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RESEARCH ARTICLE

Packed cell volume and its relation to obesity, gender and smoking status

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Objective: Our aim was to evaluate the packed cell volume (PCV) correlation with body mass index, body fat percentage, also differences between genders and smokers & non-smokers, among Iraqi students. **Methods**: A cross-sectional study was done on 112 healthy individuals (from which 52.7% were males), aged between 18-23 years old, in December 2022. A short informative history was taken through a questionnaire, anthropometric measures were taken to calculate body mass index and body fat percentage, and the determination of packed cell volume was done by the Microhematocrit method. **Results**: Packed cell volume among males was higher 47.45±3.409% than for females 39.90±3.169%, with a difference statistically significant (p=0.000), also the correlation of PCV revealed direct significance with body mass index (p=0.011) and indirect statistically significant with body fat percentage (p=0.000). The prevalence rate of smoking was 13.4% and the level of PCV among smokers was 46.80±6.085%, significantly higher (p=0.015) than among non-smokers 43.43±4.702%. **Conclusion**: Packed cell volume showed a direct correlation with body mass index, an inverse one with the body fat percentage, and was significantly higher among young smokers, emphasising the idea that this parameter can help to evaluate the health risk and to be included in preventive programs and assessment protocols.

Keywords: packed cell volume, body fat percentage, body mass index

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Introduction

"Packed Cell Volume (PCV)" or "Hematocrit (HCT)" is the fraction of compacted red blood cells (RBCs) in the entire blood. It is a quick test that can detect diseases like polycythemia or anemia and track how well a patient responds to treatment and its threshold can be used to estimate the need for blood transfusions [1,2]. It is also the primary component affecting blood viscosity, cardiac output, blood pressure, return of venous blood, and the adhesion of platelets [3-5].

Obesity and overweight are referred to as the buildup of abnormally high levels of fat that could harm one's health [6]. Obesity is acknowledged by "The World Obesity Federation" as a persistent, relapsing, and evolving illness, rejecting the notion that it is just a disease risk factor [7]. To evaluate overweight and obesity, the "Body Mass Index (BMI)", which depends on the relation of both weight and height, is currently the most often employed measure [8]. BMI is the most frequently utilised indicator when determining a person's nutritional health. The simplicity of measurement, low cost and link to morbidity and death are the main benefits of this indicator [9]. BMI measures excess weight, not excess body fat, it doesn't reveal the distribution of fat, nor does it make a distinction between excess fat, muscles, or bone composition. A high BMI may be a result of increased muscle mass in muscular people or highly trained athletes [10].

Another anthropometric measure of obesity is "body fat percentage (BFP)", which is essential to discriminate between healthy and obese people. It quantifies the percentage of fat in the body's composition. Obesity, metabolic illnesses, cardiovascular diseases, and overall mortality are linked to BFP [11]. Obesity and PCV are risk factors for diseases including diabetes mellitus and cardiovascular disorders [12-15]. HCT has been implicated in a number of epidemiologic studies as one of the main contributors of blood rheology [12], blood rheological abnormalities associated with obesity are being looked at as one of the potential factors for several co-morbidity because they significantly affect blood flow in the microcirculation [16]. In addition, measurement of both BMI and PCV would be helpful in determining the blood donor's level of fitness and nutrition, protecting both the donor and the intended recipient and ensuring both their safety and the supply of high-quality blood and blood products [9].

Several studies showed that smoking had detrimental impacts on individuals' health and was a risk factor for the emergence of several pathological disorders and diseases. Though the specific causes of these diseases in smokers are unknown, it seems that disturbances in blood rheology, infections and inflammation, oxidative stress, and disturbances in the antithrombotic and fibrinolysis systems are to blame [17].

The present research aimed to 1) Study the PCV correlation with BMI and BFP. 2) Differences in PCV in both genders and between smokers & non-smokers in young adults. 3) The frequency of smokers among students.

Materials and Methods

This was a cross-sectional study done on 112 medical students in the "Department of Medical Physiology, College of Medicine, University of Mosul/Iraq", in December 2022. Age was between 18-23 years old. Institutional ethi-

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cal approval and informed consent from each participant were taken. The participants were apparently healthy, not on diet restriction nor taking any iron tonics and non-pregnant females. Data was collected in three steps:

A short informative personal, medical, surgical, drug and smoking history was taken by answering short questionnaire forms.

Anthropometric measures: To the closest 0.1 cm, height without shoes was measured, and to the closest 0.1 kg, weight in light clothing was measured, both on a standard weight and height scale. BMI was calculated as "the product of weight (kg) to height (m) squared (kg/m^2)". "Deuremberg formula" was used to measure BFP.

"BFP=1.2×(BMI)+0.23×(Ageinyears)−10.8×(sex)−5.4" where "female= 0 and male= 1" [8].

Determination of PCV by Microhematocrit method: capillary blood was obtained under aseptic technique through skin puncture, blood was collected directly into a heparinized capillary tube (to approximately 75% of its length), sealed with clay sealant then centrifuged in a microhematocrit centrifuge at 11,000-12000 RPM for five minutes, readings of PCV were taken directly from the scale on the microhematocrit reader [1].

Statistical analysis

In Microsoft Excel 2007 sheets, the study's data was collected and summarised. The statistical analysis was done by IBM-SPSS 20. The Shapiro-Wilk test was applied to determine whether these data were normal, and the parametric tests were chosen. Standard deviation and mean were used to express the data. The difference between the two groups was calculated using the t-test for independent two means. The Pearson's correlation coefficient was utilised to test the relationship between levels of PCV and the study parameters. The r parameter is the correlation coefficient, values close to 1 indicate a strong correlation between two variables and those close to zero indicate poor correlation. P-value ≤ 0.05 was considered as significant.

Results

The study sample comprised 112 persons; 52.7% were males and 47.3% were females distributed from age of 18 to age of 23 years as shown in figure 1.

The comparison of study parameters between the males and females in the study sample was demonstrated in table 1.

PCV among the males was 47.45±3.409 % and among females was 39.90±3.169 % and the difference was statistically significant at (p=0.000). Means of height, weight, and BMI among males were 175.74±6.218 cm, 75.94±13.476 kg, and 24.60±4.240 kg/cm2 respectively, which were significantly higher than those among females 160.81±5.406 cm, 58.83±9.322 kg, and 22.77± 3.564 kg/cm2 respectively. The means of BFP among males was 17.93±5.065 %

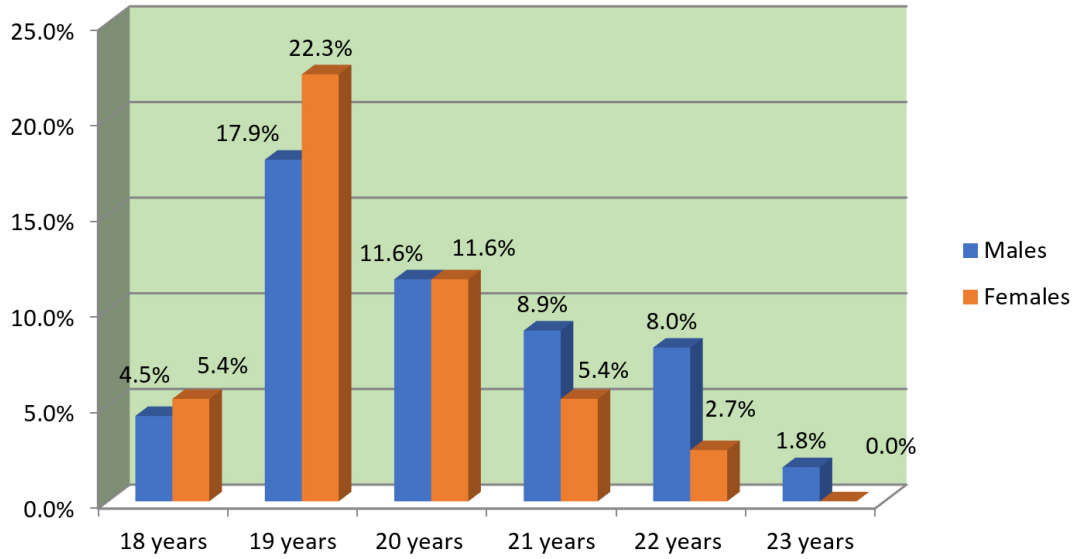

Fig. 1. Distribution of study sample in regards to age and gender.

Table 1. Comparison of study parameters between the genders.

	Males Mean± SD n=59	Females Mean± SD n=53	p-value*	95% CI
Age (yrs)	20.06±1.337	19.52±1.030	0.019	6.314, 8.789
PCV (%)	47.45±3.409	39.90±3.169	0.000	0.088,0.990
Height (cm)	175.74±6.218	160.81±5.406	0.000	12.740, 17.128
Weight (kg)	75.94±13.476	58.83±9.322	0.000	12.731, 21.506
BMI (kg/cm2)	24.60±4.240	22.77± 3.564	0.016	0.350, 3.302
BFP (%)	17.93±5.065	26.42± 4.304	0.000	-10.254, -6.713

*t-test for independent two means

which was lower than that among females 26.42± 4.304% in a statistically significant association (p=0.000).

The correlation of PCV with study parameters among the study sample was shown in table 2, which revealed direct significance with height (p=0.000), weight (p=0.000), and BMI (p=0.011) although the strength of correlations was moderated with height (r = 0.617) and weight (r = 0.517) and poor with age (r = 0.263) and BMI (r=0.239). The correlation with BFP demonstrated an indirect (inverse), mild, and statistically significant relation (r=-0.452, p=0.000).

Among the study sample, the number of persons who smoked was only 15 out of the 112 participating persons and the prevalence rate of smoking was (13.4%) as illustrated in figure 2.

The comparison of PCV between smokers and non-smokers is shown in table 3. The level of PCV among the smokers 46.80±6.085 % was significantly higher (p=0.015) than that among non-smokers 43.43±4.702 % .

Discussion

Male and female differences in PCV have already been documented [18]. These PCV levels are higher in men than in women; as this study showed. There have been reports of genetic variances between males and females in the erythropoietin gene and its receptor, but this has also been connected to greater men's testosterone levels, which enhance erythropoiesis. In addition, menstrual blood losses in women of reproductive age have been shown to lower PCV [18,19].

This study tested the relationship between BMI and BFP with PCV in healthy young adults, which found that BFP was negatively and significantly correlated with PCV as shown by Salih *et al.* in their study on 97 individuals at Al-Mustansiriyiah University in Baghdad / Iraq,2016 [20]. Adipose tissue obviously contributes blood to the total, but considerably less so than lean tissue does. Several sources of data point to a proportionate decrease in blood flow, blood volume, and metabolism in adipose tissue [21].

In addition, iron deficiency anemia affects obese and overweight people more commonly than normal-weight people, which is probably due to an obesity-related chronic inflammatory response and the effects of hepcidin. According to Bekri et al., the proinflammatory adipokine hepcidin decreases iron bioavailability by inhibiting the "ferroportin-1 exporter", which causes severe iron deficient anemia in obese people. As a result, chronic inflammation brought on by obesity may affect the serum iron level [22]. BMI showed a significant positive correlation with PCV, as shown by Felix et al. [9] who did their study among 194 blood donors aged 18-36 years, Jeon et al. [22] who conducted their study on 7997 individuals aged 10-18 years, Gligoroska et al. [23] in their study on 109 healthy boys aged 10-17 years, Moussoki et al. [24] in their study on 82 subjects aged 11-17 years. Moafi et al. [25] also found in their study on 1675 students that a low BMI was associated with anemia. Guiraudou et al. [26] found that fat-free mass is correlated with HCT. While Salih et al. [20] found a positive but insignificant relationship between HCT and BMI, a similar finding by Akinnuga et al. [27] in their study on 113 normotensive individuals aged 19-70 years. Compared to men, women have higher fat mass; as shown in this study; this discrepancy seems to be caused by oestrogen.[28,29]

Table 2. Correlation of PCV with study parameters among study sample.

Pearson's r	r -value	Asymp. Std. Error[a]	Approx. T[b]	p-value
Height (cm)	0.617	0.061	8.217	0.000[c]
Weight (kg)	0.517	0.057	6.341	0.000[c]
BMI (kg/cm2)	0.239	0.075	2.580	0.011[c]
BFP (%)	-0.452	0.060	-5.313	0.000[c]

a. Not assuming the null hypothesis. b. Using the asymptotic standard error assuming the null hypothesis. c. Based on normal approximation.

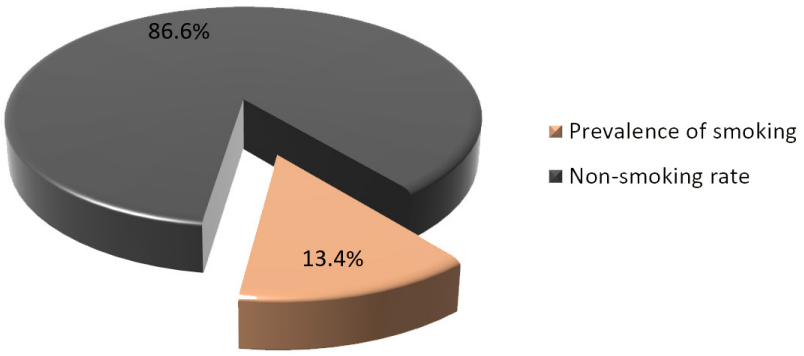

Fig. 2. Prevalence rate of smoking among the study sample.

Table 3. The comparison of PCV between smokers and non-smokers.

	Smoker Mean± SD n=15	Non-smoker Mean± SD n=97	p-value*	95% CI
PCV (%)	46.80±6.085	43.43±4.702	0.015	0.672, 6.061

*t-test for independent two means

In the present research, there were 13.4% of students who smoked; all of them were male. Younus et al. 2022; showed 33.1% of students in three different universities in Erbil/Iraq were smokers [30]. While the prevalence of smokers was 12.3% among students at Hawler Medical University/Iraq in 2007 [31], at Karbala University/Iraq in 2005 was 10.5% [32] while in 2009 it was 19.4% [33], 233 out of 500 students were smokers at Hilla college/ Babylon/Iraq in 2021 [34]. While among college students in other countries: Alkhalaf et al.at KSA found 12.4% of medical students were smokers [35], 8.9% by Kabbash et al. in Egypt [36], 15.1% in UAE by Ahmed et al. [37], 51.4% by Alolabi et al. [38] in Syria, 6.8% by Telayneh et al. in Ethiopia [39]. The PCV level between smokers and non-smokers was also investigated and showed that the smokers had higher levels of PCV than non-smokers as shown by other researchers [40-44]. Smokers have higher levels of erythrocytes and HCT because of the increased generation of carboxyhemoglobin, which results in tissue hypoxia. This raises the secretion of erythropoietin, which then enhances erythropoiesis. Moreover, the permeability of the capillaries is increased by carbon monoxide from cigarette use, which lowers plasma volume and mimics polycythemia, which can be identified by a raised percentage of RBCs in blood volume and confirmed by high HCT values [17].

Conclusions

Packed cell volume PCV test done on young medical students from Iraq in 2022, showed a significant direct correlation with Body Mass Index BMI, an inverse significant correlation with body fat percentage BFP, and was significantly higher among smokers, emphasising the idea that this parameter can help to evaluate the health risk and to be included in preventive programs and assessment protocols.

Author contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, writing and preparation of manuscript and final approval to be published.

Conflicts of Interest

The author declares no conflict of interest.

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