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Article

Assessment of Physiological and Anthropometric Parameters of Athletic Performance in Medical Students: A Comparative Study

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Abstract: Athletic participation is generally presumed to be associated with positive anthropometric and cardiorespiratory characteristics; however, the role that demographic factors versus physiological factors plays in making this difference is not clear. A cross-sectional study carried out on groups of different ages and sexes. Group I consisted of 204 people (70 males), aged 20 ± 2.1, while Group II consisted of 107 athletic students (69 males), aged 20.55±1.49. Group one consists of apparently healthy but sedentary medical students whereas group two consists of trained athletes medical students. Various parameters including BMI, blood pressure (BP), pulse rates (PR), and PaO2 were analyzed statistically. Among 311 individuals, sex had the greatest association with athletic status via bivariate correlation ($r = .288$, $p < .001$); while age had weak correlation ($r = .140$, $p = .014$). According to multivariable logistic regression analysis, only sex was an independent determinant of athletic status ($p < .001$). ANCOVA revealed that overall model was statistically significant ($p < .001$); sex ($p < .001$) and age as a categorical variable ($p = .022$) were the only independent predictors among variables included in the model. Athletic Sex emerged as the only variable merged as a correlate and independent predictor of being an athlete. The age was more complicated; age had a very weak correlation with our study subjects at bivariate level but was a significant predictor within the framework of ANCOVA and nonsignificant as a continuous linear predictor within the context of logistic regression, indicating the possible nonlinear connection of Age with the athletic status or that the relationship depends on age bands specifically.

Keywords: BMI, Pulse Rate, Blood Pressure, PaO2, Trained Athletes, Sedentary

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1. Introduction

Obesity is a major global health concern and has reached epidemic proportions worldwide. It develops as a consequence of an imbalance between energy intake and energy expenditure, commonly associated with sedentary behavior and excessive caloric consumption. [1] Body mass index (BMI) is widely used as an indirect measure of adiposity and remains a practical tool for the clinical assessment of obesity. In infants, children, and adolescents, BMI interpretation depends on age- and sex-specific reference standards. [2,3] Among adults, obesity is defined as a BMI of at least 30 kg/m², whereas individuals with a BMI between 25.0 and 29.9 kg/m² are classified as overweight. [4] The diagnostic threshold for adult obesity has not remained constant over time. Earlier recommendations considered a BMI of approximately 27 kg/m² as the defining value; however, this was later revised to the currently accepted cutoff of 30 kg/m² in Western populations. [5]

Current evidence suggests that the underlying causes of obesity are primarily intrinsic, while external influences act mainly as contributing factors. Intrinsic mechanisms include disturbances in the regulation of energy homeostasis resulting from physiological or behavioral abnormalities. Genetic susceptibility is also recognized as an important determinant of obesity. In contrast, environmental factors, including increased availability of energy-dense, highly palatable foods and reduced physical activity, facilitate the development of a positive energy balance in genetically or physiologically susceptible individuals. [5] Although both genetic predisposition and environmental influences have an established role in the obesity epidemic, growing evidence indicates that epigenetic modifications may contribute to the marked interindividual variation observed in obesity development. [1]

Obesity is associated with an increased risk of several chronic diseases that contribute substantially to morbidity and mortality. These include type 2 diabetes mellitus, cardiovascular disease, metabolic syndrome, chronic kidney disease, hyperlipidemia, hypertension, nonalcoholic fatty liver disease, certain malignancies, obstructive sleep apnea, and osteoarthritis, [6] in addition to depression. Consequently, obesity represents a considerable burden on healthcare systems because of its association with increased morbidity, premature mortality, and escalating medical costs. [7]

Pulse rate and blood pressure are routinely used as cardiovascular screening parameters and provide valuable information regarding cardiovascular function. In healthy adults, resting blood pressure generally ranges between 100 and 120 mmHg systolic and 60–80 mmHg diastolic. [8] Blood pressure increases progressively with age, particularly among individuals adopting a Western dietary pattern and lifestyle, thereby increasing the lifetime risk of hypertension. [9,10] Environmental factors also influence blood pressure regulation. Excess dietary sodium intake contributes to elevated blood pressure in salt-sensitive individuals, whereas physical inactivity and central obesity further increase the likelihood of hypertension. [9-11]

Regular participation in sports and other forms of physical activity is widely accepted as an important component of a healthy lifestyle. The World Health Organization (WHO) advocates regular physical activity because of its well-established health benefits. Exercise produces favorable effects on the cardiovascular system, and numerous studies have demonstrated reductions in both cardiovascular disease incidence and cardiovascular mortality among physically active individuals. [12,13] Under conditions of excessive energy intake, adequately functioning thermogenic adipose tissue can dissipate surplus energy, thereby contributing to body weight regulation. Conversely, impaired thermogenic capacity may predispose individuals to weight gain. [14]

Hypertension affects approximately one-quarter of the world's population, and its prevalence is also evident among athletes and individuals participating in recreational sports. Accordingly, regular physical exercise is recommended as an effective strategy for the prevention, management, and treatment of hypertension. [15] Previous studies have examined the effects of exercise on autonomic regulation and have consistently reported resting bradycardia in trained athletes. However, it remains uncertain whether the observed sympathovagal balance is predominantly attributable to reduced sympathetic activity or enhanced vagal tone. In addition, the long-term physiological effects of prolonged athletic training have not been fully elucidated. [16]

The present study was designed to determine whether sex, age, BMI, BP, HR, and PaO2 distinguished athletes from non-athletes medical students. To ascertain independent determinants of athletic status by concurrently controlling for demographic (sex, age), anthropometric (body mass index (BMI), hemodynamic (systolic and diastolic blood pressure), and cardiorespiratory (heart rate, arterial oxygen saturation (PaO2)) factors using multivariable logistic regression analysis.

2. Materials and Methods

This cross sectional study was conducted from the beginning of November2024 till mid-February 2025 at Al-Iraqia Medical Collage, Baghdad, Iraq. A 311 students from the collage in 2nd to 4th stage were included in the study. After taken permission to involved in the research survey certain questions according to the planned questioner (age, being smoker or not, being an athlete with number of hours of exercise the person was exercising each week, having any respiratory problem, diabetic or hypertensive) then pulse rate and blood pressure measurement with assessing the height and weight to calculate body mass index .Patients with BMI 18.5–29.9 kg/m ^{2}were included in the study and patients with BMI ≥ Over 30 – kg/m2 were considered obese according to the conventional WHO classification [3].

PO2 by digital oximeter reading taken after student stabilized, the right middle finger was cleaned and fitted with an oximeter to measure SpO2 and pulse rate. The initial data was recorded after the readings remained stable for approximately one minute. then blood pressure was measured according to the American Heart Association and Joint National Committee) JNC-8) guideline for blood pressure measurements, with Automated device Rossmax MG150f Digital Blood Pressure Monitor sphygmomanometer device was used to record systolic BP (SBP) and diastolic BP (DBP). [8].

Statistical analysis: Statistical analyses were conducted by IBM SPSS Statistics (Version 27.0); Independent-samples t tests were done to compare the differences in continuous variables (age, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), PR, PaO2) between the sudy groups, while Chi-square test was used to examine the association between sex and group affiliation. Pearson's correlation analysis was performed to evaluate the relationship between all variables of the study. Binary logistic regression with simultaneous entry of all predictors revealed independent predictors of being an athlete, presented as odds ratio (95% CI). ANCOVA analysis was performed to determine between group effects and partial eta square.

3. Results

A total of 311 medical students from the collage from different stages mainly from stage two to stage four were included in the study classified according to the results of being athletic or not:

Group I :Consist of 204 non athletic students; 70 males with a mean age of 20.09±2.1 years and **Group II** :Consist of 107 athletic students; 69 males with a mean age of 20.55±1.49 years.

These are presented in Table 1. which revealed that they were statistically difference regarding age being higher in athletic group ($P < 0.05$) .

Table 1: Demographic and anthropometric data of the studied groups.

Variables	Group I n = 204 (mean ± SD)	Group II n = 107 (mean ± SD)	P value
Age (years) mean ± SD age in years	20.09±2.1 (17-27)	20.55±1.49 (18-25)	0.0137**
BMI (Kg/m²)	23.4±4.43	24.2±3.78	0.1005

Table 2 Demonstrate no statistically difference regarding BMI though the higher overweight & obese reading recorded in athletic group(gpII) ($P > 0.05$) while the highest percentage in both groups being healthy weight .

Regarding the age distribution among studied groups with higher frequency of being non athletic was twenty years old age students with higher frequency of athlete reported in twenty two years old age.as shown in fig. 1.

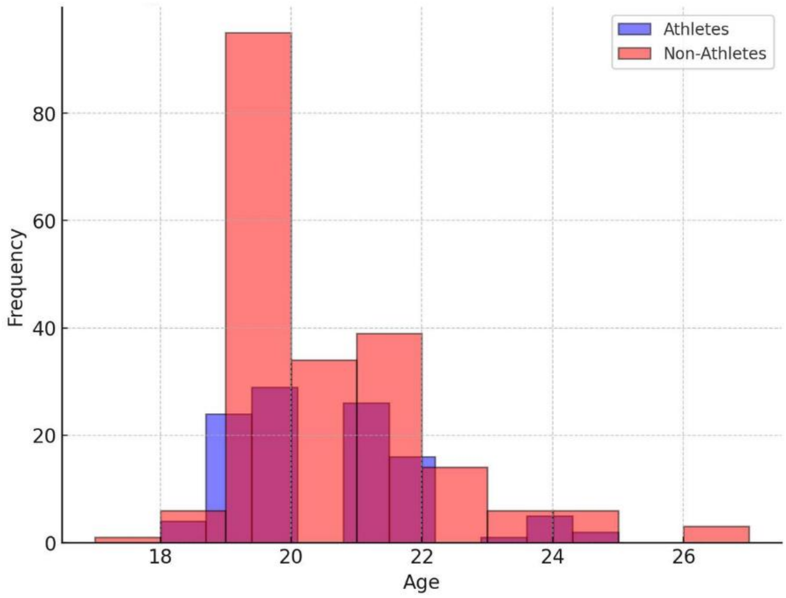

Fig 1 Age distribution among studied groups

Table 2: BMI data of the studied groups

Variables	Group I n = 204 frequency (no.)	Group II n = 107 frequency (no.)
Under weight	5.4%(11)	1.87%(2)
Healthy	64.7%(132)	59.8%(64)
Over weight	22.5%(46)	28.03%(30)
Obese	7.35%(15)	10.2%(11)

Furthermore, the lower percentage of male in respect to the higher percentage of female noticed in the first group (34.3%) to (65.7%) while a higher percentage of male to female were recorded in Group II (64.4%) and (35.6%) as clarified in table 3 .

Table 3: Sex distribution among studied groups

Variables	Group I n = 204 frequency (no.)	Group II n = 107 frequency (no.)
Male	34.3% (70)	64.4% (69)
Female	65.7% (134)	35.6% (38)

Regarding the cardiovascular parameters of the studied groups were shown in the 4 table. Both Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were normal with no significant differences with slight higher reading in athlete group but it revealed that they were statistically difference regarding pulse rate& PO2 ($P < 0.05$) among the studied groups being lower in the athlete group.

Table 4: Cardiovascular parameters of the studied groups.

Variables	Group I n = 204	Group II n = 107	P value
Pulse rate/min	87.4±13.8	84.2±12.2	0.048**
SBP(mmHg)	123±12	125±15	0.1316
DBP(mmHg)	77± 8	77.9±7	0.317
PO2%	98.4±1.7	97.9 ±1.85	0.021**

Table 5 presented that the sex had the highest correlation coefficient value with group membership ($r = .288$, $p < .001$), while age had a significant but low correlation with group ($r = .140$, $p = .014$). This suggests that there is a small difference between the two groups in terms of demographics. PR and PaO2 were found to have negative correlations with group ($r = -.112$ and $r = -.138$, respectively), which means that athletes have low pulse rate at rest and unexpectedly, low PaO2 levels. On the other hand, BMI did not have a significant correlation with group ($p = .101$ and $p = .182$), but has an extremely strong correlation with each other ($r = .862$, $p < .001$).

Table 5. Correlations Analysis Among the Study Variables

Variable	Group	Sex	Age	BMI	BMI Catagories	SBP	DBP	PR	PaO2
Group	**1.00**	—	—	—	—	—	—	—	—
Sex	**.288****	**1.00**	—	—	—	—	—	—	—
Age	**.140***	**.187****	**1.00**	—	—	—	—	—	—
BMI	**.093**	**.243****	**.208****	**1.00**	—	—	—	—	—
BMI Catagories	**.076**	**.182****	**.173****	**.862****	**1.00**	—	—	—	—
SBP	**.086**	**.294****	**.121***	**.235****	**.192****	**1.00**	—	—	—
DBP	**.057**	**.185****	**.098**	**.142***	**.129***	**.508****	**1.00**	—	—
PR	**-.112***	**-.165****	**.009**	**-.108**	**-.129***	**.012**	**.136***	**1.00**	—
PaO2	**-.138***	**-.248****	**-.134***	**-.106**	**-.125***	**-.113***	**-.006**	**.116***	**1.00**

Pearson correlation coefficients, SBP = systolic blood pressure; DBP = diastolic blood pressure; PR = pulse rate; PaO2 = partial pressure of arterial oxygen. *p < .05. **p < .01 (two-tailed).

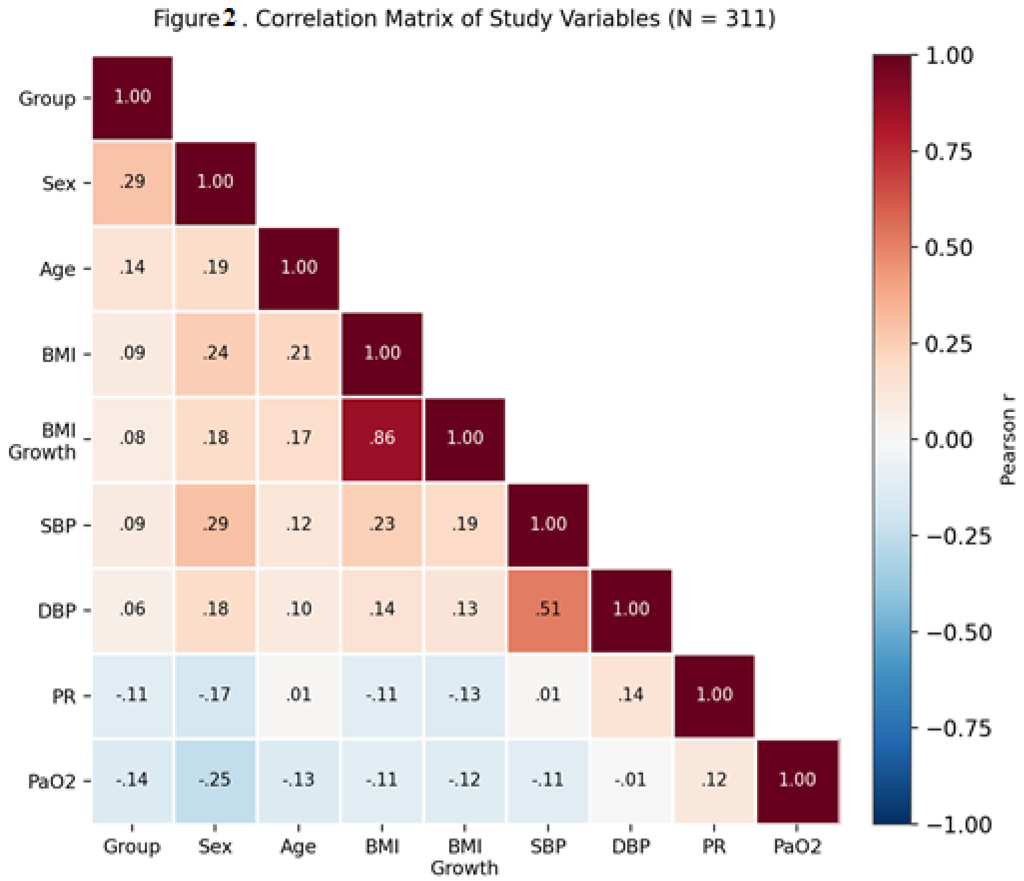

Figure 2. Heatmap of Pearson correlations among the Study Variables

However, after controlling for age, BMI, BMI categories, SBP, DBP, PR, and PaO2. The sex was the only statistically significant independent predictor of athletic status (B = 1.073, Wald = 15.200, p < .001) with an odds ratio of 2.92 (95% CI [1.71, 5.02). This implies that, controlling for the covariates, the odds of belonging to the athletic category were about three times more likely for one sex compared to the other as shown in table 6& fig. 2. None of the other predictors were significant (all p > .10), implying that, after controlling for sex, neither age nor the anthropometric and cardio-respiratory variables studied here predict athletic status among the subjects in this study. In this regard, the associations found between age, PR, and PaO2 and the two groups in Table 5 may be attributed to their association with sex rather than their independent effect on athletic status.

Table 6. Binary Logistic Regression Predicting Athletic Status

Variable	B	SE	Wald	df	p	Exp(B)	95% CI LL	95% CI UL
Sex	1.073	.275	15.200	1	<.001	2.924	1.705	5.015
Age	.128	.082	2.457	1	.117	1.137	.968	1.334
BMI	.004	.064	.005	1	.946	1.004	.886	1.139
BMI Growth	-.019	.364	.003	1	.957	.981	.481	2.000
SBP	-.002	.011	.049	1	.824	.998	.976	1.020
DBP	.007	.019	.122	1	.727	1.007	.970	1.044

Variable	B	SE	Wald	df	p	Exp(B)	95% CI LL	95% CI UL
PR	-.013	.010	1.647	1	.199	.987	.967	1.007
PaO2	-.071	.071	1.004	1	.316	.931	.810	1.070
Constant	3.007	7.398	.165	1	.684	20.232	—	—

Dependent variable: group (athletic vs. non-athletic). SE = standard error; df = degrees of freedom; Exp(B) = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit.

The adjusted model was statistically significant, $F(17, 293) = 3.126$, $p < .001$, partial $\eta^2 = .154$, explaining around 15.4% of the variance in group membership (adjusted $R^2 = .104$). Like the logistic regression results, gender proved to be a significant main effect ($F(1, 293) = 14.986$, $p < .001$, partial $\eta^2 = .049$). Categorical age, which was measured in this analysis, proved significant as well ($F(10, 293) = 2.127$, $p = .022$, partial $\eta^2 = .068$), demonstrating that there are differences among groups with respect to age categories, despite the fact that the continuous linear relationship shown in Table 6 is not statistically significant. It seems possible that the relationship may be non-linear instead of completely insignificant. All other variables (BMI, SBP, DBP, PR, PaO2) had minimal, statistically non-significant effects (partial $\eta^2 \leq .004$, $p > .25$) as shown in fig. 3,4 & table 7.

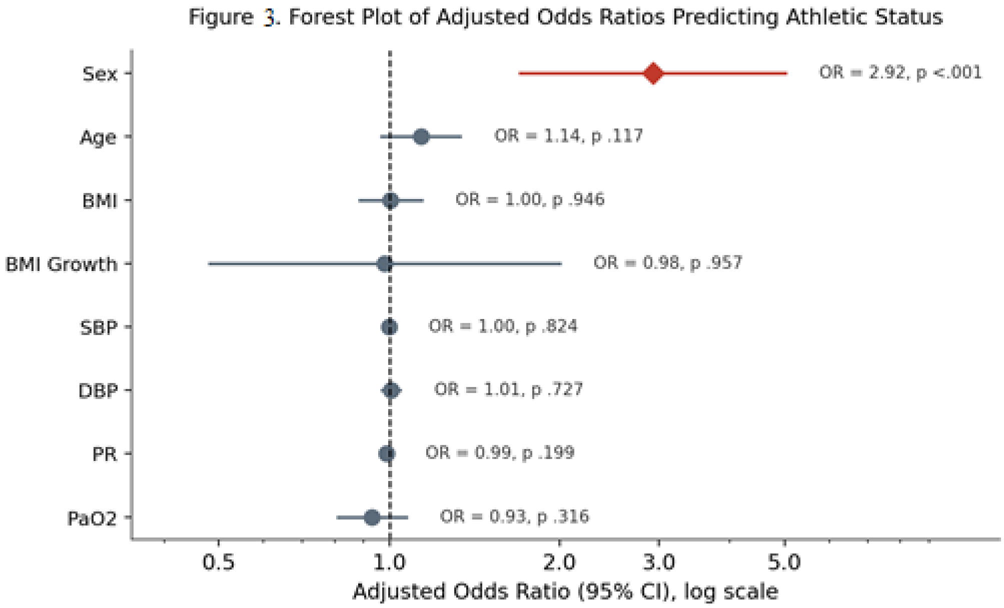

Figure 3. Binary Logistic Regression Predicting Athletic Status

Table 7. (ANCOVA) Tests of Between-Subjects Effects for Athletic Status

Source	Type III SS	df	MS	F	p	$\eta^2 p$
Corrected Model	10.777	17	.634	3.126	**<.001**	.154
Intercept	.363	1	.363	1.792	.182	.006
Sex	3.039	1	3.039	14.986	**<.001**	.049
BMI	.001	1	.001	.004	.952	<.001
BMI Growth	.001	1	.001	.007	.932	<.001

Source	Type III SS	df	MS	F	p	η^2p
SBP	.003	1	.003	.014	.907	<.001
DBP	.012	1	.012	.061	.804	<.001
PR	.267	1	.267	1.315	.252	.004
PaO2	.073	1	.073	.362	.548	.001
Age	4.314	10	.431	2.127	**.022**	.068
Error	59.410	293	.203			
Total	632.000	311				
Corrected Total	70.186	310				

Dependent variable: group (athletic vs. non-athletic). SS = sum of squares; MS = mean square; η^2p = partial eta squared. R^2 = .154 (adjusted R^2 = .104).

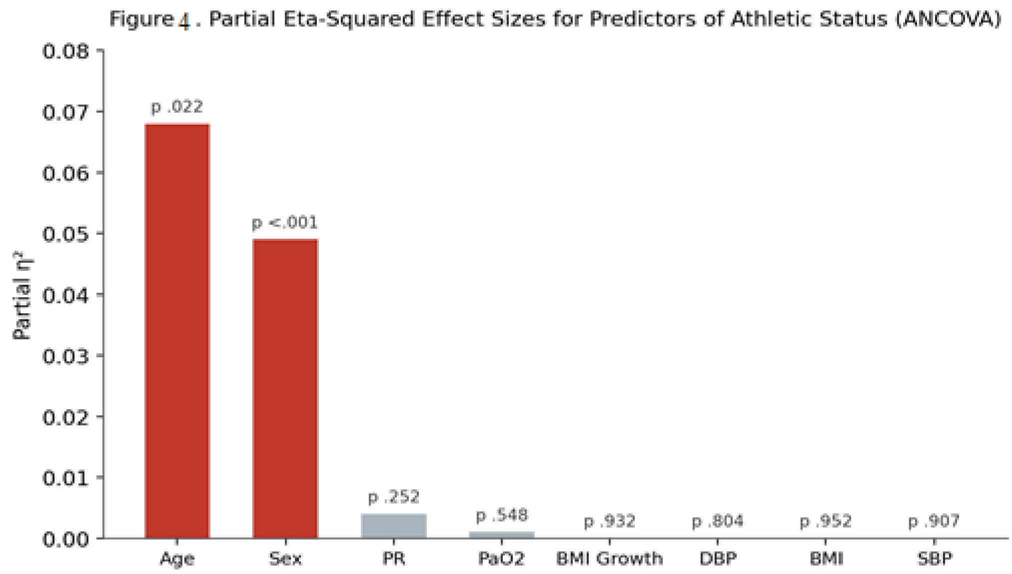

Figure 4. Partial eta-squared effect sizes for each predictor in the ANCOVA model, ordered from largest to smallest

4. Discussion

This was a cross-sectional descriptive study based on self collection data, where we assessed BMI, Pulse rate, blood pressure and PO2 on medical student. The majority of the participants were third,forth & second -stage medical students, whereas students from the first, fifth, and sixth stages constituted the minority. This disparity may be attributed to the greater availability of second- to fourth-stage students during the data collection period, as the study sample was recruited from the student accommodation, where these students were more readily accessible.

BMI results show higher BMI in athletes group than non athletes group matched with who noticed by Annika C Grams et al and ArShA KriShnAn [8,9]. The explanation is that athletic student have higher muscle mass than non athletics. While in table that shown the distribution of weight categories shown higher percentage of healthy students in both groups explained that medical students care for being having healthy weight.

Regarding the cardiovascular parameters, the results demonstrated a lower pulse rate among the athletes compared with the non-athletes. This finding is consistent with that reported by Flannery, F. Sully et al. [11]. The lower resting pulse rate has been attributed to increased vagal modulation. Specifically, previous studies suggest that enhanced parasympathetic activity together with reduced sympathetic activity decreases the firing frequency of the sinoatrial node. However, this autonomic hypothesis has been challenged by other studies, which propose that the principal adaptation responsible for the lower resting heart rate in athletes is an intrinsic reduction in sinoatrial node firing frequency. [16]

Blood pressure results show high systolic blood pressures in athletes group same what is observed by Victor Schweiger et al. Highly trained young athletes may exhibit spurious systolic hypertension, characterized by elevated brachial systolic blood pressure and pulse pressure despite normal diastolic blood pressure. This represents a physiological rather than a pathological finding and is attributed to increased stroke volume in combination with highly compliant arteries and low peripheral vascular resistance in athletic individuals. [15]

PO2 saturation show higher percentage in non athletic group with a reading of 98% In athletic group which is matched with what was noticed by Jesse A Goodrich et al [17].The same reported regarding pulse rate and PO2 saturation were reported slightly lower in athletic person which is reported by Chinedu Imo [18] although this lower reading than nonathletic person still within normal. In other studies reported an increase in PO2 saturation [19,20]

This variation as decreased can be explained as in exercise, the muscles work harder and produce extra carbon dioxide and lactic acid, which drops blood pH. This shift makes body heat up and increases levels of 2,3-DPG. All of these changes work together to alter how hemoglobin holds onto oxygen. Essentially, it causes hemoglobin to loosen its grip, allowing it to release oxygen much more easily to working muscles. [21]

5. Conclusion

Athletic Sex appeared to be the sole predictor of being an athlete regardless of the model used. However, the case with Age turned out to be more complicated – Age appeared to have very low correlation with our study population at the stage of bivariate analysis but became a significant predictor in the model of ANCOVA and a nonsignificant predictor in the linear model of logistic regression, which indicates a possible nonlinear nature of the Age-Athlete relationship. BMI, SBP, DBP, PR and PaO2 were not associated with the status of being an athlete independently of Sex and Age, though some of them (PR and PaO2) were found to be correlated with our study population.

Thus, one can conclude based on the obtained results that demographic characteristics, namely sex and, partially, age, are the key characteristics differentiating an athlete from a non-athlete. There are some other variables which have not been taken into account in our analysis and which may play an important role in the distinction between athletes and non-athletes in the future.

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