

## Original Research Article

# Age and sex variation in visceral adipose tissue

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### ABSTRACT

**Background:** Adipose tissue mainly visceral fat is said to be harmful and acts as a harbinger of metabolic disorders. A changing trend is seen in the recent decades with decreasing incidence of metabolic disorders in men even though visceral fat is said to be higher in them. Sex hormones may influence the deposition pattern of adipose tissue. The aim of this study was to observe effects of age on visceral fat and to know if the difference in gender pattern of fat distribution is maintained throughout life or disappears after menopause.

**Methods:** This cross-sectional observational study was conducted in Thrissur on 385 apparently healthy subjects using Omron body composition analyser. Data was analysed using SPSS 20.0 version. The tests employed were NOVA, independent samples t-test.

**Results:** In each age group, men had significantly higher visceral fat than females. As age increased, visceral fat increased significantly in both genders. In each group, except for younger age groups, VF levels were equal in men and women.

**Conclusions:** Visceral fat is higher in men and this difference is seen in all age groups. As age increases, visceral fat levels also increased in men and women. The distribution of visceral fat is such that a greater number of men have high to very high levels at a younger age group, a feature observed in women only in the peri and post-menopausal age. Adoption of an active lifestyle coupled with healthy diet should protect against onset of metabolic disorders.

**Keywords:** Gender, Lifestyle, Metabolic disorders, Subcutaneous fat, Visceral fat

### INTRODUCTION

Human adipose tissue can be subcutaneous or visceral. Women have a higher percentage of body fat seen right from prepubertal stages and the distribution of this fat is predominantly subcutaneous while males have higher proportion of fat in the viscera.<sup>1</sup> While fat forms an epidemiological basis of metabolic diseases, research is more focused now in unraveling the mystery of the role played by visceral fat (VF) as a causative agent of these metabolic disorders.<sup>2</sup> The age old method of body mass index (BMI) as an index of body adiposity and metabolic syndrome risk evaluation is being gradually and surely replaced by waist circumference measurements which in

turn reflects fat in the viscera.<sup>2</sup> Endocrine society guidelines on metabolic risk recommends a decreased waist circumference in Asian population compared to the Caucasians from 102cm to 90cm in male and 88 to 80cm in females.<sup>3</sup> The risk for metabolic diseases increase with age but researchers have found that this risk develops at a much younger age which is a changing trend.<sup>4</sup> Considering this serious scenario, American heart association (AHA) recommends a continuous check for individual risk factors as early as the age of 20years.<sup>5</sup> The armamentarium of risk factors for metabolic disorders include hypertriglyceridemia, hyperglycemia, hypertension, smoking, poor diet, sedentary lifestyle and increased BMI.<sup>6</sup>

Of these risk factors, the present study focuses on central obesity which is an indirect reflection of BMI in addition to be a factor that exerts influence on all the other risk factors, is a modifiable risk factor.

**METHODS**

This following cross sectional study was done on 385 apparently healthy subjects of both genders aged above 18 years residing in Thrissur district after obtaining Institutional Ethics clearance. The body fat analysis was done using Omron HBF 375 body composition analyzer in the Department of Physiology in Jubilee Mission Medical College. The subjects signed the consent form after the procedure was explained to them. They were given an appointment to report to the department on a convenient day in the fasting state.

The data was collected over a period of one year and the timing allowed was between 9 to 11am. Female participants were advised to come when they were not menstruating. The height to the nearest 0.1cm was recorded using a wall mounted stadiometer. The subject data which includes the age, gender and height was fed into the Omron body composition analyzer which uses the method of bioimpedance flowing through both hands and feet.<sup>7,8</sup>

The VF levels were recorded and grouped into the following categories according to the device manual.

- Normal - 0.5-9.5,
- High - 10.0-14.5,
- Very high - 15.0-30.0.

The data was normally distributed which was checked using QQ plot. The difference between various VF levels in each age group was analyzed using one-way ANOVA. Independent samples t-test was used to analyze the difference in VF in each age groups between both genders. The data was expressed in Mean±SD and was analyzed using SPSS 20.00 version software.

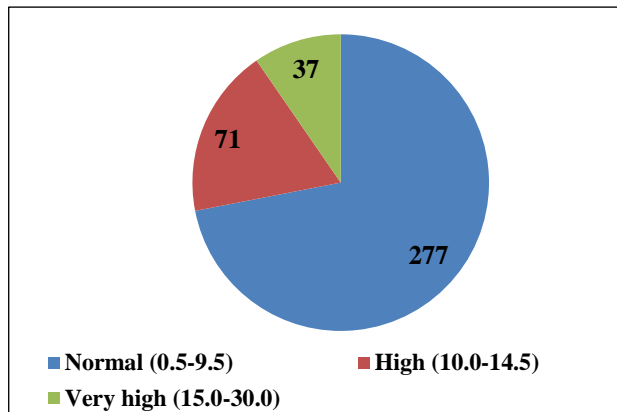
**RESULTS**

The present study was done on 385 (233 females, 152 males) apparently normal healthy adult subjects residing in Thrissur. The mean (SD) was 33.03 (12.95), height 161.4 (12.21), weight 63.86 (12.43), body fat% 28.78 (7.09), VF% 7.42 (4.85).

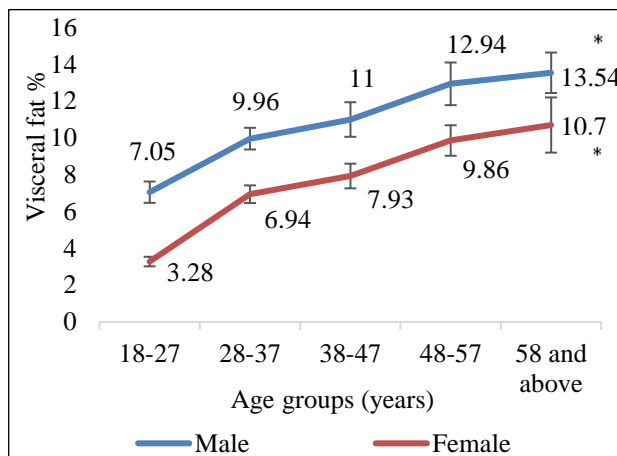
The study participants were grouped based on their levels of VF into normal (0.5-9.5), high (10-14.5) and very high (15-30) categories. Most of the participants (277) belonged to the normal category, 71 in the high group and 37 in the very high group as shown in Figure 1.

Figure 2 depicts VF levels across different ages for 152 males and 233 females. VF levels were found to be higher than that in females across all age groups and this

was statistically significant. In both the groups, it was noted that as age advances, VF levels also increase to a significant level.



**Figure 1: Distribution of subjects in different categories of visceral fat (n=355).**



Data represented as Mean±SE mean. Solid line represents male. Females are represented as broken line. One-way ANOVA. \*p<0.01, statistically significant between the age groups.

**Figure 2: Visceral fat of the subjects in each age group.**

Table 1 compares VF in males in various age groups. Out of 152 males, 80 had normal, 47 had high and 25 had very high VF levels. The age groups were divided into 18-27years which had 60 males, 28-37years which had 35 males, 38-47years with 21 males, 48-57years had 23 males and 13 aged above 58years. In each age group, a statistically significant difference was found between the participants in 3 groups of VF.

Table 2 compares 233 females in various age groups according to their VF level. Out of 233 females, 197 have normal fat, 24 have high and 12 have very high VF levels. 102 participants were between the ages of 18-27, 59 in 28-37, 42 in 38-47, 22 in 48-57 and 8 females above the age of 57. In each age group a statistically significant difference was seen between the 3 groups of VF.

Table 3 compares VF levels between genders in each category of VF in different age groups. There was a

significant difference between both genders in younger age groups among the normal and high VF levels.

**Table 1: Comparison of visceral fat in males within different age groups.**

Age groups	Normal (n=80)	High (n=47)	Very high (n=25)	P value
18-27 (n=60)	5.05±2.20 (46)	11.80±1.57 (10)	18.13±3.38(4)	0.00*
28-37 (n=35)	7.06±2.24 (17)	12.11±1.14 (15)	15.67±0.29 (3)	0.00*
38-47 (n=21)	5.71±1.82 (7)	12.65±1.51 (10)	16.13±0.75 (4)	0.00*
48-57 (n=23)	7.88±1.19 (8)	11.56±1.24 (8)	20.29±3.15 (7)	0.00*
58 and above (n=13)	7.0±1.41 (2)	11.50±1.08 (4)	16.57±1.62 (7)	0.00*

Data expressed in Mean±SD. One-way ANOVA. \*p<0.01, statistically significant.

**Table 2: Comparison of visceral fat in females within different age groups.**

Age groups	Normal (n=197)	High (n=24)	Very high (n=12)	P value
18-27 (n = 102)	3.17±1.80 (101)	13.5 (1)	-	0.00*
28-37 (n = 59)	5.68±1.91 (49)	10.64±0.80 (7)	18.83±3.51 (3)	0.00*
38-47 (n = 42)	5.98±2.35 (31)	11.38±1.60 (8)	18.83±3.21 (3)	0.00*
48-57 (n = 22)	7.08±1.68 (12)	11.50±1.19 (7)	17.17±2.02 (3)	0.00*
58 and above (n = 8)	6.15±1.84 (4)	10.5 (1)	16.83±1.04 (3)	0.01*

Data expressed in Mean±SD. One-way ANOVA. \*p<0.01, statistically significant.

**Table 3: Comparison on visceral fat between gender within different age and fat groups.**

Age groups	Normal			High			Very high		
	Male (n=80)	Female (n=197)	P value	Male (n=47)	Female (n=24)	P value	Male (n=25)	Female (n=12)	P value
18-27	5.04±2.20 (16.6%)	3.17±1.80 (36.46%)	0.00*	11.8±1.57 (14.08%)	13.5 (1.41%)	0.00*	18.13±3.38 (10.81%)	-	-
28-37	7.06±2.24 (6.14%)	5.68±1.91 (17.69%)	0.01*	12.11±1.14 (21.13%)	10.64±0.81 (9.86%)	0.01*	15.67±2.89 (8.11%)	18.83±3.51 (8.12%)	0.20
38-47	5.71±1.82 (2.53%)	5.98±2.35 (11.19%)	0.78	12.65±1.51 (14.08%)	11.38±1.60 (11.27%)	0.10	16.13±0.75 (10.81%)	18.83±3.21 (8.12%)	0.15
48-57	7.88±1.20 (2.88%)	7.08±1.68 (4.33%)	0.26	11.56±1.24 (11.27%)	11.50±1.20 (9.86%)	0.92	20.29±3.15 (18.92%)	17.17±2.02 (8.12%)	0.16
58+	7.0±1.41 (0.72%)	6.15±1.84 (1.44%)	0.60	11.5±1.08 (5.63%)	10.5 (1.41%)	0.47	16.57±1.62 (18.92%)	16.83±1.04 (8.12%)	0.81

Data expressed in Mean±SD. Independent samples t-test. \*p< 0.01, statistically significant.

## DISCUSSION

Ideal cardiovascular health, by 2020 is the goal put forward by AHA.<sup>6</sup> Coronary vascular deaths lack prior warning signs and have long asymptomatic period. Hence, comes the importance of risk assessment to lower the burden of CVD.<sup>6</sup> One of the major risk factors for CVD is adiposity, which in addition also is a psychological and social hazard. Site specific adiposity especially VF is an important predeterminant of CVD which includes a constellation of other metabolic abnormalities including hypertriglyceridemia, insulin resistance, hypertension.<sup>2</sup> The present study was designed to evaluate the changes in VF levels with advancing age in both genders.

The apparently healthy 385 participants were divided into 3 categories based on their VF levels as shown in Figure 1. VF levels between 0.5 and 9.0 are normal and has 277 participants, high (10-14.5) includes 71 subjects and very high (15-30) with 37 participants. Adipose tissue in the human can be subcutaneous or visceral depending upon its drainage. Visceral adipose tissue which forms 6-20% of total body fat drains into portal circulation resulting in excess intrahepatic fat, a major risk factor for metabolic diseases and CVD.<sup>9-11</sup>

Typically, females tend to accumulate more body fat than males, bringing into the light the existence of sexual dimorphism.<sup>12,13</sup> However, the distribution of body fat is such that females have lesser visceral fat than males as

also demonstrated in Figure 2. In this study, the effect of advancing age does not obliterate this difference as is obvious in the figure. The fundamental difference seen in male and female pattern of VF distribution can be attributed to the gonadal hormones. Hence, author assumed that this difference in distribution pattern should disappear with the onset of menopause, which was not seen in this study. The fact that these differences are seen even before the onset of puberty questions the role of gonadal hormones alone in determining fat distribution.<sup>14,15</sup> Hence, a complex interplay of various genetic and epigenetic factors was evident.

Table 1 and 2 compare VF across various age groups. As age advances, VF increases in both males and females and was statistically significant. Further, VF in each age group was classified into normal, high and very high groups. In the youngest age group, there were no females in very high category (Table 2). Authors also observe that more number of participants was distributed in the normal group of VF than in above normal groups in both genders, in the younger ages and a reversal of this occurred with increasing age. What are the factors that cause such an age related shift remains an interesting question. It can be hypothesized that the weight gain, loss of muscle mass and physical inactivity are the main contributors to this shift and all of the above are modifiable factors.<sup>4</sup> The role of hormones cannot be undermined here.

In males, declining testosterone levels accompany an increase in VF while in females, decreased levels of estrogen and progesterone associated with menopause cause a similar effect.<sup>16</sup> Hypertrophy and hyperplasia of adiposities determine fat distribution. Visceral adipocytes in females are smaller when compared to males. Accumulation of fat in females was associated with hyperplasia while in males, it was associated with hypertrophy.<sup>17</sup> Basal lipolytic activity was higher in males compared to females, while both genders have a similar response to action NE stimulated hormone sensitive lipase activity.<sup>18</sup> This makes it evident that women will respond better to an exercise regimen targeted at weight loss, while in the resting stage, men will have lesser mean values of fat compared to women of the same age group (peri and postmenopausal) as was also seen in this study.

One of the proposed mechanisms of action of sex steroid were via the hypothalamus. Male rats have more projecting subcutaneous fat.<sup>19</sup> Estrogen through the action of ventromedial nucleus of hypothalamus enhances brown adipose tissue thermogenesis and limits VF accumulation.<sup>20</sup>

A consolidated picture of the participants of both genders of all the age groups and having various levels of VF was depicted in Table 3. About 277 participants having normal (0.5-9.5) levels of VF belong to different age groups. Despite VF levels being normal, VF levels are significantly lower in females in the younger age groups.

With advancing age, as women enter the peri and post-menopausal age groups, this difference disappears. While considering the absolute number of participants, the following points become clear. Among the 277 normal participants, 36% are females and 16 % are males in the 18-27 age group. In each category of age, the percentage of females having normal VF was higher than males. This picture leads us to believe that females have lesser VF levels than males and we expect them to be safeguarded against metabolic disorders since VF is directly linked to metabolic disorder, a fact proven by many researchers.<sup>21</sup>

Upon analyzing the high VF categories, authors found that only the younger age group (18-27, 28-37years) showed statistically significant difference between genders. The trend was not seen in the very high category and the mean value of VF was higher in females than in males. In the age above 38 years in all the 3 groups, no significant change between genders were noted. This forms the peri and post-menopausal age in females.

Studies across the globe have proved as an eye opener in the regard that women who were considered to be cardio protected up to menopausal age are no longer safe. AHA has cautioned that death rates in females between ages of 35-54years now appear to be increased and this was attributed to the effects of obesity.<sup>5</sup>

The cardiovascular risk scores as assessed by the 7 health matrix which includes 4 health behaviour (BMI <23, not smoking, physically active, healthy diet) and 3 health factors (cholesterol <200, untreated BP <120/80mmHg and FBS <100mg/dl) appear to have improved in males according to studies.<sup>5</sup> A similar trend was also noted in a 7 year longitudinal study done in Kerala, India to which the participants belong, however the authors in that study considered BMI as a tool of assessment of central obesity and not visceral fat.<sup>22</sup> Determination of VF levels was a better predictor of metabolic syndrome and hence was used in this study.<sup>23</sup>

## CONCLUSION

This study proves that VF increases with advancing age in both genders and VF remains higher in males in any age group but in the 'very high' VF category, the absolute values of VF were found to be higher in females, an area which needs to be further explored. Hence, authors would like to recommend lifestyle interventions to bring about ideal cardiovascular and metabolic health.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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