

## The BMI, fat percentage and total cholesterol of athletes: what is their status?

### El IMC, el porcentaje de grasa y el colesterol total de los deportistas: ¿cuál es su situación?

\*, \*\* Isti Dwi Puspita Wati, \*Nining Widyah Kusnanik, \*Endang Sri Wahjuni, \*\*Y Touvan Juni Samodra, \*\*Asriah Nurdini Mardiyyaningsih, \*\*\*Didi Suryadi, \*\*\*\*Nurul Musfira Amahoru, \*\*Sesilia Seli, \*\*\*\*\*Adiska Rani Ditya Candra, \*\*Tulus Gover Siringo-ringo

\*Universitas Negeri Surabaya, (Indonesia), \*\*Universitas Tanjungpura, (Indonesia), \*\*\*Universitas Negeri Yogyakarta, (Indonesia), \*\*\*\*Universitas Negeri Makasar, (Indonesia), \*\*\*\*\*Universitas Negeri Semarang, (Indonesia)

**Abstract.** There is a mutual relationship between body mass index (BMI), percentage of fat, and total cholesterol levels in the blood. Maintaining a normal BMI becomes a reference for health maintenance. A higher BMI increases the risk of a higher percentage of fat and cholesterol which contribute to a negative impact on health. This study was conducted to determine whether the BMI, fat levels and total blood cholesterol of sportsmen can be maintained properly. The research involved 323 athletes, ranging from 13 - 46 years with an average of 22 years of age. The participants represented 26 sports fields. The BMI test is done by measuring their weight and height. Fat percentage test was conducted by measuring the total fat of triceps, abdominal, and supra iliac fat, as well as by measuring the width of the upper arm, humeral, and femur. The total cholesterol was determined from the blood sample. All data were analyzed using Excel and SPSS IMB serial 26. Results showed that on average the BMI status was 22.82, meanwhile, the percentage of fat was 18.94 and the total cholesterol was 170.77. There was a high correlation between BMI and the percentage of fat (0.505). However, the correlation between BMI and cholesterol was not significant, and only a low correlation was detected between fat percentage and cholesterol.

**Keywords:** BMI, Fat Percentage, Total Cholesterol, Athlete

**Resumen.** Existe una relación mutua entre el índice de masa corporal (IMC), el porcentaje de grasa y los niveles de colesterol total en sangre. Mantener un IMC normal se convierte en una referencia para el mantenimiento de la salud. Un IMC más elevado aumenta el riesgo de un mayor porcentaje de grasa y colesterol, lo que contribuye a influir negativamente en la salud. Este estudio se realizó para determinar si el IMC, los niveles de grasa y el colesterol total en sangre de los deportistas pueden mantenerse adecuadamente. En la investigación participaron 323 deportistas, con edades comprendidas entre los 13 y los 46 años y una media de 22 años. Los participantes representaban a 26 ámbitos deportivos. La prueba del IMC se realizó midiendo su peso y su altura. La prueba del porcentaje de grasa se realizó midiendo la grasa total del tríceps, abdominal y supraílica, así como midiendo la anchura de la parte superior del brazo, el húmero y el fémur. El colesterol total se determinó a partir de la muestra de sangre. Todos los datos se analizaron utilizando Excel y SPSS IMB serie 26. Los resultados mostraron que, por término medio, el IMC era de 22,82, mientras que el porcentaje de grasa era de 18,94 y el colesterol total de 170,77. Se observó una alta correlación entre el IMC y el colesterol total. Existía una alta correlación entre el IMC y el porcentaje de grasa (0,505). Sin embargo, la correlación entre el IMC y el colesterol no fue significativa, y sólo se detectó una correlación baja entre el porcentaje de grasa y el colesterol.

**Palabras clave:** IMC, porcentaje de grasa, colesterol total, deportista

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Isti Dwi Puspita Isti

[isti.21003@mhs.unesa.ac.id](mailto:isti.21003@mhs.unesa.ac.id)/[isti.dwi.puspita.w@fkip.untan.ac.id](mailto:isti.dwi.puspita.w@fkip.untan.ac.id)

## Introduction

Generally, athletes are often regarded as great examples of fitness and health. However, behind their brilliant sporting achievements, there are certain health factors to consider. A study explained that over the past two decades, there has been an increase in the incidence of childhood obesity in Indonesia (Rachmi, Hunter, Li, & Baur, 2017). Furthermore, facts released by the CDC (Centers for Disease Control) state that only 29% of students attend physical education classes, let alone the average student, who is active for 60 minutes per day for 1 week (CDC, 2019). This fact shows that only a very small portion of students conduct daily physical activity (Hardinata et al., 2023). Less active students result in less mobility and less fit children (Rubiyatno et al., 2023; Suryadi et al., 2023), which in turn will cause them to be overweight. Research shows that there is a significant correlation between higher BMI with the degree of obesity obese (Liu, 2021). Obese children, which was indicated by having high BMI, less fitness, and

high cholesterol, were not healthy. Furthermore, a less active lifestyle, which results in a less healthy state, is not easy to change. An experiment shows that only 75% of respondents adhered to a healthy lifestyle after being given training (Kavanagh, Cooper, Bolton, & Keaver, 2022).

The surprising fact is that Sumo athletes have higher cholesterol levels compared to other sportsmen and the general public (Ogawa et al., 2021). Research conducted by (Hojat, Jahromi, Koshkaki, & Rahmanian, 2019) concluded that men have a higher risk of cardiovascular disease when compared to women. Athletes have a good percentage of body fat and cholesterol level during active training and competition, however, because of their large muscle mass, they have a high risk of high blood pressure. Further study findings revealed that participating in sports does not guarantee to be free from cardiovascular disease. Even though doing active exercise, athletes may have an increase in BMI, which will increase their total cholesterol as well as their blood pressure (McHugh, Hind, Cunningham, Davey, & Wilson, 2020). Thus, it is not surprising that former ath-

letes will experience obesity with a BMI of more than 29, and a body fat percentage above 22% (men) and 35% (women), which is exacerbated by having low HDL (Nunes et al., 2020).

Interestingly, body fitness does not always reflect a good health. For example, firefighters who look like have a firm fitness, turn to have high LDL levels and less supportive cardiovascular conditions (McAllister et al., 2022). Another fact revealed by the American footballers. Both the defenders ( $31.38 \pm 4.43$  kg/m<sup>2</sup> and  $26.13 \pm 8.79\%$ ) as well as attackers ( $32.95 \pm 4.77$  kg/m<sup>2</sup> and  $30.06 \pm 7, 33\%$ ) are categorized as obese (Güneşliol & Baş, 2021). The BMI above 30 raise the risk of cardiovascular disease (77%). The risk becomes 100% for those who have the waist circumference  $\geq 90$  cm and body fat percentage  $\geq 25\%$  (man) or  $\geq$  waist circumference 80 cm (woman) and body fat percentage  $\geq 35\%$  (woman) (Ruiz-González, Torres, Malacara, & Guardado-Mendoza, 2022). The risk can be lowered into 65% -80% if treated by doing treadmill exercise 3 times per week for 8 weeks, indicated by a decrease in body weight and an increase in HDL-C. Another study also revealed that doing exercise in water for 12 weeks with an intensity of 45-65% of maximum pulse turned out increasing HDL-C in type 2-diabetic women (Gharakhanlou & Bonab, 2022). Similarly, it is expected that students who take part in school sports will have a lower BMI and have a higher HDL.

There is a significant correlation between BMI the body fat. The higher the BMI, the higher the fat mass (Pour Abbasi, Shojaei, & Farhangi, 2022). This condition exacerbates health, for creating adjacent diseases, such as cardiovascular, type II diabetes and many others. If cholesterol level rises, especially high HDL-C levels, it will increase the risk of having osteoporosis (Hussain et al., 2023). However, other studies revealed contradictory results, i.e. no correlation between BMI and body fat composition, for example, the study by (Ocobock, Soppela, & Turunen, 2022), although it requires further evidence to prove the finding. Given the findings of the fact that BMI is positively related to the incidence of cholesterol, it is further stated that a higher BMI can be caused by a large bone diameter, overweight and obesity and a high percentage of fat (García, Carrasco, García, Navarro-Orocio, & Zamora, 2022) Finally, blood sugar and cholesterol are related to a person's BMI.

Overweight people also showed in having a high-fat percentage and lower status of HDL. An increase in body fat percentage is significantly associated with cardiometabolic risk factors in children and adolescents (Serrano, Suarez, Silva, Gamboa-Delgado, & Quintero-Lesmes, 2019), especially cholesterol. Cholesterol levels affect the incidence of. The cholesterol will also trigger the occurrence of DM II. Thus, there is a link between the level of cholesterol and diabetics. A recommendation from the study states that weight loss, physical activity, cupping therapy, and consumption of dragon fruit can reduce LDL cholesterol levels

Doing physical activities is important to reduce the risk

of disease due to the lack of movement (Rubiyanatno et al., 2023; Saleh, Umar Gaya, Abdulsalam, & Dahiru Abdullahi, 2020; Samodra et al., 2023; Suryadi, 2022; Suryadi et al., 2023). People who do exercise have a better health indicator than those who don't. For example, aerobic exercise reduces blood vessel stiffness in the elderly (Wang et al., 2021). The effort to overcome BMI and high cholesterol due to obesity is to do a low-carbohydrate diet (Pour Abbasi et al., 2022) as well as do regular exercise. Exercise can protect adults from having metabolic syndrome (Menezes et al., 2022). The incidence of stroke can be reduced by avoiding hypertension, smoking, diabetes mellitus, obesity, dyslipidemia, and lack of activity (Agianto, Yulise, Agustina, & Rizany, 2023). Physical activity can reduce the incidence of hypertension (Apidechkul, Upala, Chomchoei, & Yeemard, 2023). The results of this review provide a message that exercise is a solution to overcome degenerative diseases.

Various reviews of this study give an insight that the increase in BMI will raise the body fat percentage which also impacts the increase of cholesterol level. The combination of the three will lead on to various health problems such as cardiovascular disease, high blood pressure, and type II diabetes. The way to deal with the problem is to make nutritional arrangements and do physical activity and or exercise. Research facts also imply that sportsmen are not automatically safe and are exposed to degenerative diseases. Nevertheless, based on studies, exercise is a solution. This study aims to uncover information about the condition of BMI, percentage of fat and cholesterol of athletes.

## Materials and Methods

### Participant

The research was conducted by applying the purposive sampling technique. Samples are 323 professional athletes, those who won provincial sports week events and or won national championships in 26 sports branches: athletics, weightlifting, fencing, aero modelling, bicycle racing, billiards, handball, badminton, parachuting, Judo, karate, kempo, Muaythai, archery, wall climbing, pencak silat, petanque, swimming, sepak takraw, taekwondo, martial arts, table tennis, boxing, volleyball beach, and Wushu. They come from 14 districts in West Kalimantan Province, Indonesia.

### Research Design

This research uses a quantitative approach with a correlation study. In this study, there are tests and measurements to get research results. Data were collected by conducting tests and measurements. The tests and measurements were carried out by appointed medical personnel from the Pontianak City Hospital. The measurement includes determining the weight and height to find out the athlete's BMI. The percentage of body fat data was collected by using a skinfold calliper to measure the triceps, abdomen, and supra iliac, as well as the around upper arm, the width of the humerus and

the width of the femur. Total cholesterol is measured through blood analysis.

### Statistical Analysis

This study analyzed the data to see the relationship between body mass index (BMI), body fat percentage, and cholesterol level. The analysis also displays descriptive data on BMI, body fat percentage, and cholesterol level. Data testing in the study went through the stages of normality test, linearity test and hypothesis testing. All data were then processed using Excel and SPSS series 26.

### Result

The descriptive analysis of BMI, body fat percentage and blood-cholesterol level are depicted in Table 1.

It can be inferred that on average, the athlete's BMI is 22,82, the percentage of body fat is 18,95, whilst the blood cholesterol level is 170,77. A detailed look at classification of participants' BMI, body percentage and blood cholesterol are presented consecutively at Table 2, Table 3 and Table 4.

The participants' BMI are fall into six (6) categories, as described in Table 2. Most of them (62.53%) are normal, however, some of them belong to overweight (21.98%) and underweight (11.45%) categories. A very small percentage (less than 5%) also found in level 1 to level 3 of obesity.

Table 3 shows the distribution frequency of athletes' body fat percentage. Most of participants have under normal body fat percentage (68.81%), only 14.68% are normal and others are over or obese.

Table 4 depicted the cholesterol level of athletes. The majority (80.88%) have a normal cholesterol level; however, others have a higher level of cholesterol.

Table 5 shows the average BMI, fat percentage and cholesterol based on gender. From the table, it can be inferred that the average BMI of male athletes (22.85) and females (22.76) is not much different, however, the fat percentage and cholesterol show a big gap between males and females. The average female body fat percentage is almost two-fold the value of males, whilst the average cholesterol has a gap value of 21.21 between males and females.

It is interesting to investigate whether there is a significant correlation between BMI and body fat percentage, BMI and cholesterol level, and body fat percentage and cholesterol level. Normality and homogeneity tests (Table 6 and Table 7 consecutively) are measured to determine the correct statistical tool. Based on the calculation, the three data are normal ( $p < 0.005$ ). However, the BMI test is not homogenous ( $p > 0.005$ ), though the other two are homogenous. Therefore correlation test is obtained through the non-parametric Spearman's rho analysis (as shown on Table 8). Based on the Spearman-Rho test, it is concluded that BMI is significantly correlated with the body fat percentage

with the value of 0.505 ( $p < 0.005$ ), however, there is no correlation between BMI and cholesterol level (0.006,  $p > 0.005$ ). Body fat percentage has a low correlation with blood cholesterol level (0.289,  $p < 0.005$ ).

Table 1. Descriptive Statistics for BMI, body fat percentage and Blood-cholesterol level of athlete's participants

	BMI	Body Fat %	Blood-Cholesterol
N	323	322	320
Valid	323	322	320
Missing	0	1	3
Mean	22.8205	18.9466	170.7719
Median	22.0000	16.5500	161.0000
Mode	20.60 <sup>a</sup>	9.60	123.00 <sup>a</sup>
Std. Deviation	3.93956	11.01225	46.51997
Minimum	16.60	5.00	100.00
Maximum	41.70	79.90	357.00

Table 2. Frequency distribution of Athletes' BMI (Di Angelantonio et al., 2016)

Classification	Status	Frequency	Percentage
Underweight	<18,5	37	11,45
Normal	18,5-25	202	62,53
Overweight	25-30	71	21,98
Obesity I	30-35	9	2,78
Obesity II	35-40	3	0,92
Obesity III	40-60	1	0,309

Table 3. Index of Athletes' Body Fat Percentage

Classification	Range	Frequency	Percentage
Obese	>35%	25	11,467
Over	>31%	11	5,045
Normal	≥ 16% s/d ≤31%	32	14,678
Under	<16%.	150	68,81

Table 4. Blood-cholesterol Level (Grundy., 2001)

Total cholesterol	Status	Frekuensi	Persentase
<200	Normal	258	80,88
200-239	Upper normal limit	32	10,03
≥240	High	29	9,09

Table 5. Participants' Gender based of BMI, body fat percentage and cholesterol

		N	Mean	Std.	Min.	Max.
				Deviation		
BMI	Male	213	22.8551	3.68596	16.60	40.10
	Female	110	22.7534	4.40645	16.90	41.70
	Total	323	22.8205	3.93956	16.60	41.70
Body Fat Percentage	Male	212	14.7967	9.72587	5.00	79.90
	Female	110	26.9445	8.71629	9.30	55.50
	Total	322	18.9466	11.01225	5.00	79.90
Cholesterol	Male	210	159.6619	39.74494	100.00	338.00
	Female	110	191.9818	51.11562	103.00	357.00
	Total	320	170.7719	46.51997	100.00	357.00

Notes: N = number of participants, Mean = average value, Std Deviation = standard deviation, Minimum = Minimum value, Maximum = Maximum value

Table 6. Normality Test of BMI, Body Fat percentage, and Cholesterol Level

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
BMI	.116	319	.000	.920	319	.000
Fat percentage	.103	319	.000	.890	319	.000
Cholesterol	.115	319	.000	.904	319	.000

a. Lilliefors Significance Correction

Table 7.  
Homogeneity Test of BMI, Body Fat percentage, and Cholesterol Level

		Levene Statistic	df1	df2	Sig.
BMI	Based on Mean	2.547	1	321	.111
	Based on Median	1.955	1	321	.163
	Based on Median and with adjusted df	1.955	1	308.407	.163
	Based on trimmed mean	2.108	1	321	.147
Body percentage	Based on Mean	.127	1	320	.722
	Based on Median	.296	1	320	.587
	Based on Median and with adjusted df	.296	1	298.39	.587
	Based on trimmed mean	.293	1	320	.589
Kolesterol	Based on Mean	11.651	1	318	.001
	Based on Median	10.907	1	318	.001
	Based on Median and with adjusted df	10.907	1	312.15	.001
	Based on trimmed mean	11.741	1	318	.001

Tabel 8.  
Spearman Rho test for BMI, Fat percentage and Cholesterol Level of Athletes

			BMI	fatpercentage	Colesterol
Spearman's rho	BMI	Correlation Coefficient	1.000	.505**	.006
		Sig. (2-tailed)	.	.000	.922
		N	323	322	320
fatpercentage	Correlation Coefficient	Correlation Coefficient	.505**	1.000	.289**
		Sig. (2-tailed)	.000	.	.000
		N	322	322	319
Colesterol	Correlation Coefficient	Correlation Coefficient	.006	.289**	1.000
		Sig. (2-tailed)	.922	.000	.
		N	320	319	320

## Discussion

The correlation test in this study revealed a significantly high correlation between BMI and fat percentage with a value of 0.505, and a low but significant correlation between fat percentage and cholesterol with a value of 0.289. It is portrayed that while athletes do active exercise, they will maintain good BMI, fat percentage and cholesterol. Although this study did not find a significant correlation between BMI and cholesterol (0.006 with  $p > 0.005$ ), other studies suggest a link between BMI and cholesterol reduction. It is confirmed that doing physical activity training, is good for maintaining good cardiovascular (Guo, Zhou, & Zhu, 2023), and at the same time can significantly reduce LDL (Tok, Kişioğlu, Ersöz, Kahveci, & Göktaş, 2021). For example, doing aerobic exercise for 50 minutes 3 times a day for 12 weeks had a positive change in BMI and decrease cholesterol levels (Saremi, Shavandi, Parastesh, & Daneshmand, 2010) found that similar activity also had a positive effect on reducing the waist fat percentage.

### *The impact of physical activity on the BMI*

A good knowledge of the needs of the body's nutrition could help athletes in experiencing a reduction of muscle mass and weight loss, as well as maintain a consistent BMI. A study find that the strength of respiratory muscles and the function of the lung are related to the athlete's BMI. Basal metabolism also closely related to a person's BMI, the higher the BMI, the higher the basal metabolism. Different BMI values have an impact on different capacities of respiratory muscle and lung function (Karaduman, Bostancı, & Bayram, 2022). Active sports and exercise can control BMI, waist and hip fat and improve physical fitness (Dinç & Arslan, 2022). Gender and participation in sports will affect

BMI as well as self-esteem for teens (Noonan, 2022). All in all, the various studies provide information that good and balance BMI will be achieved for having a knowledge of good nutritional intake and doing active sports or physical activity.

A correlation between BMI and waist-hip fat percentage which determines a person's level of metabolic health varies widely depending on age (Mäkinen et al., 2023). The higher the BMI, the higher the risk of developing cardiovascular disease. Athletes who have a low BMI will have a high level of agility (Hidayat, Saraswati, Widnyana, & Kinandana, 2022). Bicycles and swimming, which also help develop children's motor skills, can affect fitness and BMI (Richards et al., 2022). The disadvantage of having a high BMI is the possibility of experiencing a decrease in cognitive function. A higher BMI and a habit of not getting enough rest between sessions are associated with an increased risk of injury. Research on weightlifters has deviated from what it should be but can be protected from adverse effects due to high BMI and large muscle mass (Delkhouh, Fahravandi, & Ghorbani, 2020).

The results of this study illustrate that BMI and body fat percentage are positively correlated. This result is obtained among athletes, who are more aware of their nutritional needs during competition, have a lesser mass muscle loss and show more consistent body weight and BMI levels. Therefore, athletes are characterized by having a higher body mass, a higher lean body mass content, and a higher skeletal muscle mass. Nutritional knowledge affects the stability of body composition in both age groups during all analyzed periods: preparation, competition, and transition (Staśkiewicz et al., 2023). In connection with this research, it turns out that there are research facts which state that weightlifters have a high percentage of fat that they should not have. Athletes must minimize fat percentage and maximize muscle mass. With increasing physical activity, nutrients and body fat will decrease and vice versa.

### *The impact of physical activity on Cholesterol*

The results of this study illustrate that 80.88% of all athletes are normal, 10.03% lower limit is high and only 9.09% is high. Cholesterol consists of HDL and LDL. Total cholesterol in the body should not be more than 200. LDL is often referred to as bad cholesterol which causes plaque in the blood vessels, and if it falls off it will clog the blood vessels. This blockage of blood vessels causes people to have strokes, either occur in the heart or brain. This stroke can be prevented by limiting the increase in LDL cholesterol and high-intensity aerobic exercise can prevent rigidity in weight control (Swift et al., 2023).

Evidence from research studies with active living as an effort to improve cardiovascular fitness and prevent diabetes has proven this. It turns out that parents who actively play tennis for a longer duration have an advantage in the flexibility of blood vessels and lower insulin resistance

(Chao, Liao, & Chou, 2021). Participation in competitive sports can help meet the demands of physical activity,

improve lipid profiles, and prevent the development of cardiovascular disease in female students. Exercise benefits for improving metabolism and cardiovascular status, especially in sports that demand cardiovascular fitness. Research on physical activity and exercise conclude that increasing the quality and quantity will reduce the risk of metabolic syndrome (Cleven et al., 2022). By doing exercise, irisin, a mediator for increasing energy use, will be increasing (R.S. & H.A., 2019).

Further research evidence shows that physical activity for 2 months against 265 military personnel decreased LDL (Pourtaghi, Bidel, Madvari, Akhondikalour, & Samadi, 2021), as well as swimming training for 4 weeks 3 times per week, can have a positive effect on LDL (Adigüzel, 2021). Furthermore, the results of the study stated that actively participating in volleyball as a recreation for 2-3 times per week for 90 minutes turned out to have an effect on reducing LDL (Trajković, Sporiš, Krističević, & Bogataj, 2020), there was also a decrease in blood sugar, LDL, especially cyclic exercise. Based on this study, it can be understood that living an active lifestyle, both recreational and low-intensity exercise, has been able to reduce the rate of increase in LDL cholesterol.

The next study is about research findings related to HDL. Various research results provide evidence that various exercises can increase HDL levels in the blood. High-volume exercise in the experimental group experienced an increase in HDL in people with type-2 diabetes (Malekinezhad, Moflehi, Abbasi, & Behzadi, 2019), compared to the control group 5 minutes of cardio, and 10 minutes of stretching twice a day for 8 weeks had a positive effect on reducing BMI and total body cholesterol with samples of office workers (Choi, Jayanty, & Landis-Piwowar, 2018). Physical exercise can improve the quality of life of the elderly and is effective for improving lipid profiles by reducing the average value of total and LDL cholesterol and increasing HDL besides functioning to reduce depressive symptoms. Further research suggests that recreational exercise can improve lipid profile by lowering total and LDL cholesterol values and increasing HDL (Faria et al., 2020).

## Conclusion

The study reveals that on average athletes' BMI is classified as normal (73.98%) with a fat percentage of 18.94% which tend to be categorised as thin (68.81%) and most of them (80.88%) have normal cholesterol of 170.77. This data shows that athletes in this study are in good condition. The findings of subsequent studies stated that athletes' BMI and percentage of fat are highly correlated, while BMI and cholesterol show a no significant very low correlation. Although low, there is also a significant correlation found between athletes' levels of cholesterol and body fat percentage. Based on these findings, most athletes are in normal condition, and it can be recommended to do sports seriously, especially regular sports such as performance sports

to maintain a balance of BMI, fat percentage and cholesterol.

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