

ANEMIA IN FEMALE ATHLETES: A CROSS-SECTIONAL STUDY OF TEAM AND INDIVIDUAL SPORTS WITH DISCIPLINE-SPECIFIC RISKS

ANEMIJA KOD SPORTISTKINJA: STUDIJA PRESJEKA TIMSKIH I INDIVIDUALNIH SPORTOVA SA RIZICIMA SPECIFIČNIM ZA SPORTSKU DISCIPLINU

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Abstract: This study examined the prevalence of anemia among female athletes in team ball sports (volleyball, soccer, and basketball) and individual sports (karate, dance, and athletics) aged 11 to 35. The results showed no statistically significant difference in anemia prevalence between athletes in team sports (2.15%) and individual sports (1.73%). Older female athletes (19–35 years) demonstrated a significantly higher prevalence of anemia compared to younger athletes (11–18 years), regardless of the type of sport. Within the individual sports group, significant differences were observed, with track and field athletes showing a higher anemia prevalence (7.14%) compared to athletes in karate and dance. These findings suggest that the type of sport does not significantly influence anemia risk, but specific disciplines with high aerobic demands, such as athletics, carry a higher risk. The study highlights the need for targeted approaches to anemia prevention and monitoring based on the sport and physical demands of individual disciplines.

Key words: Anemia, female athletes, team sports, individual sports, prevalence

Sažetak: Ovo istraživanje je ispitivalo prevalenciju anemije među sportistkinjama u timskim sportovima sa loptom (odbojka, fudbal i košarka) i individualnim sportovima (karate, ples i atletika) u uzrastu od 11 do 35 godina. Rezultati su pokazali da nema statistički značajne razlike u prevalenciji anemije između sportistkinja iz timskih (2.15%) i individualnih sportova (1.73%). Starije sportistkinje (19–35 godina) pokazale su značajno višu prevalenciju anemije u poređenju sa mlađim sportistkinjama (11–18 godina), bez obzira na tip sporta. Unutar grupe individualnih sportova, primjećene su značajne razlike – atletičarke su imale višu stopu anemije (7.14%) u odnosu na sportistkinje u karateu i plesu. Ovi nalazi ukazuju na to da tip sporta ne utiče značajno na rizik od anemije, ali specifične discipline sa velikim aerobnim zahtjevima, poput atletike, nose veći rizik. Studija naglašava potrebu za specifičnim pristupom u prevenciji i praćenju anemije u zavisnosti od sporta i fizičkih zahteva pojedinih disciplina.

Ključne riječi: Anemija, sportistkinje, timski sportovi, individualni sportovi, prevalencija

INTRODUCTION

Anemia, particularly iron deficiency anemia, is a common issue among athletes, with female athletes being especially susceptible due to physiological demands and nutritional challenges (Beard & Tobin, 2000; Rowland, 2011). Research in recent decades has focused on the

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Anemija, posebno anemija uzrokovana nedostatkom gvožđa, je čest problem među sportistima, a sportistkinje su posebno podložne zbog fizioloških zahtjeva i nutritivnih izazova (Beard & Tobin, 2000; Rowland, 2011). Istraživanja u poslednjih nekoliko decenija su se fokusirala na

prevalence of anemia across various sports, with special interest in risks depending on the type of sport, including team and individual disciplines. Female athletes show higher rates of anemia compared to male athletes, mainly due to iron deficiency (Peeling et al., 2007). Several factors contribute to this increased risk, including menstrual blood loss, increased iron metabolism due to intensive training, and dietary challenges in maintaining adequate iron levels (DellaValle, 2013). Anemia can affect physical abilities, slow down recovery, and increase the risk of injuries (Ashenden et al., 1999; Dellavalle & Haas, 2012). Athletes in endurance sports, such as long-distance running and swimming, are particularly prone to anemia due to hemolysis resulting from repetitive trauma in runners and frequent exposure to oxidative stress, which affects red blood cell metabolism (Nieman et al., 2001; Fallon, 2008). Therefore, maintaining optimal iron levels is essential for performance in sports and the health of female athletes with high levels of physical exertion. The type of sport—particularly the distinction between team and individual sports—plays a role in the risk of anemia among female athletes. Individual endurance sports, such as long-distance running, triathlon, and cycling, have higher rates of iron deficiency anemia compared to team sports (Malczewska et al., 2000). The repetitive impacts and high aerobic demands of these sports increase the likelihood of hemolysis, iron loss through sweating, and gastrointestinal microbleeds, all of which contribute to the depletion of iron stores (Schumacher et al., 2002; Mettler & Zimmermann, 2010). Team sports, on the other hand, such as soccer and basketball, though physically demanding, show lower rates of anemia due to more varied physical demands and often shorter, intense work intervals (Rowland, 2011). However, studies indicate that female athletes in team sports are still at risk, especially if they have heavy menstrual cycles or a history of insufficient dietary iron intake (McClung et al., 2009). Female endurance athletes are among the most at risk for anemia. A systematic review by DellaValle & Haas (2012) found that iron deficiency affects approximately 30-50% of female endurance athletes, with a significant proportion reaching clinical anemia. The demands of these sports accelerate iron loss while also requiring optimal oxygen transport for demanding training and competitions. Although less affected than female endurance athletes, female athletes in team sports still show significant anemia prevalence, with rates varying according to competition level and training intensity (Ziegler et al., 2014). For instance, female soccer players can register high levels of iron breakdown and anemia risk due to physical con-

prevalenciju anemije u različitim sportovima, s posebnim interesovanjem za rizike u zavisnosti od tipa sporta, uključujući timske i individualne discipline. Sportistkinje bilježe veće stope anemije u poređenju sa sportistima, uglavnom zbog nedostatka gvožđa (Peeling i saradnici, 2007). Više faktora doprinosi ovom povećanom riziku, uključujući menstrualni gubitak krvi, povećan metabolizam gvožđa zbog intenzivnog treninga i prehrane izazove u održavanju odgovarajućeg nivoa gvožđa (DellaValle, 2013). Anemija može uticati na fizičke sposobnosti, usporiti oporavak i povećati rizik od povreda (Ashenden i saradnici, 1999; Dellavalle & Haas, 2012). Sportisti u disciplinama koje zahtijevaju izdržljivost, kao što su trčanje na duge staze i plivanje, posebno su skloni anemiji zbog hemolize usljed ponavljajućih trauma kod trkača i čestog izlaganja oksidativnom stresu, što utiče na metabolizam eritrocita (Nieman i saradnici, 2001; Fallon, 2008). Stoga je održavanje optimalnog nivoa gvožđa ključno za izvedbu u sportu i zdravlje sportistkinja sa visokim nivoom fizičkog opterećenja. Tip sporta — posebno razlika između timskih i individualnih sportova — igra ulogu u riziku od anemije među sportistkinjama. Individualni sportovi koji zahtijevaju izdržljivost, kao što su trčanje na duge staze, triatlon i biciklizam, bilježe veće stope anemije zbog nedostatka gvožđa u poređenju sa timskim sportovima (Malczewska i saradnici, 2000). Repetitivni udarci i visoki aerobni zahtjevi ovih sportova povećavaju vjerovatnoću hemolize, gubitka gvožđa znojenjem i gastrointestinalnih mikrokrvarenja, što sve doprinosi iscrpljivanju rezervi gvožđa (Schumacher i saradnici, 2002; Mettler & Zimmermann, 2010). Timski sportovi, s druge strane, kao što su fudbal i košarka, iako su fizički zahtjevniji, bilježe niže stope anemije zbog raznovrsnijih fizičkih zahtjeva i često kraćih intenzivnih intervala rada (Rowland, 2011). Međutim, studije ukazuju na to da su sportistkinje u timskim sportovima i dalje u riziku, posebno ako imaju obilne menstrualne cikluse ili istoriju nedovoljnog unosa gvožđa putem ishrane (McClung i saradnici, 2009). Sportistkinje u sportovima izdržljivosti su među najugroženijima kada je u pitanju rizik od anemije. Sistematski pregled DellaValle i Haas (2012) pokazao je da nedostatak gvožđa pogađa otprilike 30-50% sportistkinja u sportovima izdržljivosti, pri čemu značajan procenat dolazi i do stanja kliničke anemije. Zahtjevi ovih sportova ubrzavaju gubitak gvožđa, dok istovremeno zahtijevaju optimalan transport kiseonika za zahtjevne treninge i trke. Iako su manje pogođene od sportistkinja u sportovima izdržljivosti, sportistkinje u timskim sportovima i dalje bilježe značajnu prevalenciju anemije, sa stopama koje variraju u zavisnosti od nivoa takmičenja i intenziteta treninga (Ziegler i saradnici, 2014). Kod

tact, sprinting, and combined aerobic-anaerobic activity, albeit to a lesser extent than in endurance sports (Hinton, 2014). Based on previous research and the need for further investigation on this issue, the aim of this study was defined. The goal was to determine whether there is an association between the prevalence of anemia in female athletes and the type of sport they practice (team ball sports and individual sports). Additionally, the aim was to determine whether there is a difference in anemia prevalence within these two groups of sports, between different sports disciplines.

METHODS

Study Design

This research employed a cross-sectional study design with data (blood hemoglobin levels) obtained from medical records of athletes tested at the Institute of Occupational and Sports Medicine of the Republic of Srpska (Bosnia and Herzegovina) in 2023.

Participants

The sample consisted of 949 female athletes aged 11-35, divided into two categories: team ball sports and individual sports. In the team sports sub-sample, there were 604 female athletes, while the individual sports sub-sample included 345 athletes. Among the 604 team sport athletes, 321 were volleyball players, 194 were football players, and 89 were basketball players. In the individual sports sub-sample, 131 were karate athletes, 172 were dancers, and 42 were athletes in track and field. The structure of the sample is presented in Table 1.

Variables

To detect anemia in female athletes, blood hemoglobin concentration (HGB) results from complete blood counts were analyzed. Blood sampling for analysis was performed by an accredited technician according to the standardized protocol of the Institute of Sports Medicine of the Republic of Srpska, and venous blood samples were tested on a fully automated hematology analyzer Sysmex XN-330. A hemoglobin concentration below 12 g/dL was the threshold for determining anemia (Lopez et al., 2016). Athletes with hemoglobin levels below 12 g/dL were diagnosed with anemia.

Statistical Analyses

Statistical analyses were performed using IBM SPSS Statistics Version 20. Based on empirical data, the percentages of anemia prevalence in all participant categories were calculated. The Chi-square test was used to compare categorical variables between female athletes in team and individual sports, as well as between athletes

fudbalerki se, na primjer, može registrovati visok stepen raspada gvožđa i rizik od anemije zbog fizičkog kontakta, sprinteva i kombinovanog aerobnog-anaerobnog rada, mada u manjoj mjeri nego u sportovima izdržljivosti (Hinton, 2014). Na osnovu dosadašnjih istraživanja i potrebom da se ova problematika dodatno istraži definisan je i cilj ovog istraživanja. Cilj je bio da se utvrdi da li postoji veza između prevalencije anemije kod sportistkinja i tipa sporta kojim se bave (timski sportovi sa loptom i individualni sportovi). Pored toga, cilj je bio da se utvrdi da li postoji razlika u prevalenciji anemije unutar ove dvije grupe sportova, a između različitih sportskih disciplina.

METODE

Dizajn studije

U ovom istraživanju je korištena studija presjeka sa podacima (hemoglobin u krvi) koji su uzeti iz medicinskih kartona sportista koji su testirani u Zavodu za medicinu sporta Republike Srpske (Bosna i Hercegovina) u toku 2023. godine.

Ispitanici

Uzorak ispitanika je činilo 949 sportistkinja uzrasta od 11-35 godina podijeljnih u dvije kategorije, timski sportovi sa loptom i individualni sportovi. U subuzorku timski sportovi sa loptom bilo je 604 sportistkinje, a u subuzorku individualni sportovi bilo je 345 sportistkinje. Od 604 sportistkinje iz timskih sportova sa loptom, 321 je bila iz odbojke, 194 iz fudbala i 89 iz košarke. Od 345 sportistkinje iz individualnih sportova, 131 je bila iz karatea, 172 iz plesa i 42 iz atletike. Struktura uzorka ispitanika je prikazana u Tabeli 1.

Varijable

Da bi se detektovalo stanje anemije kod sportistkinja uzeti su rezultati koncentracije hemoglobina u krvi (HGB) iz kompletne krvne slike. Uzorkovanje krvi za analizu obavljeno je od strane akreditovanog tehničara prema standardizovanom protokolu Zavoda za medicinu sporta Republike Srpske, a uzorci venske krvi su testirani na potpuno automatizovanom hematološkom analizatoru Sysmex XN-330. Koncentracija hemoglobina ispod 12 g/dl je bila granična za određivanje stanja anemije (Lopez i saradnici, 2016). Sportistkinjama sa nižim vrijednostima hemoglobina od 12 g/dl je dijagnostikovana anemija.

Statističke analize

Statističke analize su izvedene korištenjem statističkog paketa IBM SPSS Statistics Version 20. Na osnovu empirijskih podataka izračunati su procenti zastupljenosti anemije kod svih kategorija ispitanika. Hi-kvadrat test je korišten radi poređenja kategoričkih varijabli između

from different sports within these two categories. Statistical significance of differences was tested at the 0.05 level.

RESULTS

Table 1 shows the structure of the sample, which includes 949 female athletes. The participants were divided according to the type of sport: in the category of team ball sports (volleyball, football, and basketball), a total of 604 athletes participated, while in the category of individual sports (karate, dance, and athletics), 345 athletes participated.

Table 1. Structure of the sample of participants

Ball Sports / Timski sportovi	Volleyball / Odbojka	Soccer / Fudbal	Basketball / Košarka	Total / Ukupno
	321	194	89	604
Individual Sports / Individualni sportovi	Karate / Karate	Dance / Ples	Track and Field / Atletika	Total / Ukupno
	131	172	42	345

Table 2 presents data on the prevalence of anemia among female athletes from team and individual sports. Results show that 2.15% of athletes from team sports and 1.73% from individual sports exhibited the presence of anemia. Although there is a small difference in the percentages of anemic athletes between these two groups, statistical analysis ($\chi^2=0.191$, $df=1$, $p=0.662$) did not show a statistically significant difference, suggesting that the type of sport (team or individual) does not have a significant impact on the prevalence of anemia among participants.

Table 2. Differences in anemia prevalence between female athletes from team ball sports and individual sports

	Anemia / Anemija		
	Yes / Da	No / Ne	Total / Ukupno
Ball Sports / Sportske igre sa loptom	13 2.15 %	591 97.85 %	604
Individual Sports / Individualni sportovi	6 1.73 %	339 98.27 %	345
Total / Ukupno	19 2.00 %	930 98.00 %	949

$$\chi^2=0.191, df=1, p=0.662$$

Table 3 presents data on the prevalence of anemia among female athletes from different age categories, grouped by type of sport. The results reveal notable differences between younger athletes (11–18 years) and older athletes (19–35 years) in both sport categories. Among athletes participating in team ball sports, the

sportistkinja iz timskih i individualnih sportova, kao i između sportistkinja iz različitih sportova unutar ove dvije kategorije. Statistička značajnost razlika je testirana na nivou od 0.05.

REZULTATI

Tabela 1 prikazuje strukturu uzorka koji uključuje 949 sportistkinja. Ispitanice su bile podjeljene prema tipu sporta: u kategoriji timskih sportova sa loptom (odbojka, fudbal i košarka) učestvovalo je ukupno 604 sportistkinje, dok je u kategoriji individualnih sportova (karate, ples i atletika) učestvovalo 345 sportistkinja.

Tabela 1. Struktura uzorka ispitanika

Tabela 2 predstavlja podatke o prevalenciji anemije među sportistkinjama iz timskih i individualnih sportova. Rezultati pokazuju da je 2.15% sportistkinja iz timskih sportova i 1.73% iz individualnih sportova pokazalo prisustvo anemije. Iako postoji mala razlika u procentima anemičnih sportistkinja između ove dve grupe, statistička analiza ($\chi^2=0.191$, $df=1$, $p=0.662$) nije pokazala statistički značajnu razliku, što sugerise da tip sporta (timski ili individualni) nema značajan uticaj na prevalenciju anemije među ispitanicama.

Tabela 2. Razlike u prevalenciji anemije između sportistkinja iz sportskih igara i individualnih sportova

$$\chi^2=0.191, df=1, p=0.662$$

U Tabeli 3 su prikazani podaci o prevalenciji anemije među sportistkinjama različitih starosnih kategorija, grupisanim prema tipu sporta. Rezultati pokazuju izražene razlike između mlađih (11–18 godina) i starijih sportistkinja (19–35 godina) u obje posmatrane kategorije sportova. Kod sportistkinja koje se bave timskim spor-

prevalence of anemia was 1.20% in the 11–18 age group, whereas it increased significantly to 8.40% in the 19–35 age group. A similar pattern was observed among athletes in individual sports, with a prevalence of 0.70% in the younger group and 7.10% in the older group. Statistical analysis confirmed that these differences were significant ($\chi^2=30.147$, $df=3$, $p<0.001$), indicating that age is an important factor influencing the prevalence of anemia among female athletes, regardless of the type of sport they practice.

Table 3. Differences in anemia prevalence among female athletes in team and individual sports grouped by age

	Anemia / Anemija		
	Yes / Da	No / Ne	Total / Ukupno
Ball Sports (11-18 years) / Sportske igre sa loptom (11-18 god)	6 1.20%	503 98.80%	509
Ball Sports (19-35 years) / Sportske igre sa loptom (19-35 god)	8 8.40%	87 91.60%	95
Individual Sports (11-18 years) / Individualni sportovi (11-18 god)	2 0.70%	301 99.30%	303
Individual Sports (19-35 years) / Individualni sportovi (19-35 god)	3 7.10%	39 92.90%	42
Total / Ukupno	19 2.00%	930 98.00%	949

$$\chi^2=30.147, df=3, p=0.000$$

Table 4 analyzes anemia prevalence among athletes in three different team sports: volleyball, soccer, and basketball. Anemia prevalence in volleyball was 1.56%, in soccer 2.58%, while it was highest in basketball at 3.37%. However, analysis of these data ($\chi^2=1.333$, $df=2$, $p=0.514$) did not show a statistically significant difference among female athletes from different team sports.

Table 4. Differences in anemia prevalence among female athletes from different team ball sports

	Anemia / Anemija		
	Yes / Da	No / Ne	Total / Ukupno
Volleyball / Odbojka	5 1.56 %	316 98.44 %	321
Soccer / Fudbal	5 2.58 %	189 97.42 %	194
Basketball / Košarka	3 3.37 %	86 96.63 %	89
Total / Ukupno	13 2.15 %	591 97.85 %	604

$$\chi^2=1.333, df=2, p=0.514$$

tovima sa loptom, prevalencija anemije u grupi od 11–18 godina iznosila je 1.20%, dok je u grupi od 19–35 godina zabilježena znatno viša stopa od 8.40%. Sličan obrazac je uočen i kod sportistkinja koje se bave individualnim sportovima, gdje je prevalencija anemije kod mladih iznosila 0.70%, a kod starijih 7.10%. Statistička analiza pokazala je da su ove razlike značajne ($\chi^2=30.147$, $df=3$, $p<0.001$), što ukazuje na to da starosna dob predstavlja važan faktor u prevalenciji anemije kod sportistkinja, neovisno o tipu sporta kojim se bave.

Tabela 3. Razlike u prevalenciji anemije između sportistkinja iz sportskih igara i individualnih sportova grupisanih prema uzrastu

$$\chi^2=30.147, df=3, p=0.000$$

Tabela 4 analizira prevalenciju anemije među sportistkinjama u tri različita timska sporta: odbojka, fudbal i košarka. Prevalencija anemije u odbojci iznosila je 1.56%, u fudbalu 2.58%, dok je u košarci bila najviša, 3.37%. Međutim, analiza ovih podataka ($\chi^2=1.333$, $df=2$, $p=0.514$) nije pokazala statistički značajnu razliku među sportistkinjama iz različitih timskih sportova. Ovi rezul-

Tabela 4. Razlike u prevalenciji anemije između sportistkinja iz različitih timskih sportova sa loptom

These results indicate that although there is variability in anemia prevalence among different team sports, it is not statistically significant.

Table 5 presents differences in anemia prevalence among female athletes in individual sports: karate, dance, and athletics. The lowest prevalence of anemia was recorded among athletes who engage in dance (0.58%), while the highest prevalence was recorded among track and field athletes (7.14%). Statistical analysis ($\chi^2=8.560$, $df=2$, $p=0.014$) showed a statistically significant difference in anemia prevalence among different individual sports, indicating that athletes in athletics have a significantly higher risk of anemia compared to athletes from other individual sports.

Table 5. Differences in anemia prevalence among female athletes from different individual sports

	Anemia / Anemija		
	Yes / Da	No / Ne	Total / Ukupno
Karate / Karate	2 1.53 %	129 98.47 %	131
Dance / Ples	1 0.58 %	171 99.42 %	172
Track and Field / Atletika	3 7.14 %	39 92.86 %	42
Total / Ukupno	6 1.74 %	339 98.26 %	345

$$\chi^2=8.560, df=2, p=0.014$$

DISCUSSION

The aim of this research was to examine the existence of a difference in anemia prevalence between female athletes involved in team ball sports and those engaged in individual sports, specifically dance, karate, and track and field events. Additionally, differences in anemia prevalence among sports within these two categories were explored. The results of this study showed no statistically significant difference in anemia prevalence between female athletes in team ball sports (2.15%) and individual sports (1.73%). These findings align with previous research, which also suggests that the type of sport (team or individual) may not significantly impact the risk of anemia. This is evident in studies showing similar prevalence rates across various types of sports (Beard & Tobin, 2000; DellaValle, 2013). The lack of statistically significant differences between these groups may be explained by the fact that female athletes in both types of sports experience similar physiological demands in terms

tati ukazuju na to da, iako postoji varijabilnost u prevalenciji anemije među različitim timskim sportovima, ona nije statistički značajna.

Tabela 5 prikazuje razlike u prevalenciji anemije među sportistkinjama u individualnim sportovima: karate, ples i atletika. Najniža prevalencija anemije zabilježena je kod sportistkinja koje se bave plesom (0.58%), dok je najviša zabilježena kod sportistkinja u atletici (7.14%). Statistička analiza ($\chi^2=8.560$, $df=2$, $p=0.014$) pokazala je statistički značajnu razliku u prevalenciji anemije između različitih individualnih sportova, što ukazuje da sportistkinje u atletici imaju značajno veći rizik od anemije u poređenju sa sportistkinjama iz drugih individualnih sportova.

Tabela 5. Razlike u prevalenciji anemije između sportistkinja iz različitih individualnih sportova

$$\chi^2=8.560, df=2, p=0.014$$

DISKUSIJA

Cilj ovog istraživanja bio je da se ispita postojanje razlike u prevalenciji anemije između sportistkinja koje se bave timskim sportovima sa loptom i onih koje se bave individualnim sportovima, konkretno plesom, karateom i trkačkim disciplinama u atletici. Takođe, istraženo je i postojanje razlika u prevalenciji anemije među sportovima unutar ove dvije kategorije. Rezultati ovog istraživanja pokazali su da ne postoji statistički značajna razlika u prevalenciji anemije između sportistkinja u timskim sportovima sa loptom (2.15%) i individualnim sportovima (1.73%). Ovi podaci su u skladu sa prethodnim istraživanjima koja takođe sugerišu da tip sporta (timski ili individualni) možda nema značajan uticaj na rizik od anemije, što je primjećeno u studijama koje pokazuju slične stope prevalencije u različitim tipovima sportova (Beard & Tobin, 2000; DellaValle, 2013). Nedostatak statistički značajnih razlika između ovih grupa može se objasniti činjenicom da sportistkinje u oba tipa sporta doživljavaju slične fiziološke zahtjeve u smislu

of training intensity and iron requirements. Studies indicate that, regardless of the sport type, intense physical activity can lead to an increased need for iron due to higher erythrocyte turnover and losses through sweating (Rowland, 2011; Peeling et al., 2007). Additionally, the menstrual cycle poses an added risk for iron deficiency among female athletes, especially in high-intensity sports (DellaValle & Haas, 2012). The age-specific results demonstrate that the prevalence of anemia among female athletes is significantly influenced by age, with older athletes (19–35 years) exhibiting substantially higher rates of anemia compared to their younger counterparts (11–18 years), regardless of whether they participate in team or individual sports. These findings align with previous studies suggesting that physiological and hormonal changes, as well as the cumulative effects of prolonged exposure to intense physical training and menstrual blood loss, may increase the risk of iron deficiency and anemia in adult female athletes (Thomas et al., 2016; DellaValle, 2013). In contrast, although iron requirements are elevated during adolescence due to growth, development, and the onset of menstruation, the lower anemia rates observed in younger athletes might reflect a shorter duration of exposure to risk factors or more effective physiological adaptation at a younger age. These findings emphasize the need for age-specific strategies in the prevention and monitoring of iron status, particularly during the transition from adolescence to adulthood in athletic populations. The second aspect of this research examined differences in anemia prevalence among female athletes within team ball sports and individual sports. Among team sports, no significant differences were found in anemia prevalence between athletes in volleyball, soccer, and basketball. This conclusion aligns with research indicating that athletes in team ball sports are exposed to similar physical demands, such as intensive training and periodic physical contact, which may have comparable effects on iron levels and anemia risk (Hinton, 2014; Nicotra et al., 2023). In contrast, within the group of individual sports, statistically significant differences in anemia prevalence were observed among different sports, with track and field athletes showing a substantially higher anemia prevalence (7.14%) compared to those in karate and dance. This finding is consistent with previous research, which indicates that athletes in endurance sports, such as track events, are at an increased risk of iron deficiency and anemia due to enhanced hemolysis from repeated trauma and other physiological stressors that accelerate erythrocyte breakdown (Schumacher et al., 2002; Fallon, 2008). Furthermore, dietary restrictions

intenziteta treninga i potrebe za gvoždem. Studije ukazuju da, bez obzira na vrstu sporta, intenzivan fizički napor može uzrokovati povećanu potrebu za gvoždem zbog veće potrošnje eritrocita i gubitaka kroz znojenje (Rowland, 2011; Peeling et al., 2007). Osim toga, menstrualni ciklus kod sportistkinja predstavlja dodatni rizik za manjak gvožđa, što je dodatno važno kada se radi o ženama u sportovima visokog intenziteta (DellaValle & Haas, 2012). Rezultati prema starosnim kategorijama pokazuju da starost sportistkinja ima značajan uticaj na prevalenciju anemije, pri čemu starije sportistkinje (19–35 godina) bilježe znatno više stope anemije u poređenju sa mlađima (11–18 godina), bez obzira na to da li se bave timskim ili individualnim sportovima. Ovi nalazi su u skladu sa dosadašnjim istraživanjima koja ukazuju da kod odraslih sportistkinja hormonske promjene, duži periodi izlaganja fizičkom stresu, kao i kumulativni efekti intenzivnih treninga i menstrualnih gubitaka, mogu povećati rizik od deficita gvožđa i anemije (Thomas et al., 2016; DellaValle, 2013). Nasuprot tome, kod mlađih sportistkinja, iako su potrebe za gvoždem povećane usljed rasta i razvoja, učestalost anemije ostaje niska, što može ukazivati na bolju adaptaciju organizma u ranom uzrastu ili na kraće trajanje izloženosti faktorima rizika. Ovi rezultati naglašavaju potrebu za starosno specifičnim strategijama prevencije i praćenja statusa gvožđa kod sportistkinja, posebno u periodu prelaska iz adolescencije u odraslo doba. Drugi aspekt istraživanja je ispitivao razlike u prevalenciji anemije među sportistkinjama unutar timskih sportova sa loptom, kao i među individualnim sportovima. U okviru timskih sportova, nije utvrđena značajna razlika u prevalenciji anemije između sportistkinja koje se bave odbojkom, fudbalom i košarkom. Ovaj zaključak je u skladu sa istraživanjima koja pokazuju da su sportistkinje u timskim sportovima sa loptom izložene sličnim fizičkim zahtevima, kao što su intenzivni treninzi i periodični fizički kontakt, što može imati slične efekte na nivoe gvožđa i rizik od anemije (Hinton, 2014; Nicotra i saradnici, 2023). Nasuprot tome, unutar grupe individualnih sportova, primjećene su statistički značajne razlike u prevalenciji anemije između različitih sportova, pri čemu su sportistkinje u atletici imale znatno veću prevalenciju anemije (7.14%) u poređenju sa sportistkinjama u karateu i plesu. Ovaj rezultat je u skladu sa dosadašnjim istraživanjima čiji nalazi ukazuju na to da sportistkinje u sportovima izdržljivosti, poput trkačkih disciplina, imaju povećane rizike od nedostatka gvožđa i anemije usljed pojačane hemolize zbog ponavljajućih trauma i drugih fizioloških stresora koji povećavaju raspad eritrocita (Schumacher et al., 2002; Fallon, 2008). Osim toga, kod sportistkinja u atletici često su prisutna ograničenje u ishrani, što dodatno može povećati rizik od anemije zbog nedo-

are often present among track athletes, which may further increase the risk of anemia due to inadequate iron intake (McClung et al., 2009). These results emphasize the specific needs of female athletes in particular disciplines concerning iron intake and balance. Endurance athletes require special attention to nutritional needs, as the high training intensity and increased erythrocyte turnover elevate iron requirements. Research on anemia among female athletes largely confirms the conclusions of this study. Studies have shown that female athletes in high-intensity and endurance sports, such as athletics, are more prone to anemia compared to those in lower-intensity sports, such as dance or team sports with shorter aerobic periods (Malczewska et al., 2000; Ziegler et al., 2014). These data support the theoretical premise that specific physical demands, such as prolonged activities and frequent impact on surfaces, are factors contributing to a higher anemia risk in sports like athletics.

One limitation of this study pertains to the sample size within specific sports, which may affect the statistical power of the results and the ability to generalize. Additionally, factors such as diet, supplement intake, or menstrual cycle were not considered, which could further impact anemia prevalence. Future research should include these variables to provide a more comprehensive picture of the impact of different factors on anemia risk among female athletes across various disciplines. Another limitation of this study concerns the wide age range of participants, from 11 to 35 years. This broad age range may influence the results, as physiological and hormonal factors affecting iron levels and anemia prevalence vary significantly between adolescents and adult women. During adolescence, iron needs increase due to growth and development, as well as the onset of menstrual cycles, while in adult women, additional factors, such as training intensity and sports experience, may have a different impact on anemia risk.

Future research should consider a narrower age range or analyze results by age category to gain a more precise understanding of the impact of age on anemia prevalence in different sports. Additionally, future studies could include factors such as diet, iron supplementation, menstrual cycle, and the specific demands of individual sports to better understand the interaction between these variables and anemia risk across different age groups.

CONCLUSION

The analysis of the results showed that, while the type of sport (team vs. individual) was not significantly associated with anemia prevalence, a significant differ-

statka unosa gvožđa (McClung et al., 2009). Ovi rezultati naglašavaju specifične potrebe sportistkinja u pojedinim disciplinama kada je u pitanju unos i balans gvožđa. Sportistkinje u sportovima izdržljivosti zahtijevaju posebnu pažnju u pogledu nutritivnih potreba, jer visoki intenzitet treninga i veća potrošnja eritrocita povećavaju potrebu za gvoždem. Istraživanja u oblasti anemije kod sportistkinja u velikoj mjeri potvrđuju zaključke ovog istraživanja. Studije su pokazale da su sportistkinje u sportovima visokog intenziteta i izdržljivosti, poput atletike, sklonije anemiji u odnosu na sportistkinje u sportovima nižeg intenziteta, kao što su ples ili timski sportovi sa kraćim periodima aerobnog rada (Malczewska et al., 2000; Ziegler et al., 2014). Ovi podaci podržavaju teorijsku postavku da su specifični fizički zahtjevi, kao što su dugotrajne aktivnosti i česti udarci od podlogu, faktori koji doprinose većem riziku od anemije u sportovima kao što je atletika.

Jedno od ograničenja ovog istraživanja odnosi se na veličinu uzorka u pojedinim sportovima, što može uticati na statističku snagu rezultata i mogućnost generalizacije. Takođe, nisu uzeti u obzir faktori kao što su ishrana, uzimanje suplemenata ili menstrualni ciklus, koji bi mogli dodatno uticati na prevalenciju anemije. Buduća istraživanja bi trebalo da uključe ove varijable kako bi se dobila sveobuhvatnija slika uticaja različitih faktora na rizik od anemije među sportistkinjama u različitim disciplinama. Jedno od ograničenja ovog istraživanja odnosi se na širok raspon starosti ispitanica, od 11 do 35 godina. Ovaj veliki raspon godina može uticati na rezultate, jer fiziološki i hormonalni faktori koji utiču na nivo gvožđa i prevalenciju anemije variraju značajno između adolescenata i odraslih žena. Tokom adolescencije, potrebe za gvoždem su povećane zbog rasta i razvoja, kao i zbog početka menstrualnih ciklusa, dok kod odraslih žena dodatni faktori, poput intenziteta treninga i iskustva u sportu, mogu imati drugačiji uticaj na rizik od anemije.

Buduća istraživanja trebalo bi da uzmu u obzir uži raspon starosnih grupa ili da analiziraju rezultate po starosnim kategorijama kako bi se dobio precizniji uvid u uticaj starosti na prevalenciju anemije u različitim sportovima. Pored toga, buduća istraživanja bi mogla da obuhvate dodatne faktore kao što su ishrana, suplementacija gvoždem, menstrualni ciklus i specifične zahtjeve pojedinačnih sportova, kako bi se bolje razumjela interakcija između ovih varijabli i rizika od anemije u različitim uzrasnim grupama.

ZAKLJUČAK

Analiza rezultata pokazala je da, dok tip sporta (timski naspram individualnog) nije značajno povezan sa prevalencijom anemije, postoji značajna razlika unutar pojedinih in-

ence exists within certain individual sports, with track and field athletes exhibiting a higher rate of anemia. The results revealed a significantly higher prevalence of anemia among female athletes aged 19 to 35 compared to their younger counterparts, highlighting the importance of monitoring iron status in older age groups. These findings underscore the need for tailored approaches in monitoring and preventing anemia based on the sport practiced by female athletes, especially in high-intensity sports like athletics.

dividualnih sportova, gde su sportistkinje u atletici pokazale višu stopu anemije. Rezultati su pokazali da je prevalencija anemije značajno viša kod sportistkinja uzrasta od 19 do 35 godina u poređenju sa mlađim sportistkinjama, što ukazuje na važnost praćenja statusa gvožđa u starijim starosnim kategorijama. Ovi rezultati naglašavaju potrebu za specifičnim pristupima u praćenju i prevenciji anemije u zavisnosti od sporta kojim se sportistkinje bave, naročito u sportovima visokog intenziteta poput atletike.

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