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Original Research Article

The Relationship between Visceral Adiposity Index and Dietary Pattern of Emerged Adult Females, Cross-Sectional Study

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Abstract

The Visceral Adiposity Index (VAI) has recently emerged as a novel marker for cardiometabolic risk, indicating the distribution of abdominal fat and dyslipidemia. This paper explored the association between VAI and daily nutrient intake among young adult females aged 20 to 24 years. The study involved 106 adolescent girls from urban areas in Menoufia, excluding those who were married, disabled, or chronically ill. Data on dietary habits and food consumption patterns were collected through a questionnaire. At the same time, body measurements were taken, and nutrient intake was assessed using a 24-hour dietary recall across three non-consecutive days. The visceral fat index was calculated based on serum triglyceride levels, high-density lipoprotein levels, waist circumference, and body mass index, with subsequent statistical analysis performed. The results revealed a modest correlation between nutrient intake and visceral fat index, except for total fat intake. Notably, an inverse association was observed between dairy consumption and visceral fat index. This underscores the significance of examining dietary components, particularly starchy foods, concerning visceral adiposity. The conclusion drawn from the study underscores the importance of exploring the types and quantities of starchy foods, milk/dairy products, magnesium, and vegetable fats consumed to gain insights into dietary patterns linked to visceral adiposity. Such insights can aid in developing strategies to promote healthier eating habits, thereby effectively managing health risks related to adiposity. The potential for further research in this area is vast and could offer valuable information for enhancing dietary recommendations and combating adiposity-related health challenges.

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1. Introduction

There is strong evidence that having too much body fat, especially around the organs, is strongly associated with several metabolic illnesses, such as diabetes, cardiovascular disease, and some types of cancer [1]. The Visceral Adiposity Index (VAI) has recently become a dependable measure of visceral obesity and its related cardiometabolic risk factors [2].

The Visceral Adiposity Index (VAI) is a mathematical model used to estimate the amount of visceral adipose tissue in the human body. The VAI formula is based on waist circumference (WC), body mass index (BMI), serum triglyceride (TG), and serum high-density lipoprotein cholesterol (HDL-C) [3].

The classification of VAI values for young adults can vary depending on the source and reference population. However, a common way to categorize VAI levels in young

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adults is as follows [3,4]: Low VAI: Below 1 (indicating low visceral adiposity); Moderate VAI: 1-2 (indicating moderate visceral adiposity); and High VAI: Above 2 (indicating high visceral adiposity)

Dietary patterns significantly influence the onset and progression of obesity. Research indicates that specific eating patterns and nutrient consumption are linked to higher levels of visceral fat buildup and negative metabolic consequences [5]. Furthermore, dietary patterns impact important metabolic health indicators, including insulin resistance, inflammation, and lipid profiles [6].

Scientists have been studying the connection between eating habits and VAI to identify factors that can be changed to affect body fat levels and metabolic health in young women. According to Xue and colleagues [6], nutrition significantly affects body composition and levels of adiposity, with some dietary components (total energy and salt intake) having a critical role in developing visceral adiposity.

In addition, the results of a cross-sectional study conducted by Liu et al. [7] provide more evidence for the importance of dietary patterns in influencing measures of body fatness in young adults. They emphasized that the quality and quantity of food consumed can influence the VAI scores, indicating the intricate relationship between diet and visceral adiposity. Such findings highlight the necessity for a thorough investigation to clarify the complicated connection between dietary consumption and VAI in young adult females.

Research has shown that poor dietary habits, characterized by high intake of energy-dense foods and low intake of fruits and vegetables, are associated with increased adiposity and metabolic dysfunction among young adults [7]. Furthermore, specific nutrients such as saturated fats and added sugars have been linked to visceral adiposity and insulin resistance in young females [8].

Study hypothesis

Emerged adults with normal body weight (BMI 18.5 to 25 kg/m2) have low or moderate visceral adiposity. There is no relationship between VAI and diet among emerged adults with normal body weight

Study objectives

1- Find out the association between food consumption patterns and VAI among emerging adults.

2- Explore the relationship between nutrient intakes and VAI among emerging adults.

The present research, with its focus on the association between VAI and diet, holds the potential to provide significant insights. The findings are expected to pave the way for the development of targeted interventions and health promotion programs designed explicitly for this group, offering hope for improved metabolic health.

2. Subjects and Methods

2.1. Subjects

The participants were exclusively female and chosen from urban regions within the Menoufia Governorate. The study included participants who provided their consent, agreed to participate and fulfilled the inclusion criteria. Conversely, participants who declined to participate or did not meet the exclusion criteria were excluded from the study.

2.1.1. Inclusion Criteria

(1) Females who were between the ages of 20 and 25; (2) BMI falls between 18.5 and 25 kg/m2, (3) Residing in the urban regions of Menoufia Governorate, (4) Possess a secondary certificate or a college degree and higher, (5) and Agreed to participate and signed a consent form

2.1.2. Exclusion Criteria

(1) Married (Uniformity in marital status can decrease the influence of married status as a confounding factor on study results, thereby improving the accuracy of the findings), (2) Experience a persistent or long-lasting illness, such as diabetes, heart disease, cancer, or thyroiditis, (3) Females adhering to dietary regimens, (4) and Possess any disabilities.

2.1.3. Sample Size

The sample size was calculated according to the following formula given by Cohen (1970) [9].

$$\text{Sample Size (SS)} = \frac{z^2 \times (p) \times (1-p)}{ci^2}$$

Where:

z = Z value (e.g., 1.96 for 95% confidence level)

p = expected prevalence (7%)

ci = confidence interval, expressed as decimal (05 = ±5)

$$\text{Sample Size (SS)} = \frac{(1.96)^2 \times 7 \times 97}{(5)^2}$$

The total sample size is 106, reflecting the comprehensive nature of our research.

2.2 Methods

2.2.1 Experimental Design

This study is a cross-sectional study involving emerged adult Egyptian females from urban areas of Menoufia Governorate.

2.2.2 Data Collection

This study followed a specific process to create the questionnaires. A panel of ten esteemed experts in obesity and clinical nutrition dedicatedly evaluated the questionnaires, offering diverse perspectives and insightful recommendations that played a pivotal role in refining the questionnaires. Following this, the questionnaires were piloted on a group of ten participants whose feedback was instrumental in uncovering any ambiguities, challenges, or

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limitations that could impact the effectiveness of the questionnaires. This comprehensive and inclusive methodology ensured that the questionnaires were honed based on the authentic experiences and input of the participants.

2.2.2.1 Demographic data

Data about age, education degree, occupation, monthly income, family size, housing status, social status, and living place were obtained.

2.2.2.2. Health History

Health history was used for inclusion and exclusion criteria, and researchers asked participants about diseases, disabilities, medications, weight status, and neurological and psychological injuries.

2.2.3. Anthropometric

Body height (cm) was measured to the nearest 0.1 cm using a non-stretchable meter.

Body weight (kg) was assessed using a portable scale to within 0.1 kg.

Body mass index (BMI) (kg/m2) was calculated using body height (m) and body weight (kg) measurements.

Waist Circumference (WC) (cm) was measured at the midpoint between the lowest rib and the top of the hip bone (iliac crest).

Mid-upper arm circumference (MUAC) (cm) was measured by a non-stretchable meter at the mid-point between the tip of the shoulder and the tip of the elbow.

Triceps skinfold thickness (TSF) (mm), using a plastic caliper, was measured at the mid-point between the tip of the shoulder and the tip of the elbow.

Arm muscle circumference AMC (cm) was calculated using the following equation:

AMC=MUAC-(TSF×0.314).

2.2.4. Calculation of visceral adiposity index (VAI)

The calculation of VAI was carried out according to the formula given by Amato et al [3] and involves both anthropometric measurements and metabolic parameters. The formula for VAI typically includes the following:

a- Waist Circumference (WC):

b- Body Mass Index (BMI)

c- Triglyceride (TG) Levels

d- HDLc Levels.

$$\text{VAI} = \frac{\text{WC(cm)}}{36.58 + (1.89 \times \text{BMI})} \times \frac{\text{TG(mmol/l)}}{0.81} \times \frac{1.52}{\text{HDL(mmol/l)}}$$

Assigning specific percentage ranges to VAI categories can vary across studies, and there may not be a universally agreed-upon classification with percentage values. Therefore, we categorized individuals in this study according to their VAI as follow:

i- Low Risk (%): VAI values below the 25th percentile.

ii- Moderate Risk (%): VAI values falling between the 25th and 75th percentiles.

iii- High Risk (%): VAI values above the 75th percentile.

2.2.5. Food Consumption Pattern

The researchers actively involved the participants in collecting data using a fully quantitative Food Frequency Questionnaire (FFQ). The FFQ was organized based on eight food groups:

1. Starchy foods (e.g., bread, rice, macaroni)
2. Legumes (e.g., Mesdames, falafel, chickpeas)
3. Milk and dairy products (e.g., milk, cheese, yoghurt)
4. Meats (e.g., beef, poultry, fish)
5. Fats (e.g., oils, fats)
6. Vegetables (both fresh and cooked)
7. Fruits (both fresh and in juice form)
8. Sugars (e.g., sugar, honey, jam)

Participants were asked about their consumption patterns, including the serving size and grams consumed, and the frequency of consumption (daily, weekly, monthly, infrequent, or abstained) for each food item. The daily quantities consumed for each food item were then calculated by multiplying the frequency of consumption by the serving size in grams.

2.2.6. Nutrient intakes

Nutrient intake was assessed through a 24-hour food recall method. Participants were instructed to recall and report all the food and beverages they had consumed in the previous 24 hours. This information was collected for three separate days, including one day during a vacation. The average values for the three days were later analyzed using the Egyptian food composition data published by the National Nutrition Institute, Ministry of Health, Egypt, in 1996.

2.2.7. Statistical Analysis

Using SPSS version 21, all obtained data were statistically analyzed and displayed as frequency, percentage, or mean and standard deviation (SD). Analysis of variance (ANOVA) was used to calculate significant differences between groups, followed by the least significant differences (LSD) test. A value less than 0.05 indicated that the data were significant.

2.2.8. Ethical considerations

Respondents participated voluntarily and were well-informed of the study's objectives and methods. The Department of Nutrition and Food Sciences in the Faculty of Home Economics at Menoufia University, Egypt, approved this research.

3. Results and discussion

As evidenced in Table 1, all participants were residents of urban areas, highlighting the pivotal role of urban settings in our study. As Kondo et al., [10] emphasize, this demographic factor has wide-ranging and profound implications for healthcare, the environment, and social

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dynamics. Therefore, it is crucial to incorporate the urban environment into our data analysis and interpretation. This lens will enable us to understand the findings within the participants' urban contexts, which are deeply influenced by these factors.

Table 1 showed that all participants are unmarried, which is a significant demographic consistency [11].

Table 1 underscores the profound influence of education as a key demographic factor. Notably, 90.6% of participants held university degrees, indicating a highly educated cohort. This advanced level of education can significantly shape their awareness, comprehension, and cognitive abilities regarding the research topic, thereby enriching our understanding of the research findings.

The data presented in Table 1 clearly indicate that the majority of the study participants are without employment. The employment status and occupational experiences of the participants could provide valuable insights into the study's findings on employment, financial resources, and social support networks, highlighting the significance of these issues in our research [12].

Table 1: General characteristics of studied subjects

	no	%
Education		
Secondary or its equivalent	4	3.8%
University	96	90.6%
Postgraduate studies	6	5.7%
Total	106	100.0%
Job		
Unemployed	86	81.1%
Dietitian	6	5.7%
Teacher	4	3.8%
Nurse	2	1.9%
Accounting	2	1.9%
Not specified	6	5.7%
Total	106	100.0%
Family size		
4 persons	20	17.0%
5 persons	54	50.9%
6 persons	34	32.1%
Total	106	100.0%
Family income		
less than 2000 Egp/month	8	7.6%
2000 – 3000 Egp/month	24	22.6%
3000 – 4000 Egp/month	28	26.4%
4000 – 5000 Egp/month	18	17.0%
more than 5000 Egp/month	28	26.4%
Total	106	100.0%

EGP: Egyptian pound

Most participants have families consisting of five individuals (50.9%) and six individuals (32.1%). The demographic data, encompassing family size, income, and housing, provides invaluable insights into socioeconomic factors [13]. For instance, households with four individuals may have a wide array of familial obligations and social engagements. The prevalence of households earning less than five thousand pounds is a stark reminder of the financial constraints that impede respondents' access to resources and services, potentially exerting a substantial influence on the study's results.

As shown in Table 2, the research participants, aged between 20 and 24, with an average age of 20.9±1.19 years, represent a narrow age range. This suggests that age-related factors may continuously influence visceral adiposity in young adults, making the study's findings highly applicable to this demographic [11].

The participants' BMI ranged from 18.5 to 25.03 kg/m², averaging 21.5±2.06 kg/m². This BMI range is noteworthy because it implies that body fat, a key component of BMI, may significantly affect VAI scores, as Ozcelik et al. emphasized in 2013 [14].

The results revealed a waist circumference (WC) range of 62.0-84.0 cm, averaging 71.1±4.50 cm. The small dispersion of waist circumference (WC) values is significant as it underscores the crucial role of central adiposity, as measured by WC, in determining the Visceral Adiposity Index (VAI) values, a point highlighted by Borruel et al. in 2014 [15].

Triglyceride (TG) levels ranged from 45.0 to 235.0 mmol/l, averaging 96.8±44.16 mmol/l. The considerable range in TG levels among individuals shows how lipid metabolism affects visceral adiposity since greater TG levels increase visceral fat formation [16]. The HDL cholesterol levels vary from 31.0 to 63.0 mmol/l, with an average of 43.7±8.39 mmol/l. The sample's HDL range suggests lipid profile modifications may impact abdomen fat formation. In n 2014, Salazar et al. found [17] that low HDL levels enhance visceral fat accumulation.

The visceral adiposity index (VAI) ranged from 1.83% to 10.17%, averaging 3.8±1.70%. The research participants' VAI results indicate different degrees of visceral adiposity, emphasizing the need to use many parameters for assessing visceral fat distribution [18].

To conclude, Table 2 clarifies the critical elements in assessing visceral adiposity. The complete statistics on age, BMI, WC, TG levels, HDL levels, and VAI percentages show how these factors vary across participants. This highlights the complexity of visceral obesity and its health effects.

Table 2: Variables used in estimation of visceral adiposity index

	Min	Max	Mean±SD
Age (year)	20.0	24.0	20.9±1.19
BMI (kg/m^2)	18.5	25.03	21.5±2.06
WC (cm)	62.0	84.0	71.1±4.50
TG (mmol/l)	45.0	235.0	96.8±44.16
HDL (mmol/l)	31.0	63.0	43.7±8.39
VAI (%)	1.83	10.17	3.8±1.70

WC waist circumference, TG: Triglycerides

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Table 3 presents a comprehensive analysis of various statistical measures, shedding light on the distribution and characteristics of VAI data in the studied population. The mean VAI value of 3.8 serves as a reference point, providing a clear understanding of the average VAI level in the sample [15]. The median VAI value of 3.3, being the midpoint of the dataset, underscores its importance in representing the distribution of VAI values [19].

The standard deviation, which has a magnitude of ±1.7, indicates the extent of variation in VAI values from the mean. This metric calculates the extent to which data points deviate from the average, emphasizing the span in which most VAI observations are concentrated [20]. In addition, the variance value 2.9 enhances the standard deviation by offering information on how VAI values are dispersed and deviate from the average [21].

The skewness score of 2.1 indicates a right-skewed distribution of VAI data, suggesting a higher prevalence of higher VAI values in the dataset. This distribution pattern can influence the identification of potential outliers or understanding the frequency of extreme VAI values in the sample [21]. Similarly, the kurtosis value of 5.3, indicating a leptokurtic distribution with a peak form and heavy tails, suggests a higher likelihood of extreme VAI values than a normal distribution. This information can guide further investigation into the factors contributing to this distribution pattern [22].

The VAI values vary from 1.8 to 10.2, indicating the variation in visceral adiposity levels across the research subjects. This metric highlights the variability of VAI values in the dataset and the extent to which individual values vary [23]. In addition, including percentiles such as the 25th, 50th, and 75th provides a more complete understanding of how VAI values are distributed within specific portions of the dataset. This offers valuable insights into the dispersion of VAI data across quartiles [24].

Table 3: Statistics of visceral adiposity index (VAI) variable

		VAI
Mean		3.8
Median		3.3
Std. Deviation		±1.7
Variance		2.9
Skewness		2.1
Kurtosis		5.3
Range		8.3
Minimum		1.8
Maximum		10.2
Percentiles	25th	2.69
	50th	3.3
	75th	4.14

The data provided in Table 4 categorized the participants into three distinct ranges based on their VAI values: below 2.7%, from 2.7% to 4.1%, and above 4.1%. Each category's distribution, mean VAI value, standard deviation, and statistical measures like the F-value and significance were analyzed to provide a comprehensive overview of the participants' visceral adiposity.

The category with VAI values below 2.7% encompassed 22.64% of the individuals. This group had an average VAI of 2.3 with a relatively low standard deviation of ±0.2. The statistical analysis revealed a high F-value of 97.59 and a significant p-value of <0.000, indicating a substantial difference in VAI compared to the other categories [19].

Most subjects (52.83%) fell within the 2.7% to 4.1% VAI range. The average VAI value within this group was 3.4, with a slightly higher standard deviation of ±0.4, suggesting a more diverse distribution of VAI values among participants in this range [4].

Participants with VAI values exceeding 4.1% accounted for 24.53% of the total population under study. This group exhibited an average VAI of 6.1 with a broader standard deviation of ±1.9, indicating more significant variability in VAI values within this category [25]. The analysis of VAI values across the study's subjects highlighted the prevalence of different levels of visceral adiposity within the population. The ANOVA and LSD tests conducted on the data revealed a significant variation in mean VAI values among the categories, suggesting notable disparities in visceral adiposity levels within the various segments of the study population [26].

Table 4: Distribution of studied subjects according to VAI values

	no (%)	Mean±SD	F	Sig.
Less than 2.7%	24 (22.6%)	2.3^{a}±0.2	97.6	0.000
2.7% to 4.1%	56 (52.8%)	3.4^{b}±0.4		***
More than 4.1%	26 (24.5%)	6.1^{c}±1.9		
Total	106 (100%)	3.8±1.7		

Mean values subscribed showed significant difference between those values at P<0.05 as shown by ANOVA and LSD test. *** P<0.001

The findings in Table 5 shed light on the nuanced interplay between these parameters within the three categorized VAI groups. Age was one of the factors explored, and the mean age differences observed were statistically significant (F=3.24, P.=0.043). This suggests that age plays a role in influencing VAI levels within the studied population [27].

Body Mass Index (BMI) was a significant indicator across the VAI categories, with notable variations identified (F=4.52, P.=0.013). These results underline the relevance of BMI in assessing visceral adiposity and its potential implications for overall health outcomes [28].

Arms Muscle Circumference (AMC) also exhibited significant variations (F=4.64, P.=0.012) among VAI groups. This finding hints at differing muscle composition profiles impacting the subjects' VAI levels and overall metabolic health [29]. While not statistically significant, Triceps Skinfold showed trends that suggest possible associations with VAI levels (F=3.04, P.=0.052). This warrants further investigation

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into body fat distribution patterns to better understand their relationships with VAI [30].

On the other hand, Weight (WT) and Waist Circumference (WC) did not demonstrate statistically significant differences among VAI groups. However, their numerical variations still contribute to the broader understanding of adiposity distribution within the studied population [31].

The Arm Circumference (AC) data analysis revealed mean values and standard deviations for the three VAI groups, with statistically nonsignificant results (F=0.70, p=0.501). Although insignificant, these findings provide additional insights into the complex relationships between anthropometric indices and VAI levels [32].

These findings underscore the multifactorial nature of adiposity and the importance of considering various anthropometric indices when assessing metabolic health parameters. Further studies and continued research are crucial to unraveling the intricate associations between different body dimensions and visceral adiposity levels.

Table 5: Relationship between VAI and anthropometric indices of studied subjects

	Less than 2.6 (n=24)	2.7 to 4.1 (n=56)	More than 4.1 (n=26)		
	Mean±SD	Mean±SD	Mean±SD	F	Sig.
Age (year)	21.1^{ab}±1.1	20.6^{a}±0.9	21.3^{b}±1.7	3.24	0.043*
Weight (Kg)	56.5±5.0	53.9±7.1	56.4±3.5	2.49	0.088
BMI (kg/m2)	22.3^{a}±2.0	21.0^{b}±2.1	22.0^{a}±1.6	4.52	0.013*
Arm circumference (cm)	22.6±1.7	22.0±2.0	22.4±2.3	0.70	0.501
Triceps skinfold thickness (mm)	2.8^{a}±1.2	3.0^{ab}±1.3	3.5^{b}±0.8	3.04	0.052
Arm muscle circumference (cm)	13.8^{a}±2.7	12.7^{a}±3.1	11.3^{b}±2.4	4.64	0.012*
Waist circumference (cm)	71.7±5.6	70.8±4.4	71.2±3.4	0.33	0.717

Mean values subscribed showed significant difference between those values at P<0.05 as shown by ANOVA and LSD test. *** P<0.001

As shown in Table 6, the triglyceride levels (TG) were found to vary significantly among the different VAI groups. The mean values of 65.4, 85.2, and 150.8, with standard deviations of ±14.0, ±25.6, and ±47.8, respectively, indicate a progressive increase in TG levels with higher VAI values. This significant difference is underscored by the calculated F-value of 56.51 (p = 0.000), emphasizing the importance of TG as a marker for assessing metabolic changes associated with visceral adiposity [33].

In addition to TG, the study also observed variations in other biochemical parameters such as Total Cholesterol (TC), Very Low-Density Lipoprotein (VLDL), and Thyroid-Stimulating Hormone (TSH) across the different VAI groups. The differing mean values for TC, VLDL, and TSH suggest potential associations with levels of visceral adiposity among the subjects. While these associations are present, the statistical significance varies for TC, VLDL, and TSH, with specific differences observed among the groups for VLDL and TSH [14].

The findings underscore the importance of further research and clinical investigation to comprehensively explore these associations and their implications for overall health and disease risk. Understanding the relationships between visceral adiposity and biochemical markers can provide valuable insights for assessing metabolic health and guiding interventions to reduce visceral adiposity and associated health risks.

Table 6: Relationship between VAI and biochemical parameters of studied subjects

	Less than 2.6 (n=24)	2.7 to 4.1 (n=56)	More than 4.1 (n=26)		
	Mean±SD	Mean±SD	Mean±SD	F	Sig.
Total cholesterol (mmol/l)	164.5±29.0	163.4±31.9	174.0±35.4	1.01	0.367
Triglycerides (mmol/l)	65.4^{a}±14.0	85.2^{b}±25.6	150.8^{c}±47.8	56.5	0.000***
HDL (mmol/l)	46.0±7.4	43.0±8.5	43.0±8.8	1.19	0.308
LDL (mmol/l)	105.5±25.0	103.4±27.6	100.9±30.2	0.17	0.843
VLDL (mmol/l)	12.9^{a}±2.8	17.0^{b}±5.1	30.2^{c}±9.7	56.5	0.000***
Total cholesterol /HDL (ratio)	3.6^{a}±0.7	3.9^{ab}±0.8	4.1^{b}±0.6	2.88	0.061
LDL/HDL (ratio)	2.3±0.8	2.5±0.6	2.3±0.6	1.22	0.301
HbA1c %	5.3±0.5	5.2±0.4	5.2±0.4	1.62	0.204
TSH (uIU/mL)	2.2^{a}±1.2	1.7^{b}±0.9	1.5^{b}±0.5	3.48	0.034*

Mean values subscribed showed significant difference between those values at P<0.05 as shown by ANOVA and LSD test. *** P<0.001

Table 7 displays the relationship between VAI levels and the amounts consumed from various food groups among the subjects. Based on their VAI levels, the subjects were categorized into three groups: less than 2.6, 2.7 to 4.1, and more than 4.1. The analysis revealed interesting insights into these groups' diets.

Subjects with higher VAI levels (more than 4.1) were found to consume significantly lower amounts of starchy foods

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compared to those with lower VAI levels. This finding is supported by a high F-value of 7.19 and a significant level of 0.001 indicates a clear association between VAI levels and starchy food consumption [34].

Significant differences were observed in the consumption of milk group among the different VAI groups. Subjects in the more than 4.1 VAI group tended to consume more milk and dairy products than other groups, as evidenced by an F-value of 2.78 and a significant level of 0.066 [35].

No significant differences were found in the consumption of other food groups, including meats, legumes, oils and fats, vegetables, fruits and juices, and sugars, between the VAI groups: the non-significant F-values and higher significant levels (> 0.05) indicate that dietary patterns related to these food groups were consistent across different VAI levels [36].

The results from this study provide valuable insights into the dietary habits associated with VAI levels, particularly concerning starchy foods and milk/dairy products. These findings suggest potential associations between dietary patterns and VAI levels, highlighting the importance of dietary interventions in managing visceral adiposity and related health conditions.

One of the study's key findings in table 8, was the significant difference in vegetable fat intake among the VAI groups. The analysis revealed an F-value of 3.36 with a p-value of 0.039, indicating that individuals with a VAI ranging from 2.7 to 4.1 exhibited significantly higher vegetable fat intake than those with VAI levels below 2.6 and above 4.1. This result suggests a potential correlation between elevated vegetable fat consumption and increased VAI, underscoring the importance of monitoring fat intake from plant-based sources for persons at risk of visceral adiposity [37]

Table 7: Relationship between VAI and amounts consumed from different food groups of studied subjects

	Less than 2.6 (n=24)	2.7 to 4.1 (n=56)	More than 4.1 (n=26)		
	Mean±SD	Mean±SD	Mean±SD	F	Sig.
Starchy foods (g/day)	232.8^{a}±71.5	208.5^{a}±96.1	142.6^{b}±88.8	7.19	0.001***
Meats (g/day)	191.7±87.7	198.3±87.7	200.2±95.9	0.06	0.938
Legumes (g/day)	66.0±71.3	61.3±50.0	91.8±134.4	1.23	0.295
Milk and dairy products (g/day)	34.4^{ab}±19.6	27.0^{a}±18.9	38.1^{b}±25.9	2.78	0.050*
Oils and fats (g/day)	29.4±17.2	38.4±48.4	55.5±69.8	1.80	0.170
Vegetables, fresh and cooked (g/day)	20.4±21.7	20.5±26.5	32.9±58.4	1.16	0.318
Fruits and juices (g/day)	67.8±67.0	249.2±998.5	83.5±89.5	0.74	0.478
Sugars (g/day)	18.4±11.6	19.0±16.8	17.5±20.2	0.07	0.937

Mean values subscribed showed significant difference between those values at P<0.05 as shown by ANOVA and LSD test. *** P<0.001

Moreover, the study highlighted significant disparities in total fat intake across the VAI groups. Individuals with VAI levels between 2.7 and 4.1 had higher total fat consumption than those with VAI levels outside this range, supported by an F-value of 3.22 and a p-value of 0.044. This observation reinforces the significance of discerning the origins and nature of consumed fats concerning visceral adiposity [38].

Furthermore, the analysis revealed a noteworthy difference in magnesium intake across the VAI groups, with individuals in the higher VAI range exhibiting substantially higher magnesium intake than those with lower VAI levels. This disparity was statistically significant, with an F-value of 4.83 and a p-value of 0.010, suggesting a potential link between elevated magnesium intake and VAI levels [39].

However, other assessed nutrients, such as protein, carbohydrates, sodium, potassium, calcium, phosphorus, iron, zinc, vitamins A and C, thiamine, and riboflavin, did not show significant differences across the VAI groups based on the provided F-values and p-values.

These findings of Table 8 underscore the importance of evaluating dietary nutrient intakes, particularly fats (both plant-based and animal-based) and magnesium, concerning visceral adiposity. Further exploration into the specific sources and types of fats consumed and the impact of magnesium-rich foods on visceral adiposity could offer valuable insights for designing dietary interventions tailored to manage health concerns associated with visceral adiposity.

Table 8: Relationship between VAI and nutrient intakes of studied subjects

	Less than 2.6 (n=24)	2.7 to 4.1 (n=56)	More than 4.1 (n=26)		
	Mean±SD	Mean±SD	Mean±SD	F	Sig.
Energy (Kcal/day)	1502.1±596.7	1672.1±522.5	1687.2±633.8	0.87	0.420
Plant protein (g/day)	26.7±10.0	29.4±9.9	29.4±14.2	0.55	0.582
Animal protein (g/day)	22.0±12.0	26.9±12.6	28.8±17.8	1.60	0.206
Total Protein (g/day)	48.6±21.2	56.3±17.2	58.2±25.6	1.56	0.214
Vegetable fats (g/day)	29.1^{a}±12.0	39.4^{b}±17.9	37.1^{ab}±15.8	3.36	0.039*
Animal fat (g/day)	18.0±10.0	20.3±10.9	24.2±12.9	1.93	0.151

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	Less than 2.6 (n=24)	2.7 to 4.1 (n=56)	More than 4.1 (n=26)		
	Mean±SD	Mean±SD	Mean±SD	F	Sig.
Total Fats (g/day)	47.1[a]±20.1	59.7[b]±23.9	61.3[b]±20.4	3.22	0.044*
Fiber (g/day)	4.4±1.8	5.0±2.0	5.4±3.7	1.04	0.357
Carbohydrates (g/day)	204.2±80.2	205.9±59.3	200.0±84.3	0.06	0.945
Sodium (mg/day)	2705.2±1273.2	2529.7±772.6	2447.7±1257.5	0.40	0.671
Potassium (mg/day)	1719.7±665.0	1900.9±639.5	1951.3±1031.4	0.66	0.519
Calcium (mg/day)	336.1±200.9	377.5±148.9	378.6±142.0	1.12	0.330
Phosphors (mg/day)	598.0±276.8	721.6±289.8	725.3±342.8	1.59	0.210
Magnesium (mg/day)	71.0[a]±25.9	94.6[b]±35.8	105.4[b]±56.5	4.83	0.010**
Plant iron (mg/day)	2.6±1.8	2.8±1.7	3.4±2.4	1.12	0.330
Animal iron (mg/day)	5.4±2.2	6.3±2.3	6.8±4.5	1.40	0.252
Total Iron (mg/day)	8.0±3.7	9.1±3.1	10.2±5.5	1.85	0.163
Zinc (mg/day)	6.8±2.9	7.5±3.2	8.1±3.8	1.01	0.367
Cupper (mg/day)	2.8±3.3	2.7±1.9	1.8±1.5	1.48	0.232
Vitamin A (mcg/day)	519.9±1098.5	585.4±1379.5	496.3±1035.1	0.05	0.950
Vitamin C (mg/day)	24.8±23.0	32.0±26.9	38.7±49.2	1.07	0.347
Thiamin (mg/day)	1.5±1.8	1.5±1.0	1.0±0.8	1.70	0.188
Riboflavin (mg/day)	2.1±2.4	1.9±1.5	1.3±1.0	1.76	0.177

Mean values subscribed showed significant difference between those values at P<0.05 as shown by ANOVA and LSD test. *** P<0.001

4- Conclusion

In conclusion the lowest VAI among young adult with normal body weight in this was 2.7% which was higher than values postulated by researchers. Moreover, VAI was associated with consumption of starchy foods, milk and dairy products, dietary fat intakes (both plant-based and animal-based), and magnesium intakes.

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