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Analysis of Body Composition in Middle-aged and Elderly People of Mulam Ethnic Group in Guangxi, China

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Abstract: Body composition mainly includes fat mass, muscle mass, body moisture, etc. These components are important parts of body mass and also important factors affecting human function and health. Abnormal body composition can cause many diseases. Objective: Explore the characteristics of body composition and the incidence of overweight and obesity in middle-aged and elderly people from the Mulam ethnic group in Guangxi, China, and provide a scientific basis for improving their health. Methods: This study included 384 Mulam minority individuals over the age of 45 years of age from the Luocheng Mulam ethnic autonomous county, Hechi, Guangxi, China. There were 165 males and 219 females. Body composition was measured using a bioelectric impedance analyzer in all of these participants. Results: The percentage of overweight and obesity in middle-aged and elderly Mulam people was relatively low; Their body composition distribution had certain rules. The non-lipid indices of men were higher than those of women. Lipid-related indexes were greater in women than in men. With increasing age, the related indexes of fat mass increased first and then decreased, while muscle mass decreased with increasing age. In women, body composition indicators slowly decreased with age. Conclusions: The decrease in muscle mass with age may lead to decreased body function. Therefore, it is suggested that middle-aged and elderly Mulam people adhere to good living habits and eating behaviors, maintain appropriate exercise, and maintain appropriate weight to promote physical health.

Keywords: Mulam, middle-aged and elderly, body composition, muscle mass, fat mass.

1. Introduction

Body composition refers to the amount of each body component, which is mainly composed of four molecular-level components: water, fat, proteins, and minerals, and their compositional ratios in the total body mass(Borga et al., 2018). Chemical analysis of bodily tissues stands as the only direct method for evaluating body composition(Gallagher et al., 2020). Body

composition is widely used in clinical investigations and field research as an indicator of energy-nutrient equilibrium, functional capacity and overall health(Gallagher et al., 2020). The study of body composition is an important field of human biology, which focuses on the quantities and patterns of many components in the human body, the methods of measuring body composition in vivo, and the effects of various factors inside and outside of the body on the quantitative relationship between the components(BING Qiang & Jian, 2001). Body Composition is in a dynamic process of change, and once it reacts to external stimuli such as food, climate, stress, and physical exercise, and internal stimuli such as metabolism, hormonal changes, and various diseases, body composition will change. Related studies have found that race, genetics, gender, age, environment, diet and nutrition, living habits, economic level, and other factors impact on body composition(Crawford et al., 2015; Yu, 2020). Body composition can affect human health and body functions, and its measurement is important for clinical diagnosis, judgment of disease risk, evaluation of the effectiveness of therapeutic methods, and improvement of clinical therapeutic effects (Kyle et al., 2004; Muller et al., 2016). Kerherve HA etc. (2020) found an increased risk of disease in ostensibly healthy obese women due to chronic exposure to elevated blood pressure, despite their normal resting blood pressure and heart rate responses during exercise(Kerherve et al., 2020). A study found that body fat rate predicts diseases such as hypertension and diabetes. Acquiring body composition data from diverse populations, including different regions, ethnicities, and age groups, and analyzing their distribution characteristics is of significant importance to improve the physical fitness of these populations and for the prevention and treatment of related diseases.

The Mulam ethnic minority is one of the ethnic minorities in China. 60% of the Mulam ethnic group lives in the Luocheng Mulam Autonomous County. The Luocheng Mulam Autonomous County is the only Mulam Autonomous County in China, which is subordinate to Hechi City of Guangxi. In this study, the body composition of the Mulam ethnic group was analyzed to provide basic data for the study of the body composition of minority ethnic groups in China.

2. Objects and Methods

2.1 Objects and Sampling

According to the results of the pre-survey, the rate of the rate of overweight or obesity is 44% (22/50) among middle-aged and elderly people in the Mulam ethnic group in Luocheng County, Guangxi, China. Take 30% to estimate the required sample content, let α=0.05, and the allowable error is 0.05. According to the calculation formula of sample content:

$N = \frac{u_{\alpha}^2 p(1-p)}{\delta^2}$ ，in the formula，u_a=1.96, p=0.3, δ=0.05.

The required sample content is calculated to be 322, and considering the 10% loss to follow-up rate, the number of people needed is 322×1.1=355. That is, at least 355 people are needed. This study adopted the method of stratified cluster sampling. Two towns of Mulam Ethnic Minority were selected, and then all the Mulam ethnic minority people in one village were randomly selected as the research objects. This is a cross-sectional study. From May 2022 to

August 2022, 384 middle-aged and elderly individuals (aged 45 and above) belonging to the Mulam ethnic minority (with at least 3 generations of ancestry) were selected as participants for this study. Among them, 165 were men (mean age 63.6±9.78 years) and 219 were women (mean age 60.16±10.14 years). Participants were stratified into six groups based on 5-year intervals (including 45, 50, 55, 60, 65, and 70). **(shown in Table 1).** Before participation, all individuals provided their informed written consent, and the study protocol was approved by the university's ethics committee.

Table 1 shows the number of subjects in each age group

Groups（age）	men（n）	women（n）	Total（n）
45-	16	41	57
50-	14	29	43
55-	24	33	57
60-	38	53	91
65-	27	26	53
70-	46	37	83
Total	165	219	384

2.2 Methods

Height was measured with the Martin altimeter（FYBM-19, Fanying police equipment new Technology Co, LTD, China）.

Body composition was measured using a bioelectrical impedance analyzer (TANITA, MC-180, Japan). Participants' heights were inputted, and they were instructed to remove outer garments and any metal objects from their bodies (internal metallic implants are also prohibited). Then, they are asked to stand barefoot on the foot electrode plates of the body composition analyzer, gripping the hand electrodes as directed. With the arms naturally hanging at their sides and the body relaxed, a low electrical current passes through the body. Impedance measurements of various body parts are calculated and converted into various composition indicators, and the participant's body composition data is obtained. Indicators such as height, weight, lean body mass, total fat mass, trunk fat mass, subcutaneous fat mass, visceral fat mass, body fat rate, trunk fat rate, muscle mass, trunk muscle mass, body water moisture, and body mass index (BMI) are analyzed.

According to the guidelines for the prevention and control of overweight and obesity in Chinese adults, underweight was defined as BMI<18.5kg/m^2, normal weight was defined as 18.5kg/m^2≤BMI < 24kg/m^2, overweight was defined as 24kg/m^2≤BMI < 28kg/m^2, and obesity was defined as BMI≥28kg/m^2.

2.3 Statistical Analysis

SPSS26.0 statistical software was used to analyze the data. Data were tested for normality and fitted to a normal distribution. The T-test was used to compare the two groups. Analysis of variance was used to compare multiple groups. The Chi-Square test was used to compare the rates. $P< 0.05$ was considered statistically significant.

3. Results

3.1 Results of the Measurement of Body Composition in Middle-Aged and Elderly Mulam Men

These indexes of the Mulam middle-aged and elderly men were tested to be in line with normal distribution($P>0.05$), and the measurement results are shown in Table 2. Table 2 also shows the F-values and P-values for the one-way ANOVA. Post hoc multiple comparisons were made using the LSD method. As shown in Table 2, there was no statistically significant difference in height and trunk muscle mass among middle-aged and elderly Mulam men ($P>0.05$), while the rest of the indicators showed statistically significant differences between age groups ($P<0.05$). Lean body mass was lower in the 70-year age group compared to the 45-year age group ($P<0.01$); fat mass, trunk fat mass, and subcutaneous fat mass were higher in the 50-, 55-, 60- and 65-year age groups than in the 45-year age group ($P<0.05$). The body fat rate and the trunk fat rate were lower in the 45-year-old group than in the other age groups ($P<0.05$). Muscle mass and body moisture were lower in the 70-year age group than in the 45-year age group ($P<0.01$).

Table 2 Measurement of body composition in Mulam middle-aged and elderly men [mean (SD)]

Body Composition	Age45-	Age50-	Age55-	Age60-	Age65-	Age70-	F-value	P-value
Height(cm)	161.88(8.09)	160.21(4.77)	160.10(5.18)	160.95(4.96)	161.74(6.18)	159.15(5.66)	1.017	0.409
Weight(kg)	60.31(8.25)	64.15(9.61)	63.34(7.67)	62.88（7.31）	64.83（10.97）	56.76（7.99）	4.410	0.001
Lean body Mass(kg)	49.51(5.43)	49.50(5.12)	48.51（4.33）	48.78（4.06）	49.19（5.75）	44.60（5.13）[b]	5.421	＜0.001
Fat mass(kg)	10.85(3.92)	14.66(5.63)[a]	14.84±4.72[a]	14.12±4.81[a]	15.67±5.86[b]	12.19±4.07	3.398	0.006
Trunk fat mass(kg)	6.01(2.50)	8.56(3.70）[a]	9.02±3.11[b]	8.40±3.31[a]	9.55±3.56[b]	7.68±2.66	3.236	0.008
Subcutaneous fat mass（kg）	9.18(3.09）	11.88(4.09)[a]	11.86(3.48)[a]	11.34(3.55)[a]	12.30(4.30)[b]	9.57（2.98）	3.58	0.004
Body fat rate	17.59（4.33）	22.22(5.93)[b]	22.98(5.56)[b]	21.98(5.58)[b]	23.36(5.72)[b]	21.01(5.32)[a]	2.78	0.019
Trunk fat	17.65	23.26(7.3	24.28(6.6	22.97(6.84	25.08(6.60	22.49(6.18	2.99	0.013

continued

rate	（5.25）	6)[a]	8)[b]	)[b]	)[b]	)[a]		
Muscle mass(kg)	46.61（5.17）	46.92(4.87)	45.96(4.11)	46.22(3.88)	46.63(5.47)	42.26(4.88)[b]	5.39	＜0.001
Trunk muscle mass(kg)	25.76（2.44）	25.64(2.77)	25.86(2.17)	25.54(2.70)	25.94(2.540	24.45(2.65)	1.75	0.127
Body moisture(kg)	33.86（4.26）	33.76(4.29)	32.58(3.50)	33.41(3.56)	33.40(4.510	30.20(3.97[b]	4.44	＜0.001
Body mass index	22.93（1.89）	25.00(3.74)	24.70(2.72)	24.25(2.54)	24.71(3.60)	22.38(2.78)	4.20	0.001

Notes: Compared to the 45-year-old group, a: <0.05, b: P<0.01.

3.2 Results of the Body Composition Measurement in Middle-Aged and Elderly Mulam Women

These indexes of the Mulam middle-aged and elderly women were tested to be in line with normal distribution(P>0.05), and the measurement results are shown in Table 3. Table 3 also shows the F-values and P-values for the one-way ANOVA. Post hoc multiple comparisons were made using the LSD method. As shown in Table 3, the differences in height, body fat rate, and trunk fat rate of middle-aged and elderly Mulam women were statistically significant between age groups (P<0.01), while the differences in the rest of the indicators were not statistically significant between age groups (P>0.05). Height was lower in the 70-year age group than in the 45-year age group (P<0.01). The body fat rate and the trunk fat rate were lower in the 45-year-old group than in the other age groups (P<0.01).

Table 3 Measurement of body composition in Mulam middle-aged and elderly women [mean (SD)]

Body Composition	Age45-	Age50-	Age55-	Age60-	Age65-	Age70-	F-value	P-value
Height(cm)	152.34(4.90)	151.34(5.20)	151.03(5.30)	150.94(5.38)	150.58(5.45)	147.46(5.93)[b]	4.596	0.004
Weight(kg)	54.22(7.68)	54.92(7.35)	53.46(7.34)	53.97(7.89)	53.44(9.29)	52.52(8.79)	0.347	0.884
Lean body Mass(kg)	37.34(3.50)	36.76(2.61)	36.28(3.32)	36.74(4.21)	35.85(2.86)	35.05(4.62)	1.781	0.118
Fat mass(kg)	16.91(5.82)	18.19(5.52)	17.21(5.44)	17.25(5.83)	17.63(7.18)	17.49(5.63)	0.55	0.736
Trunk fat mass(kg)	9.15(3.68)	10.14(3.68)	9.85(3.44)	9.84(3.98)	10.45(4.82)	10.54(3.36)	0.74	0.592
Subcutaneous fat mass（kg）	14.82(4.69)	15.76(4.22)	14.75(4.30)	14.73(4.51)	14.81(5.37)	14.59(4.48)	0.26	0.934

continued

Body fat rate	30.41(7.05)	32.45(5.87)[b]	31.51(6.51)[b]	31.26(7.12)[b]	31.82(7.45)[b]	32.65(6.31)[b]	163.16	＜0.001
Trunk fat rate	29.30(8.57)	31.71(7.13)[b]	30.98(7.63)[b]	30.35(9.03)[b]	31.38(8.80)[b]	32.55(7.10)[b]	108.40	＜0.001
Muscle mass(kg)	35.23(3.21)	34.70(2.39)	34.27(3.02)	34.70(3.84)	33.87(2.61)	33.14(4.22)	1.179	0.116
Trunk muscle mass(kg)	19.92(2.10)	19.83(1.42)	20.04(1.88)	20.52(2.79)	20.20(1.52)	20.15(2.52)	0.53	0.587
Body moisture(kg)	27.42(3.31)	26.99(2.11)	26.59(3.05)	27.12(3.88)	26.35(2.65)	26.15(4.13)	0.78	0.560
Body mass index	23.35(3.16)	23.96(2.88)	23.43(3.00)	23.64(3.04)	23.57(3.95)	24.02(2.82)	0.27	0.930

Notes: Compared to the 45-year-old group, b:P<0.01

3.3 Gender Differences in Body Composition in Middle-Aged and Elderly Mulam People

The body composition data of Mulam middle-aged and elderly people were tested to conform to a normal distribution(P>0.05). Therefore, a T-test was used to compare the body composition between the two genders. The measurement results are shown in Table 4. Table 4 also shows the T-values and P-values. From Table 4, it can be seen that except for the difference in body mass index, which was not statistically significant, there were statistically significant differences between men and women in the other indexes (P<0.01). These indexes, including height, weight, lean body mass, muscle mass, trunk muscle mass, and body moisture of men were higher than those of women. Other indexes including fat mass, trunk fat mass, subcutaneous fat mass, body fat rate, and trunk fat rate of women, were greater than those of men. The results are shown in **Table 4**.

Table 4 Comparison of the body composition of the Mulam people in gender [mean (SD)]

Body composition	men(n=165)	women(n=219)	T-value	P-value
Height(cm)	160.48(5.74)	150.64(5.52)	16.992	＜0.001
Weight(kg)	61.42(8.96)	53.76(7.98)	8.829	＜0.001
Lean body Mass(kg)	47.76(5.25)	36.39(3.740	23.66	＜0.001
Fat mass(kg)	13.67(4.96)	17.39(5.82)	6.60	＜0.001
Trunk fat mass(kg)	8.26(3.22)	9.94(3.80)	4.584	＜0.001
Subcutaneous fat mass（kg）	10.92(3.67)	14.87(4.54)	9.424	＜0.001
Body fat rate	21.67(5.59)	31.59(6.74)	15.749	＜0.001

continued

Trunk fat rate	22.89(6.69)	30.92(8.15)	10.590	＜0.001
Muscle mass(kg)	45.27(4.99)	34.37(3.42)	24.101	＜0.001
Trunk muscle mass(kg)	25.38(2.60)	20.14(2.19)	20.861	＜0.001
Body moisture(kg)	32.47(4.16)	26.83(3.37)	14.242	＜0.001
Body mass index	23.80(3.03)	23.65(3.09)	0.476	0.634

3.4 Trends in Body Composition of Middle-Aged And older Mulam People Growing with Age

As shown in **Figures 1 to 5**, the fat mass and trunk fat mass of Mulam middle-aged and elderly men appeared to increase first from the age of 45 years and then declined more significantly after the age of 70 years. The subcutaneous fat mass appeared to increase first from 45 years of age, smoother in the 50~, 55~, 60~, and 65~ age groups, with a more pronounced trend of decline after 70 years of age. Muscle mass and trunk muscle mass show a slow decline with age.

The fat mass, the trunk fat mass, the subcutaneous fat mass, the muscle mass, and the trunk muscle mass of the middle and elderly women of Mulam slowly decreased with age, and the curve trend was relatively smooth.

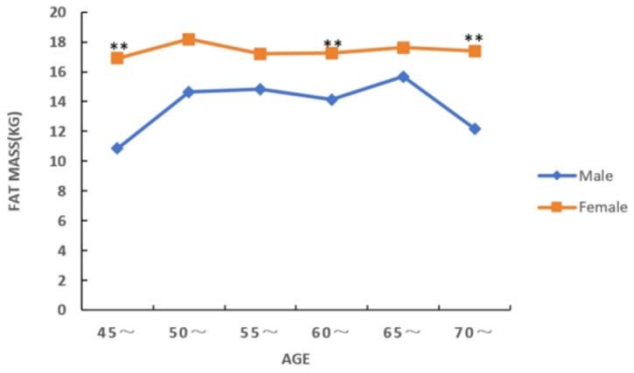

Fig. 1 Trends of fat mass with age in middle-aged and elderly Mulam people. (men vs. women in the same age group, ** $p< 0.01$).

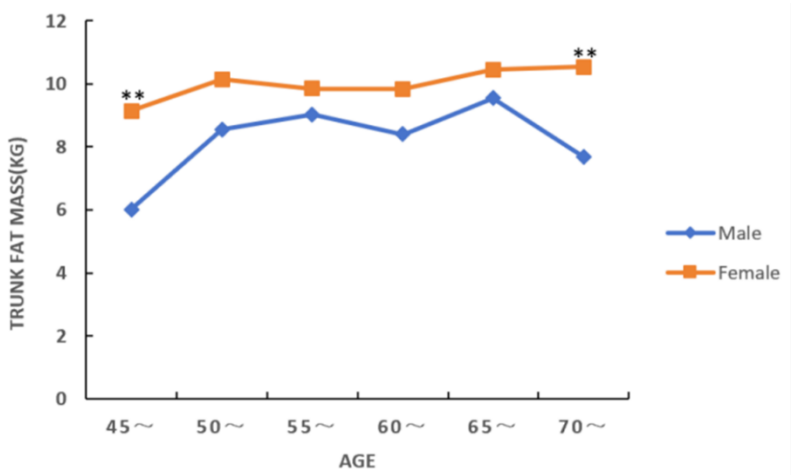

Fig. 2 Trends in trunk fat mass with age in middle-aged and elderly Mulam people. (men vs. women in the same age group, ** $p< 0.01$).

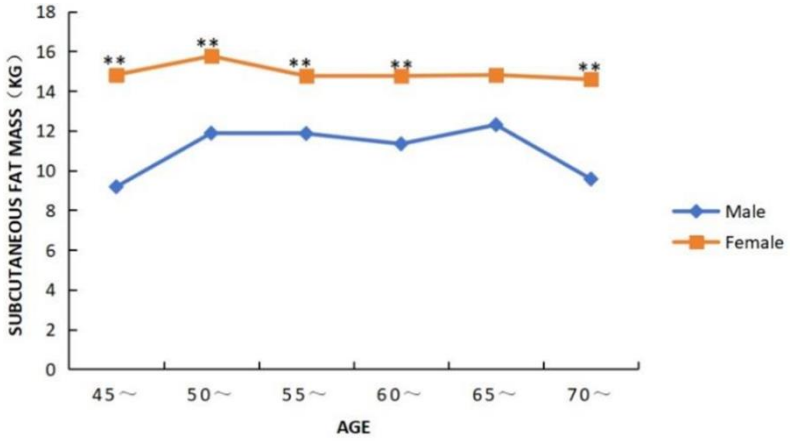

Figure 3 Trends in subcutaneous fat mass with age in middle-aged and elderly Mulam people. (men vs. women in the same age group, ** $p< 0.01$).

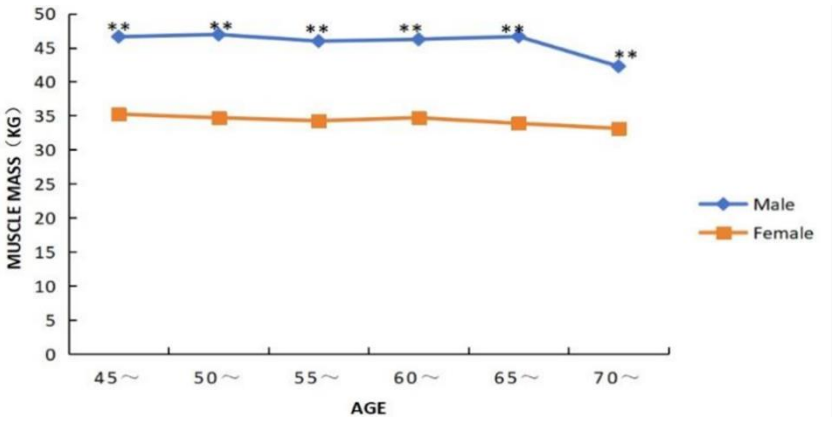

Figure 4 Muscle mass trends in middle-aged and elderly Mulam people. (men vs. women in the same age group, ** p< 0.01).

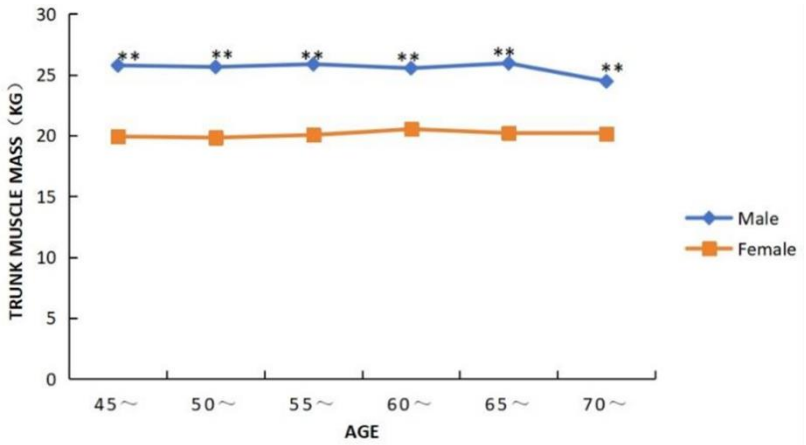

Figure 5 Trends in trunk muscle mass in middle-aged and elderly Mulam people. (men vs. women in the same age group, ** p< 0.01).

3.5 Results of Overweight and Obesity in Middle-Aged and Elderly Mulam People

Comparison of the overweight and obesity rates in different age groups used Chi-square text. As shown in Table 5, the percentage of overweight and obesity among middle-aged and elderly Mulam men showed a tendency to increase and then decrease with age, the highest percentage being 66.7% in the 55-age group. The percentage of overweight and obesity for men was 44.8%. The percentage of overweight and obesity among middle-aged and elderly Mulam women gradually increased with age and the highest percentage was 56.8% in the 70-age group. The percentage of overweight and obesity for women was 45.7%. The percentage of overweight and obesity was higher in women than in men in the 70-year group (P<0.01), and the difference was not statistically significant in the remaining age groups.

Table 5 Comparison of the overweight and obesity rates in different age groups

Age Groups	men		women		Chi-square value	P-value
	Normal n(%)	overweight and obesity n(%)	Normal n(%)	overweight and obesity n(%)		
45～	12（75.0）	4（25.0）	25（61.0）	16（39.0）	0.994	0.319
50～	7（50.0）	7（50.0）	17（58.6）	12（41.4）	0.285	0.595
55～	8（33.3）	16(66.7）	19（57.6）	14（42.4）	3.275	0.070
60～	18（47.4）	20（52.6）	27（50.9）	26（49.1）	0.113	0.737

continued

65～	12（44.4）	15（55.6）	15（57.7）	11（42.3）	0.930	0.335
70～	34（73.9）	12（26.1）	16（43.2）	21（56.8）	8.053	0.005
Total	91(55.2)	74(44.8)	119(54.3)	100(45.7)	0.025	0.847

4. Discussion

China has the world's fastest aging population and the largest elderly population. According to China's seventh population census, 18.70 percent of the population were 60 years or older, of which 13.50 percent were 65 years of age or older(Statistics & Council, 2021). It is expected that by 2025, China's population of 60 years old will reach 300 million. By that time, China will have become a super-aged country(Statistics & Council, 2021). The Mulam ethnic group, as one of the minority groups in China, also needed to face the problem of aging. Body composition changes with age and is associated with many health problems and diseases (such as abnormal glucose metabolism, hypertension, lipid disorders, and osteoporosis)(Magee et al., 2024; Pereira et al., 2016; Zhu et al., 2016). At the same time, the study of body composition is of great importance in guiding the public to adjust weight, monitor health behavior, and evaluate the promotion of health through exercise and nutrition(Yingbin, 2017). It is helpful to evaluate the physical condition and promote the health of middle-aged and elderly Mulam people by analyzing their body composition characteristics and changing rules.

4.1 Characteristics of Body Composition and Gender Differences of Middle-Aged and Elderly Mulam People

This study showed that the body composition of middle-aged and elderly Mulam people was different between males and women. These indexes, including height, weight, lean body mass, muscle mass, trunk muscle mass, and body moisture of men were greater than women. Other indexes including fat mass, trunk fat mass, subcutaneous fat mass, body fat rate, and trunk fat rate of women were greater than men. In simple terms, non-lipid indicators of body composition were greater in men than women, while lipid-related indicators were greater in women than in men. The gender difference in body composition in the Mulam ethnic group is consistent with that in the Han, Zhuang, and Maonan ethnic groups in Guangxi, China(Bin et al., 2016; Luo, 2022; Yang et al., 2022). Gender is an important factor affecting body composition(Horlick et al., 2002). Differences in genes and expression between sexes and biological differences between sexes cause different characteristics of body composition (Horlick et al., 2002). The distribution of fat is regulated by sex hormones, and when the level of androgen in the body increases, it can promote muscle enlargement, and female estrogen promotes fat deposition, so the muscle mass of men is significantly higher than that of women, and the fat content of women is higher than that of men (Leeners et al., 2017; Rosen & Klibanski, 2009). There are gender differences in the division of labor in the Mulam ethnic group, which was a pattern of "men dominant outside, women dominant inside." As the main force in labor production, men have been engaged in physical activities such as farming for a long time, with more muscle exercise and a high level of physical consumption. As the main force in labor production, men have been engaged in physical activities such as farming for a

long time, with more muscle exercise and a high level of physical consumption. This was why men have a lower percentage of fat and higher muscle mass than women.

4.2 Age-related Changes in Body Composition in The Mulam Ethnic Group

With increasing age, the fat mass, the trunk fat mass, and the subcutaneous fat mass of Mulam men first increased and then decreased, and obviously decreased after 70 years. Their muscle mass, trunk muscle mass, and water showed a trend of decline with age. The fat mass, the trunk fat mass, the subcutaneous fat mass, the muscle mass, the trunk muscle mass, and the body water of the ethnic Mulam women decreased slowly with age. This may be due to the increase in body fat content caused by the decrease in physical labor, as men gradually stop being the main labor force at home after entering 50 years of age. In general, the gradual decline in body composition with age may be related to slowing of metabolism, reduced diet, and decreased digestion and absorption capacity caused by aging (Yu, 2020).

4.3 Prevalence of Overweight and Obesity in the Mulam Ethnic Group

This study showed that the percentage of overweight and obesity in middle-aged and elderly Mulam men was 44.8%. The percentage of overweight and obesity in middle-aged and elderly Mulam women was 45.7%. They are less than the rate of overweight or obesity among Chinese adults (50.7%). This may be because Luocheng County, the habitat of the Mulam ethnic group, is located in the north of Guangxi, China, with many stone mountains and karst landscapes. The locals mainly grow rice, and the Mulam ethnic group eats rice as its staple food, supplemented by corn, sweet potato, various vegetables, fruits, and meat, with a light diet. This may be because Luocheng County, the habitat of the Mulam ethnic group, is located in the north of Guangxi, China, with many stone mountains and karst landscapes. The locals mainly grew rice, and they ate rice as a staple food, supplemented by corn, sweet potato, various vegetables, fruits, and meat, with a light diet. In addition to traditional agriculture, such as land farming, the Mulam ethnic group also engaged in the breeding industry with a high labor intensity, which is also the reason for the low detection rate of overweight and obesity in middle-aged and elderly people. Obesity raises the risk of many diseases and increases the risk of early death. Obesity also causes unnecessary medical expenses and imposes a huge financial burden on families and society. Therefore, it is necessary to measure the body composition of middle-aged and elderly people and measure overweight and obesity.

5. Conclusion

The results of this study showed that the percentage of overweight and obesity in middle-aged and elderly Mulam people was relatively low. Their body composition distribution had certain rules. The non-lipid indices of men were greater than that of women. Lipid-related indexes were greater in women than men. With increasing age, the related indexes of fat mass increased first and then decreased, while muscle mass and water moisture decreased with increasing age. In women, body composition indicators slowly decreased with age. Loss of lean body mass, muscle mass, water, etc., can impair the function of the body. Therefore, it is suggested that middle-aged and elderly Mulam people adhere to good living habits and eating behaviors,

maintain appropriate exercise, and maintain appropriate weight to promote physical health.

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Institutional Review Board Statement: The study was carried out according to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Youjiang Medical University for Nationalities (protocol code 2020040901 and date of approval is 20200409).
Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.
Data Availability Statement: The analyzed data sets generated during the study are available from the first author on a reasonable request.
Conflicts of Interest: The authors declare that they have no conflict of interest.

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