Prevalence and risk factors of overweight and obesity among individuals over 40 years old in Luzhou city

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ABSTRACT. In this study, a survey was conducted through questionnaire distribution and physical examinations were performed in 10,150 residents that were over 40 years old in Luzhou city. Respondents were selected by the multi-stage sampling method. The mean body mass index (BMI) of the sample population was 23.9 ± 3.3 kg/m². Among men, BMI showed a negative relationship with increasing age ($P < 0.05$), whereas among women, it showed a positive relationship ($P < 0.001$). The rates of overweight and obesity increased with age and reached a peak between 60 to 70 years of age ($P < 0.001$). The rates of overweight and obesity varied with different working conditions, training situations, educational levels, marital status, and other factors ($P < 0.05$). Age, educational level, daily sitting time, and family history of diabetes were factors that influenced the prevalence of overweight and obesity through multivariate logistic regression analysis ($P < 0.05$). The incidences of overweight and obesity among the middle-aged population were

found to be significantly high. Therefore, prevention and control measures should be adopted as soon as possible.

Key words: Body mass index; Middle-aged; Obesity; Overweight; Prevalence; Risk factors

INTRODUCTION

The latest data from the World Health Organization (WHO) show that approximately 15 million adults 20 years old and above are overweight, of which more than 200 million men and nearly 300 million women were obese, indicating that more than 10% of the world's adult population are obese (Obesity and Overweight [EB/OL], WHO). In low- and middle-income countries, overweight and obesity rates are significantly higher, especially in urban areas. The prevalence of overweight and obesity is also rising in China (Wu et al., 2005). In the past decade, obesity has become a substantial threat to health and a major public health challenge. Obesity increases the risks of coronary heart diseases, type 2 diabetes, cancer, high blood pressure, sleep apnea syndrome, biliary tract disease, osteoarthritis, and other diseases. In 2008, the medical cost related to obesity was estimated to have reached $14.7 billion in the United States. Overweight and obesity have therefore resulted in heavy economic burdens in the country (Ma et al., 2002; Finkelstein et al., 2009; Centers for Disease Control and Prevention (CDC), 2010). Domestic and international studies have shown that overweight and obesity rates increase with increasing age (WHO, 2000; Wu et al., 2005). The process of aging in the population of China is accelerating; aging has become more evident and health problems have become increasingly pronounced in the elderly population (Hu and Peng, 2011). Age, overweight, and obesity are all risk factors for cardiovascular and cerebrovascular diseases, diabetes, cancer, and other diseases (Dong et al., 2009). There are few studies on the prevalence of overweight and obesity in China and other countries, particularly among the middle-aged population. The current study was designed to determine overweight and obesity epidemic distribution rules and risk factors in the Luzhou region through a survey on overweight and obesity status among members of the population who are over 40 years old. The results of this study should provide a foundation for the control of overweight and obesity in the middle-aged population.

MATERIAL AND METHODS

Subjects

The subjects of this study were residents of Luzhou city from May 2011 to November 2011. Six communities were randomly selected in the city by the multi-stage sampling method. Streets were randomly selected from each community, and then subjects were randomly selected from each street. The subjects, who were all over 40 years old, voluntarily participated. They completed the questionnaire and underwent a physical examination. Gender was not limited, and both men and women were included in this study. Subjects with mobility and communication barriers were eliminated. This study was conducted in accordance with the declaration of Helsinki, and with approval from the Ethics Committee of the Affiliated Hospital of Luzhou Medical College. Written informed consent was obtained from all participants.

Data collection

A standardized questionnaire survey was performed to collect general information (gender, age, community, etc.), lifestyle (eating habits, exercise activities, etc.), work situation, medical history, obstetrical history, menstrual history, and personal history. All investigators received unified training. All subjects underwent routine physical examinations, which included determinations of height, weight, and resting blood pressure. Height was exacted to 0.1 cm and weight was exacted to 0.1 kg.

Defined indicators

The standards for overweight and obesity were based on "The Prevention Guide for Overweight and Obesity in Chinese Adults": the body mass index (BMI) for overweight individuals is between 24 kg/m^2 and 27.9 kg/m^2 and the BMI for obesity is more than 28 kg/m^2 (Chen et al., 2003). Overweight and obesity can be divided into three groups based on the alcohol consumption classification criteria of the 2005 US Dietary Guidelines: 1) moderate alcohol consumption refers to ≤2 drinks/day for men and ≤1 drink/day for women, 2) heavy drinking refers to >2 drinks/day for men and >1 drink/day for women (1 drink = 14 g ethanol, equivalent to 360 mL beer, 180 mL/140 g wine, or 45 mL/42 g ethanol drinks of 90 standard degrees), and 3) no drinking. This standard is based on the amount of alcohol beverages consumed in any given day, and not the daily average volume (US Department of Agriculture and Health and Human Services, 2005). Sedentary behavior refers to actions in which energy consumption does not increase above the resting level (such as sleeping, sitting, lying down, watching TV, and other forms of screen behavior) (Pate et al., 2008). According to the WHO diet standard, the daily intake of fruits and vegetables associated with overweight/obesity is less than 400 g (WHO, 2003).

Statistical analysis

This study was designed to employ Epidata data entry and to perform statistical analysis using the SPSS Statistics 17.0 software package. Continuous variables between groups were compared through the Student t-test. Rates between groups were compared with the χ^2 test. Trends were also analyzed with the χ^2 test. For single-factor χ^2 tests and multivariate logistic regression analysis, $P < 0.05$ indicated that the difference was statistically significant.

RESULTS

General information

A total of 10,150 individuals above 40 years old participated in this investigation, from which 10,007 copies of valid questionnaires were collected. The respondents were composed of 3442 men, accounting for 34.40% of the sample population, and 6565 women, accounting for 65.60% of the population. The average age was 58.7 ± 10.1 years. A normality test was performed on the BMI of middle-aged individuals over the age of 40. We found that the resulting data followed a normal distribution (Z = 1.344, P = 0.054). The mean BMI was

23.9 ± 3.3 kg/m²; the mean male BMI was 24.0 ± 3.2 kg/m² and the mean female BMI was 23.9 ± 3.4 kg/m² (Table 1). No statistically significant difference was found in the BMIs of men and women ($t = -0.827$, $P = 0.408$). Male BMI decreased with increasing age, and the difference was statistically significant ($r_s = -0.039$, $P = 0.025$). By contrast, female BMI increased with increasing age, and the difference was also statistically significant ($r_s = 0.126$, $P < 0.001$).

Table 1. Distribution condition of weight indexes at different ages.

Age group (years)	Male		Female		Total	
	N	Means ± SD	N	Means ± SD	N	Means ± SD
40~	592	24.2 ± 3.3	1582	23.3 ± 3.1	2174	23.5 ± 3.2
50~	949	23.8 ± 3.1	2356	23.9 ± 3.3	3305	23.9 ± 3.3
60~	1221	24.1 ± 3.1	1737	24.4 ± 3.5	2958	24.3 ± 3.3
70~	579	23.7 ± 3.2	777	24.2 ± 3.5	1356	24.0 ± 3.4
80~	101	23.0 ± 3.5	113	23.3 ± 3.6	214	23.2 ± 3.5
Total	3442	24.0 ± 3.2	6565	23.9 ± 3.4	10007	23.9 ± 3.3

Distribution of overweight rates across different ages and genders

The overweight rate for individuals over 40 years old was 36.19%, of which males accounted for 38.41% and females accounted for 35.03%. The difference between men and women was statistically significant ($\chi^2 = 10.362$, $P = 0.001$). The difference in overweight rate between men and women in the 40 years and above age group was statistically significant ($\chi^2 = 9.752$, $P < 0.02$); the differences among other age groups were not statistically significant (Table 2). The overweight rate differed significantly among age groups ($\chi^2 = 36.947$, $P < 0.001$). The overweight rate rose gradually with increasing age, and reached a peak among respondents in their 60s ($\chi^2 = 8.261$, $P < 0.01$). The analysis by gender indicated that overweight rates varied significantly in females of different age groups ($\chi^2 = 24.173$, $P < 0.001$), which tended to increase with age and reached a peak for women in their 60s. Overweight rates for males also varied significantly across age groups ($\chi^2 = 17.188$, $P = 0.002$); however, the overweight rate had no upward trend with age among males (Table 2).

Table 2. Distribution of overweight rate at different age and gender.

Age group (years)	Male			Female			Total			χ^2	P
	No.	No. of overweight	Overweight rate (%)	No.	No. of overweight	Overweight rate (%)	No.	No. of overweight	Overweight rate (%)		
40~	592	226	38.18	1582	492	31.10	2174	718	33.03	9.751	0.002
50~	949	338	35.62	2356	821	34.85	3305	1159	35.07	0.176	0.675
60~	1221	508	41.61	1737	679	39.09	2958	1187	40.13	1.752	0.186
70~	579	226	39.03	777	273	35.14	1356	499	36.80	2.167	0.141
80~	101	24	23.76	113	35	30.97	214	59	27.57	1.389	0.239
Total	3442	1322	38.41	6565	2300	35.03	10007	3622	36.19	10.362	0.001
χ^2 trend		0.005			9.373			8.261			
P value		0.946			0.002			0.004			

Distribution of obesity rates across different ages and genders

The obesity rate for individuals over 40 years old was 11.32%, of which males accounted for 10.89% and females accounted for 11.55%. No significant difference was found

between males and females. The obesity rate of males in their 40s was significantly higher than that of females ($\chi^2 = 24.920$, P < 0.001). The obesity rate of females in their 60s and 70s was significantly higher than that of males (P < 0.001) (Table 3). The incidences of obesity differed significantly across age groups ($\chi^2 = 29.955$, P < 0.01). Overall, the obesity rate showed an upward trend with age and reached a peak in the 60s ($\chi^2 = 8.261$, P < 0.01). The obesity rate of females significantly increased with age, whereas the obesity rate of males significantly decreased with age (Table 3).

Table 3. The distribution of obesity rate at different age and gender.

Age group (years)	Male			Female			Total			χ^2	P
	No.	No. of obesity	Obesity rate (%)	No.	No. of obesity	Obesity rate (%)	No.	No. of obesity	Obesity rate (%)		
40~	592	81	13.68	1582	109	6.89	2174	190	8.74	24.920	<0.001
50~	949	101	10.64	2356	256	10.87	3305	357	10.80	0.035	0.852
60~	1221	133	10.89	1737	262	15.08	2958	395	13.35	10.371	0.001
70~	579	51	8.81	777	117	15.06	1356	168	12.39	11.938	<0.001
80~	101	9	8.91	113	14	12.39	214	23	10.75	0.673	0.412
Total	3442	375	10.89	6565	758	11.55	10007	1133	11.32	0.935	0.334
χ^2 trend		5.975			53.330			18.741			

Distribution of overweight and obesity rates in different single-factor populations

In this study, the following 11 factors were set as independent variables: gender, educational level, marital status, work, exercise (various forms of movement such as tai chi, dancing, aerobics, yoga, running, etc.), alcohol consumption, daily vegetable intake, family history of diabetes, sedentary time, birthday, and menstrual situation. These factors were statistically evaluated with respect to overweight and obesity rates, as well as the prevalence of a BMI $\geq$ 24 kg/m². The χ^2 test revealed that overweight and obesity rates of male subjects who lacked exercise and who had stopped working were significantly higher than those of female subjects who exercised and who had a job. Among women, overweight and obesity rates of postmenopausal women were significantly higher than those of menstrual females. Overweight and obesity rates varied significantly among respondents with different marital status. Overweight and obesity rates decreased significantly with increased education level (Table 4). However, other factors, such as family history of diabetes, daily sitting time, daily vegetable intake, alcohol consumption, birthday, etc., had no influence on overweight and obesity rates (Table 4).

Overweight and obesity risk factors

Gender, age, educational level, marital status, work, exercise activities, alcohol consumption, daily vegetable intake, family history of diabetes, daily sitting time, birthday, and 11 other factors used as independent variables, were included in the non-conditional logistic regression model. Using a gradual forward method of analysis, age, educational level, daily sitting time, and family history of diabetes were determined to be significant factors influencing overweight and obesity. The difference was statistically significant among different groups (Table 5). The tendency for overweight and obesity increased with age and decreased with higher educational level. The risk of overweight and obesity was 1.144 times greater among

people whose daily sitting time was more than 5 h compared with those whose daily sitting time was less than 5 h. The risk was 1.161 times greater among people with a family history of diabetes than those with no family history of diabetes (Table 5). The effects of gender, exercise, alcohol consumption, daily vegetable intake, and birth month on overweight and obesity prevalence were not statistically significant (Table 5).

Table 4. Distribution of overweight and obesity rate in different population with variants.

Variants	No.	No. of overweight and obesity	Overweight and obesity rate (%)	χ² trend	P
Gender					
Male	3359	1653	49.21	6.167	0.013
Female	6565	3058	46.58		
Exercise					
Yes	2209	982	44.45	10.364	0.001
No	7283	3522	48.36		
Work					
Yes	2158	950	44.02	13.192	<0.001
No	7767	3762	48.44		
Degree of education					
Illiteracy or semiliterate	975	491	50.36	36.478	<0.001
Primary school	2434	1271	52.21		
Junior high school	3502	1636	46.72		
High school/secondary	2042	877	42.95	9.014	0.011
Specific college course or above	822	360	43.80		
Marital status					
Married or cohabiting	8706	4174	47.94		
Divorced/separated/widowed	1040	462	44.42		
Spinsterhood	39	12	30.77		
Menopause (female)					
Yes	4907	2389	48.69	35.602	<0.001
No	1339	529	39.51		

Table 5. Analysis of risk factors of overweight and obesity.

Variants	B	SE	Wald	P	OR	95%CI
Age group			55.011	<0.001		
40~					1	
50~	0.121	0.062	3.830	0.050	1.128	1.000-1.273
60~	0.393	0.065	37.088	<0.001	1.482	1.306-1.682
70~	0.312	0.079	15.619	<0.001	1.366	1.170-1.595
80~	-0.275	0.163	2.846	0.092	0.760	0.552-1.045
Degree of education			34.150	<0.001		
Illiteracy or semiliterate					1	
Primary school	-0.005	0.084	0.003	0.955	0.995	0.844-1.174
Junior high school	-0.174	0.083	4.410	0.036	0.841	0.715-0.988
High school/secondary	-0.349	0.089	15.501	<0.001	0.705	0.593-0.839
Specific college course or above	-0.319	0.109	8.591	0.003	0.727	0.587-0.900
Sedentary time <5 h/day					1	
≥5 h/day	0.134	0.051	6.832	0.009	1.144	1.034-1.265
Diabetes history						
No					1	
Yes	0.150	0.075	3.990	0.046	1.161	1.003-1.345

DISCUSSION

Overweight and obesity are common conditions worldwide. Overweight is already very widespread in the Chinese population. The ratio of obesity shows the same growth rate as the ratio of overweight, and the potential dangers of both conditions to health are becoming increasingly apparent (Wu et al., 2005; Obesity and Overweight [EB/OL], WHO). This study

was concerned with the prevalent characteristics of overweight and obesity in middle-aged populations, thus revealing the regular pattern of overweight and obesity. The middle-aged respondents in this study were all Luzhou city residents, a factor that may have contributed to the limitations of this study. This study showed that the ratios of overweight and obesity in people above 40 years old were 36.19 and 11.32%, respectively, which means that 4 of 10 people are overweight, and 1 of 10 people is obese. These results demonstrate the alarming situation of overweight and obesity in China. The ratio of overweight and obesity is 3.5:1, which means that the potential risk of the progression from overweight to obesity is worthy of concern. The rates of overweight and obesity in our study are significantly higher than those reported in the national epidemiological survey of residents in 2002 (Wu et al., 2005), indicating that special attention should be paid to the middle-aged population with regard to the prevention and control of overweight and obesity. According to the 2002 national overweight and obesity epidemiological investigation, the rates of overweight and obesity among people older than 40 years in Luzhou were slightly lower than those of the urban population, higher than those of the rural population, and higher than the total incidence of urban and rural areas (Wu et al., 2005). The aforementioned study showed that the overweight rate was higher among males than among females, but no significant difference was found in the rate of obesity. According to the most recent US obesity epidemiology research, female obesity rates have always been higher than those of males; however, male obesity rates are increasing significantly. The ratio of obesity has not differed significantly between males and females in recent years (Flegal et al., 2010). As such, we speculate that obesity in males still has room for growth, and should not be ignored. Our study indicates that the obesity rate is higher among females above 60 years old than among males of this age group, which is consistent with results of similar local and international studies. For people more than 40 years old, the obesity rate was higher among males than among females, which is similar to the results from the CDC. In Chongqing, overweight and obesity rates are higher among males than among females for people older than 45 years old, whereas the result is reversed for people younger than 45 years old; such findings are slightly different from the data in our study (Flegal et al., 2010; Zhang et al., 2010). The different incidences of overweight and obesity in different ages and genders result from race, educational level, economic level, social status, and physiological hormonal changes (Wang and Beydoun, 2007). Overweight and obesity rates were significantly higher in postmenopausal women than in premenopausal women, suggesting that female hormones are closely related to overweight and obesity. One study showed that the mouse brain estrogen receptor could regulate energy expenditure and fat distribution. Another study confirmed that estrogen binds to estrogen receptors and takes part in glucose transport, synthesis of fat oxidation, and the mitochondrial respiratory chain. Therefore, estrogen and its involvement in obesity and other diseases has become a research hotspot (Gao et al., 2007; Chen et al., 2009; Newbold et al., 2009).

Genetic and living environment factors also contribute to the development and progression of overweight and obesity. This study showed that the risk of overweight and obesity increased in individuals with a family history of diabetes. Although the mechanism is not clear, a family history of diabetes is an easy characteristic to identify, thus taking positive interventions to prevent the development of overweight and obesity among this population would be undoubtedly beneficial. The risk of obesity was shown to increase by 23% for each additional 2 h of watching TV or sitting. Sedentary behavior, especially watching TV, greatly

increases the risk of obesity (Hu et al., 2003; Suter, 2005). The present study showed that a sitting time of ≥5 h per day is one of the risk factors of overweight and obesity, which is consistent with foreign research conclusions. Reducing sitting time can prevent weight gain. This study also showed that good habits are beneficial for maintaining normal body weight, and that various forms of exercise, such as tai chi, dancing, aerobics, yoga, and running, are beneficial for middle-aged people. This investigation also suggests that alcohol consumption is not related to overweight and obesity among middle-aged people. The association between alcohol consumption and weight is controversial, and results from epidemiological research on alcohol consumption and weight also vary. However, a study from the US confirmed that moderate alcohol consumption was associated with overweight and obesity based on characteristics of energy metabolism (Hu et al., 2003). Variations in conclusions may result from different references for drinking standards, frequencies, and groups.

Luzhou is one of the medium-sized cities in western China, in which overweight and obesity are highly prevalent among middle-aged people. The overweight population is large, and the prevalence of obesity may increase further. Overweight and obesity are serious problems among the middle-aged population. In particular, the incidence of overweight and obesity is imminent among people with a family history of diabetes, middle-aged men, and menopausal women. Health education programs regarding overweight and obesity risk behaviors and lifestyles should be strengthened, thus prompting the promotion of a reasonable diet, exercise, and other healthy behaviors and lifestyles for the prevention and control of overweight and obesity among the middle-aged population.

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