec 13]. Available

from: https://www.who.int/ageing/decade-of-healthy-ageing.
10. Blokzijl F, de Ligt J, Jager M, Sasselli V, Roerink S, Sasaki N, et al. Tissue-specific mutation accumulation in human adult stem cells during life. Nature 2016;538:260-4.
11. Boulton ER, Horne M, Todd C. Multiple influences on participating in physical activity in older age: Developing a social ecological approach. Health Expect 2018;21:239-48.
12. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med 1995;41:1403-9.
13. Adachi T, Kamiya K, Kono Y, Iwatsu K, Shimizu Y, Honda I, et al. Predicting the future need of walking device or assistance by moderate to vigorous physical activity: A 2-year prospective study of women aged 75 years and above. Biomed Res Int 2018;2018:1340479.
14. Langhammer B, Bergland A, Rydwik E. The importance of physical activity exercise among older people. Biomed Res Int 2018;2018:7856823.
15. Schuch FB, Vancampfort D, Richards J, Rosenbaum S, Ward PB, Stubbs B. Exercise as a treatment for depression: A meta-analysis adjusting for publication bias. J Psychiatr Res 2016;77:42-51.
16. Das P, Horton R. Rethinking our approach to physical activity. Lancet 2012;380:189-90.
17. Camboim FEF, Nóbrega MO, Davim RMB, Camboim JCA, Nunes RMV, Oliveira SX. Benefits of physical activity in the third age for the quality of life. J Nurs Recife 2017;11:2415-22.
18. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. Lancet 2017;390:2673-734.
19. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016;388:1659-724.
20. Mohammed M, Mohamed A. Self-imposed activity limitation among community-dwelling older adults in Alexandria, Egypt. World J Nurs Sci 2015;1:163-77.
21. Štefan L, Petrinović L, Sporiš G, Vrgoč G. Frequency of dietary intake and physical activity in older adults: A cross-sectional study. Nutrients 2018;10:1960.
22. Dumith SC, Hallal PC, Reis RS, Kohl HW 3rd. Worldwide prevalence of physical inactivity and its association with human development index in 76 countries. Prev Med 2011;53:24-8.
23. Song A, Liang Y, Yan Z, Sun B, Cai C, Jiang H, et al. Highly prevalent and poorly controlled cardiovascular risk factors among Chinese elderly people living in the rural community. Eur J Prev Cardiol 2014;21:1267-74.
24. Kaur J, Kaur G, Ho BK, Yao WK, Salleh M, Lim KH. Predictors of physical inactivity among elderly malaysians: recommendations for policy planning. Asia Pac J Public Health 2015;27:314-22.
25. Maneerattanasak S, Thanapop C, Thanapop S. Factors associated with motivational stages of change for weight management among older informal workers in southern Thailand. Thai J Public Health 2020;50:132-47.
26. Pan WH, Yeh WT. How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations. Asia Pac J Clin Nutr 2008;17:370-4.
27. Gutiérrez-Fisac JL, López E, Banegas JR, Graciani A, Rodríguez-Artalejo F. Prevalence of overweight and obesity in elderly people in Spain. Obes Res 2004;12:710-5.
28. Song MN, Cheng X, Kong JX, Wang HM. Prevalence and influencing factors of overweight and obesity among middle-aged and elderly people in China. Chin J Dis Control Prev 2018;22: 804-8.
29. Singh P, Kapil U, Dey AB. Prevalence of overweight and obesity amongst elderly patients attending a geriatric clinic in a tertiary care hospital in Delhi, India. Indian J Med Sci 2004;58:162-3.
30. Gomez-Cabello A, Pedrero-Chamizo R, Olivares PR, Luzardo L, Juez-Bengoechea A, Mata E, et al. Prevalence of overweight and obesity in non-institutionalized people aged 65 or over from Spain: the elderly EXERNET multi-centre study. Obes Rev 2011;12:583-92.
31. Mathus-Vliegen EM. Obesity and the elderly. J Clin Gastroenterol 2012;46:533-44.
32. Lim EL, Hollingsworth KG, Aribisala BS, Chen MJ, Mathers JC, Taylor R. Reversal of type 2 diabetes: normalisation of beta cell function in association with decreased pancreas and liver triacylglycerol. Diabetologia 2011;54:2506-14.
33. Wang Q, Zhang X, Fang L, Guan Q, Gao L, Li Q. Physical activity patterns and risk of type 2 diabetes and metabolic syndrome in middle-aged and elderly Northern Chinese adults. J Diabetes Res 2018;2018:7198274.
34. Sadrollahi A, Hosseinian M, Masoudi Alavi N, Khalili Z, Esalatmanesh S. Physical activity patterns in the elderly Kashan population. Iran Red Crescent Med J 2016;18:e25008.
35. Zurc J, Cirila HR, Skela-Savič B. Dietary habits and physical activity patterns among Slovenian elderly: cross-sectional survey with cluster analysis. Slovenian Nurs Rev 2015;49:9-17.
36. Bakhshi E, Seifi B, Biglarian A, Mohammad K. Factors associated with obesity in Iranian elderly people: results from the national health survey. BMC Res Notes 2011;4:538.
37. Corona LP, Alexandre TD, Duarte YA, Lebrão ML. Abdominal obesity as a risk factor for disability in Brazilian older adults. Public Health Nutr 2017;20:1046-53.
38. Carter AO, Hambleton IR, Broome HL, Fraser HS, Hennis AJ. Prevalence and risk factors associated with

obesity in the elderly in Barbados. J Aging Health 2006;18:240-58.
39. Albanes D, Jones DY, Micozzi MS, Mattson ME. Associations between smoking and body weight in the US population: analysis of NHANES II. Am J Public Health 1987;77:439-44.
40. Pan D, Wang S, Su M, Wei J, Wang K, Luo P, et al. Roles of drinking and diet in the U-shaped relationship between smoking and BMI in middle-aged and elderly Chinese rural adults. Sci Rep 2020;10:17118.