Exploring Positive Correlations of Psychological Parameters and Body Composition Indices in Sports and Non-Sports Adolescent Women during Menstruation

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Abstract: The menstrual cycle, governed by the hypothalamic-pituitary-ovarian (HPO) axis, involves hormonal fluctuations that impact both the psychological and physiological domains. These changes affect various bodily systems, including cardiovascular, metabolic, and thermoregulatory functions. Additionally, body composition metrics like BMI and waist-to-hip ratio (WHR) are associated with menstrual regularity and overall health. This study aimed to investigate the relationship between psychological parameters (stress, anxiety, and depression) and body indices (BMI, WHR, and waist-to-height ratio, or WHtR) in young women, comparing athletes with non-athletes. Fifty women aged 18-25 from Banaras Hindu University were divided into two groups: 25 sportswomen (SW) and 25 non-sportswomen (NSW). The Depression Anxiety Stress Scales (DASS 21) questionnaire was used to assess psychological states, while a measuring tape was used for anthropometric measurements. The findings showed a strong positive correlation between depression, anxiety, and stress. While the body indices were interrelated, no significant link was found between these physical metrics and psychological outcomes. Sportswomen exhibited healthier body profiles and more stable psychological responses compared to non-sportswomen. The study concludes that incorporating both psychological and anthropometric monitoring during menstruation is crucial, and that sports participation acts as a protective factor, enhancing both physical and mental well-being. These insights are valuable for improving women's health research.

Keywords: Menstrual cycle, Depression Anxiety Stress(DASS-21), Body Mass Index (B.M.I.), Waist – Hip Ratio (WHR), Waist – Height Ratio (WHtR)

Introduction

The menstrual cycle isn't just about "that time of the month"—it's actually this wild, ongoing dance between your hormones, brain, body, and, honestly, your mood. It's all run by the hypothalamic–pituitary–ovarian (HPO) axis. Yeah, that's a mouthful, but basically, it's the ultimate control panel behind estrogen, progesterone, LH, and FSH—the hormones that keep the whole show running (shoutout to Thiyagarajan, Basit, & Jeanmonod, 2024 for that deep dive).

We'll breakdown it step by step:

- **Menstrual Phase (Days 1-5):** Welcome to the main event—your period. Progesterone and estrogen take a nosedive, the uterine lining bails, and you get cramps, fatigue, maybe you're bloated, maybe you just wanna nap for five days straight. Bodies are dramatic like that. (Mihm, Gangooly, & Muttukrishna, 2011).
- **Follicular Phase (Days 1-13):**Estrogen's on the rise, follicles in the ovaries are prepping for their big break, and your uterus is redecorating in case there's a baby on the horizon. You might feel a bit more energetic, and your body's actually better at regulating temperature and handling exercise around now. (Janse de Jonge, 2003).
- **Ovulatory Phase (Day 14-ish):** This is peak fertility time. LH surges, estrogen's at its max, and—boom—egg drops. Cervical mucus changes, maybe you feel a little extra flirty or sharp-minded. Nature's got jokes. (Alliende, 2002).
- **Luteal Phase (Days 15-28):** Progesterone takes the wheel. Your body temp goes up a notch, there's fluid retention, and, honestly, this is when PMS likes to crash the party. Cue mood swings, irritability, maybe even the urge to eat your weight in chocolate. Not everyone gets hit hard, but when you know, you know. (Rapkin & Mikacich, 2013).

But here's the kicker: this whole cycle isn't just about prepping for pregnancy. The hormonal rollercoaster hits your brain, too. Stuff like serotonin, GABA, and cortisol get in on the action (Indychenko et al., 2024). Late luteal and menstrual phases: Yeah, emotions can be all over the place—irritable, anxious, just generally "ugh." Mid-follicular phase, though: That's the sweet spot. More stable mood, higher energy, you might actually feel like leaving the house (Yonkers & Simoni, 2018).Bottom line: The menstrual cycle is not just a monthly "inconvenience." It's this crazy, interconnected process that messes with almost every part of you—body, brain, mood, performance, the works. It's honestly kind of impressive… or at least, complicated enough to deserve some respect.Importance of studying psychological health (stress, anxiety, depression) during menstruation. The menstrual cycle includes physical changes, but it also greatly affects psychological health, especially relating to stress, anxiety, and depression. Hormonal shifts, especially changes in estrogen and progesterone, are linked to neurotransmitter activity such as serotonin, dopamine, and γ-aminobutyric acid (GABA). These chemicals help regulate mood and stress responses (Yonkers & Simoni, 2018; Rapkin & Mikacich, 2013). These neuroendocrine processes make women

more vulnerable to mood issues, particularly during the late luteal and menstrual phases. Many women report increased emotional sensitivity and irritability at this time (Pearlstein & Steiner, 2008).Stress during menstruation often gets worse due to physical symptoms like painful periods, fatigue, and sleep problems.These can interfere with daily living, scholastic achievement, and athletic performance (Gore et al., 2020). Increased stress can exaggerate hormonal disruptions; physical symptoms and psychological effects thus form a positive feedback loop (Wang et al., 2019).
Amenorrhea is a common symptom of anxiety during episodes of menstruation. They might be the outcome of an amygdala that is more reactive, modulated by fluctuating sex hormones, and altered activity in the HPA axis (Schiller et al., 2016). For women who already suffer from anxiety disorders, symptoms can intensify during premenstrually and menstrually related symptoms. This further emphasizes these stages as periods of psychological sensitivity (Epperson et al. 2012).Symptoms of depression are not uncommon and can range from mild mood changes to very serious PMDD. Around 20–30% of women have clinically relevant depression during their cycle with serious consequences in personal, academic or professional activity (Halbreich et al., 2003). Recognizing these patterns is essential, as they often go unrecognized or are dismissed as "normal PMS," even though they have a real impact on quality of life and mental health care (Yonkers & Simoni, 2018).Studying psychological health during menstruation is important for three main reasons:

- It sheds light on the interactions between hormones, mood, and thought processes.
- It guides preventive and treatment approaches for menstrual-related mood issues in clinical and non-clinical settings.
- It helps improve the performance and well-being of young women, particularly students and athletes, whose demands may be greatly affected by changes in psychological health during menstruation (Indychenko et al., 2024).

Overall, mood changes related to the menstrual cycle are a crucial yet underexplored area of women's health. This area needs more focused research to better support psychological well-being.Role of anthropometric indices (BMI, WHR, WHtR) as markers of health and fitness. Anthropometric indices offer simple, non-invasive, and cost-effective ways to assess health, nutrition, and fitness levels across different populations (Figure 1). The Waist-to-Height Ratio (WHtR), Waist-to-Hip Ratio (WHR), and Body Mass Index (BMI) are the most researched indices. These all offer information about body composition and associated health hazards.

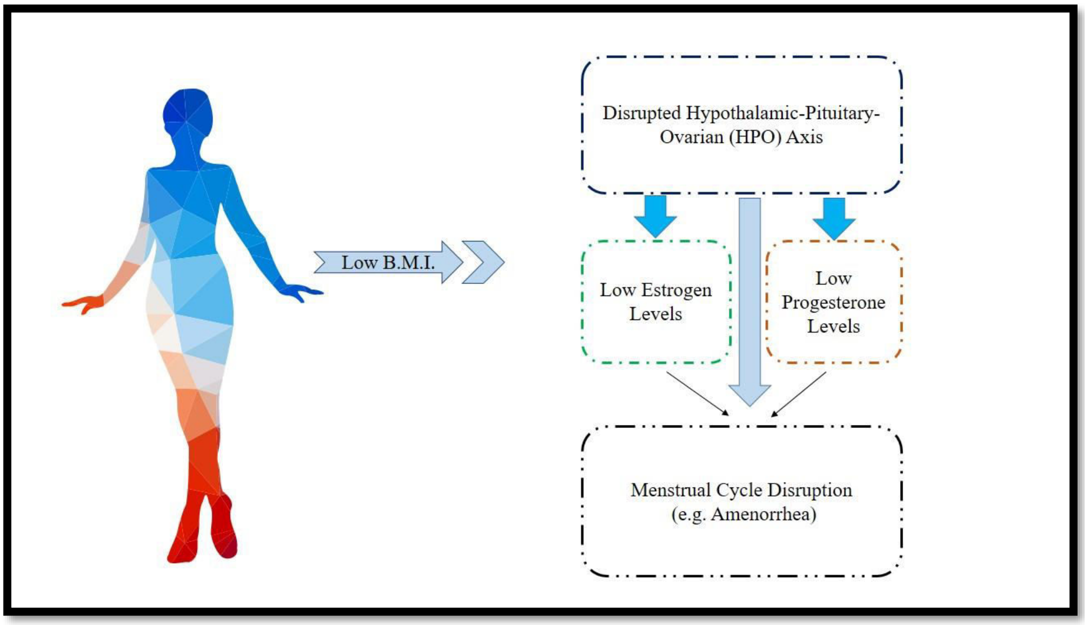


Figure 1: Impact of Low BMI on HPO Axis Function and Menstrual Cycle Regulation

BMI is the ratio of weight in kilograms to height in square meters. It has been commonly used as a worldwide screening measure for underweight, overweight, and obesity (WHO, 2020). While it doesn't distinguish between lean body mass and fat mass, it is a good predictor of overall health risks of developing heart disease, type 2 diabetes and some cancers (Bhaskaran et al., 2018). In most athletes, BMI is either under, or within acceptable values when compared with inactive individuals. This is due to healthier body composition and higher levels of physical activity (Zaccagni et al., 2020).

Waist-to-Hip Ratio (WHR): is indicator of fat distribution especially around the abdomen. An elevated WHR is closely associated with visceral fat accumulation, leading to metabolic syndrome, hypertension, and coronary heart disease (Yusuf et al., 2005). For women, the WHR threshold she risks would be over 0.85. The athlete typically end to have a smaller amount of central fat and better overall metabolic profile with a lower WHR (Miller et al., 2019).

Waist-to-Height Ratio (WHtR) has also been advocated as a more sensitive indicator of cardiometabolic risk than BMI and WHR as it incorporates body proportionality (Ashwell & Gibson, 2016). As a simple public health message "stay half your height" has been proposed to represent a WHtR of 0.5 (Ashwell et al., 2012). It has been found that WHtR is closely associated with hypertension, unfavorable lipid profiles, and insulin resistance, leading to its usefulness as an index for the early onset of disease in both clinical and sports medicine (Li et al., 2020).These indices are important in sport and fitness science research for athlete and non-athlete tracking purposes. Athletes also tend to be within healthy ranges for BMI, WHR, and WHtR. This is an indicator of the preventive potential of regular physical activity on body composition and cardio-metabolic health (Indychenko, et al., 2024) Conversely, higher values in the non-athletic groups reveal the fact that sedentary life style has implications in health risks.On that note, although the anthropometric indexes are simple measurements, they are important health, metabolic risk and physical fitness markers. If we couple them with psychological and physiological evaluations, we get comprehensive well-being information, particularly for young women under periods of vulnerability such as the menstruation. Distinction between sportswomen (trained athletes) and non-sportswomen. Sports participation significantly shapes the physiological, psychological, and anthropometric profiles of women. Sportswomen are trained athletes who engage in regular physical training. This training improves cardiovascular fitness, muscle strength, endurance, and metabolism (Nassis et al., 2020). In contrast, non-sportswomen, who do not participate in structured sports or regular exercise, usually lead sedentary or moderately active lifestyles. This can lead to higher risks of metabolic and psychological issues (Warburton & Bredin, 2017).Physiologically, sportswomen often have a lower resting heart rate, better respiratory efficiency, and improved hormonal balance compared to non-athletic women (George et al., 2011). Athletic training also brings positive changes in body composition. Sportswomen typically have a lower body fat percentage, an ideal BMI, and favourable WHR/WHtR values, indicating a lower risk of cardio-metabolic issues (Zaccagni et al., 2020, Figure 2). On the other hand, non-sportswomen tend to have a higher BMI and more central body fat, which results from lower energy expenditure. This can have negative long-term health effects (Ortega et al., 2018).From a psychological standpoint, regular sports training connects to better stress resilience, lower anxiety, and improved mood regulation. This mainly comes from the release of endorphins during exercise and enhanced coping strategies (Reigal et al., 2021). Sportswomen often report lower levels of depression and anxiety compared to non-sportswomen, who may be more prone to mood swings, especially during hormonally sensitive periods like the menstrual cycle (Eime et al., 2013).Additionally, the discipline, time management, and social connections that come with sports boost self-esteem and psychological health in sportswomen. While non-sportswomen may engage in academic or professional activities, they often miss the unique psychosocial benefits that structured sports offer (Martínez-Rodríguez et al., 2017).Thus, the differences between sportswomen and non-sportswomen are clear in physiological, psychological, and anthropometric areas, highlighting the health benefits of regular athletic involvement. Few studies have looked at the positive links between psychological factors and body measurements during menstruation. Although there is extensive research on menstrual cycle physiology and its effects on mood and performance, little is known about how psychological factors like stress, anxiety, and depression relate to body measurements such as BMI, WHR, and WHtR specifically during menstruation. Most studies have either focused separately on the psychological aspects of the menstrual cycle, such as mood issues or premenstrual syndrome (Yonkers et al., 2008; Rapkin & Mikacich, 2013), or on the physiological and body-related factors relevant to women's health, including obesity, waist-to-hip ratio, or heart health indicators (Ashwell et al., 2012;

Browning et al., 2010). Very few studies have combined both areas to examine mental and physical connections during menstruation. Research indicates that higher BMI and central body fat are linked to a greater likelihood of experiencing depressive symptoms and stress disorders in women (de Wit et al., 2010; Gibson-Smith et al., 2020). Hormonal changes during menstruation can worsen mood-related issues, especially in women who have less favorable body composition (Schmidt et al., 2011). However, the evidence remains scattered (Figure 2), and most research has not specifically targeted young women across different lifestyle categories (sportswomen vs. non-sportswomen vs. differently abled non-sportswomen).

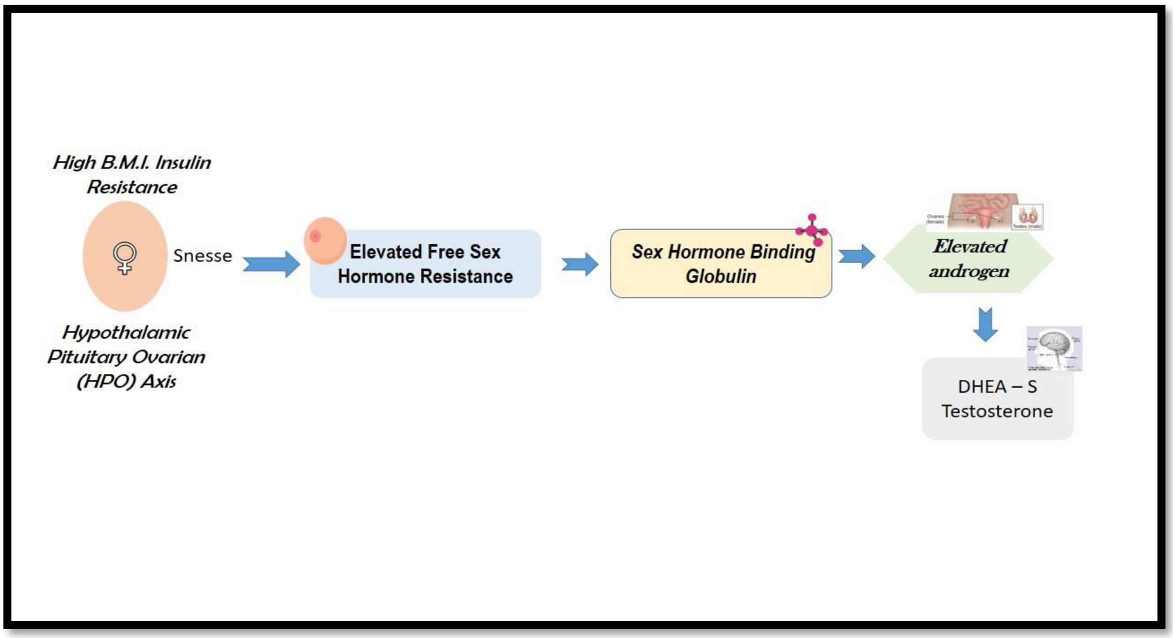


Figure 2: Role of BMI and Insulin Resistance in Altering Sex Hormone Regulation

This presents a significant research gap. Understanding the correlations, whether positive or negative, between psychological health and body measurements during menstruation could offer useful insights for women's overall health, preventive screening, and lifestyle changes. In particular, exploring this relationship in various groups—including trained athletes, non-athletes, and women with disabilities—could reveal specific vulnerabilities and strengths that researchers have yet to explore fully.

Table 1: Aim and Objectives of the Study

Objectives	Research Questions	Hypotheses
1. To assess levels of stress, anxiety, and depression among young women during the second day of the menstrual cycle using the DASS-21.	Do psychological parameters (stress, anxiety, and depression) vary significantly between sportswomen, non-sportswomen, and differently abled non-sportswomen during menstruation?	Ho_1: No significant difference in psychological variables across groups. $H1_1$: Significant differences exist in psychological variables across groups.
2. To evaluate anthropometric indices (BMI, WHR, WHtR) among sportswomen, non-sportswomen, and differently abled non-sportswomen.	Are there significant differences in anthropometric indices (BMI, WHR, WHtR) among the three groups?	Ho_2: No significant difference in anthropometric indices across groups. $H1_2$: Significant differences exist in anthropometric indices across groups.
3. To explore the correlation between psychological parameters and body indices during menstruation.	Is there a positive correlation between psychological parameters and body indices during menstruation?	Ho_3: No significant correlation between psychological parameters and body indices. $H1_3$: Significant positive correlations exist between psychological parameters and body indices.

Menstrual cycle and their effect on psychology and physiology. The menstrual cycle is a complicated process maintained primarily by the HPO axis. This sex hormone roller-coaster surprisingly revolves around estrogen & progesterone premature and postovulatory and the luteinizing hormone (LH) & follicle stimulating hormone (FSH) cycle (Thiyagarajan, Basit, & Jeanmonod, 2024). These fluctuations of hormones regulate not just reproduction but profoundly affect mental well-being and body response systems.Increased estrogen affects mood, cognition, and energy, regulation by modulating neurotransmitters such as serotonin and dopamine process during follicular phase (Petersen et al., 2023). Conversely, lower oestrogen and higher progesterone levels during luteal phase have been associated with irritability, fatigue, and negative affect. These fluctuation are also linked with premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD) (Yonkers, & Simoni, 2018). On day 2 of the menstrual cycle, levels of both estrogen and progesterone are at their nadir. This phase coincides with heightened levels of stress, anxiety and depression symptoms (Martínez-Domínguez et al., 2022).On a biological level, hormonal changes affect heart rate, blood pressure variability, respiration, temperature regulation and metabolism (Janse de Jonge et al., 2019). For instance, progesterone increases basal body temperature and respiratory rate, and estrogen tends to increase blood vessel dilation and heart protection (Charkoudian & Joyner, 2004). These modifications also influence muscle function, and fatigue and recovery in female athletes (McNulty et al., 2020).Therefore, hormonal function, psychology, and physiology interact dynamically during the menstrual cycle. It significantly impacts women's everyday activities, sports performance, and health. Developing successful therapies in clinical and athletic contexts requires an understanding of these hormonal impacts.

Table 2: Present Studies on the Relationship between Psychological Health and Body Composition Indices

Anthropometric Index	Mental Health Outcome	Main Findings	Reference
BMI	Depression	Higher BMI significantly increased the risk of depression; bidirectional relationship between obesity and depression.	Luppino et al. (2010)
BMI	Depression (adolescents & young adults)	Elevated BMI associated with subsequent depressive symptoms; psychosomatic relationship evident.	Mannan, Mamun, & Doi (2016)
WHR	Depression & Stress	Higher WHR positively correlated with depression and perceived stress in women.	Zhang et al. (2016)
WHtR	Depressive Symptoms	Increased WHtR strongly linked with depressive symptoms in young adults; abdominal obesity more predictive than BMI.	Hoebel et al. (2017)
BMI & WHR	Depression, Obesity	Shared biological mechanisms: inflammation, HPA axis dysregulation, serotonin changes.	Milaneschi et al. (2019)
BMI, WHR, WHtR	Body Image, Psychological distress	Sociocultural pressures and body dissatisfaction mediate relationship with anxiety, depression, and stress.	Richardson et al. (2019)

Role of exercise in reducing psychological distress during menstruation. The menstrual cycle has commonly been associated with psychological distress such as stress, anxiety, irritability, and depression. These symptoms are mainly due to fluctuations in estrogen and progesterone (Bäckström et al., 2011). And those mood shifts can be detrimental to the well-being, academic success and life quality of young women. There is an increasing body of evidence suggesting that exercise has an ameliorating effect on these psychological symptoms.Physical activity has been consistently reported as an effective way to enhance mood, through multiple pathways. These mechanisms involve the release of endorphins, the regulation of the hypothetical-pituitary-adrenal (HPA) axis and modulation of neurotransmitters such as serotonin and dopamine (Craft & Perna, 2004; Dishman et al., 2006). For women, this can translate into less premenstrual and menstrual agony. Empirical studies back this up, Dehnavi et al. (2018) who demonstrated that aerobic exercise resulted in significant decline of depression and anxiety symptoms among women with PMS. In the same vein, Daley (2009) demonstrated that both aerobic physical activity as well as mind–body activity such as yoga were able to reduce stress, irritability and mood swings associated with the menstrual cycle. Moreover, canonical authors like McDonough & Walters (2019) established athletes, by virtue of their practice, tend to have more capability to resist psychological disturbances at menstruation time, improving the comparative with women who do not practice sports.Exercise also heightens self-efficacy and body image that are associated with psychological well-being. This is particularly significant during the menstrual cycle when many women may have less favourable perceptions of their bodies because of bloating, pain and tiredness (Faubion et al., 2015).All things considered, research suggests that engaging in regular physical activity not only enhances physical health but also protects against mental anguish during menstruation. Therefore, it represents a valuable non-drug intervention. However, further studies are necessary to examine its effects in diverse groups, including women with disabilities, who are often left out of existing research.The menstrual cycle is controlled by a psycho-neuroendocrine system, where hormones, neurotransmitters, and psychological states interact with each other in both directions.

- Hormonal changes (estrogen, progesterone, FSH, LH) affect neurotransmitters like serotonin, dopamine, and GABA, directly influencing mood and thinking (Schiller et al., 2016).
- Cortisol and the HPA axis connect psychological stress to physical changes, affecting immune function, energy levels, and emotional reactions (Bao & Swaab, 2019).
- Body measures (BMI, WHR, WHtR) reflect metabolic status, which interacts with both hormone levels and psychological health (Milaneschi et al., 2019).

- Physical activity serves as a moderator, increasing endorphin release, decreasing HPA overactivation, and protecting against psychological distress (Dishman et al., 2006).

Thus, experiences during the menstrual cycle, such as mood swings and body discomfort, can be explained by psycho-neuroendocrine loops that connect body composition, hormonal changes, and psychological responses. Limited comparative data between sports and non-sports populations. While there is increasing research on how the menstrual cycle affects psychological and physical aspects, much of this research has been conducted in general female populations or in athletes without making systematic comparisons between athletic and non-athletic women. For instance, McNulty et al. (2020) showed that the phase of the menstrual cycle can impact physical performance and well-being in athletes, but such findings are rarely compared to those from non-athletes. Similarly, Sims and Heather (2018) pointed out that trained athletes may have different hormonal, metabolic, and psychological responses to menstrual changes than sedentary women, highlighting the need for comparative studies.

The absence of integrated research that examines how psychological health (stress, anxiety, depression) relates to body measures (BMI, WHR, WHtR) among both trained and untrained young women limits our ability to generalize findings and develop targeted interventions. Therefore, there is a significant gap in comparative research investigating the interactions between psychological and physical health during menstruation across athletic and non-athletic populations.

Materials and Methods

The study was conducted on 50 young women aged 18–25 years, divided into two groups: sportswomen (25, SW) and non-sportswomen (25, NSW). Participants were taken from Banaras Hindu University. Only those with a self-reported regular menstrual cycle (28 ± 2 days) and not using hormonal contraceptives were included. Exclusion criteria included known endocrine disorders, irregular cycles, and use of medications influencing mood or body composition. Inclusion criteria included those young females who are studying in Banaras Hindu University – like for sportswomen who had participation at inter- university level, for non-sports women who are pursuing regular course in the campus only. Data collection was scheduled during the **second day of the menstrual cycle** to ensure consistency in hormonal and symptomatic phases.

Instruments and Metrics

1. Psychological Assessment: To assess psychological factors, the Depression, Anxiety, and Stress Scale-21 (DASS-21) was used. The 21 items on this scale are broken down into three subscales (stress, anxiety, and depression), and each is evaluated on a 4-

point Likert scale. On the second day of menstruation, every subject filled out the questionnaire.

2. Anthropometric Measurements:

- Height: Determined with a stadiometer to the closest 0.1 cm.
- Weight: Determined using a calibrated digital scale to the closest 0.1 kg.
- Waist circumference: Using a flexible measuring tape, this measurement is taken at the halfway point between the top of the iliac crest and the bottom edge of the last perceptible rib.
- Hip Circumference: Determined with a measuring tape at the buttocks' widest point.

Derived indices included:

- **Body Mass Index (BMI)** = Weight (kg) / Height² (m²)
- **Waist-to-Hip Ratio (WHR)** = Waist circumference / Hip circumference
- **Waist-to-Height Ratio (WHtR)** = Waist circumference / Height

Statistical Analysis

Microsoft Excel, IBM SPSS Statistics (Version 27), and PAST software were used to code and analyze the data. For every variable, descriptive statistics (mean and standard deviation) were calculated. Anthropometric indices (BMI, WHR, WHtR) and psychological characteristics (DASS-21 scores) were compared using Pearson's correlation analysis. A p-value of less than 0.05 was deemed statistically significant.

Results

The descriptive statistics for the non-athletes' Depression, Anxiety, and Stress (DASS-21) scores showed that their psychological symptoms varied in intensity. 10.72 ± 1.77 was the mean depression score, while 8 was the median and 4 was the mode. A subset of participants tended to have greater depression scores, as indicated by the distribution's positive skewness (skewness = 1.084) and kurtosis of 0.66. With a range of 0 to 34 (Table 3)and a coefficient of variance of 82.36%, the depression scores showed significant heterogeneity within the group.

In terms of anxiety, the median score was 8, the mode was 4, and the mean score was 8.68 ± 1.25. Given the distribution's negative kurtosis (-0.92) and slight positive skewness (0.51), it appears to be flatter than usual. The coefficient of variance was 71.85%, suggesting moderate heterogeneity across subjects, while the anxiety levels ranged from 0 to 20.

The mean stress score was 13.36 ± 1.73, with a mode of 4 and a median of 10 (Table 3). It had a mildly platykurtic distribution (-0.56) with a modest positive skew (0.63). A coefficient of variation of 64.93% indicated that the scores, which ranged from 4 to 34, were relatively less variable than those for anxiety and depression. Overall the non-sportswomen exhibited moderate mean levels of depression, anxiety, and stress, with depression showing the highest relative variability across individuals.

Table 3: Descriptive statistics for Psychological Variables among Non-Sports women (NSW).

Descriptive Statistics table of DASS-21 Non-Sportswomen			
	Depression	**Anxiety**	**Stress**
Mean	10.72	8.68	13.36
Standard Error	1.766	1.247	1.73
Median	8	8	10
Mode	4	4	4
Standard Deviation	8.83	6.24	8.67
Sample Variance	77.96	38.89	75.24
Kurtosis	0.66	-0.92	-0.56
Skewness	1.084	0.51	0.63
Range	34	20	30
Coeff. var	82.36	71.85	64.93

Sportswomen's DASS-21 scores showed moderate levels of psychological symptoms with relatively less variability than those of non-sportswomen, according to descriptive statistics. With a median of 10 and a mode of 6, the mean depression score was 11.76 ± 1.39. The distribution displayed almost normal kurtosis (-0.135) and a slight positive skew (0.696). Participants' depression scores showed moderate dispersion, ranging from 0 to 28 with a coefficient of variance of 59.18% (Table 4).In terms of anxiety, the median score was 12, the mode was 4, and the mean score was 11.12 ± 1.32. A comparatively flat curve in comparison to normal was indicated by the distribution's platykurtic (-0.86) and almost symmetrical (skewness = 0.036) characteristics. The group's moderate variability was shown by the coefficient of variance of 59.22% for anxiety scores, which ranged from 0 to 24.
A mean of 16.08 ± 1.52, a median of 16, and a mode of 20 indicated comparatively greater stress ratings. Nearly symmetrical (skewness = 0.065) and slightly platykurtic (-0.20) was the distribution's characteristics. Stress ratings were less variable than those for anxiety and depression, ranging from 0 to 32 with a coefficient of variation of 47.29% (Table 4).

Overall, sportswomen showed somewhat higher mean scores for stress, anxiety, and depression than non-sportswomen, but there was less relative variability, indicating a more stable psychological profile that may have been impacted by structured training and stress adaption.

Descriptive Statistics table of DASS-21 Sportswomen			
	Depression	**Anxiety**	**Stress**
Mean	11.76	11.12	16.08
Standard Error	1.392	1.32	1.52
Median	10	12	16
Mode	6	4	20
Standard Deviation	6.96	6.58	7.60
Sample Variance	48.44	43.36	57.83
Kurtosis	-0.135	-0.86	-0.20
Skewness	0.696	0.036	0.065
Range	28	24	32
Coeff. var	59.18	59.22	47.29

Table 4: Descriptive statistics for Psychological Variables among Sportswomen (SW)

Across anthropometric measures, there was some variation in the descriptive statistics for non-sportswomen's body indices. The median height was 155.2 cm, whereas the mean was 154.32 ± 1.09 cm. With minimal variability (CV = 3.54%) and a somewhat normal distribution, the group's stature was homogeneous. The heights varied from 143.5 cm to 163.5 cm. The median weight was 56 kg, and the mean was 56.64 ± 2.23 kg. Indicating a fairly uniform distribution across values, the distribution was platykurtic (-0.73) and virtually symmetrical (skewness = -0.02). The coefficient of variation was 19.72% (Table 5), indicating greater variability than height, and the range was 36.9 to 77 kg.

The group's average BMI was 23.85 ± 0.95 kg/m2, which is higher than usual. The distribution's values ranged from 14.7 to 30.9, indicating a small negative skewness (-0.42). Moderate variability (CV = 19.90%) indicated that both underweight and overweight people were present.The median waist circumference was 81 cm, and the mean was 79.92 ± 2.24 cm. There was moderate variability (CV = 13.99%) in the scores, which ranged from 58 to 96 cm. The average hip circumference was 94.86 ± 1.87 cm, with a range of 80–114 cm and a lower variability (CV = 9.86%), suggesting that hip measurements are more uniform than waist measurements. The waist-hip ratio (WHR) ranged from 0.72 to 0.94, with a median of 0.84 and a mean of 0.84 ± 0.012. Low variability in WHR (CV = 7.14%) indicated a group-wide trend of body proportion (Table 5). The waist-height ratio (WHtR) varied from 0.36 to 0.62, with moderate variability (CV = 14.69%), and had a mean of 0.52 ± 0.015 and a median of 0.54. The BMI of non-athletes was generally normal, although their central adiposity indices (WHR, WHtR) were slightly higher. While height and WHR had the most consistency, body weight and BMI showed the highest variability, indicating variance in body composition.

Table 5: Descriptive statistics for Body Indices among Non-Sportswomen (NSW)

Descriptive statistics body indices table of Non-Sportswomen							
	Height	Weight	B.M.I	Waist circumfrence	Hip circumfrence	Waist-hip ratio	Waist height ratio
Mean	154.32	56.64	23.852	79.92	94.86	0.84	0.52
Standard Error	1.09	2.23	0.95	2.24	1.87	0.012	0.015
Median	155.2	56	23.2	81	94	0.84	0.54
Mode	#N/A	#N/A	15	59	93	0.89	0.54
Standard Deviation	5.47	11.16994	4.75	11.18	9.35	0.060	0.076
Variance	29.92	124.77	22.53	124.99	87.49	0.0036	0.0058
Kurtosis	-1.04	-0.73	-0.44	-0.579	-0.72	-0.56	-0.16
Skewness	-0.19	-0.02	-0.42	-0.57	0.12	-0.39	-0.72
Range	20	40.1	16.2	38	34	0.22	0.26
Coeff. var	3.54	19.72	19.90	13.99	9.86	7.143	14.69

According to a descriptive examination of body indices, athletes had balanced anthropometric profiles and, on average, lower levels of adiposity than non-athletes. With a median height of 156.5 cm and a mode of 160 cm, the average height was 156.23 ± 1.20 cm. A reasonably uniform height range (143.7–165.2 cm) was indicated by the distribution's limited variability (CV = 3.85%) and minor negative skew (-0.519).

With a median of 49.9 kg, the average body weight was 51.79 ± 1.92 kg. Leptokurtic (4.61) and positively skewed (1.68), the distribution indicated a grouping of data at the lower end with a few higher-weight outliers. Weight ranged from 36.8 to 84.5 kg (Table 6), with a moderate degree of variability (CV = 18.53%).The median BMI was 20.5 and the mode was 19.5, with an average of 21.18 ± 0.69 kg/m². The distribution was leptokurtic (8.77) and extremely positively skewed (2.56), suggesting that although the majority of participants had BMI values within the normal range, a small number of people with higher BMIs contributed to outliers. Variability was moderate (CV = 16.34%), with a range of 17.3 to 34.5.The range of the waist circumference was 59-98 cm, with a median of 71 cm and a mean of 72.96 ± 2.02 cm. The variability was moderate (CV = 13.85%), and the distribution was positively skewed (1.07). The average hip circumference was 89.4 ± 1.47 cm, with a median of 88 cm, a mean of 87 cm, and a narrower variability (CV = 8.27%), indicating that the subjects were relatively consistent (Table 6). The median waist-to-hip ratio (WHR) was 0.80, and the mean was 0.814 ± 0.012. Consistent body proportions were reflected in the WHR values, which ranged from 0.72 to 0.96 and displayed minimal variability (CV = 7.42%). The median waist-height ratio (WHtR) was 0.45, while the average was 0.47 ± 0.013. With values ranging from 0.38 to 0.63 and moderate variability (CV = 13.63%), the distribution was favourably skewed (1.141).Overall, sportswomen had lower waist and hip circumferences than non-athletes, as well as optimum BMI and central adiposity measurements (WHR and WHtR). With just a few higher-weight and BMI outliers, the distributions indicated a generally slim profile that was in line with the benefits of consistent exercise and training.

Table 6: Descriptive statistics for Body Indices among Sportswomen (SW).

Descriptive statistics body indices table of sportswomen							
	Height	**Weight**	**B.M.I**	**Waist circumfrence**	**Hip circumfrence**	**Waist-hip ratio**	**waist-height ratio**
Mean	156.23	51.79	21.176	72.96	89.4	0.814	0.47
Standard Error	1.2038	1.92	0.69	2.020	1.47	0.012	0.013
Median	156.5	49.9	20.5	71	88	0.8	0.45
Mode	160	#N/A	19.5	72	87	0.78	0.45
Standard Deviation	6.019	9.598	3.46	10.10	7.39	0.060	0.064
Variance	36.23	92.11	11.97	102.04	54.67	0.0037	0.004
Kurtosis	-0.16	4.61	8.77	0.662	0.54	-0.085	0.860
Skewness	-0.519	1.68	2.56	1.070	0.84	0.72	1.141
Range	21.5	47.7	17.2	39	31	0.24	0.25
Coeff. Var	3.85	18.53	16.34	13.85	8.27	7.42	13.63

There were significant variations between the three groups when physical indices and psychological characteristics were compared. The mean WHR of 0.840 and BMI of 23.85 for non-sportswomen (NSW) were both marginally higher than the recommended limit (Table 7). Their average ratings for stress (13.36), anxiety (8.68), and sadness (10.72) were moderate, and their psychological reactions varied more, suggesting that they had trouble controlling their emotions. The optimal WHR (0.814) and BMI (21.18) of sportswomen (SW) indicated a balanced body composition. In the areas of stress (16.08), anxiety (11.12), and depression (11.76), their psychological ratings were somewhat higher than those of NSW; however, they also showed less variability, indicating a more stable and consistent psychological profile (Table 7). This stability can be a result of the resilience that comes with playing sports and the adaptive benefits of disciplined training. Sportswomen generally maintained ideal body indices and had more consistent psychological responses, whereas non-sportswomen displayed slightly higher BMI/WHR and varied psychological discomfort levels.

Table 7: Anthropometric influence on Psychological Variables among Non-Sportswomen (NSW), Sportswomen (SW)

	BMI (M)	WHR (M)	Depression (M)	Anxiety (M)	Stress (M)	Prominent Feature
Non-Sportswomen (NSW)	23.85	0.840	10.72	8.68	13.36	Slightly high BMI & WHR; higher variability in psychological scores
Sportswomen (SW)	21.18	0.814	11.76	11.12	16.08	Ideal BMI & WHR; more consistent psychological profile

Table 8, Correlation between the psychological variables (Depression, Anxiety, and Stress) and body indices (BMI, WHR, WHtR) was observed with a definite pattern. Within the psychological measures, highly significant ($r = 0.92$, $p < 0.01$) correlations were found between depression and stress, whereas moderate positive correlations were observed between depression and anxiety ($r = 0.62$, $p < 0.05$). Anxiety and stress were cross-sectionally related as well ($r = 0.67$, $p < 0.05$). These findings suggest that people with higher depression symptoms are likely to report more anxiety and stress, dimensions of emotions overlapping. In contrast, the body indices did not significantly correlate with depression, anxiety, or stress, revealing no direct relationship of psychological distress with either BMI or central adiposity in this group. Depression and stress were both weakly correlated with BMI ($r = -0.026$ and $r = 0.04$), WHR ($r = -0.027$ and $r = -0.002$), and WHtR ($r = -0.002$ and $r = 0.073$). There were strong correlations between the body indices themselves. Correlation between BMI and WHtR was high ($r = 0.96$, $p < 0.01$) and moderate with WHR ($r = 0.66$, $p < 0.05$). WHR and WHtR were also highly correlated ($r = 0.80$, $p < 0.01$), indicating good agreement between the two measures of central fatness. In summary, and in light of the results, the psychological factors correlated with high degree of interrelationship, were mostly related to anthropometric variables. On the other hand, body measures/aggregates showed strong correlations with each other, particularly BMI and WHtR, taking these as both correlated indices of body composition.

Table 8: The level of interrelationships shown in the form of Pearson's correlation coefficient (r) in the Non- Sportswomen (NSW) observed during the menstrual cycle

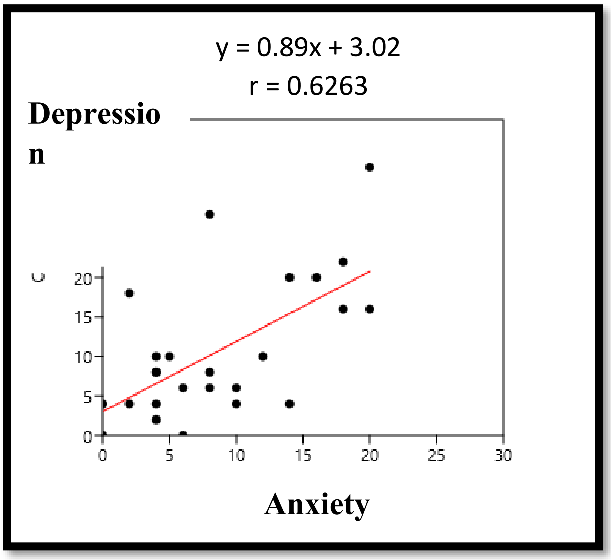
	Depression	Anxiety	Stress	B.M.I.	Waist - Hip Ratio	Waist - Height Ratio
Depression	1					
Anxiety	0.62*	1				
Stress	0.92**	0.67*	1			
B.M.I.	-0.026	0.05	0.04	1		
Waist - Hip Ratio	-0.027	-0.22	-0.002	0.66*	1	
Waist - Height Ratio	-0.002	0.016	0.073	0.96**	0.80**	1

At 23 d. f. the critical value is 0.39 at 0.05 (*, **p<0.05, ***p<0.01).

Regression analysis for Non-sportswomen (NSW)

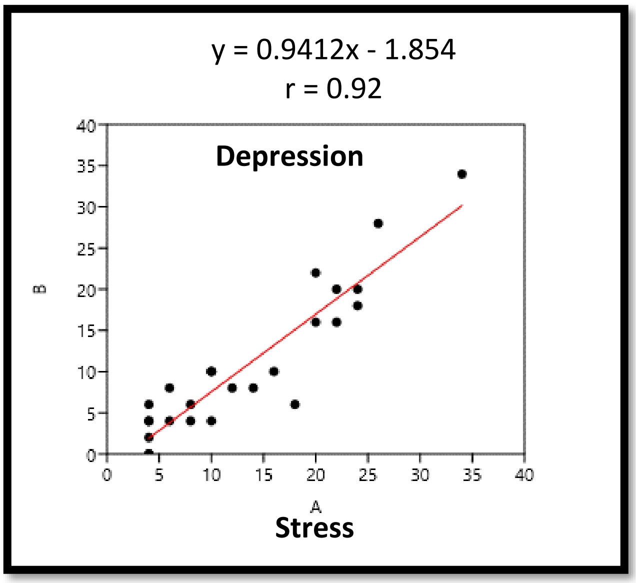
The graph exhibits a scatter plot with a linear trend that is positive. This indicates that the values on the y-axis (Depression) tend to rise in tandem with the values on the x-axis (Anxiety). This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 3).

Figure 3: Regression curve showing relationship between Anxiety and Depression in Non-Sportswomen (NSW)



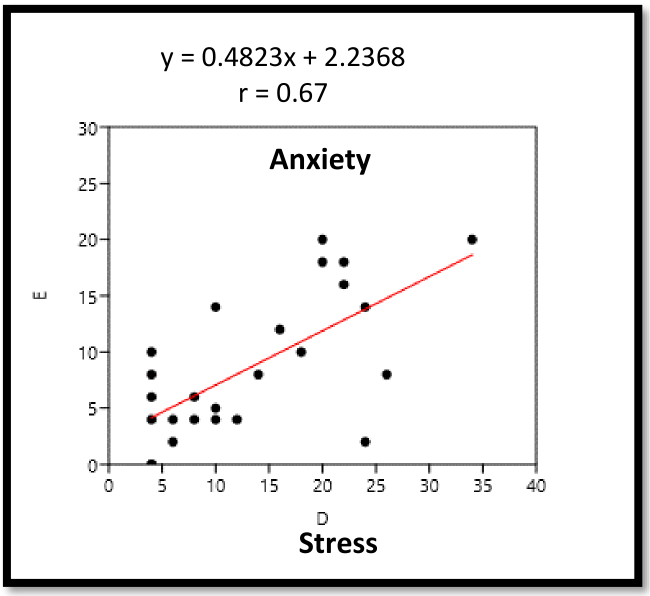
The figure shows a scatter plot with a positive linear trend. This means as the values on the x-axis (Stress) increase, the values on the y-axis (Depression) also tend to increase. The red line, known as the regression line or line of best fit, visually represents this positive relationship (Figure 4).

Figure 4: Regression curve showing relationship between Stress and Depression in Non-Sportswomen (NSW)



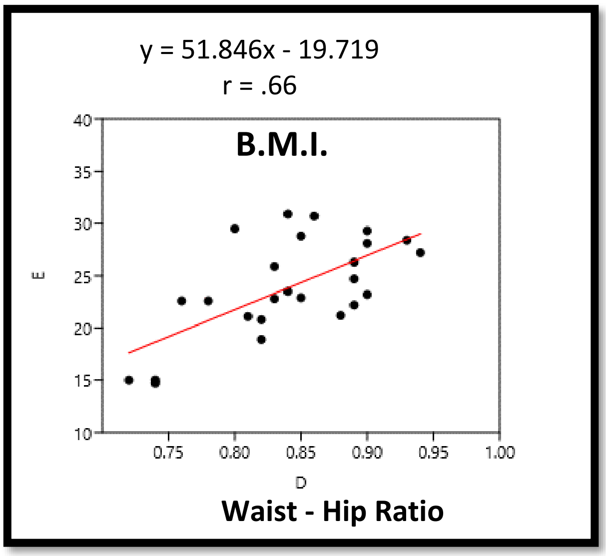
The scatter chart on the figure has a positive linear trend. This indicates that the values on the y-axis (Anxiety) tend to rise in tandem with the values on the x-axis (Stress). The red line, also known as the regression line or line of greatest fit, visually illustrates this positive correlation (Figure 5).

Figure 5: Regression curve presents relationship between Stress and Anxiety in Non-Sportswomen (NSW)



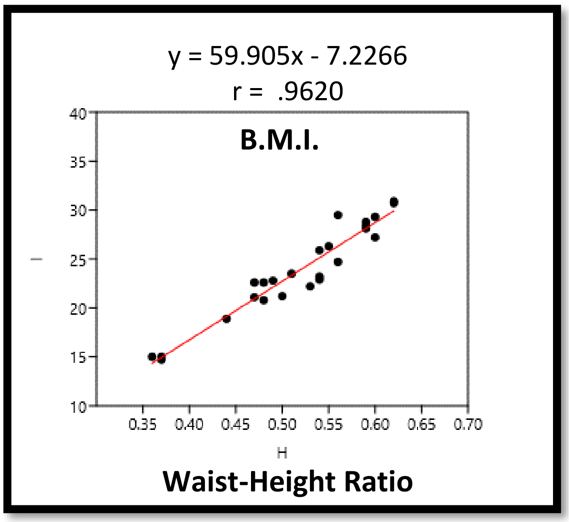
The graph illustrates a scatter plot with a linear trend that is positive. This indicates that the values on the y-axis (B.M.I.) also tend to rise as the values on the x-axis (Waist-Hip Ratio) do. This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 6).

Figure 6: Regression curve showing relationship between Waist-Hip Ratio and B.M.I. in Non-Sportswomen (NSW).



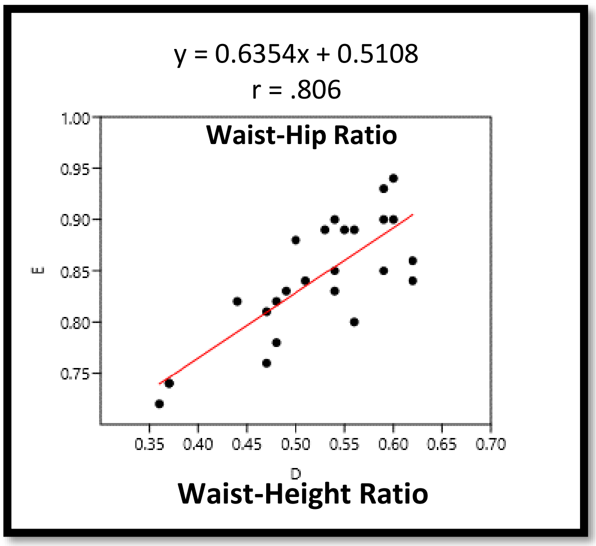
A scatter chart with a positive linear trend is displayed on the graph. This indicates that the values on the y-axis (B.M.I.) also tend to rise as the values on the x-axis (Waist-Height Ratio) do. This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 7).

Figure 7: Regression curve showing relationship between Waist-Height Ratio and B.M.I. in Non-Sportswomen (NSW).



The graph depicts a scatter plot with a positive linear trend. This means as the values on the x-axis (Waist-Height Ratio) increase, the values on the y-axis (Waist-Hip Ratio) Also tend to increase. The red line, known as the regression line or line of best fit, visually represents this positive relationship (Figure 8).

Figure 8: Regression curve showing relationship between Waist-Height Ratio and Waist-Hip Ratio in Non-Sportswomen (NSW).



Significant positive relationships were found between the psychological factors in the correlation analysis (Table 9). Depression and anxiety were significantly positively correlated ($r = 0.84$, $p < 0.01$) and indeed depression was also significantly correlated with stress ($r = 0.70$, $p < 0.01$). Anxiety and stress were associated with one another ($r = 0.69$, $p < 0.05$). This suggests that higher levels of depressive symptoms were invariably associated with higher anxiety and stress levels, consistent with shared psychological constructs. Physical measures were weak/near absent correlates of depression, anxiety and stress, thus implying that psychological distress was for the most part, independent of anthropometric measurements in this sample. For instance, depression had weak correlation with BMI ($r = -0.12$), WHR ($r = -0.049$) and WHtR ($r = -0.09$). Similarly, anxiety showed weak negative correlations with BMI ($r = -0.19$) and WHtR ($r = -0.19$). On the other, the body indices themselves were strong correlated (Table 9). BMI was moderately associated with WHR ($r = 0.51$, $p < 0.05$) and more strongly with WHtR ($r = 0.63$, $p < 0.05$). In addition, WHR and WHtR were able to show a very strong positive correlation ($r = 0.88$, $p < 0.01$) indicating the consistency of these central adiposity parameters. The psychological variables were strongly intercorrelated, while they did not explain any significant variance in BMI, WHR, and WHtR. On the other hand, body indices were highly associated with each other, especially between WHR and WHtR, which indicates consistent anthropometric measures within the group.

Table 9: The level of interrelationships shown in the form of Pearson's correlation coefficient (r) in the Sportswomen (SW) observed during the menstrual cycle.

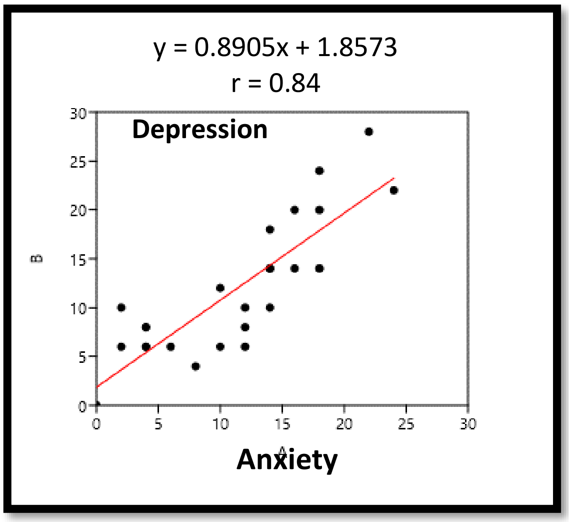
	Depression	Anxiety	Stress	B.M.I	Waist-Hip ratio	Waist-Height Ratio
Depression	1					
Anxiety	0.84**	1				
Stress	0.70**	0.69*	1			
B.M.I	-0.12	-0.19	0.08	1		
Waist-Hip ratio	-0.049	-0.101	0.1	0.51*	1	
Waist-Height Ratio	-0.09	-0.19	0.15	0.63*	0.88**	1

At 23 d.f. the critical value is 0.39 at 0.05 (*, **p<0.05, ***p<0.01).

Regression analysis for Sportswomen (SW)

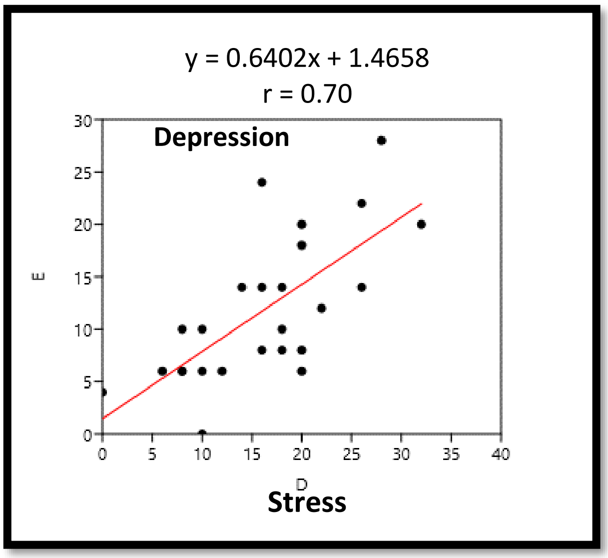
The scatter plot that appears on the graph has a positive linear trend. This indicates that the values on the y-axis (depression) also tend to rise in tandem with the values on the x-axis (anxiety). This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 9).

Figure 9: Regression curve showing relationship between Anxiety and Depression in Sportswomen (SW).



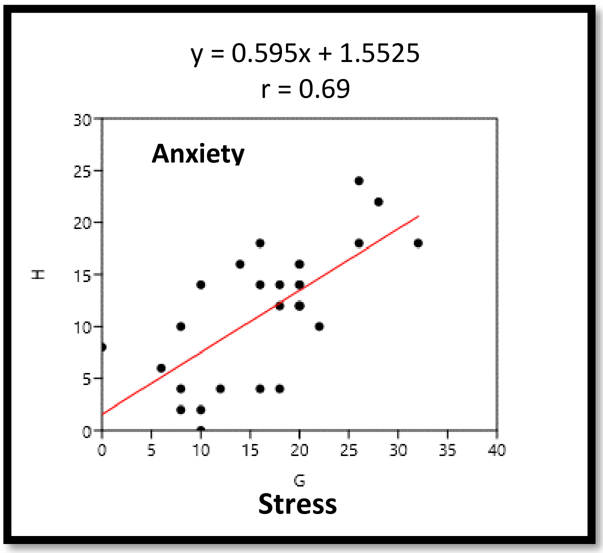
The graph illustrates a scatter plot with a linear trend that is positive. This shows that the values on the y-axis (Depression) also have a tendency to rise in side by side with the values on the x-axis (Stress). This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 10).

Figure 10: Regression curve depicts relationship between Stress and Depression in Sportswomen (SW).



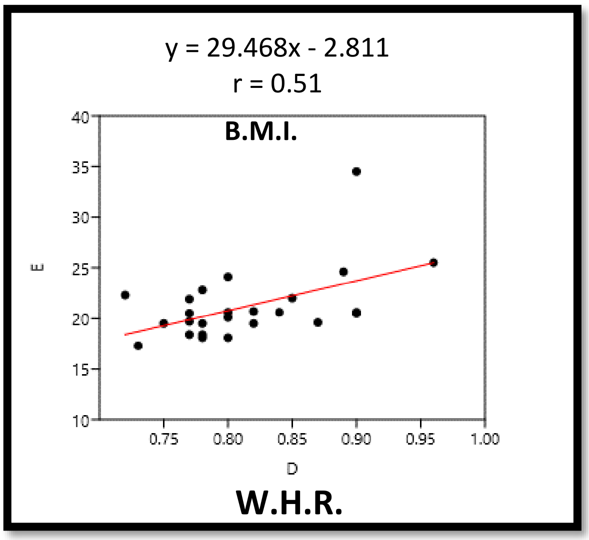
The graph presents a scatter plot with a positive linear trend. This suggests that as the numbers on the x-axis (stress) increase, so do the values on the y-axis (anxiety). The red line, also known as the regression line or line of greatest fit, visually illustrates this positive correlation (Figure 11).

Figure 11: Regression curve presents relationship between Stress and Anxiety in Sportswomen (SW).



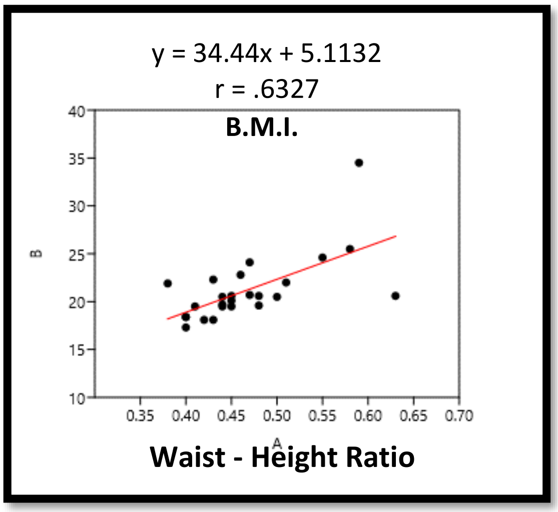
The graph shows a scatter plot with a positive linear trend. This means as the values on the x-axis (Waist-Hip Ratio) increase, the values on the y-axis (B.M.I.) Also tend to increase. The red line, known as the regression line or line of best fit, visually represents this positive relationship (Figure 12).

Figure 12: Regression curve showing relationship between Waist-Hip Ratio and B.M.I. in Sportswomen (SW).



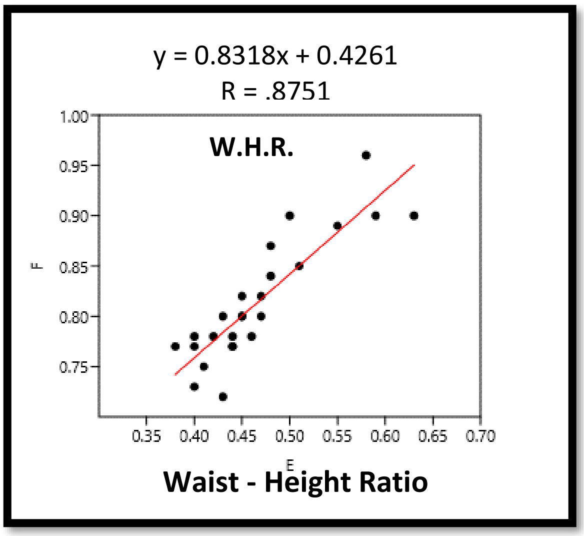
The scatter plot on the graph has a positive linear trend. This indicates that the values on the y-axis (waist-hip ratio) also tend to rise as the values on the x-axis (B.M.I.) do. This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 13).

Figure 13: Regression curve showing relationship between Waist-Height Ratio and B.M.I. in Sportswomen (SW).



A scatter plot with a positive linear trend may be seen on the graph. This indicates that the values on the y-axis (waist-hip ratio) also tend to rise as the values on the x-axis (waist-height ratio) do. This positive association is graphically shown by the red line, also referred to as the regression line or line of greatest fit (Figure 14).

Figure 14: Regression curve showing relationship between Waist-Height Ratio and Waist-Hip Ratio in Non-Sportswomen (NSW).



Discussion of Findings

Hence, the objective of this study was to do an analysis of psychological (depression, anxiety and stress) and body indices (BMI, WHR, WHtR) in sportswomen (SW) and non-sportswomen (NSW). Results contribute to the body of knowledge about the effects of lifestyle (i.e., physical activity and sports participation) on women's psychophysiological well-being.

Positive correlations Explanation - Depression, anxiety and stress were correlated positively, such that an increase in any psychological domain was accompanied by an increase in the remaining domains. This overlap implies common variance with emotional regulation circuits and is consistent with the fact that mood disorders are often comorbid in women (Schiller et al., 2016). Conversely, mp indices showed weak associations with psychological dimensions, reflecting that in this specific sample BMI and central adiposity were not affecting directly the psychological distress. However, the interrelationships of anthropometric indexes (SS SB and WHpTB) were consistently significant in this study, which concurred with their applicability in predicting body composition.

Role of Sports and Physical Activity -Participants who played sports presented lower BMI, WHR and WHtR as compared to those who did not in our population, which likely reflects structured training and lower adiposity. It's also interesting to note that, whilst average depression, anxiety and stress scores were just slightly higher in sportswomen, variability of the scores was lower, indicating that sportswomen may also have more predictable psychological profiles. This finding might be due to the adaptive effect of systematic training and competitive experience exerted upon athletes to be stress-resilient and psychologically stable. Indeed, prior research has highlighted that participation in sports can buffer against psychosocial distress by encouraging self-regulation, as well as resilience and coping (Reardon et al., 2019).The biological explanation is that the observed psychological tendencies were most likely impacted by hormonal shifts that took place during the menstrual cycle. By altering neurotransmitters such as dopamine and serotonin, changes in progesterone and oestrogen have an impact on mood and stress responses (Thiyagarajan et al., 2024).Sportswomen may have distinct interactions between body composition, HPA/HPG axis control, and self-perception, which could influence their psychological outcomes due to their leaner body composition and structured activity levels. On the other hand, even if they are not directly connected with the distress ratings in our group, the somewhat higher adiposity indications in NSW may help to lower emotional vulnerability and self-perception.

Analysis of Previous Research: Although the current study did not discover any significant correlations, these results are in part consistent with earlier research that linked psychological discomfort to a higher BMI (Atlantis & Baker, 2008). The very small BMI range among participants or the moderating influence of cultural and lifestyle factors on the relationship between body image and mental health could be the reasons for the lack of association. Research on female athletes has also shown that training stress and menstrual cycle changes have a greater impact on psychological states than anthropometric status alone (Indychenko et al., 2024).In both sports and non-athletic populations, our findings underscore the significance of psychological screening for women. While non-athletes may benefit from lifestyle therapies that address both body composition and psychological well-being, athletes may benefit from continuous mental health care to manage stress and anxiety connected to performance. Promoting physical activity and integrating mental health programs can be a successful strategy for women's health initiatives.

Limitations and Future Directions: Response bias may have been created by the study's dependence on self-reported psychological measurements, and its cross-sectional design limits the ability to interpret causality. The biological interpretation was limited by the small sample size and the lack of direct assessment of hormonal state. To better understand how body indices, hormones, and psychological health interact, future research should use longitudinal designs to record cycle-specific changes, incorporate hormonal assays, and assess interventions like structured exercise or stress-management programs.

In the present study, we examined the relationship between psychological factors (depression, anxiety, and stress) and anthropometric measures (BMI, WHR and WHtR) among sportswomen and non-sportswomen. Psychological indices also showed significant inter-correlation, the body indices showed close positive associations with each other and their relationships with psychological distress were weak. Sportswomen also showed superior body indices and more stable psychological

profiles than the non-sportswomen, which reflects the adaptive effects of sports regular practice. These findings support the hypothesis that the combination of psychological and anthropometric monitoring is pertinent during menstruation, as there may be a link between hormonal changes, body composition and emotional condition. Routine assessment has the potential to detect sensitivity to distress early and is helpful in individualized treatment for women's health. On the other hand, sport practice was shown as effect modifier and positively associated in one case: physiologically beneficial effects such as a low BMI and adiposity, as well as mentally resistant / adaptive uniform oral stress. This highlights the syncremental role of physical activity for the overall health of women.
The present report also adds to the extended literature on women's health through demonstrating the modulatory relation among body indices, mental health, and sports participation. It also demonstrates the need for bio-psychosocial models that consider the physical, emotional and hormonal aspects of well-being across the menstrual cycle.

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Author contributions
VP conceived and designed the research. VP conducted the experiments and analyzed the data. VP wrote the manuscript. VS and OR guided and helped in the data collection. All authors read and approved the manuscript.

Conflict of interest
No conflict of interest.

Ethical clearance statement
Current investigation was approved by the Institutional Ethics Committee under reference number IMS/IEC/2024/7770. Informed consent was obtained from all the participants, and the research was conducted in accordance with institutional and ethical guidelines.

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