RESEARCH
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AN ANALYSIS OF ANTHROPOMETRIC PARAMETERS, BODY COMPOSITION AND MENSTRUAL HEALTH PROFILE OF YOUNG FEMALE SPORTSPERSONS IN KERALA

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Abstract
The objective of this study was to assess the anthropometric measurement, body composition and menstrual health profile of chosen young female sportspersons in Kerala. This research was carried out on a total of 131 young athletes, ranging in age from 13 to 24 years old, who were recruited from various colleges throughout the state of Kerala. The average age of the participants was approximately 18.78 years old, with a standard deviation of 2.35 years. All participants underwent an evaluation of their height, weight, Body Mass Index (BMI), waist circumference, hip circumference, Waist-Hip Ratio (WHR), and body composition variables, including body fat percentage, water percentage, protein percentage, obesity percentage, bone mass, muscle mass, lean body mass, metabolism, visceral fat, and body age. The anthropometric parameters and body composition variables were evaluated with standard techniques and tools. In this study, descriptive statistics, including the mean, frequency, and standard deviation, as well as the one-sample t-test, were applied. The findings of the anthropometric parameters indicated that the mean BMI values were found to be 21.18±4.37, p=.000. According to WHO BMI classification for Asians, 49.61% of the players were normal, 12.97% belonged to the overweight category and 9.16% to pre-obese category. 23.66% and 4.5% were in the underweight and obese type I categories respectively. Mean Waist to Hip ratio (WHR) was .885±.104, p=.000. The results of the body composition revealed that the mean body fat percentage was 21.78±9.63, p=.000, mean water percentage was 51.56±7.66, p=.034, mean protein percentage was 20.61±4.60, p=.128, mean obesity percentage was .686±19.79, p=.000, mean bone mass was 2.09±.58, p=.044, mean muscle mass was 39.84±6.18, p=.000, mean lean body mass was 42.06±6.89, p=.000 and mean visceral fat was 2.74±2.18, p=.000. The women's health profile also showed that high perception towards regularity in menstrual periods and low perception towards taking medicines for menstrual cramps.
In the results, anthropometric parameters and body composition profiles (Protein Percentage) were statistically significant (p-values >0.05), indicating better anthropometric measurements and body composition scores among the sportspersons.
Keyword: Body composition –sportspeople – body fat percentage – lifestyle – anthropometry parameters.

INTRODUCTION

The study of anthropometry involves learning about the human body's construction, such as how it develops over time and the dimensions of its different parts. Sports measurement is based on anthropometry, the oldest and most crucial aspect of sports (Lintang, 2020). Anthropometric research indicates that one's performance and physical activity are influenced by one's anthropometrics (Mulyadi, 2013).Maintaining performance is critical for elite athletes who want to continue participating in sports (Tsukahara et al., 2020).A sportsman's body composition and somatotype in addition to other elements, play a vital effect on sports performance such as physiological and physical health, psychological fitness aspects, abilities, etc. A specific physique required for good athletic performance has been aided by many studies.

Body composition is a physical measurement that provides more detailed information about the body's composition than body weight alone. The percentage of fat and fat-free mass (FFM) in the body is called body composition. Muscle, bone, and water are the main components of fat-free mass, along with a few minor substances. Fat mass includes fat stored as an energy source as well as important fat found in the central nervous system, organs and bone marrow (Rockwell, 2022).Athletic performance and health are influenced by body composition (Alves Junior et al., 2021).To determine the effectiveness of a diet or nutritional features, its evaluation is imperative (Campa et al., 2021).

Menstrual cycles can provide important information about an athlete's overall health, including whether they're getting enough nutrition, training too hard, and if their bones are being strengthened. Many athletes, especially those who practice

sports that emphasize leanness, believe that amenorrhea (the absence of periods) will help them go from normalcy to excellence. RED-S is the result of athletes not getting enough energy through food to support the demands of daily life and training. Athletes who do not consume enough energy through food can experience amenorrhea. Menstrual disorders are one of the negative components of the female athlete triad, which the IOC recently introduced as Relative Energy Deficiency in Sport (RED-S).In addition to physically affecting women athletes, menstrual dysfunction can also affect their emotional experiences (Mountjoy et al., 2014).Furthermore, reproductive hormones may affect cardiovascular, respiratory, thermoregulatory, and metabolic parameters, making the menstrual cycle an important factor in sports performance (Brown et al., 2021). Regardless of sport type or competition level, women face challenges regarding menstrual function and their health and well-being are not always supported in sport (Adam et al., 2022). According to some studies, there is a prevalence of up to 40% of menstrual cycle disorders in female athletes (De Souza et al., 2010). It has been reported that women in sports are more likely to experience menstrual irregularities than the general population, particularly those who are professional athletes. However, research on female athletes is few (Martín-Matillas et al., 2014).

Relevance of the study

To evaluate the effectiveness of a diet, it is important to consider the athlete's nutritional status and the performance of the diet. It is important to understand how training affects body composition to control weight and adjust body composition safely.

Objectives

The purpose of this study was to assess the anthropometric characteristics, body composition, and menstrual health profile of selected young female sportspeople from Kerala.

METHODOLOGY

Subjects

In this study, 131 female athletes (18.78 ± 2.358) aged between 13 and 24 years from different districts of Kerala participated. The researchers explained the purpose of the study to the appropriate participants at their first visit and allowed them to complete the questionnaire. Each subject provided written consent with information before participation in the study.

Assessment of Anthropometry

The science of anthropometry tries to comprehend how the human body evolves, as well as the proportions of its many components. The measurement of human anthropometry is one of the sport's oldest and most fundamental parts. These measurements can be used to estimate the optimum body form or composition, as well as the physical condition (caca, 2020). Anthropometry is utilised in a range of sectors involving the human body and its supporting equipment. Body mass index (the ratio of height to weight) can be calculated using anthropometric techniques used in sports and health measurements.

Height

A stadiometer, ideally connected to a wall, is used to measure a person's height, and the floor should be level and hard (Stewart et al., 2011).The subject's highest point was measured with a measuring rod and horizontal cursor. The subject must be barefoot and lightly dressed to observe his posture and positioning. He has to join his feet at the heels, stand as straight as possible, and keep his head parallel to his entire body. The subject lies flat and vertically on his back, buttocks, and heels with his arms hanging freely. A moving cursor touches the highest point of the head. Height is measured in metres plus 0.1 centimetres.

Weight

Using an Eagle balance, the body mass was measured. The subject must be able to stand up on his or her own without assistance. A body must stand still in the middle of the weighing pan and distribute its weight evenly over two feet spaced slightly apart. Shoes should be removed and the subject should be dressed lightly. The body mass was measured in kilograms ± 100 grams.

BMI

The BMI is widely used to assess adiposity. BMI is calculated by dividing body weight by height (kg/m2) (‘Obesity’, 2000). The Body Mass Index (BMI = kg/height m2) was calculated by dividing an individual's weight (kg) by their height (m).

Waist Circumference

Standard methods were followed for measuring waist circumference with an anthropometric tape. A standing participant's waist circumference was measured along the midline between the rib cage's lowest border and the iliac crest.

Hip circumference

Using normal techniques, the hip circumference was measured with an anthropometric tape. The hip circumference was measured while standing, using the convex area of the hip.

Waist-Hip ratio (WHR)

The Waist-Hip Ratio (WHR) is computed by dividing the waist and hip circumferences using the same measurement units.

Determination of body composition

A BCA is a quick and inexpensive technique to see if and how a person's routines and lifestyle habits affect their body and health (DMU, 2021). Body composition is calculated by separating fat, protein, minerals, and body fluids to determine a person's health. As a result, it paints a more complete picture of general health and correctly describes weight than previous methods. A body composition analysis can provide precise precision for changes in fat mass, muscle mass, and body fat percentage. It is used to increase athletic performance by athletes who want to get the best body composition.

Body fat percentage

A key factor in assessing an individual's body composition has been their percentage of body fat, which is the proportion of fat to overall weight.

Muscle mass

Maintaining skeletal muscle mass is crucial for immunity, mobility, posture, and overall health. It is expected that the body contains muscle weight. Muscle mass is made up of skeletal muscles, smooth muscles (such as the heart and stomach muscles), and fluids. Because they function as engines, muscles use energy. Gaining muscle mass causes the body to burn calories more quickly, which leads to healthy weight loss and a

decrease in excess body fat. Vigorous exercise can increase muscle mass without increasing total body weight.

Bone mass
To measure bone mineral weight, a statistical calculation based on fat-free mass and skeleton size is performed.

Visceral fat
Visceral fat is accumulated within the abdominal cavity. There are other important organs nearby, including the liver, stomach, and intestines.

Water percentage
Extracellular water (ECW) and intracellular water (ICW) are the two types of water in the body. Maintaining a proper body water balance is crucial for optimum health.

Protein percentage
Protein, which makes up 18% of the human body, is necessary for the structure and operation of cells. Muscle cell protein content provides information on a person's health, physical growth, and nutritional status.

Obesity percentage
The degree of obesity is indicated by the discrepancy between the ideal and actual weights.
Obesity = (actual weight-ideal body weight)/ideal weight * 100%.

Lean body mass
Lean body mass, which comprises water, muscle, bone, connective tissue, and internal organs, is defined as the total amount of water in the body.

Metabolism
The amount of calories required by the body to function at its most basic level is referred to as the body's metabolic rate. Even while the body is at rest, it consumes calories to carry out essential functions such as breathing, circulation, nutrient digestion, cell formation, and so forth. It's common to use the words resting metabolic rate and basal metabolic rate interchangeably. BMR is the amount of calories needed for basic functions while at rest.

Body age
Biological ageing is described as the gradual degradation of cells and tissues in the body. It is also known as functional age or physiological age. In contrast to a chronological age, a biological age takes into account additional elements in addition to the person's birth date. An individual's biological age can fluctuate based on their lifestyle, diet, level of activity, attitude, sleep patterns, and stress levels. Depending on genetics and lifestyle choices, this may be greater or lower than the chronological age in certain instances.

Statistical Analysis
One-sample t-test, mean, SD, and standard error were used. The probability value was <0.05. The statistical package of Social Sciences 20 was used.

RESULTS AND DISCUSSIONS

Table 1: Socio-demographic profile of young female sportspersons in Kerala

Age		
13-16 yrs	**11**	**8.40%**
16-20 yrs	**70**	**53.5%**
20-24 yrs	**50**	**38.16%**
Gender		
Females	**131**	**100%**
Educational Qualification		
08-10th class	**3**	**2.29%**
10-12th class	**49**	**37.40%**
Degree	**79**	**60.30%**
PG	**0**	**0%**
Type of family		
Joint	**23**	**17.55%**
Nuclear	**107**	**81.67%**
Extended	**1**	**.76%**
Area of residence		
Rural	**90**	**68.70%**
Urban	**22**	**16.79%**
Coastal	**19**	**14.50%**
Tribal	**0**	**0%**
Economic Status		
Yellow card	**15**	**11.45%**
Pink Card	**70**	**53.43%**
Blue Card	**31**	**23.66%**
White Card	**15**	**11.45%**

Table 1: Socio-demographic Profile of young female sportspersons in Kerala. Participants ranged from 13-24 years of age.8.40% were between 13 and 16 years of age,53.5% between 16 and 20 years of age, 38.16 years of age between 20 and 24 years of age8.29% were between 8 and 10th classes, and 60.30% went to secondary schools. Eighty-seven per cent of the population went to Degree. Nuclear and joint families accounted for eighty-seven per cent and seventeen per cent of households respectively. Extended family accounts for.76 per cent of households. According to the study results, Seventy-eight per cent of the subjects lived in the rural area, sixteen per cent in the urban area, and fourteen per cent in the coastal region.11.45% of the subjects belonged to the Yellow Card category (the most economically backward segment of society), 53.43% of them belonged to the Pink Card category (the lowest-income group), 23.66% belonged to the Blue Card category (the highest-income group), and only.

Table 2: Personal/Sports profile of young female sportspersons in Kerala

PARAMETERS	TOTAL NUMBER	PERCENTAGE
Sports Specialization		
Cricket	9	5.5
Wrestling	2	1.1
Archery	3	1.1
Football	37	63.9
Wushu	1	.5
Handball	6	3.3
Hockey	5	.5
Netball	1	1.1
Kho-Kho	7	3.8
Athletics	18	11.5
Karate	6	3.3
Decathlon	1	.5
Judo	3	3.3
Kabbadi	3	.5
Badminton	6	4.6
Fencing	1	.8
Tug of War	8	6.1
Baseball	11	8.4
Yoga	1	0.8
Kalari	1	0.8
Body Building	1	0.8
Level of Participation		
School	33	25.2
Inter-collegiate	7	5.3
District	13	9.9
State	1	0.8
Revenue	43	32.8
South	1	.8
National	32	24.4
Khelo-India	1	.8
Nutrition Class		
Yes	55	42
No	76	58
Special Diet		
Yes	3	2.3
No	128	97.70
Sleep		
4-6 hrs	12	9.16
6-8 hrs	70	53.43
8-10 hrs	46	35.11
10-12 hrs	3	2.29

Table 2 shows the personal/sports profiles of young sportspersons in Kerala. The study participants specialized in cricket (6.5%), wrestling (1.5), archery (2.3), football (28.2), wushu (80%), handball (4.8%), netball (0.9), kho (5.4), athletics (13.7), karate (4.6), decathlon (.8), judo (2.3%) and kabbadi (2.2%). The study included 25.2% of participants at the school level of participation; 5.3% at the inter-collegiate level; 9.9% at the district level;.8% at the state level; 32.8 at the revenue level;.8 at the south level; 24.4 at national level; and .8 with Khelo- India level. 42% had a nutrition class; 58% had no nutrition class; 2.3% had a special diet; and 97% had no diet. The study participants slept 4-6 hours a day; 53% slept 6-8 hours a day; 35% slept 8-10 hours a day.

Body Mass Index (BMI)

Table 3: Body Mass Index (BMI) of young female sportspersons in Kerala

BMI	NUMBER	PERCENTAGE
<18.5 - UNDERWEIGHT	31	23.66
18.5-22.9 – NORMAL	65	49.61
23-24.9 - OVERWEIGHT	17	12.97
25-29.9 – PRE-OBESE	12	9.16
≥30 - OBESE **30-40 - OBESE TYPE 1**	6	4.5

The distribution of these players in terms of their BMI is shown in Table 3. The majority of 49.61% were in the standard category, while 23.66% fell into the underweight category. In addition, Overweight and Obese persons represented 12.97% and 9.16% of the participants. The obesity type I category accounts for 4.5% of them.

Waist-Hip Ratio (WHR)

Table 4: Waist-Hip Ratio (WHR) of young sportspersons in Kerala: Female

Waist-Hip Ratio (WHR)	*Excellent <0.85*	*Good 0.85-0.89*	*Average 0.90-0.95*	*At Risk ≥0.95*
Female	*51*	*20*	*37*	*23*

Table 4 presents the Waist-Hip Ratio (WHR) of young female sportspersons in Kerala. The majority of these were in the excellent category, with 20 being in the good category, 37 in the normal category and 23 in the risk category.

BODY FAT PERCENTAGE

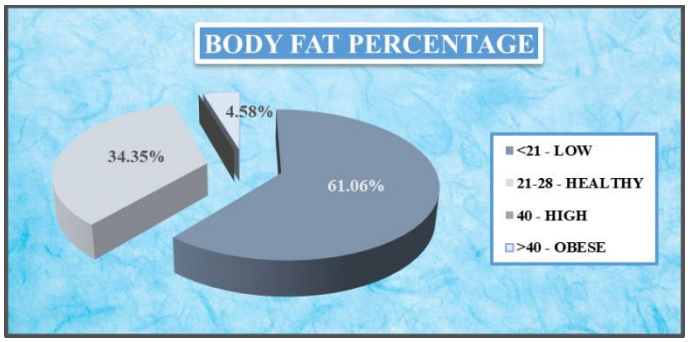

Fig 1: Body fat percentage distribution of young female sportspersons in Kerala

Fig 1 shows the Body fat percentage distribution of young female sportspersons in Kerala

MUSCLE MASS

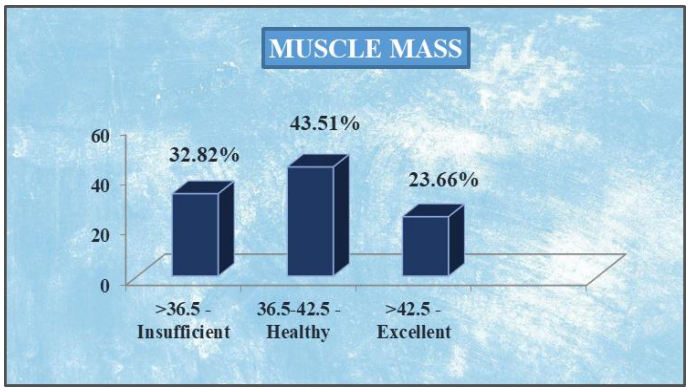

Fig 2: Muscle mass distribution of young female sportspersons in Kerala

Fig 2 shows the Muscle mass distribution of young female sportspersons in Kerala

WATER PERCENTAGE

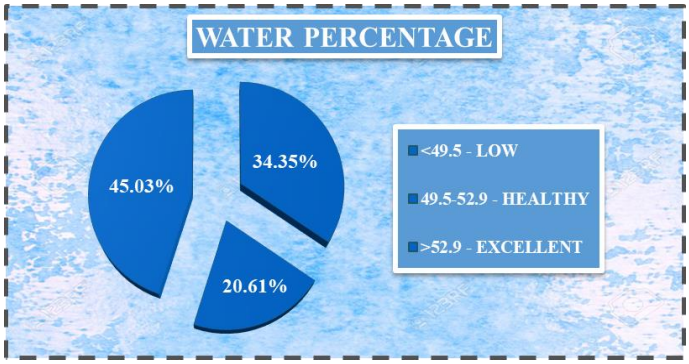

Fig 3: Water percentage distribution of young female sportspersons in Kerala

Fig 3 shows the Water percentage distribution of young female sportspersons in Kerala

BONE MASS

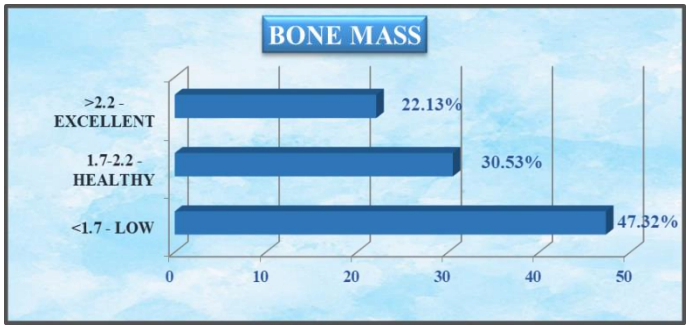

Fig 4: Bone mass distribution of young female sportspersons in Kerala

Fig 4 shows the Bone mass distribution of young female sportspersons in Kerala

OBESITY PERCENTAGE

Table 5: Obesity Percentage of Young Female Sportspersons in Kerala

OBESITY PERCENTAGE	NUMBER	FREQUENCY
<10% - HEALTHY	97	74.04
10-20% - OVERWEIGHT	19	14.50
20-30% - MILDY	10	7.63
30-50% - MODERATE	1	0.76
>50% - SEVERE	4	3.05

Table 5 shows the distribution of the obesity percentages. In the healthy category, 74.04% and 14.50% in the overweight category were found. In the mild and moderate categories, there were also 7.63% and 0.76% respectively. A total of 3.05% were classified as extreme.

METABOLISM

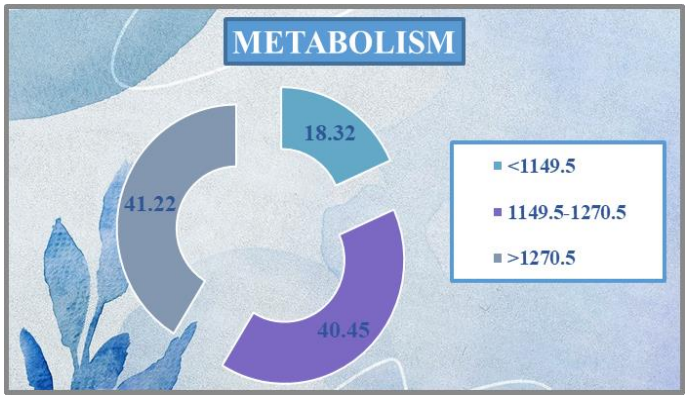

Fig 5: Metabolism distribution of young female sportspersons in Kerala

Fig 5 shows the Metabolism distribution of young female sportspersons in Kerala

PROTEIN PERCENTAGE

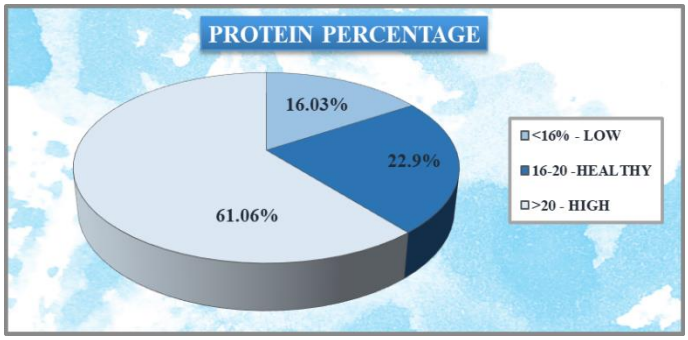

Fig 6: Protein Percentage distribution of young female sportspersons in Kerala

Fig 6 shows the Protein Percentage distribution of young female sportspersons in Kerala

VISCERAL FAT

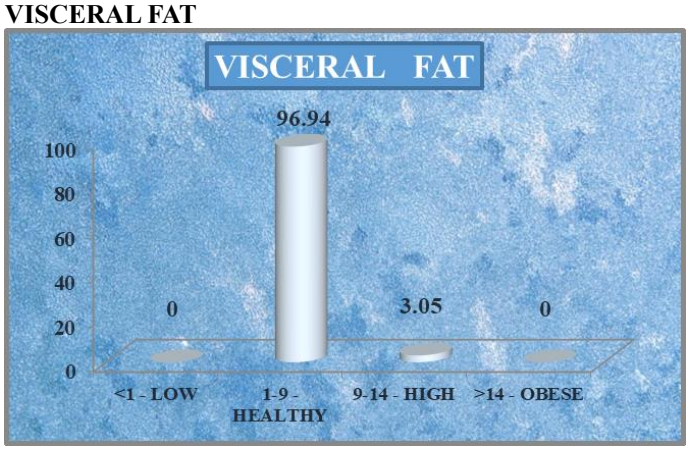

Fig 7: Visceral fat distribution of young female sportspersons in Kerala

Fig 7 shows the Visceral fat distribution of young female sportspersons in Kerala

Table 6: Anthropometric Parameters of young female sportspersons in Kerala

Anthropometric Parameters	Sports Professionals (N=183)	Normal Range	T Value	P Value
Height	1.59±.075	1.60	-.804	.423
Weight Body Mass Index (BMI)	53.90±11.43 21.18±4.37	55 22.9	-1.098 -4.475	.274 .000
Waist Circumference (WC)	76.11±10.525	80	-4.227	.000
Hip Circumference (HC)	86.19±10.198	95	-9.884	.000
Waist-Hip Ratio (WHR)	.885±.104	0.80	9.365	.000

An independent sample t-test was employed to analyse anthropometry values. The mean height was 1.59±.075 (t=-.804, p=.423), which was not statistically significant. The mean weight was 53.90±11.43 (t=-1.098, p=0.274), not statistically significant. The mean BMI was 21.18±4.37 (t=-4.475, p=.000), indicating statistical significance. The mean waist circumference was 76.11±10.525 (t=-4.227, p=0.000), which was statistically significant. The mean hip circumference was 86.19±10.198 (t=-9.884, p=0.000), indicating statistical significance. The mean waist-hip ratio (WHR) of.885±.104 (t=9.365, p=0.000) was statistically significant. (Table 6)

Table 7: Body Composition Variables of young female sportspersons in Kerala

Body Composition Variables	Sports Professionals (N=183)	Normal Range	T Value	P Value
Body Fat Percentage	21.78±9.63	28	5.687	.000
Muscle Mass	39.848±6.18	42.5	-4.908	.068
Visceral Fat	2.74±2.18	5	-11.771	.000
Lean Body Mass	42.06±6.89	50	-13.180	.000
Water Percentage	51.56±7.66	53	-2.147	.034
Bone Mass	2.09±.586	2.2	-2.032	.044
Metabolism	1286.30±172.18	1150	9.060	.000
Protein Percentage	20.61±4.60	20	1.532	.128
Obesity Percentage	.686±19.79	10	-5.386	.000
Body Age	19.66±4.35	20	4.379	.000

Body composition variables were analyzed using independent samples t-tests. Body fat percentage (t=-5.647, p=.000) was within the acceptable and statistically significant range. Mean muscle mass was within the acceptable range (t=-4.908, p=0.068) and was found to be significant. Average visceral fat (t=-11.771 p=.000); statistically significant. Mean lean body mass (t=-13.180, p=0.000) was found to be significant. The water percentage (t=-2.147, p=0.034) was significant. The mean bone mass (t=-2.032, p=0.044) was significant. The mean metabolic rate was highly significant and greater than the acceptable range (t=9.060, p=0.000). Average protein percentage (t=1.532, p=.128); not significant. Average obesity (t=-5.386, p=.000); statistically significant. (Table 7)

WOMEN'S PROFILE

NUMBER OF DAYS OF MENSTRUATING

Table 8: Number of days of Menstruating of young female sportspersons in Kerala

No of Days of Menstruating	Number	Frequency
<3 - DAYS	3	2.29%
3-5 - DAYS	53	40.45%
5-7 - DAYS	54	41.22%
>7 - DAYS	21	16.03%

Table 8 shows the number of days of menstruation of young female sportspersons in Kerala. There was 2.29% of the females were menstruating for less than 3 days and 40.45% of the females were menstruating in between 3-5 days. There were also 41.22% and 16.03% menstruating for 5-7 days and more than 7 days, respectively.

AGE OF MENARCHE

Table 9: Age of Menarche of Young Female Sportspersons in Kerala

Age of Menarche	Number	Frequency
08-10	11	8.39%
10-12	20	15.2%
12-14	74	56.48%
14-16	26	19.84%

Table 9 shows the age of Menarche of young female sportspersons in Kerala. There was 8.39% of the females were menstruating at the age of 8-10 years and 15.2% of the females were menstruating at the age of 10-12 years. There were also 56.48% and 19.84% menstruating at the age between 12-14 years and 14-16 years, respectively.

Table 10: Women's Menstrual Health Profile

SL NO	FOR WOMEN ONLY (N=131)	SD	D	N	A	SA	Mean	SD	Decision
1	I have menstrual periods regularly.	22 (16.8%)	9 (6.9%)	18 (13.7%)	28 (21.4%)	54 (41.2%)	3.62	1.51	High Perception
2	I feel severe menstrual cramps during my periods.	36 (27.5%)	29 (22.1%)	25 (19.1%)	16 (12.2%)	25 (19.1%)	2.77	1.47	High Perception
3	I usually take medicine for menstrual cramps.	70 (53.5%)	17 (13%)	34 (26%)	7 (5.3%)	3 (2.3%)	1.83	1.14	Low Perception
4	I perform heavy exercise during periods.	27 (20.6%)	22 (16.8%)	30 (22.9%)	18 (13.7%)	34 (26%)	3.07	1.49	High Perception
5	I miss periods during times of heavy exercise.	63 (48.1%)	19 (14.5%)	37 (28.2%)	8 (6.1%)	4 (3.1%)	2.02	1.14	Low Perception
6	I have strong food cravings before or during periods	22 (16.8%)	30 (22.9%)	51 (38.9%)	12 (9.2%)	16 (12.2%)	2.77	1.21	High Perception

Notes: N= 131, SD- Strongly Disagree, D- Disagree, N-Neutral,A-Agree, SA- Strongly disagree, Mean, Standard Deviation, Weighted Average- 16.08/6 = 2.68

The data analysis shows that the majority of the sportspersons (41.2%) had a high perception regarding regular menstrual periods. 27.5% of the sportspersons had a high perception that they didn't feel having severe menstrual cramps during their periods. 53.5% of the sportspersons had a low perception regarding medicines for menstrual cramps. 26% of the sportspersons had a high perception of performing heavy exercise during periods. 48.1% of the sportspersons had low perception and felt that they didn't miss periods during times of heavy exercise. 38.9% of the sportspersons had a high perception towards strong food cravings before or during periods. (Table 10)

SUMMARY AND CONCLUSIONS

The result of human measurements, height, weight, Body Mass Index (BMI), hip circumference and waist circumference were below the normal range and waist-to-hip ratio (WHR) above the normal range. Body composition indicators such as body fat percentage, visceral fat percentage, lean body mass, water content, muscle mass (not excessive), bone mass, fat mass and the number were well below the normal range. On the other hand, the ratio of metabolism and protein is higher (not significant), than the normal range

Sports activities and activities related to body and body structure. Athletes can use their body to determine their optimal competition weight, assess their health and monitor training effectiveness. To maintain a high level of performance, athletes should always pay attention to their anthropometric parameters and body composition.

Understanding and addressing the importance of menstrual health in sportspersons is essential for optimizing training, performance, and overall health. In conclusion, prioritizing menstrual health in the world of sports is a vital step toward empowering female athletes to achieve their full potential. By acknowledging and addressing the intricacies of the menstrual cycle, the sports community can create an inclusive and supportive environment that enhances the physical and mental well-being of sportswomen, ultimately contributing to sustained excellence in their athletic endeavours.

The menstrual health of female sportspersons is crucial for overall well-being and performance. The menstrual health profile shows that the sportspersons had a high perception towards menstrual health and a low perception regarding missing periods during heavy exercise and taking medicines for menstrual cramps. Proper nutrition, hydration and sufficient rest play vital roles in maintaining menstrual health for optimal athletic performance. Through a comprehensive health assessment, tracking body fat and muscle growth, ensuring a balanced approach to training and menstrual health, and making appropriate changes to diet, exercise, and lifestyle, individuals and practitioners can control their health better.

In conclusion, anthropometry and body composition analysis emerge as indispensable tools in the realm of sports science, offering a multifaceted understanding of the athlete's physique. By leveraging these tools, coaches, sports scientists, and nutritionists can tailor their strategies with precision, unlocking the full potential of sportspersons and paving the way for sustained excellence in the highly competitive world of sports. The significance of these assessments extends far beyond the traditional measures of weight and height, providing nuanced insights that are pivotal for optimizing performance, preventing injuries, and tailoring individualized training and nutritional strategies.

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Conflict of interest
The authors report no conflicts of interest.

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