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CORRELATION OF ANTHROPOMETRY AND BODY COMPOSITION IN WOMEN WITH AGE

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ABSTRAK

Latar Belakang: Penuaan sering kali menyebabkan perubahan komposisi tubuh, seperti penurunan massa otot, peningkatan massa lemak, dan penurunan laju metabolisme basal, yang berkaitan dengan perubahan molekuler dan fisiologis. Perubahan ini meningkatkan kerentanan terhadap obesitas, gangguan metabolik, dan komplikasinya, terutama pada wanita. **Tujuan:** Penelitian ini mencari hubungan antara parameter antropometri dan komposisi tubuh dengan usia pada perempuan untuk mengidentifikasi perubahan yang terjadi seiring bertambahnya usia. **Metode:** Studi potong lintang dengan pengambilan sampel bertujuan dilakukan pada 144 wanita berusia 18 tahun ke atas. Data antropometri seperti berat badan, tinggi badan, dan lingkar diukur bersamaan dengan parameter komposisi tubuh seperti total lemak tubuh, lemak visceral, dan massa otot rangka. BMR *(Basal Metabolic Rate)* ditentukan dengan Omron Karada Scan HBF 375, sementara korelasinya dipelajari menggunakan korelasi Pearson. **Hasil:** Terdapat korelasi signifikan antara usia dengan parameter utama komposisi tubuh seiring bertambahnya usia. Terdapat peningkatan total lemak tubuh (r = 0,249, p = 0,003) dan penurunan massa otot rangka (r = -0,206, p = 0,013), yang berkontribusi terhadap penurunan BMR (r = -0,231, p = 0,005). Lingkar betis juga berkorelasi negatif signifikan dengan usia: r = -0,201, p = 0,015. **Kesimpulan:** Pengaruh paling signifikan dari penuaan adalah pada komposisi tubuh dan BMR karena peningkatan massa lemak dan pengurangan massa otot rangka yang menurunkan aktivitas metabolik. Kondisi ini dapat berkontribusi pada risiko gangguan metabolik, sehingga diperlukan pemantauan komposisi tubuh dan pendidikan kesehatan secara reguler.

Kata Kunci: Antropometri; Komposisi Tubuh; Usia; Wanita

ABSTRACT

Background: *Ageing has been associated with molecular and physiological changes, which lead to a change in body composition, a reduction in lean mass, an increase in fat mass, and a reduction in basal metabolic rate. These further increase vulnerability to obesity, metabolic disorders, and their complications, particularly in women.* ***Objectives:*** *This study investigates the relationship between anthropometric parameters and body composition with age in women to identify changes that occur as age increases.* ***Method:*** *A cross-sectional study by purposive sampling was carried out on 144 women aged 18 years and above. Anthropometric data such as weight, height, and circumferences were measured alongside body composition parameters like total body fat, visceral fat, and skeletal muscle mass. BMR (Basal Metabolic Rate) was determined by the Omron Karada Scan HBF 375, while its correlations were studied using Pearson's correlation.* ***Results:*** *There were significant correlations of age with major body composition parameters with aging. There was an increase in total body fat (r = 0.249, p = 0.003) and a decrease in skeletal muscle mass (r = -0.206, p = 0.013), contributing to a decline in BMR (r = -0.231, p = 0.005). Calf circumference was also significantly negatively correlated with age: r = -0.201, p = 0.015.* ***Conclusion:*** *The most significant influences of aging are on body composition and BMR due to increased fat mass and reduced skeletal muscle reduction that lower metabolic activity. This condition increases the risk of metabolic disorders, regular body composition, and health education monitoring.*

Keywords: *Age; Anthropometry; Body Composition; Women*

1. INTRODUCTION

Various molecular, cellular, and physiological changes drive aging (Briand et al., 2024; López-Otín et al., 2023). As a result, body composition undergoes alterations, including a decrease in lean mass (LM) and bone mineral content (BMC) and an increase in fat mass (FM). In addition, energy metabolism is affected, reducing daily energy expenditure when adjusted for fat-free mass (Briand et al., 2024; Pontzer et al., 2021). Body composition varies between men and women, with women having a larger proportion of fat mass and males often having more lean mass. Additionally, there are differences in fat distribution; males are more likely to store fat in the trunk and stomach areas (Bredella, 2017). Meanwhile, estrogen is a significant factor in women, affecting metabolism and fat distribution. Women usually exhibit a gynoid fat distribution pattern: fat buildup around the hips and thighs (Bredella, 2017; Deatsman et al., 2016). Depending on a person's history of infertility or need for fertility treatments, fertility may start to diminish at about age 35 (Deatsman et al., 2016). Post-reproductive women have increased muscle mass due to increased exercise and hormonal assistance compared to their less active peers (Trikudanathan et al., 2013).

Anthropometric measures include body weight, height, waist, hip, upper arm, neck, and calf circumference. The human body comprises fat, lean tissue, and bone at the tissue level and water, fat, proteins, and minerals at the molecular level. It is crucial to keep these elements in the proper proportions. Obesity is caused by excess fat, lipodystrophy is caused by inadequate fat, sarcopenia, and cancer-related cachexia result in decreased skeletal mass, and osteoporosis is linked to poor bone density. Lipid is the most changeable of the three main tissue types within and between individuals. Subcutaneous adipose tissue is the body's primary location for storing excess energy. At the same time, visceral adipose tissue contains lipids (Chen, 2021; Liu et al., 2010).

2. METHODS

Study Design

This study was conducted in 2024 and employs a cross-sectional design, analyzing 144 adults and elderly individuals at RPTRA Krendang through purposive sampling. Inclusion criteria were females over 18, with signed written informed consent to participate. Exclusion criteria included taking medication that could affect body composition or metabolism (e.g. corticosteroids or hormone replacement therapy), being pregnant or lactating, undergoing bariatric or other major surgery within the past 6 mo, inability to perform physical testing or complete study protocols due to physical disability, and having any severe psychiatric condition that could interfere with participation.

Variables and Instruments

This study's dependent variables included various body composition parameters such as total body fat, visceral fat, basal metabolic rate, and subcutaneous fat distribution in different body areas. Anthropometric measurements such as body weight, height, waist, hip, upper arm, neck, and calf circumference were also assessed. Body composition and weight were evaluated using the Omron Karada Scan HBF 375, while height was measured with a microtoise. Circumference measurements were obtained using measuring tape. The independent variable was age, and all measuring devices were calibrated beforehand to ensure accuracy and reliability.

Statistical Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26 for univariate and bivariate quantitative data. Data normality was achieved using the Kolmogorov-Smirnov test, while correlation tests of anthropometry, body composition, and age in women were performed using Pearson's correlation coefficient test. The statistical analysis revealed significance at $p < 0.05$. The relationships between the datasets were categorized as follows: trivial (0.00–0.10), weak (0.10–0.39), strong (0.40–0.69), very strong (0.70–0.89), and perfect (0.90–1.00). The characteristics of the respondents were presented using mean values and standard deviations.

3. RESULTS AND DISCUSSION

Respondents included 144 people who met the inclusion criteria (Table 1). The mean age was 36.82 years (±10.1), with a weight of 59.07 kg (±11.16) and a height of 150.31 cm (±13.34). The average anthropometric variables were waist circumference scores of 81.67 cm, hip circumference scores of 96.32 cm, and calf circumference scores of 35.13 cm. The mean basal metabolism rate was 1,252.01 kcal/day (±153.31), and the body mass index score was 25.82 kg/m² (±4.73). Total body fat was measured at 33.80% (±4.99), and visceral fat was 8.13% (±4.74). Total skeletal muscle was estimated at 24.09% (±3.48). (Table 1)

Additionally, this research applied the Kolmogorov-Smirnov test to evaluate the data distribution's normality. The findings demonstrated that all variable outcomes exhibited a normal distribution.

Table 1. Respondent Characteristics

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Age (years)		36.82 (10.1)	35 (23 – 71)
18 – 25	13 (9)		
26 – 30	27 (18.8)		
31 – 35	35 (24.3)		
36 – 40	27 (18.8)		
41 – 45	19 (13.2)		
46 – 50	9 (6.3)		
51 – 55	4 (2.8)		
56 – 60	3 (2.1)		
61 – 65	4 (2.8)		
66 – 70	2 (1.4)		
71 – 75	1 (0.7)		
Body Weight		59.07 (11.16)	58.75 (23.9 – 82)
Body Height		151.7 (6.51)	152 (104 – 168)
Waist Circumference		81.67 (10.19)	81 (58 – 105)
Hip Circumference		96.32 (9.27)	96 (79 – 125)
Upper Arm Circumference		28.38 (4.08)	28 (20 – 37)
Neck Circumference		33.25 (3.92)	33 (19 – 45)
Calf Circumference		35.13 (3.97)	35 (20 – 44)
Bicep Fat Caliper		5.6 (4.28)	4.2 (1.1 – 29)
Tricep Fat Caliper		15.76 (5.45)	15.35 (4.8 – 33.9)
Suprailiac Fat Caliper		19.22 (6.4)	18.5 (6.3 – 53.5)
Subscapular Fat Caliper		14.33 (4.14)	14.2 (4.6 – 27.1)
Total Body Fat		33.80 (4.99)	34.2 (20.6 – 42.4)
Total Visceral Fat		8.13 (4.74)	7.5 (1 – 21)
Basal Metabolic Rate (BMR)		1252.01 (153.31)	1243.5 (937 – 1620)
Body Mass Index		25.82 (4.73)	25.75 (16.5 – 37.2)
Total Subcutaneous Fat		30.09 (6.83)	30.35 (15.7 – 68.4)
Trunk Subcutaneous Fat		25.92 (5.58)	26.35 (12.9 – 40.6)
Upper Extremity Subcutaneous Fat		45.42 (6.95)	46.2 (18.4 – 57.6)
Lower Extremity		41.62 (7.55)	40.9 (23.4 – 57.9)

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Subcutaneous Fat			
Total Skeletal Muscle		24.09 (3.48)	23.55 (18.1 – 54.8)
Trunk Skeletal Muscle		18.32 (2.73)	18 (13 – 31.9)
Upper Extremity Skeletal Muscle		25.40 (4.53)	25.3 (13.7 – 36)
Lower Extremity Skeletal Muscle		36.13 (3.97)	36.6 (8.3 – 46.3)

The Pearson correlation analysis revealed significant relationships between age and specific body composition parameters in women. Notable correlations were observed with calf circumference ($r = -0.201$, $p = 0.015$), total body fat ($r = 0.249$, $p = 0.003$), and basal metabolic rate ($r = -0.231$, $p = 0.005$). Additionally, total skeletal muscle showed a significant negative correlation ($r = -0.206$, $p = 0.013$). These findings underscore that aging in women can increase total body fat and decrease total skeletal muscle, which reduces BMR. (Table 2; Figure 1)

Table 2. Correlation of Anthropometry and Body Composition in Women with Age

Parameter	r-correlation	p-value
Body Weight	-0.117	0.163
Body Height	-0.082	0.328
Waist Circumference	-0.036	0.668
Hip Circumference	-0.026	0.759
Upper Arm Circumference	-0.040	0.634
Neck Circumference	-0.079	0.346
Calf Circumference	-0.201	0.015*
Bicep Fat Caliper	-0.005	0.951
Tricep Fat Caliper	-0.009	0.914
Suprailiac Fat Caliper	-0.023	0.780
Subscapular Fat Caliper	0.006	0.946
Total Body Fat	0.249	0.003**
Total Visceral Fat	0.126	0.132
Basal Metabolic Rate (BMR)	-0.231	0.005**
Body Mass Index	-0.016	0.854
Total Subcutaneous Fat	0.140	0.094
Trunk Subcutaneous Fat	0.161	0.054
Upper Extremity Subcutaneous Fat	0.132	0.116
Lower Extremity Subcutaneous Fat	-0.065	0.441
Total Skeletal Muscle	-0.206	0.013*
Trunk Skeletal Muscle	0.024	0.774
Upper Extremity Skeletal Muscle	-0.201	0.016
Lower Extremity Skeletal Muscle	-0.051	0.544

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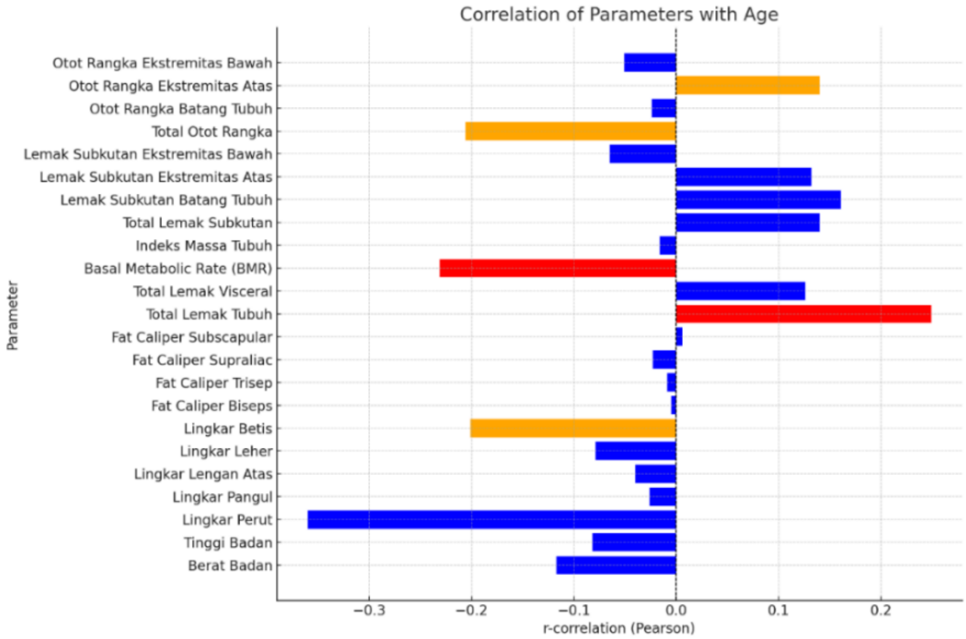

Figure 1.

Correlation of Anthropometry and Body Composition in Women with Age

Factors associated with the physiological changes conditioning aging can account for the shift in body composition with age, and lifestyle variables such as diet and physical activity could affect it, too. This study aligns with Briand et al., who identified factors related to age and body composition and determined several breakpoints for every variable. They additionally emphasized the sex-related disparities for each body composition (Briand et al., 2024). Various biological, hormonal, and lifestyle factors have been connected to women's body composition changes. These elements show how the body reacts to significant life transitions, like menopause, both internal and external changes (Sowers et al., 2007). It increases with age up to 75, with lean mass remaining relatively stable until age 31, followed by a statistically significant decrease of 0.03 kg/year in females. For fat mass, females showed a progressive increase with age, up to 75, at a rate of 0.07 kg/year (Briand et al., 2024).

The onset of puberty is triggered by signals from the brain that activate the hypothalamic-pituitary-gonadal axis. This includes the release of GnRH from the hypothalamus, which stimulates the pituitary gland to release LH and FSH (Burt Solorzano & McCartney, 2010). These hormones, in turn, stimulate the ovaries to secrete estrogen, primarily estradiol. Estrogen plays a role in the adiposity regulator (Krotkiewski et al., 1983). It encourages subcutaneous fat to accumulate, and menopause-related estrogen depletion is linked to increased central fat (Brown & Clegg, 2010; Poehlman, 1995). When estrogen directly affects adipose tissues, visceral fat storage in females rises as estrogen levels fall (Crandall et al., 1998). Meanwhile, androgen receptors are more prevalent in visceral fat, while estrogen receptors and progesterone receptors are more concentrated in subcutaneous fat. Estrogen promotes fat storage in subcutaneous rather than visceral depots by downregulating androgen receptor expression in subcutaneous fat (Bjorntorp, 1997; Brown & Clegg, 2010). It also promotes visceral fat mobilization and subcutaneous fat deposition by amplifying the effects of leptin, which in turn controls the distribution of body fat (Brown & Clegg, 2010).

The positive correlation between total fat mass and age ($p = 0.003$) indicates a shift in body composition, where fat mass increases due to a slower basal metabolic rate (BMR) and hormonal alterations. This study aligns with Ponti et al. which uses imaging technologies like dual-energy X-ray absorptiometry (DXA), CT scans, and MRI to precisely measure changes in body composition. It is essential for creating treatments that can lessen or even stop the detrimental effects of fat buildup in later life, such as diet plans and exercise regimens (Ponti et al., 2020).

Midlife women's body composition is influenced by chronological and ovarian age (Sowers et al., 2007). Dietary and physical activity choices also significantly impact changing body composition. Regular exercise helps to mitigate some of the detrimental effects of aging on fat distribution and muscle mass. Other lifestyle factors that affect body composition such as sleep quality, smoking, and infrequent alcohol consumption (Haapanen et al., 2024). Another parameter that decreases is BMR $r = -0.231$ dan $p = 0.005$, as age increases because of changes in body composition and tissue metabolic activity. Aging reduces skeletal muscle mass and increases fat mass since skeletal muscle has a lower metabolic rate than organ tissues. The fact that older persons have a more significant percentage of metabolically active organ tissues cannot compensate for this reduction in metabolic activity (Piers et al., 1998). Various factors have been cited to contribute to these changes, including structural and functional changes such as the loss of muscle cells, the infiltration of fat into tissues, and reduced liver function. Furthermore, one of the major determinants of BMR, the whole-body protein turnover, declines with advancing age, especially in skeletal muscle (Soares et al., 1994; Soares & Shetty, 1991). Calf circumference negatively and significantly correlated as age increased. This research aligned with Wang et al. that the substantial inverse relationship between age and calf circumference indicates a decrease in peripheral muscle mass, most likely brought on by sarcopenia or age-related muscle atrophy. Consequently, smaller calf circumference correlates with poorer physical performance indicators, such as slower gait speed and weaker grip strength (Wang et al., 2022). This measurement of the elderly additionally impresses with its valuable predictability of fall events, frailty, malnutrition, morbidity, and mortality (Kiss et al., 2024).

It is critical to comprehend these changes since they could have serious health consequences for women. Changes in body composition and a rise in fat mass raise the risk of cardiovascular disease and metabolic syndrome, among other health issues (Brown & Clegg, 2010). Routine body composition monitoring is essential for early detection and appropriate intervention to prevent and manage the risks of obesity and metabolic diseases. Health education and intervention programs focusing on a balanced diet and increased physical activity are crucial for improving overall health (Santoso et al., 2024).

4. CONCLUSION

The study concludes that aging reduces basal metabolic rate, increases fat mass, decreases skeletal muscle mass, and lowers metabolic activity of lean tissues, compounded by muscle cell loss and reduced organ function. These changes heighten the risk of obesity and metabolic disorders, emphasizing the need for routine body composition monitoring and tailored interventions. Future research should explore longitudinal changes in body composition, assess diverse populations, evaluate intervention strategies, investigate molecular mechanisms of reduced metabolic activity, and validate calf circumference as a biomarker for sarcopenia and metabolic health, ultimately contributing to a better quality of life.

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