SPORT TK-EuroAmerican Journal of Sport Sciences

https://revistas.um.es/sportk Online ISSN: 2340-8812

Received: **30/03/2025.** Accepted: **29/07/2025.** Published: **22/11/2025**

# Comparison of lipid and lipoprotein values among male elite student-athletes and students receiving sports training

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## ABSTRACT

This study aimed to compare the lipid and lipoprotein values of elite male athletes and male students receiving sports training, and to investigate the risks of cardiovascular disease. A total of 209 male students who received sports training at the Ondokuz Mayıs University were included. Fasting blood samples were taken from the subjects' antecubital vein 48 hours before the exercise sessions. Triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) levels were determined using the Hitachi 717 Auto Analyzer. The students were similar in age, training age, height, body weight and body mass index (BMI). No significant difference was found in TG levels ($p>0.05$)), but TC, HDL-C, LDL-C, apolipoprotein A1 (Apo A1), apolipoprotein B (Apo B), and lipoprotein(a) [(Lp(a)] differed significantly ($p<0.05$ and $p<0.001$). Moreover, a statistical difference was found in serum lipid value according to the ratios of TC/HDL-C, LDL-C/HDL-C and Apo-B/Apo-A1 ($p<0.001$). Differences were found in lipid and lipoprotein values of elite athletes and students receiving sports training. Although all values were within normal limits, elite wrestlers had worse levels than other athletes and students. No group was at risk for cardiovascular diseases.

## KEYWORDS

Lipid; Lipoprotein; Cardiovascular Diseases; Athletes; Students

## 1. INTRODUCTION

With the development of the social level and the increase in living standards, the nutritional structure of people changes in the direction of high blood fat, high sugar and high fever, which causes many diseases and hyperlipidemia (increasing cholesterol or triglyceride levels in the blood). Prolonged increases in blood lipids can cause cholesterol to easily invade the walls of large blood vessels, accumulating and increasing coronary heart disease, atherosclerosis, and other cardiovascular and cerebrovascular diseases (Shefer et al., 2013).

In studies, especially aerobic exercise decreased serum triglyceride levels, total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels in patients with hyperlipidemia, while improving serum lipids by increasing high-density lipoprotein cholesterol (HDL-C) levels (Rothenbacher et al., 2006). Regular physical activity is thought to reduce the risk of cardiovascular disease, at least in part, through its positive effect on circulating plasma lipids and lipoproteins (Durstine et al., 2001).

Changes in blood lipid profile (total cholesterol (TC), triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL)) due to exercises may be beneficial to reduce cardiovascular disease-related events (Doewes et al., 2023). It increases -C levels and HDL-C to LDL-C ratio (HDL-C/LDL-C), while lowering plasma LDL-C and triglyceride (TG) concentrations (Heath et al., 1983; Muscella et al., 2020).

Weiss et al. (2016) have shown that aerobic exercise has a positive effect on blood pressure (TG), total cholesterol (TC) (Weiss, 2016). High-density lipoproteins (HDL) make up roughly 25-30% of circulating proteins involved in the transport of circulating lipids (Sirtori et al., 2022). High-density lipoprotein cholesterol is a strong, consistent, and independent predictor of cardiovascular events, which has been confirmed by many prospective studies in different racial and ethnic groups worldwide (Toth et al., 2013; Goff et al., 2014). Both the quantity and quality of HDL are affected by aging, disease states, exposure to certain environmental factors (eg pollutants) and pathogens, smoking and diet (Cho, 2022).

High LDL-C is not only a risk factor, it is the main cause of atherosclerotic cardiovascular diseases (Baigent et al., 2010). It is stated that increased low-density lipoprotein cholesterol (LDL-C) concentration is associated with an increased risk of myocardial infarction and vascular death (Lewington et al., 2007). Lowering LDL cholesterol represents the primary goal to reduce the risk of future cardiovascular diseases (Mach et al.,2019).

It is well known that lowering LDL-C reduces the number and risk of coronary events (Mills et al., 2011; Cannon et al., 2015). Long-term exposure to low blood LDL-C was associated with a 54.5% reduction in the risk of CHD (Ference et al., 2012). It has been shown that lowering the LDL-C value below 70 mg/dL improves cardiovascular outcomes (Writing et al., 2022; Marston et al., 2021; Ray et al., 2020). It may be beneficial to lower LDL-C earlier in life, for example, through dietary and lifestyle adjustment. Even a modest reduction in LDL-C below 0.4 mmol/L over time can have a significant impact on the risk of cardiovascular disease (Maki, 2022). Numerous clinical studies suggest a strong association between high low-density lipoprotein cholesterol (LDL-C) and poor cardiovascular outcomes (Guijarro & Cosin-Sales, 2021).

Both aerobic and anaerobic exercise can raise high-density lipoprotein cholesterol levels (HDL-C), reduce total cholesterol (TC), and lower the TC/HDL-C ratio. Aerobic exercise training has been associated with positive effects on lipid profiles in the general population, particularly TG and HDL levels (Karacabey, 2009).

Many studies show that high cholesterol is associated with coronary heart disease (CHD). LDL-C/HDL-C values may indicate the risk of atherosclerosis (Earnest et al., 2013; Koca,2019; Mann et al., 2014; Ruppar et al., 2014).

LDL- HDL-C ratio may indicate the risk of atherosclerosis (İmamoğlu et al., 2005; Çetin et al.,2020). Triglycerides (TG) can enter the arterial wall at a mild to moderate concentration (2-10 mmol/L) and accumulate there, leading to the possibility of atherosclerosis (Nordestgaard et al., 1995).

Lowering serum cholesterol can help reduce the risk of coronary heart disease (CHD) (Wang & Xu, 2017). According to the World Health Organization, 32% of global deaths in 2019 were attributed to cardiovascular diseases; coronary artery disease, stroke or cerebrovascular accident were responsible for 85% of these (World Health Organization, 2023). Peripheral artery disease is strongly associated with other conditions such as coronary artery disease and cardiovascular diseases (Joshi & Martin, 2018; Zemaitis et al., 2022).

The results of the studies have shown that low HDL cholesterol can translate into a higher risk of coronary heart disease (Bartlett et al., 2016). Low HDL cholesterol plasma levels are a common abnormality reported in patients with CHD (Gotto, 2001).

It has been suggested that exercise, especially aerobic exercise, may have the potential to improve the atheroprotective functions of HDL (Ruiz-Ramie,2019). The results of studies and meta-analyses suggested that aerobic exercise has a beneficial effect on HDL-C levels (Cho ,2022).

Regular exercise and a healthy diet are thought to be crucial for maintaining a normal lipid profile and subsequent reduction in cardiovascular risk (Ruiz-Ramie, 2019). Current evidence indicates that acute and chronic aerobic exercise can increase plasma levels of HDL cholesterol in a dose-dependent manner (Durstine et al., 2001; Kodama et al., 2007).

Epidemiological studies show that physical activity leads to an increase in HDL cholesterol concentrations and a decrease in triglyceride, total and LDL cholesterol values. When the intensity of the training is well controlled, it is stated that physical activity causes an increase in HDL cholesterol concentration and a decrease in triglyceride, total and LDL cholesterol (Labovic et al.,2015; Çetin et al.,2020).

The response of the blood lipid profile to an exercise session or training program may differ depending on the type, intensity and frequency of the exercise, the duration of each session, and the time spent in such a program (Boraita, 2004). The most important effect of exercise on the human body is on the metabolic system, especially on lipids. Lipid and lipoprotein are risk factors for coronary heart disease (Labovic et al., 2015).

Values approaching abnormal plasma lipid and lipoprotein values while being an athlete may increase the possibility of developing cardiovascular diseases and metabolic syndrome diseases in the future. An intense training program emphasizing strength, power, speed ability, resistance, explosive and interval sprinting may cause undesirable health and wellness consequences for participants in power-anaerobic based sports (Rashidlamir & Ghanbari, 2011).

Lipid profile and related ratios such as TG/HDL-C, TC/HDL-C and LDL-C/HDL-C were evaluated in the diagnosis of the severity and mortality of blood diseases (Wu et al., 2021; Kozdag et al., 2013). Apolipoproteins are important components of lipoprotein particles, and there is accumulating evidence that measurement of various forms of apolipoprotein can improve the prediction of cardiovascular disease risk (Faergeman, 2006).

Apolipoprotein B (apoB) is present as a single molecule in all potentially atherogenic lipoprotein particles, namely very low-density lipoprotein, medium density lipoprotein (Barter et al., 2006). Therefore, a plasma value of total apoB reflects the number of cholesterol and, to some extent, triglyceride-containing particles (Walldius & Jungner, 2004; Cromwell & Barringer, 2009).

Apolipoprotein A1 (apoA1) is the main apolipoprotein associated with high-density lipoprotein (HDL) and is a key initiator and driver of reverse cholesterol transport (Florvall et al., 2006; Ajees et al., 2006).

ApoA1 may also exert antioxidant and anti-inflammatory effects and stimulate both endothelial nitric oxide production and prostacyclin release from the endothelium (Van Linthout et al., 2008). Apolipoprotein A1 is the main protein component of plasma HDL. This protein promotes the flow of cholesterol from the tissues to the liver for excretion.

In humans, ApoA1 has been observed to remove some lipids from bile and act as an antinucleation agent in gallstone formation. Apolipoprotein B (ApoB) is the primary apolipoprotein of chylomicrons and LDL (Chuang et al., 2013). Low Apo A-1 is normal between 80-160 mg/dl in men. Low Apo A-1 creates a risk for coronary heart disease (Mahley et al., 2006). Apo B, on the other hand, has a normal value of 40 – 125 mg/dL in adults. High apolipoprotein B means hyperlipidemia and indicates that bad cholesterol is high and the risk of cardiovascular diseases is high (Mahley et al., 2006).

Lipoprotein (a) is a type of LDL (bad) cholesterol. High levels of lipoprotein (a) may mean that you are at risk for heart disease (Banach, 2016). Higher Lp(a) levels are associated with an increased risk of atherosclerotic cardiovascular disease, and current European guidelines recommend intensifying therapy in those with high levels. According to Ference et al. (2022), unlike other lipoproteins, diet and exercise do not lower Lp(a) and there is currently no effective treatment for lowering Lp(a). If there is high Lp(a), it is stated that low LDL Cholesterol is necessary (Galimberti et al., 2022).

This study aims to compare the lipid and lipoprotein values of elite male athletes and male students receiving sports training and to investigate the risks of cardiovascular disease. It is thought that there is a difference between lipid and lipoprotein values because the trainings of wrestlers, track and field athletes and football players and students who receive sports training and do not actively participate in competitions are different. For example, the training and competitions of the students competing in the athletics branch require more aerobic energy use than the athlete students competing in other branches and the students who do not compete actively. Again, footballers do more aerobic training than wrestlers in their normal training. Wrestlers' training is more based on strength and power, and they need more anaerobic energy than athletes competing in football and athletics in general. This study is important in terms of whether there is a difference in lipid and lipoprotein values, cardiovascular disease risks, depending on the type of training and indirectly the competition.

## 2. METHODS

### 2.1. Participants

Elite athletes and male students studying at Samsun Ondokuz Mayıs University were included in this study. A total of 209 male students participated. Of the elite athletes, 21 were elite wrestlers, 43 competed in running (track and field), and 61 participated in football competitions. Additionally, 84 students were only receiving sports training. When selecting subjects for the study, care was taken to include at least 20 people from one group. In the research, no restriction was considered for the upper limit according to branch. It is important to check the blood values of as many people as possible. The age range of the subjects in the study was kept between 18-30 years. While only students competing in running disciplines from the athletics branch were included in the research, athletes competing in marathon, throwing and jumping disciplines were excluded. Among the wrestlers, heavyweight wrestlers were also excluded from the study. Those with metabolic diseases and known abnormalities in their blood values were excluded from the study. While blood parameters were being taken, care was taken to ensure that the subjects did not suffer from influenza infection. A limitation of this study is that nutritional status was not controlled. They were also evaluated according to their statements that they did not doping and did not use ergogenic substances for muscle strength development. It was assumed that the athletes did not dope or use ergogenic substances. Written consent was obtained from the students who participated in the research voluntarily. Students' education is limited to practice lessons 5 days a week, an average of 3 hours a day. The intensity and intensity of training in these training classes is lower than the training of elite athletes.

### 2.2. Measurements

#### 2.2.1. Lipid and Lipoprotein Measurement

Blood samples were obtained from the antecubital vein of the subjects 48 hours before exercise sessions. Fasting blood samples were taken in the morning. The samples were analyzed for triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL). TG, TC, HDL-C, LDL-C levels were determined by Hitachi 717 Auto analyzer. Blood samples were taken within the scope of the ethical committee report of Ondokuz Mayıs University (Report No: B.30.2.ODM.O.20.08 / 255).

#### 2.2.2. Body mass index (BMI)

Body Weight (kg) / Height (m)2 = (kg/m2)

### 2.3. Statistical Analysis

Analysis was performed using SPSS version 25.0. The Kolmogorov–Smirnov test was used to evaluate the normality of the parameters. One-way analysis of variance and LSD tests were used for statistical procedures. Statistical significance was set at $p < 0.05$.

## 3. RESULTS

Table 1 presents a comparison of age, sports age, height, body weight, and body mass index values of the students participating in the study, grouped according to their sports branches.

**Table 1.** Comparison of age, sports age, height, body weight, and BMI across branches

| Parameters | Categories | N | Mean | SD | F | p |
|---|---|---|---|---|---|---|
| Age (year) | Wrestling | 21 | 20.76 | 1.51 | 0.021 | 0.887 |
| | Track and field | 43 | 20.81 | 1.52 | | |
| | Male Student | 84 | 20.90 | 1.42 | | |
| | Soccer | 61 | 21.00 | 1.39 | | |
| Age of training (year) | Wrestling | 21 | 8.76 | 1.51 | 2.32 | 0.077 |
| | Track and field | 43 | 7.81 | 1.52 | | |
| | Male Student | 84 | 7.90 | 1.42 | | |
| | Soccer | 61 | 8.00 | 1.39 | | |
| Height (cm) | Wrestling | 21 | 170.52 | 6.15 | 0.71 | 0.545 |
| | Track and field | 43 | 172.00 | 6.10 | | |
| | Male Student | 84 | 171.99 | 5.52 | | |
| | Soccer | 61 | 172.62 | 5.47 | | |
| Body weight (kg) | Wrestling | 21 | 74.14 | 13.08 | 0.68 | 0.565 |
| | Track and field | 43 | 70.79 | 8.15 | | |
| | Male Student | 84 | 71.37 | 8.50 | | |
| | Soccer | 61 | 71.57 | 8.86 | | |
| BMI (kg/m2) | Wrestling | 21 | 25.74 | 5.63 | 0.97 | 0.404 |
| | Track and field | 43 | 24.12 | 3.83 | | |
| | Male Student | 84 | 24.26 | 3.67 | | |
| | Soccer | 61 | 24.14 | 3.81 | | |

***Note.*** ** p<0,05*

No statistically significant difference was found between the age, training age, height, body weight and BMI values of male students who competed in wrestling, athletics, football branches, and those who only received sports training without actively competing ($p > 0.05$).

Table 2 presents a comparison of certain lipid profile values (such as cholesterol, triglycerides, LDL, HDL, etc.) of the students participating in the study, grouped according to their sports branches.

**Table 2.** Comparison of some lipid profiles of the students participating in the study according to branches

| Mg/dl | Groups | n | Mean | SD | F/LSD | p |
|---|---|---|---|---|---|---|
| TC | Wrestling (1) | 21 | 183.62 | 6.82 | 26.80<br>1>2,3,4 | 0.000** |
| | Track and field (2) | 43 | 166.19 | 8.96 | | |
| | Male Student (3) | 84 | 165.67 | 8.75 | | |
| | Soccer (4) | 61 | 168.36 | 8.04 | | |
| TG | Wrestling (1) | 21 | 95.71 | 14.31 | 1.89 | 0.132 |
| | Track and field (2) | 43 | 97.65 | 6.41 | | |
| | Male Student (3) | 84 | 97.94 | 8.01 | | |
| | Soccer (4) | 61 | 94.46 | 10.56 | | |
| HDL-C | Wrestling (1) | 21 | 52.48 | 2.60 | 3.32<br>1<2,3,4 | 0.020* |
| | Track and field (2) | 43 | 54.86 | 2.94 | | |
| | Male Student (3) | 84 | 54.12 | 2.67 | | |
| | Soccer (4) | 61 | 54.39 | 3.25 | | |
| LDL-C | Wrestling (1) | 21 | 132.19 | 1.81 | 68.68<br>1>2,3,4<br>2<3,4 | 0.000** |
| | Track and field (2) | 43 | 109.65 | 5.50 | | |
| | Male Student (3) | 84 | 112.11 | 6.88 | | |
| | Soccer (4) | 61 | 112.85 | 6.87 | | |
| Apo-$A_1$ | Wrestling (1) | 21 | 145.52 | 6.15 | 6.96<br>1<2,3,4 | 0.000** |
| | Track and field (2) | 43 | 159.47 | 14.19 | | |
| | Male Student (3) | 84 | 160.19 | 14.40 | | |
| | Soccer (4) | 61 | 158.75 | 13.42 | | |
| Apo-B | Wrestling (1) | 21 | 183.62 | 6.82 | 6.20<br>1>2,3,4 | 0.000** |
| | Track and field (2) | 43 | 166.19 | 8.96 | | |
| | Male Student (3) | 84 | 165.67 | 8.75 | | |
| | Soccer (4) | 61 | 168.36 | 8.04 | | |
| Lp (a) | Wrestling (1) | 21 | 29.10 | 1.34 | 39.48<br>1>2,3,4 | 0.000** |
| | Track and field (2) | 43 | 23.07 | 2.69 | | |
| | Male Student (3) | 84 | 22.81 | 2.51 | | |
| | Soccer (4) | 61 | 22.85 | 2.60 | | |

***Note***. ** p<0.05; p<0.001*

While there was no significant difference (p>0.05) between the total triglyceride averages in the blood parameters of the students participating in the study compared according to the branches, a statistically significant difference was found between the total cholesterol, HDL-C, LDL-C, Apo A1, Apo B and Lp (a) values (p<0.05 and p<0.001). Table 3 presents a comparison of serum lipid values among the different groups of athletes.

**Table 3.** Comparison of serum lipid values among athlete groups

| Mg/100cc | Groups | Mean | SD | F/LSD | p |
|---|---|---|---|---|---|
| TC/HDL-C | Westler (1) | 3.50 | 0.16 | 25.70<br>1>2,3,4 | 0.000** |
| | Track and field (2) | 3.04 | 0.21 | | |
| | Male Student (3) | 3.07 | 0.21 | | |
| | Soccer (4) | 3.11 | 0.24 | | |
| LDL-C/HDL-C | Westler (1) | 2.52 | 0.11 | 58.04<br>1>2,3,4<br>2<3,4 | 0.000** |
| | Track and field (2) | 2.01 | 0.16 | | |
| | Male Student (3) | 2.08 | 0.16 | | |
| | Soccer (4) | 2.08 | 0.16 | | |
| Apo-B/ Apo-$A_1$ | Westler (1) | 0.74 | 0.05 | 19.76<br>1>2,3,4 | 0.000** |
| | Track and field (2) | 0.62 | 0.07 | | |
| | Male Student (3) | 0.62 | 0.07 | | |
| | Soccer (4) | 0.63 | 0.07 | | |

***Note.*** ***p<0.001*

According to Table 3, statistical differences were found in the TC/HDL-C, LDL-C/HDL-C and Apo-B/Apo-A1 ratios (p<0.001).00

## 4. DISCUSSION

There was no statistically significant difference between the age, training age, height and body mass index values of the elite athletes participating in the study according to their branches (p>0.05). It has been stated that the risk of coronary heart diseases and cardiovascular death increases with the increase in BMI (Garry & McShane, 2001). It has been determined that when the body mass index is higher than 30 kg/$m^2$ for athletes, it increases the risk of ischemic heart disease compared to normal athletes (Kujala et al., 1994).

In the study, the body mass index values of the wrestlers are higher than the others, but they are within the limits that can be considered normal. In this study, the differences between elite athletes and athlete students in total cholesterol values, HDL-C and LDL-C values, Apo A1, Apo B and Lp(a) values were found to be statistically significant, while the difference in total triglyceride values was not statistically significant (p). <0.05 and p<0.001). Total cholesterol and LDL-C values of wrestler athletes were significantly higher than other elite athletes and students who received sports training (p<0.001). HDL-C values of wrestlers were significantly lower than other elite athletes and students who received sports training (p<0.001). LDL-C values of students competing in athletics were significantly lower than other elite athletes and students receiving sports training (p<0.001). In this study, while the Apo A1 values of the wrestlers were lower than the other elite athletes and students who received sports training, higher Apo B and lp (a) values were found to be statistically significant ($p<0.001$).

The lower HDL-C values of wrestlers compared to other groups may be related to the sports branch and the training they do. Because there are some studies reporting a lower HDL-C in athletes who do anaerobic strength training (İmamoğlu et al., 2005; Rashidlamir & Ghanbari, 2011). When the similar and researches related to our study are examined, it supports that the decrease in HDL-C levels paves the way for cardiovascular diseases (Averna et al., 2017).

It is thought that the sports branches and trainings they do influence the fact that the students who do athletics have lower LDL-C values compared to the others. Studies show that lipoprotein lipase is critical in HDL formation and increases with aerobic exercise and even with intermittent exercise (Altena et al., 2004; Hui et al., 2015). HDL-C elevation lowers LDL-C levels. It has been reported that aerobic exercises cause an increase in HDL cholesterol and a decrease in LDL cholesterol (Leon & Sanches, 2001). high-intensity aerobic training improves high-density lipoprotein cholesterol (Tambalis et al., 2008). Some studies have shown that small-density LDL particles and Apo B100 are reduced (Kraus et al., 2002; Verissimo et al., 2002; Zhao et al., 2021).

In this study, the difference between TG values was found to be insignificant. A meta-analysis involving mostly western researchers and studies before 2010 found that training caused changes in HDL-C, LDL-C, TC, and TG, but did not improve TG (Kodama et al., 2007; Kelley et al., 2005; Kelley et al., 2012a and 2012b). A meta-analysis by Igarashi et al. (2019) on the effect of regular physical activity on serum lipid profile of East Asian subjects (2019) noted improvement in all lipid components, including HDL-C and TG. Many studies have shown that exercise can have an ameliorative effect on plasma serum TG, HDL-C and LDL-C (Gullu et al., 2013; Labovic et al., 2015; Lippi et al., 2006; Sarzynski et al., 2015). Aydoğan (2017) found in a study that TG and HDL-C levels were not different between wrestling groups. İmamoğlu et al. (2005) stated in their study that there was no significant difference in plasma TC and TG values between elite wrestlers and student groups receiving sports training. In a study conducted by Koca (2019) on elite wrestlers and skiers, although the training levels of the wrestlers were always more intense and different than the skiers, the TG values were not different. On the other hand, HDL-C, LDL-C and TC levels of skiers were found better than wrestlers. Çetin et al. (2020) found that football players had better total cholesterol, triglyceride, high- and low-density lipoprotein cholesterol compared to wrestlers. In a study conducted with football training, a decrease in LDL and cholesterol levels and significant increases in LDH levels were found (Selçuk et al., 2018). According to the results obtained from this study, it can be suggested that wrestlers should include more running and aerobic exercises in their training.

Cardiovascular risk ratios (TC/HDL-C) were found to be highest with 3.50 mg/100cc for wrestlers and as 3.04 mg/100cc for track and field athletes. LDL-C/HDL-C ratios were found to be 2.01 mg/100cc, with 2.52 mg/100cc being the highest for wrestlers and the lowest for track and field athletes. Apo-B/Apo-A1 ratios were highest for wrestlers with 0.74 mg/100cc, while the lowest value was 0.62 mg/100cc for track and field athletes and students receiving sports training. People with HDL-C cholesterol levels below 40 mg/100cc have more than three times the risk of cardiovascular disease than people with high HDL-C levels (Wood, 1986). Normal values in healthy adult humans are TC (mg/dl) less than 200, TG (mg/dL) between 10-150, LDL-C (mg/dL) between 70-130, and HDL-C (mg/dL) 40 It is between -60. It has been reported that the risk of early atherosclerotic heart disease increases when the lp (a) value in the blood is above 30 mg/dl (Mohammadshahi et al., 2023).

Based on the results of this study, it can be said that the risks of heart disease according to the blood values of the athletes and students are not currently available. The risk of heart disease in humans can be estimated by dividing TC by HDL-C. TC/HDL-C value 4.5-5 indicates significant cardiovascular disease risk, 3.8-4 indicates low cardiovascular disease risk (Rosato and Frank, 1990). TG/HDL-C ratio values of >2.75 in men and >1.65 in women were found to be very effective in metabolic syndrome as well as coronary diseases (Cordero & Alegria-Ezquerra, 2009). In a study by Çetin et al. (2020), they found TC/HDL-C and LDL-C / HDL-C ratios to be higher for wrestlers than for football players. Koca (2019) found TC/HDL-C and LDL-C / HDL-C ratios higher in wrestlers than skiers in his study. In a study conducted by İmamoğlu et al. (2005), they found these rates in wrestlers higher than other students. The ApoB/ApoA1 ratio reflects the balance between atherogenic and anti-atherogenic lipoproteins in plasma. Although the ratio of ApoB/ApoA1 varies according to ethnicity, there is a relationship between this ratio and metabolic syndrome (Cho et al., 2022). Again, İmamoğlu et al. (2005) stated that wrestlers carry a higher risk of cardiovascular disease than other groups, although they did not find any difference between groups in Apo-A, Apo-B and Lp(a) levels in men. Wrestling is categorized as a power-anaerobic based sport according to the high-intensity movements and competition rules in training and competition (Rashidlamir & Ghanbari, 2011).

In this study, it is significant that the TC/HDL-C, LDL-C/HDL-C and Apo-B/Apo-A1 ratios of wrestlers are higher than athletic athletes, students who only receive sports training and football players ($p<0.001$). Again, the lowest LDL-C/HDL-C ratio was found in the students competing in the athletics branch. The values of the students who only take sports education and the students who compete in the football branch were found to be like each other. The fact that wrestlers have worse values than others may be due to their weight loss and nutrition before their training and competitions. When comparing the blood values of wrestlers and athletes of other branches, it is recommended to obtain data on athletes outside the weight loss season when studies are conducted in wrestlers and in general other weight sports. CVD can be partially prevented by promoting good behavioral risk factor changes. Encouraging healthy changes, such as improving diet, increasing physical activity, quitting smoking, or managing body weight, may help lower LDL-C levels, reduce the risk of atherosclerotic cardiovascular diseases, and should be considered before and alongside pharmacological treatment (Mach et al., 2019).

## 5. CONCLUSIONS

It has been determined that there are differences in lipid and lipoprotein values of elite athletes and male students receiving sports training. It has been determined that these differences are caused by wrestlers and athletes competing in athletics. Although the blood parameter values observed in male students were within normal limits, it was concluded that they were worse in wrestlers than others. It is thought that the bad blood parameters of the wrestlers may be due to the characteristics of the wrestling branch, the fact that the wrestlers are exposed to more exercise in anaerobic environments, nutritional differences or weight loss. It is thought that the better blood parameters of the students competing in the athletics branch are generally due to the sports they do and the running. According to the data obtained, although no group has been identified as being at risk in terms of cardiovascular diseases, it is predicted that wrestlers will encounter these diseases more in the future than others. Wrestlers may be advised to do more running and include aerobic activities in their training. When comparing the blood values of weightlifters and athletes from other branches, the duration of daily training, the amount of daily energy they receive, and the work done outside the weight loss season may yield more accurate results.

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## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

## FUNDING

This research received no external funding.