

UTICAJ BIHEVIORALNIH FAKTORA RIZIKA NA NEPLODNOST

Kristina Stamenković^{1,2}

¹ Univerzitet u Novom Sadu, Medicinski fakultet Novi Sad, Republika Srbija

² Institut za javno zdravlje Vojvodine, Novi Sad, Republika Srbija

* Korespondencija: dr med. Kristina Stamenković, Univerzitet u Novom Sadu, Medicinski fakultet Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Republika Srbija; Institut za javno zdravlje Vojvodine, Futoška 121, 21000 Novi Sad, Republika Srbija; e-mail: 906006d23@mf.uns.ac.rs

SAŽETAK

Bihevioralni faktori predstavljaju promenljive faktore rizika koji mogu uticati na pojavu brojnih stanja i bolesti, a podaci iz literature ukazuju da mogu imati negativan uticaj i na mogućnost začeća. Cilj ovog preglednog rada je bio da se kroz analizu naučnih radova prikaže doprinos bihevioralnih faktora za razvoj neplodnosti kod oba pola i predlože preventivne mere. U istraživanju su pretražene sledeće baze podataka: *MEDLINE*, *PubMed* i *KoBSON*. Potom je urađena analiza prikupljenih podataka kliničkih i drugih epidemioloških studija objavljenih u poslednjih 30 godina. Istraživanja pokazuju da ishrana bogata dijetnim vlaknima, omega-3 masnim kiselinama, biljnim proteinima, vitaminima i mineralima, pozitivno utiče na plodnost žena i muškaraca. S druge strane, ishrana bogata industrijski prerađenim namirnicama, trans-mastima i rafinisanim ugljenim hidratima može negativno uticati na plodnost. Umerena fizička aktivnost pomaže u održavanju optimalnog indeksa telesne mase i poboljšanju fiziološke funkcije jajnika. Intenzivni sportovi, zbog uticaja na hipotalamo-hipofiznu osovinu, mogu dovesti do hipotalamusne amenoreje i posledične neplodnosti. Pušenje, zloupotreba alkohola i psihoaktivnih supstanci negativno utiču na plodnost i žena i muškaraca, kao i na razvoj ploda. Uravnotežena i zdrava ishrana, umerena fizička aktivnost, prevencija polno prenosivih bolesti, kao i dizajniranje i implementacija strategija za prevenciju neplodnosti, mogu doprineti boljem ishodu plodnosti i sigurnom materinstvu.

Ključne reči: plodnost, faktori rizika, ishrana, fizička aktivnost

Uvod

Neplodnost se definiše kao neuspeh da se postigne klinička trudnoća nakon dvanaest ili više meseci od redovnog nezaštićenog seksualnog odnosa (1). U savremenom svetu neplodnost predstavlja zdravstveni, psihološki i sociološki problem koji utiče na kompletan aspekt ličnosti, njen integritet i identitet i može ozbiljno psihofizički uticati na ceo organizam čoveka (2). Posledice su jače izražene kod žena, kod kojih se često javlja emocionalni stres, depresija, anksioznost i pad samopouzdanja. Infertilitet dovodi do suočavanja partnera sa društvenom stigmom i čest je uzrok razvoda (1). Za mnoge pojedince i parove, nemogućnost da ostvare željenu trudnoću može dovesti do socijalne izolacije, kliničke depresije, smanjenog radnog učinka i kvaliteta života (3).

U svetu, stopa ukupnog fertiliteta u 2024. godini je bila 2,2 (prosečan broj dece koju u reproduktivnom dobu rodi jedna žena) i kontinuirano je opadala od 1970. godine, kada je iznosila 4,8 (4). Prema podacima Svetske zdravstvene organizacije (SZO), neplodnost pogađa 80 miliona žena širom sveta, a dostupni podaci sugerišu da se jedna od šest osoba u određenom momentu svog života suoči sa ovim problemom (1,5). Incidencija neplodnosti nije ista u svim krajevima sveta i poslednjih godina raste u ekonomski razvijenim zemljama. U Sjedinjenim Američkim Državama (SAD) incidencija neplodnosti u poslednjoj deceniji iznosila je 14%, što znači da 2,5 miliona američkih bračnih parova je imalo poteškoće da dobije potomstvo (6).

THE IMPACT OF BEHAVIORAL RISK FACTORS ON INFERTILITY

Kristina Stamenković^{1,2}

¹ University in Novi Sad, Faculty of Medicine, Novi Sad, Republic of Serbia

² Institute of Public Health of Vojvodina, Novi Sad, Republic of Serbia

* Correspondence: Kristina Stamenković, MD, University in Novi Sad, Faculty of Medicine, Hajduk Veljkova 3, 21000 Novi Sad, Republic of Serbia; Institute of Public Health of Vojvodina, Futoška 121, 21000 Novi Sad, Republic of Serbia; e-mail: 906006d23@mf.uns.ac.rs

SUMMARY

Behavioral factors are modifiable risk factors that can significantly influence the development of various health conditions and diseases. Literature suggests that these factors may also have a detrimental effect on fertility. The aim of this review paper was to present the contribution of behavioral factors to the development of infertility in both sexes through the analysis of scientific literature, and to propose preventive measures. The following databases were searched: MEDLINE, PubMed, and KOBSON. Subsequently, an analysis was conducted on the collected data from clinical and other epidemiological studies published over the past 30 years. Research findings indicate that diets rich in dietary fiber, omega-3 fatty acids, plant-based proteins, vitamins, and minerals positively influence fertility in both men and women. Conversely, diets high in processed foods, trans fats, and refined carbohydrates have been shown to have a negative impact on fertility. Moderate physical activity plays a critical role in maintaining an optimal body mass index and improving ovarian function. However, intensive physical activity, due to its effect on the hypothalamic-pituitary axis, can lead to hypothalamic amenorrhea and subsequent infertility. Smoking, alcohol abuse, and the use of psychoactive substances adversely affect fertility in both sexes, as well as fetal development.

A balanced and healthy diet, moderate physical activity, prevention of sexually transmitted infections, and the design and implementation of targeted infertility prevention strategies can significantly improve fertility outcomes and contribute to safe motherhood.

Keywords: fertility, risk factors, diet, physical activity

Introduction

Infertility is defined as the failure to achieve clinical pregnancy after twelve months or more of regular, unprotected sexual intercourse (1). In the modern world, infertility is a health, psychological and social problem that affects the individual's entire personality, integrity and identity and it can have a serious psycho-physical impact on the entire human organism (2). The repercussions are more pronounced in women, who often experience emotional stress, depression, anxiety and lack of self-esteem. Infertility causes partners to face social stigma and it is a frequent cause of divorce (1). For many individuals and couples, the inability to achieve the desired pregnancy can lead to social isolation, clinical depression, reduced work performance and quality of life (3).

The global fertility rate was 2.2 in 2024 (the average number of children per woman) and it has continuously declined since 1970, when it amounted to 4.8 (4). According to the data of the World Health Organization (WHO), infertility affects 80 million women worldwide, while the available data suggest that one in six people experience infertility at some point in their lifetime (1,5). The incidence of infertility is not the same in all parts of the world and it has increased recently in economically developed countries. In the United States of America, the incidence of infertility amounted to 14% in the last decade, which means that 2.5 million American married couples had difficulty conceiving (6).

Stopa fertiliteta kod svih evropskih zemalja je bila ispod globalnog proseka. Prema podacima za 2022. godinu, među državama članicama EU, Francuska je imala najvišu stopu fertiliteta sa 1,8 živorođene dece po ženi. Nasuprot tome, najniže stope fertiliteta su bile zabeležene na Malti (1,1), u Španiji i Italiji (1,2) (7).

U našoj zemlji problem neplodnosti pogađa oko 16–18% ukupne populacije, dok kod žena starijih od 35 godina, učestalost neplodnosti prelazi 25% (2). Imajući u vidu da se naša sredina suočava sa negativnim prirodnim priraštajem, i da po najnovijim statističkim podacima stopa ukupnog fertiliteta iznosi 1,6, bračna neplodnost nije samo medicinski već i društveni problem. U Republici Srbiji, u 2023. godini, najveći broj porođaja u odnosu na starost majke je bio u dobnoj grupi od 30 do 39 godina, što ukazuje na trend odlaganja roditeljstva (8). Podaci iz literature govore da neplodnost žena čini 35% od ukupnog broja slučajeva neplodnosti, 20% slučajeva se odnosi na žene i muškarce kombinovano, 30% uključuje probleme samo kod muškaraca, dok kod 15% slučajeva uzrok neplodnosti ostaje nepoznat (1). Primarna i sekundarna neplodnost s kojom se parovi u Srbiji suočavaju može se javiti kao posledica uticaja bihejvioralnih faktora rizika na reproduktivno zdravlje (9). Osim bolesti urogenitalnog sistema i sistemskih bolesti koje direktno utiču na plodnost žena i muškaraca, narušavanju reproduktivne sposobnosti kod oba pola u velikoj meri doprinose način života i socijalni uslovi. Visoka prevalencija neplodnosti u kombinaciji sa visokim finansijskim troškovima i ograničenim pristupom lečenju inicira potrebu da se identifikuju promenljivi faktori koji utiču na mogućnost začeća. U bihejvioralne promenljive faktore koji nepovoljno utiču na plodnost spadaju nezdrava i neuravnotežena ishrana, intenzivna fizička aktivnost, kao i sedentarni način života, pušenje, konzumiranje alkohola, zloupotreba psihoaktivnih supstanci i rizično seksualno ponašanje. Savremena medicina i profesionalci koji se bave ovim problemom, posmatraju neplodnost kao problem u kome podjednako učestvuju oba partnera. Zato se u rešavanje neplodnosti uključuje veći broj stručnjaka, jer se tako ostvaruje timski rad koji omogućava da se sa različitih aspekata sačuva fizičko i mentalno zdravlje i radna efikasnost partnera, a istovremeno dođe do krajnjeg rešenja problema, odnosno ostvarivanja potomstva (1,10).

Cilj ovog preglednog rada je bio da se kroz analizu naučnih radova prikaže doprinos bihejvioralnih faktora za razvoj neplodnosti kod oba pola i predlože preventivne mere.

Metode

U okviru ovog rada prikupljeni su i analizirani podaci iz prethodno objavljenih kliničkih i drugih epidemioloških studija koji su se odnosili na uticaj bihejvioralnih faktora na reproduktivni sistem i plodnost. U istraživanju su korišćene baze podataka: *MEDLINE*, *PubMed* i *KoBSON*. Ključne reči koje su korišćene prilikom pregleda literature su: „fertility“, „female reproductive system“, „male reproductive system“, „nutrition“, „diet“, „age“, „physical activity“, „smoking“, „alcohol“, „drugs“, „sexual and reproductive health“. Literatura je pretražena za vremenski period 1994-2025. godine. Od svih publikacija koje su dobijene pretraživanjem uključene su samo one koje su se odnosile na analizu uticaja koji bihejvioralni faktori imaju na muški i ženski reproduktivni sistem i plodnost. Svi uključeni radovi su bili na srpskom i engleskom jeziku.

Promenljivi faktori rizika za nastanak neplodnosti

Podaci koji se odnose na države iz različitih delova sveta ukazuju na smanjenu stopu fertiliteta u poslednjih šest decenija, a naročito u razvijenim zemljama. Istraživači smatraju da ovaj pad stope fertiliteta može biti posledica uticaja koji promenljivi faktori rizika imaju na reproduktivno zdravlje i opšte zdravlje populacije (11). Bihejvioralni faktori mogu uticati na reproduktivno zdravlje pozitivno ili negativno, a pojedinac može da ih kontroliše i menja u cilju poboljšanja zdravlja. Smatra se da određeni bihejvioralni faktori mogu imati kumulativni efekat na plodnost (12).

Ishrana

Pod pravilnom ishranom podrazumeva se svakodnevni unos raznovrsnih namirnica raspoređen u više obroka tokom dana (doručak, ručak, večera i dve užine). Potrebno je da energetske unos bude usklađen sa ukupnom potrošnjom energije. U okviru istraživanja zdravlja stanovništva Republike Srbije iz 2019. godine, analizirane su navike u ishrani, uključujući svakodnevni unos određenih namirnica. Voće (sveže, smrznuto, konzervirano, sušeno, izuzimajući sveže ceđene sokove) svakod-

The fertility rate in all European countries was below the global average. According to the data for 2022, among EU member states, France had the highest fertility rate with 1.8 live births per woman. In contrast, the lowest fertility rates were recorded in Malta (1.1), Spain and Italy (1.2) (7).

In our country, the problem of infertility affects about 16-18% of the total population, while in women older than 35, the incidence of infertility exceeds 25% (2). Bearing in mind that our country is facing the negative natural increase, and that according to the latest statistical data, the total fertility rate is 1.6, marital infertility is not only a medical, but also a social problem. In 2023, in the Republic of Serbia, the largest number of births in relation to the age of the mother was in the age group 30 to 39 years, which indicates a trend of delaying parenthood (8). Literature data show that female infertility accounts for 35% of the total number of infertility cases, 20% of cases refer to both women and men, 30% involve problems only in men, while in 15% of cases the cause of infertility remains unknown (1). Primary and secondary infertility experienced by the couples in Serbia can occur as the result of impact of behavioral risk factors on reproductive health (9).

Apart from diseases of the urogenital system and systemic diseases that directly affect the fertility of men and women, lifestyle and social conditions greatly contribute to the impairment of the reproductive capacity in both sexes. The high prevalence of infertility combined with high financial costs and limited access to treatment initiates the need to identify modifiable factors that affect the possibility of conception. Behavioral modifiable factors that adversely affect fertility include unhealthy and unbalanced diet, intense physical activity, as well as sedentary lifestyle, smoking, alcohol abuse, abuse of psychoactive substances and risky sexual behavior. Modern medicine and professionals that deal with this problem see infertility as a problem in which both partners participate equally. Therefore, greater number of experts is involved in the treatment because the team work enables the preservation of physical and mental health from different aspects, and at the same time the ultimate solution of the problem, that is, the realization of offspring (1,10). The aim of this review article was to show the contribution of behavioral factors

to the development of infertility in both sexes through the analysis of scientific papers, and to propose preventive measures.

Methods

Within this review article, data from previously published clinical and other epidemiological studies related to the influence of behavioral factors on the reproductive system and fertility were collected and analyzed. The following databases were used in the research: MEDLINE, PubMed and KoBSON. The key words that were used during literature search were: "fertility", "female reproductive system", "male reproductive system", "nutrition", "diet", "age", "physical activity", "smoking", "alcohol", "drugs", "sexual and reproductive health". The literature was searched for the time period 1994-2025. Of all publications, which were obtained by the search, only those which related to the analysis of the impact of behavioral factors on male and female reproductive system and fertility were included. All included papers were in Serbian and English.

Modifiable risk factors for the development of infertility

Data related to different parts of the world indicate a reduced fertility rate in the last six decades, especially in developed countries. Researchers believe that this decline in the fertility rate may be the consequence of the impact that modifiable risk factors have on the reproductive health and general health of the population (11). Behavioral factors can affect reproductive health positively and negatively, and the individual can control and change them in order to improve health. It is believed that certain behavioral factors can have a cumulative effect on fertility (12).

Diet

Proper diet implies the daily intake of a variety of foods in several meals during the day (breakfast, lunch, dinner and two snacks). The energy intake should be in balance with the total energy expenditure. As part of the 2019 Serbian National Health Survey, dietary habits were analyzed, including the daily intake of certain foods. Fruit (fresh, frozen, canned, dried, not including freshly squeezed juices) was consumed by 39.4% of

neveno je konzumiralo 39,4% stanovnika, a povrće ili salatu (u svim oblicima, izuzimajući sokove od povrća i supe) 50,2% stanovnika (13).

Ishrana, odnosno specifični nutritivni faktori prednjače po svom uticaju na plodnost čoveka među bihevioralnim faktorima (14). Elementi ishrane koji mogu imati uticaj na fertilitet žena i muškaraca su ukupna energetska vrednost unete hrane i unos pojedinih hranljivih materija, posebno proteina. Zdrav način ishrane i za muškarce i za žene u reproduktivnom dobu podrazumeva upotrebu namirnica koje sadrže specifične hranljive materije potrebne za hormonalnu funkciju i ravnotežu, zdravlje jajnih ćelija i spermatozoida i razvoj fetusa. U poslednjih nekoliko decenija, glavni prehrambeni obrazac postao je takozvana „Zapadnjačka ishrana“, koja može negativno uticati na plodnost. Ovu ishranu karakteriše visok unos industrijski obrađene hrane, bogate životinjskim proteinima, jednostavnim ugljenim hidratima, trans i zasićenim mastima i prerađenim mesom (kobasice, salame itd.), a siromašnu dijetalnim vlaknima i esencijalnim nezasićenim masnim kiselinama (5). Iako definicija nezdravog načina ishrane u određenoj meri varira u različitim studijama, postoje značajna preklapanja rezultata o ishrani bogatoj kalorijama, trans-masnim kiselinama (engl. *Trans Fatty Acids* - TFA), zasićenim mastima i holesterolom koji su bili povezani sa poremećajima proizvodnje hormona i spermatogeneze, menstrualnim poremećajima, anovulacijom, neplodnošću, pobačajem i komplikacijama u trudnoći (15). TFA su zastupljene u hidrogenizovanim biljnim uljima koja se koriste u industriji brze hrane, pržene hrane i gotovih jela, te ove proizvode treba izbegavati (16). Podaci pokazuju da ishrana zasnovana na mediteranskim obrascima ishrane, odnosno ishrana bogata dijetnim vlaknima, omega-3 (ω -3) masnim kiselinama, biljnim proteinima i vitaminima i mineralima, pozitivno utiče na plodnost žena i muškaraca. Istraživanja su pokazala da mediteranska ishrana u periodu pre koncepcije može poboljšati šanse za začeće i do 40% (17).

Gojaznost je, prema podacima za 2019. godinu, česta kod muškaraca i žena, pri čemu je, prema poslednjim podacima 19% žena starijih od 18 godina u Srbiji klasifikovano kao gojazno, a 26% muškaraca (18). Žene i muškarci sa gojaznošću (*Body Mass Index* – BMI ≥ 30 kg/m²) imaju veći rizik od neplodnosti. Ovaj rizik se odnosi i na žene koje su pothranjene (BMI < 20 kg/m²). Nedovoljna tele-

sna masa, odnosno masa koja je 10-15% manja od idealne telesne mase može dovesti do poremećaja menstrualnog ciklusa, dok blago povećanje telesne mase kod žena sa izuzetno niskim procentom telesne masti može poboljšati plodnost (19). Žene sa BMI preko 30 imaju lošu endometrijalnu receptivnost, a samim tim niže stope trudnoće i značajno veći procenat spontanih pobačaja u poređenju sa fiziološkim BMI (20). Kod muškaraca, povećanje BMI od samo 3 jedinice značajno smanjuje parametre kvaliteta sperme i povećava broj mutacija DNK spermatozoida (21). Pothranjenost, baš kao i prekomerna akumulacija masti u predelu stomaka, povezana je sa smanjenom sintezom testosterona i posledično lošim kvalitetom sperme (22).

Proteini su makronutrijenti koji su neophodni za začeće i trudnoću. Rezultati istraživanja sugeriraju da zamena životinjskih izvora proteina, posebno pileline i crvenog mesa, biljnim izvorima proteina može smanjiti rizik od anovulacije i posledične neplodnosti (23). Ishrana siromašna proteinima može biti potencijalni faktor rizika za neplodnost kod muškaraca, jer dovodi do značajnog smanjenja volumena testisa, epididimisa i seminalnih vezikula, kao i smanjenja nivoa testosterona u serumu (24). Preporuke su da u ishrani treba da prevladavaju biljni izvori proteina (23).

Količina i vrsta ugljenih hidrata u ishrani je od suštinskog značaja za žene koje planiraju da zatrudne. Studije su pokazale da je veća potrošnja ugljenih hidrata i proizvoda sa visokim glikemijskim indeksom, odnosno visoka potrošnja jednostavnih šećera, u poređenju sa unosom vlakana, povezana sa manjim šansama za trudnoću usled poremećaja ovulacije. Ishrana sa niskim glikemijskim opterećenjem, bogata vlaknima i sa puno integralnih žitarica, može poboljšati plodnost žena pozitivnim uticajem na nivo estrogena (16). Prema sistematskom pregledu literature kojim je obuhvaćen vremenski period od dve decenije, unos ugljenih hidrata i glikemijsko opterećenje u ishrani negativno utiču na viskozitet sperme dovodeći do smanjenog kvaliteta sperme, nevezano za godine starosti muškarca (14).

Trans masne kiseline štetno deluju na reproduktivne funkcije i kod muškaraca i kod žena. Za povećanje plodnosti kod žena se sugeriraju veći unos polinezasićenih masnih kiselina (engl. *Polyunsaturated Fatty Acid* - PUFA), posebno dugolančanih omega-3 masnih kiselina, i manji unos trans masnih kiselina. U studiji u kojoj su bili obuhvaćeni

inhabitants every day, and vegetables and salads (in all forms, not including vegetable juices and soups) by 50.2% of inhabitants (13).

Diet, that is, specific nutritional factors are predominant factors among behavioral factors regarding their impact on fertility (14). The elements of diet that can have an impact on the fertility of men and women include the total energy value of taken food and the intake of certain nutrients, especially proteins. A healthy diet for both men and women in the reproductive age implies the use of foods that contain specific nutrients needed for hormonal function and balance, the health of ovarian cells and spermatozooids and fetal development. In recent decades, the main dietary pattern has been the so called "Western diet", which can have a negative impact on fertility. This diet is characterized by the high intake of industrially processed food, rich in animal proteins, simple carbohydrates, trans and saturated fats and processed meat (sausages, salami, etc.), and poor in dietary fibers, and essential unsaturated fatty acids (5). Although the definition of unhealthy diet varies to a certain extent in different studies, there is a significant overlap of results about diet rich in calories, trans fatty acids (TFA), saturated fat and cholesterol, which are associated with disorders relating to the production of hormones and spermatogenesis, menstrual disorders, anovulation, infertility, miscarriages and complications in pregnancy (15). TFAs are present in hydrogenated vegetable oils that are used in fast food, fried food and ready meals industries, and these products should be avoided (16). Data show that diet based on Mediterranean dietary patterns, that is, diet rich in dietary fibers, omega-3 fatty acids, vegetable proteins and vitamins and minerals, has a positive impact on fertility of men and women. Research has shown that the Mediterranean diet used in the period before conception can improve chances of conception by up to 40% (17).

According to data for 2019, obesity was common in both men and women, while according to the latest data in Serbia, 19% of women older than 18 were classified as obese, and 26% of men (18). Women and men with obesity (Body Mass Index - BMI ≥ 30 kg/m²) have a higher risk of infertility. This risk also applies to women who are underweight (BMI < 20 kg/m²). Insufficient body mass, specifically 10-15% below the ideal

body mass can lead to menstrual cycle disorders, while the slight increase in body weight in women with an extremely low percentage of body fat can improve fertility (19). Women with a BMI higher than 30 have poor endometrial receptivity, and therefore, lower pregnancy rates and a significantly higher percentage of miscarriages compared to the physiological BMI (20). In men, an increase in BMI of only 3 units significantly reduces sperm quality parameters and increases the number of sperm DNA mutations (21). Being underweight, as well as the excessive accumulation of fats in the abdominal area, is associated with reduced testosterone synthesis and consequently poor sperm quality (22).

Proteins are macronutrients that are necessary for conception and pregnancy. Research results suggest that the replacement of animal sources of proteins, especially chicken and red meat with the vegetable sources of proteins can reduce the risk of anovulation and subsequent infertility (23). Diet poor in proteins may be a potential risk factor for infertility in men because it leads to a significant reduction in the volume of the testicles, epididymis and seminal vesicles, as well as a decrease in serum testosterone levels (24). It is recommended that vegetable sources of proteins should be predominant in the diet (23).

The amount and type of carbohydrates in the diet is essential for women planning pregnancy. Studies have shown that higher consumption of carbohydrates and products with a high glycemic index, that is, high consumption of simple sugars, compared to the intake of fibers, is associated with lower chances of pregnancy due to ovulation disorders. A diet with a low glycemic load, rich in fibers and full of whole grains can improve female fertility with the positive impact on estrogen levels (16). According to a systematic review of literature covering the period of two decades, the intake of carbohydrates and the glycemic load have a negative impact on the sperm viscosity, leading to reduced sperm quality, regardless of men's age (14).

Trans fatty acids have a harmful effect on reproductive functions in both men and women. To increase fertility, a higher intake of polyunsaturated fatty acids (PUFA), especially long-chain omega-3 fatty acids and a lower intake of trans fatty acids are recommended. In a study, which included men who had practiced the "Western diet" before the

muškarci koji su pre ispitivanja imali „zapadnjački način ishrane”, primenom omega-3 masnih kiselina u koncentraciji od 75 g dnevno, u vremenskom periodu tokom 12 nedelja, došlo je do značajnog poboljšanja parametara sperme u odnosu na kontrolnu grupu ispitanika, koja nije koristila omega-3 masne kiseline (25).

Ishrana punomasnim mlečnim proizvodima je bila povezana sa manjim rizikom od ovulatorne neplodnosti, dok je upotreba mlečnih proizvoda sa niskim sadržajem masti bila povezana sa većim rizikom od ovulatorne neplodnosti (26).

Reproduktivno zdravlje se može poboljšati modifikacijom ishrane, odnosno povećanjem unosa voća i povrća, mahunarki i ribe, a manjeg unosa crvenog mesa (13).

Fizička aktivnost

Umerena fizička aktivnost pomaže u održavanju optimalnog indeksa telesne mase, pozitivno utiče na mentalno zdravlje, kao i poboljšanje fiziološke funkcije jajnika kod žena (27). Prema rezultatima istraživanja zdravlja, koje je omogućilo procenu nivoa fizičke aktivnosti stanovništva Srbije, u 2019. godini, 11,0% građana Srbije u starosnoj grupi od 18 do 64 godine, bavilo se aerobnim aktivnostima (kao što su fitnes, sport, rekreacija ili vožnja bicikla) najmanje 150 minuta nedeljno (13). Fizička aktivnost pokazala je zaštitni efekat na plodnost kada je kombinovana sa gubitkom težine kod gojaznih žena (28). Intenzivni sportovi, zbog uticaja na hipotalamo-hipofiznu osovinu, s druge strane mogu dovesti do hipotalamusne amenoreje i posledične neplodnosti (27). Način vežbanja koji je naročito karakterističan za sportistkinje, a koji podrazumeva povećanu učestalost, intenzitet i trajanje fizičke aktivnosti, može izazvati smanjenu plodnost kod žena. Intenzivni biciklizam tokom 16 nedelja pokazao je negativne efekte na zapreminu sperme, koncentraciju, pokretljivost i broj spermatozoida, koji su bili značajno niži od početne vrednosti merene pre početka treniranja (29). Prema preporukama SZO, neophodno je da su sve odrasle osobe fizički aktivne, a fizička aktivnost treba da je većim delom aerobna i da uključi kombinaciju vežbi umerenog (najmanje sto pedeset minuta nedeljno) i visokog intenziteta (najmanje sedamdeset pet minuta nedeljno) kako bi se postigli značajni zdravstveni benefiti (30).

Pušenje

Prema Istraživanju iz 2019. godine, u Srbiji ukupno 31,9% populacije uzrasta 15 godina i starijih svakodnevno ili povremeno koristi duvanske proizvode. Posmatrano po polu, 33,9% muškaraca i 30,1% žena su pušači (13). Studijom preseka koja je obuhvatila 3.910 ispitanika uzrasta 18 godina i starijih anketiranih u periodu od 20. maja do 30. avgusta 2023. godine utvrđeno je da je prevalencija svakodnevnog pušenja duvana u Autonomnoj Pokrajini Vojvodini (APV) bila 28,8%, a povremenog 7,2% (ukupno 36,0%), što je prevazilazilo tadašnji nacionalni nivo u Srbiji i bilo među najvišim u Evropi (31). Većina studija potvrđuje da je prevalencija neplodnosti veća, a vreme potrebno da do začeća dođe duže kod pušača u poređenju sa nepušačima. Smatra se da je ukupno 13% slučajeva neplodnosti izazvano pušenjem cigareta (32,33). Istraživanje sprovedeno u Velikoj Britaniji obuhvatilo je 15.000 trudnica kako bi se utvrdila povezanost aktivnog i pasivnog izlaganja duvanskom dimu sa vremenom koje je potrebno da do začeća dođe. Pored pušenja cigareta, u analizi su uzeti u obzir i faktori kao što su starosna dob, obrazovanje, zaposlenost, tip stanovanja, indeks telesne mase pre trudnoće i konzumacija alkohola, kako bi se eliminisao njihov potencijalni uticaj na plodnost. Posmatrano u odnosu na žene nepušače, žene koje su pušile imale su za 54% veći procenat odloženog začeća (vreme potrebno za začeće je bilo duže od 12 meseci). Dokazano je da aktivno pušenje bilo kog partnera ima negativne efekte na plodnost, a pasivno izlaganje dimu cigareta može imati negativne posledice na plodnost u istoj meri kao i aktivno pušenje jednog od partnera. Pušačima je potrebno dvostruko više pokušaja tokom procesa vantelesne oplodnje da bi postigli začeće u poređenju sa nepušačima (33,34). Povezanost između pušenja i zapremine sperme, ukupnog broja spermatozoida i procenta pokretnih spermatozoida je doznno zavisna. Konzumiranje više od 10 cigareta dnevno smanjuje koncentraciju sperme za 13% do 17% (35). Koncentracija sperme merena kod teških pušača bila je za 19% niža nego kod nepušača (36). Toksične materije nastale pušenjem cigareta mogu se akumulirati u folikularnoj tečnosti te ispoljiti produženo negativno dejstvo na funkciju jajnika koje je takođe doznno zavisno. Pušenje može dovesti do kraćeg menstrualnog ciklusa, iscrpljivanja folikula i ranije pojave menopauze (34).

research, the use of omega-3 fatty acids in the concentration of 75 g a day in the period of 12 weeks led to a significant improvement of sperm parameters in comparison to the control group of respondents, who did not use omega-3 fatty acids (25).

A diet rich in full-fat dairy products was associated with the lower risk of ovulatory infertility, while the use of low-fat dairy products was associated with an increased risk of ovulatory infertility (26).

The reproductive health can be improved by modifying the diet, including the increase in the intake of fruits and vegetables, legumes and fish, and reduction in the intake of red meat (13).

Physical activity

Moderate physical activity helps to maintain an optimal BMI, has a positive effect on mental health, as well as on the improvement of the physiological function of ovaries in women (27). According to the results of a health survey, which enabled the assessment of the level of physical activity of the population of Serbia in 2019, 11.0% of citizens of Serbia in the age group 18 to 64 years were engaged in aerobic activities (such as fitness, sport, recreation or cycling) at least 150 minutes a week. Physical activity has shown a protective effect on fertility when it is combined with the loss of weight in obese women (28). Intense sports, due to the impact on the hypothalamic-pituitary axis, on the other hand can lead to hypothalamic amenorrhea and consequent infertility (27). The way of exercising, which is particularly characteristic of female athletes, and which implies increased frequency, intensity and duration of physical activity can cause reduced fertility in women. Intense cycling during 16 weeks showed negative effects on sperm volume, concentration, motility and sperm count, which were significantly lower compared to the initial values measured before the beginning of training (29). According to the WHO, all adults should be physically active, and physical activity should be mostly aerobic and include the combination of moderate-intensity training (at least one hundred and fifty minutes a week) and high-intensity training (at least seventy-five minutes a week) in order to achieve significant health benefits (30).

Smoking

According to the study, which was conducted in Serbia in 2019, 31.9% of citizens aged 15 and older used tobacco products daily or occasionally. Smoking rate trends by sex show that 33.9% of men and 30.1% of women were smokers (13). In a cross-sectional study, which included 3,910 subjects aged 18 and older, who were interviewed in the period from May 20th, 2023 to August 30th, 2023, it was found that the prevalence of daily tobacco smoking in the Autonomous Province of Vojvodina (APV) was 28.8%, and occasional 7.2% (the total of 36.0%), which exceeded the national level in Serbia at that time and was among the highest in Europe (31). The majority of studies confirm that the prevalence of infertility is higher and the time needed to conceive longer in smokers in comparison to non-smokers. It is believed that a total of 13% of infertility cases are caused by cigarette smoking (32,33). A study conducted in Great Britain included 15,000 pregnant women in order to determine the association of active and passive exposure to tobacco smoke with the time it takes to conceive. In addition to cigarette smoking, in this analysis, factors such as age, education, type of residence, body mass index before pregnancy and alcohol consumption were also considered in order to eliminate their potential impact on fertility. In comparison to women who did not smoke, women who smoked had a 54% higher percentage of delayed conception (the time required for conception was longer than 12 months). It was proved that active smoking of any partner had a negative impact on fertility, while passive exposure to tobacco smoke can have negative effects on fertility to the same extent as when one of the partners is an active smoker. Smokers need twice as many attempts during the IVF process to achieve conception compared to non-smokers (33,34). The association between smoking and sperm volume, the total number of spermatozooids and the percentage of motile spermatozooids is dose-dependent. Smoking more than 10 cigarettes a day reduces the concentration of sperm by 13% to 17% (35). The concentration of sperm measured in heavy smokers was 19% lower than in non-smokers (36). Toxic substances from cigarette smoking can accumulate in the follicular fluid and therefore, have a negative impact on the ovarian function, which is also dose-dependent.

Zloupotreba alkohola

Poznato je da je hronična zloupotreba alkohola povezana sa smanjenom plodnošću i većim rizikom od razvoja menstrualnih poremećaja, ali mehanizam kojim prekomerno konzumiranje alkohola negativno utiče na plodnost nije utvrđen (37). Kod muškaraca, konzumiranje alkohola je povezano sa brojnim negativnim posledicama, kao što su atrofija testisa, smanjen libido i smanjen broj spermatozoida. Meta-analiza koja je obuhvatila 57 studija i 29.914 ispitanika je pronašla značajnu povezanost između konzumiranja alkohola i zapremine semene tečnosti, morfologije i pokretljivosti spermatozoida (38). Prema rezultatima istraživanja u Indiji, nalaz spermograma u okviru referentnih vrednosti ima samo 12% muškaraca koji hronično konzumiraju alkohol (39). Još uvek nije precizno utvrđeno koja količina alkohola negativno utiče na reproduktivnu funkciju žena, jer ne postoji univerzalna definicija mere „jedne čaše“. Tako količine alkohola koje variraju od jedne čaše nedeljno do 5 jedinica dnevno mogu imati različite efekte, uključujući povećanje vremena potrebnog da do trudnoće dođe, smanjenje verovatnoće za začeće za više od 50% i smanjenje stope implantacije, povećanje rizika od spontanog pobačaja i fetalne smrti, kao i anovulacije, disfunkcije lutealne faze i abnormalnog razvoja blastociste (29). U Istraživanju iz 2019. godine, primenjen je kriterijum za rizičnu upotrebu alkohola, unos više od 20 grama etanola dnevno za žene i više od 40 grama etanola dnevno za muškarce, pri čemu je količina etanola u standardnom piću uzeta kao 13 grama. Prema rezultatima istraživanja iz 2019. godine, ovu količinu alkohola svakodnevno je konzumiralo 1,1% stanovništva Srbije starosti 15 i više godina (13). Iako je mehanizam kojim alkohol dovodi do smanjene plodnosti još uvek nepoznat, smatra se da njegova konzumacija dovodi do hormonskih promena kod žena, uključujući povećanje nivoa estrogena, što smanjuje FSH (folikulostimulišući hormon) i potiskuje folikulogenezu i ovulaciju (29).

Zloupotreba psihoaktivnih supstanci

Zloupotreba svih psihoaktivnih supstanci negativno utiče na plodnost i žena i muškaraca, kao i na razvoj ploda, a može dovesti i do trajne neplodnosti. Kanabis, kokain i heroin, metilendioksimetamfetamin („ekstazi“), te ostale droge smanjuju nivo testosterona kod muškaraca (28,40). Prema rezultatima Istraživanja iz 2019. godine, 4,2% sta-

novništva Srbije je tokom svog života koristilo neku od ilegalnih droga obuhvaćenih istraživanjem (13). Marihuana je jedna od najčešće korišćenih droga u Srbiji i u svetu. Sadrži kanabinoide koji se vezuju za receptore na reproduktivnim organima ili struktura kao što su materica ili ductus deferens (29). Kod muškaraca, kanabinoidi smanjuju nivo testosterona, smanjuju spermatogenezu i pokretljivost spermatozoida (40). Danska kohortna studija koja je obuhvatila 1.215 učesnika, dokazala je da je povezanost između upotrebe marihuane i koncentracije spermatozoida obrnuto proporcionalna (41). Redovno pušenje marihuane više od jednom nedeljno bilo je povezano sa 28% nižom koncentracijom spermatozoida, dok je kombinovana upotreba marihuane više od jednom nedeljno i drugih droga smanjila koncentraciju spermatozoida za 52% (42). Žene koje koriste marihuanu imaju povećan rizik od primarne neplodnosti u poređenju sa ženama koje je ne koriste (29). Kod žena, zloupotreba kanabisa može dovesti do disbalansa hormona koji utiču na ovulaciju i tako umanjiti šanse za trudnoću (40). Korišćenje kokaina negativno utiče na spermatogenezu i dovodi do smanjenja ukupnog i slobodnog testosterona u serumu, a efekti kokaina kod muškaraca zavise od doze, dužine korišćenja i interakcije sa drugim drogama. Parametri spermatozoida takođe opadaju upotrebom heroina i metadona, a negativan uticaj se u najvećoj meri odražava na pokretljivost spermatozoida (29). Kod žena, upotreba kokaina i heroina može dovesti do odlublivanja posteljice (29,40).

Seksualno ponašanje

U cilju obezbeđivanja dobrog reproduktivnog zdravlja žena neophodno je raditi na smanjivanju rizika od polno prenosivih infekcija primenom kondoma, edukacijom i preduzimanjem drugih mera prevencije (43). Među odraslima starijim od 20 godina u R. Srbiji, 50,5% osoba je imalo povremene partnere sa kojima su koristile kondom prilikom poslednjeg seksualnog odnosa, pri čemu ovaj postotak opada sa godinama i znatno je ređi među osobama sa nižim obrazovnim nivoom i manjim prihodima domaćinstva (13). Istraživanjem sprovedenim u APV ispitana je povezanost između neželjenog seksualnog odnosa i sociodemografskih faktora, kao i evaluacija efikasnosti vanškolske edukacije o reproduktivnom zdravlju u podizanju svesti srednjoškolaca. Uključeno je 5.026 učenika drugog razreda iz 72 srednje škole u APV. Jedan od

Smoking can lead to a shorter menstrual cycle, follicle depletion and earlier occurrence of menopause (34).

Alcohol abuse

It is known that chronic alcohol abuse is associated with reduced fertility and increased risk of menstrual disorders, but the mechanism by which excessive alcohol consumption negatively affects fertility has not been established (37). In men, alcohol consumption is associated with numerous negative consequences, such as testicular atrophy, reduced libido and reduced sperm count. A meta-analysis, which included 57 studies and 29,914 respondents, found a significant association between alcohol consumption and volume of seminal fluid, sperm morphology and motility (38). According to the research results in India, only 12% of men who chronically consumed alcohol had a spermogram within reference values (39). It has not been determined precisely what amount of alcohol has a negative impact on the reproductive function of women, because there is no universal definition of the measure of "one glass". Thus, quantities that vary from one glass of alcohol per week to 5 units a day can have a variety of effects, including the increase in time necessary to get pregnant, the reduction of the probability of conception by more than 50% and decrease in the implantation rate, the increase in the risk of miscarriage and fetal death, as well as anovulation, luteal phase dysfunction and abnormal blastocyst development (29). In a study conducted in 2019, the criterion for risky alcohol use was the intake of more than 20 grams of ethanol a day for women and more than 40 grams of ethanol a day for men, while the amount of ethanol in a standard drink was deemed to be 13 grams. According to research results from 2019, this amount of alcohol was consumed daily by 1.1% of Serbia's citizens aged 15 and older (13). Although the mechanism by which alcohol leads to reduced fertility is still unknown, its consumption is thought to lead to hormonal changes in women, including an increase in estrogen levels, which reduces FSH (follicle-stimulating hormone) and suppresses folliculogenesis and ovulation (29).

Abuse of psychoactive substances

The abuse of psychoactive substances negatively affects the fertility of both women and men, as

well as the development of the fetus and can lead to permanent infertility. Cannabis, cocaine, heroin, methylenedioxymethamphetamine ("ecstasy"), and other drugs reduce the levels of testosterone in men (28,40). According to the research results from 2019, 4.2% of citizens in Serbia used one of the illegal drugs included in the research (13). Marijuana is one of the most commonly used drugs in Serbia and in the world. It contains cannabinoids that bind to receptors on reproductive organs or structures such as the uterus or ductus deferens (29). In men, cannabinoids reduce testosterone levels, reduce spermatogenesis and sperm motility (40). A Danish cohort study, which included 1,215 participants, proved that the relationship between marijuana use and sperm concentration was inversely proportional (41). Regular marijuana use more than once a week was associated with a 28% lower sperm concentration, while the combined use of marijuana and other drugs more than once a week reduced sperm concentration by 52% (42). Women who used marijuana had an increased risk of primary infertility compared to women who did not use it (29). In women, the abuse of cannabis can lead to the imbalance of hormones that affect ovulation and thus reduce the chances of pregnancy (40). The use of cocaine negatively affects spermatogenesis and leads to a decrease in total and free testosterone in the serum, and the effects of cocaine in men depend on the dose, length of use, and interaction with other drugs. Sperm parameters also decline with the use of heroin and methadone, and the negative impact is mostly reflected in sperm motility (29). In women, the use of cocaine and heroin can lead to placental abruption (29,40).

Sexual behavior

In order to ensure good reproductive health of women, it is necessary to work on reducing the risk of sexually transmitted infections by using condoms, education and other preventive measures (43). Among adults older than 20 in the Republic of Serbia, 50.5% of persons had occasional partners who used a condom during their last sexual intercourse, while the percentage decreases with age and it is significantly less frequent in persons with a lower level of education and lower household income (13). In a study, which was conducted in the APV, the association between the unwanted sexual intercourse and

četiri ispitanika je imao neželjen seksualni odnos, a nakon sprovedenog programa edukacije, utvrđeno je da je edukacija imala pozitivan uticaj na psihosocijalne kompetencije koje doprinose odgovornom seksualnom ponašanju (44). Pod rizičnim seksualnim ponašanjem podrazumeva se rano stupanje u seksualne odnose, česta promena seksualnih partnera i istovremeno postojanje više seksualnih partnera, nekorišćenje kondoma pri svakom seksualnom odnosu, na pravilan način, do odluke o potomstvu, neautonomnosti u donošenju odluka u vezi sa seksualnošću, neadekvatna higijena genitalnih organa (45). Zdravlje pre koncepcije je važan faktor koji utiče na ishod trudnoće i zdravlje novorođenčeta (46). Većina slučajeva neplodnosti je uzrokovana zapaljenskim oboljenjima genitalnih organa, što je posledica nelečenih polno prenosivih infekcija koje imaju tendenciju da se šire uzlazno duž reproduktivnog trakta (47). Podaci iz literature ukazuju da mikroorganizmi kao što su *Chlamydia trachomatis*, *Mycoplasma spp.*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, *Ureaplasma urealyticum* itd., mogu dovesti do neplodnosti. Humani papiloma virusi i *Herpes simplex* virus mogu smanjiti pokretljivost i koncentraciju spermatozoida (48,49). Ispravna upotreba postojećih i razvoj novih metoda zaštite od polno prenosivih infekcija, upotreba masovnih medija u cilju promocije zdravlja, kao i besplatne usluge planiranja porodice (primena kontraceptiva i redukcija neplaniranih ranih trudnoća) u dobro organizovanim jedinicama zdravstvene zaštite mogu doprineti boljem ishodu plodnosti i sigurnom materinstvu (46).

Zaključak

Neplodnost je globalni javnozdravstveni problem. Iako se ne može uticati na sve faktore rizika neplodnosti, neki važni faktori rizika se mogu redukovati ili eliminisati. Uočeno je da postoji značajna veza između određenih bihevioralnih faktora i neplodnosti. Uravnotežena i zdrava ishrana svakog pojedinca pre i tokom pokušaja začeća može biti od vitalnog značaja za poboljšanje plodnosti. Savetuje se umerena fizička aktivnost, prestanak konzumiranja cigareta, alkohola i psihoaktivnih supstanci, kao i odgovorno (bezbedno) seksualno ponašanje, rano otkrivanje i lečenje polno prenosivih infekcija. Da bi se efikasno rešio problem neplodnosti, zdravstvene politike moraju prepoznati da se ne-

plodnost često može sprečiti, čime se smanjuje potreba za skupim tretmanima. Jasno razumevanje mogućih faktora rizika za neplodnost ključno je za dizajniranje i sprovođenje efikasnih strategija za zaštitu plodnosti oba partnera. Neophodna su dalja istraživanja u ovoj oblasti radi donošenja adekvatnih preventivnih programa.

Konflikt interesa

Autor je izjavio da nema konflikta interesa.

Reference

1. World Health Organization. Infertility (Internet). Geneva: World Health Organization; c2020 (updated 2023 Jul 7; cited 2025 Jan 29). Available from: <https://www.who.int/news-room/fact-sheets/detail/infertility>
2. Đurđević S. Ginekologija. Treće izdanje. Novi Sad: Medicinski fakultet; 2019.
3. Fidler AT, Bernstein J. Infertility: from a personal to a public health problem. *Public Health Rep.* 1999;114(6):494-511. doi: 10.1093/phr/114.6.494.
4. United Nations. World Fertility Report 2024 (monograph on the Internet). New York: United Nations; 2025 (cited 2025 Mar 4). Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesd_pd_2025_wfr-2024_advance-unedited.pdf.
5. Skoracka K, Ratajczak AE, Rychter AM, Dobrowolska A, Krela-Kaźmierczak I. Female Fertility and the Nutritional Approach: The Most Essential Aspects. *Adv Nutr.* 2021;12(6):2372-2386. doi: 10.1093/advances/nmab068.
6. Nugent CN, Chandra A. Infertility and Impaired Fecundity in Women and Men in the United States, 2015-2019. *Natl Health Stat Report.* 2024 Apr;(202):1-19.
7. Eurostat (database on the Internet). Luxembourg: European Commission; c2025 (cited 2025 Jan 29). Available from: https://ec.europa.eu/eurostat/databrowser/view/demo_fagec/default/table?lang=en.
8. Institut za javno zdravlje Srbije „Dr Milan Jovanović Batut“. Zdravstveno-statistički godišnjak Republike Srbije 2023. Beograd: Institut za javno zdravlje Srbije „Dr Milan Jovanović Batut“; 2024.
9. Rašević M, Sedlecky K. Infertility and assisted reproductive technologies in Serbia. *STNV.* 2022; 60(1):19-36. doi: 10.2298/STNV220418002R
10. Foucaut AM, Faure C, Julia C, Czernichow S, Levy R, Dupont C; ALIFERT collaborative group. Sedentary behavior, physical inactivity and body composition in relation to idiopathic infertility among men and women. *PLoS One.* 2019;14(4):e0210770. doi: 10.1371/journal.pone.0210770.
11. Kumar S, Thaker R, Verma V, Gor M, Agarwal R, Mishra V. 2018. Occupational, environmental exposure and lifestyle factors: declining male reproductive health. *Journal of Gynecology and Infertility* 1 1–5.

sociodemographic factors was examined, as well as the evaluation of the effectiveness of extracurricular education on reproductive health in raising the awareness of high school students. 5,026 second-grade students from 72 secondary schools in the APV were included. One out of four participants had an unwanted sexual intercourse, and after the education program was implemented, it was observed that the education had a positive impact on psychosocial competences that contribute to responsible sexual behavior (44). Risky sexual behavior means early sexual intercourse, frequent change of sexual partners and having multiple sexual partners simultaneously, failure to use a condom correctly during every sexual intercourse until the decision about offspring is made, lack of autonomy in making decisions about sexuality, inadequate hygiene of genital organs (45). Preconception health is an important factor that affects the outcome of pregnancy and the health of the newborn (46). Most cases of infertility are caused by inflammatory diseases of the genital organs, which is a consequence of untreated sexually transmitted infections that tend to spread upward along the reproductive tract (47). Literature data indicate that microorganisms such as *Chlamydia trachomatis*, *Mycoplasma spp.*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, *Ureaplasma urealyticum* ect. can lead to infertility. Human papillomaviruses and Herpes simplex virus can reduce sperm motility and concentration (48,49). The correct use of existing and development of new methods of protection in order to ensure protection against sexually transmitted diseases, as well as the use of mass media aimed at promoting health, and the free services of family planning (use of contraceptives and reduction of unplanned early pregnancies) in well-organized health care units can contribute to better fertility outcomes and safe motherhood (46).

Conclusion

Infertility is a global public health problem. Although we cannot influence all risk factors related to infertility, some important risk factors can be reduced or eliminated. It has been noticed that there is a significant relationship between certain behavioral factors and fertility. A balanced and healthy diet of each individual before and

during trying to conceive can be of vital importance for improving fertility. Moderate physical activity, the cessation of cigarette smoking, alcohol and psychoactive substances abuse are advised, as well as responsible (safe) sexual behavior, early detection and treatment of sexually transmitted diseases. In order to solve the problem of infertility effectively, health policies must recognize that infertility can often be prevented, thus reducing the need for expensive treatments. A clear understanding of possible risk factors for infertility is essential for designing and implementing effective strategies to protect the fertility of both partners. Further research in this field is needed in order to adopt adequate preventive programs.

Competing interests

The author declared no competing interests.

References

1. World Health Organization. Infertility (Internet). Geneva: World Health Organization; c2020 (updated 2023 Jul 7; cited 2025 Jan 29). Available from: <https://www.who.int/news-room/fact-sheets/detail/infertility>
2. Đurđević S. Ginekologija. Treće izdanje. Novi Sad: Medicinski fakultet; 2019.
3. Fidler AT, Bernstein J. Infertility: from a personal to a public health problem. Public Health Rep. 1999;114(6):494-511. doi: 10.1093/phr/114.6.494.
4. United Nations. World Fertility Report 2024 (monograph on the Internet). New York: United Nations; 2025 (cited 2025 Mar 4). Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2025_wfr-2024_advance-unedited.pdf.
5. Skoracka K, Ratajczak AE, Rychter AM, Dobrowolska A, Krela-Kaźmierczak I. Female Fertility and the Nutritional Approach: The Most Essential Aspects. Adv Nutr. 2021;12(6):2372-2386. doi: 10.1093/advances/nmab068.
6. Nugent CN, Chandra A. Infertility and Impaired Fecundity in Women and Men in the United States, 2015-2019. Natl Health Stat Report. 2024 Apr;(202):1-19.
7. Eurostat (database on the Internet). Luxembourg: European Commission; c2025 (cited 2025 Jan 29). Available from: https://ec.europa.eu/eurostat/databrowser/view/demo_fagec/default/table?lang=en.
8. Institut za javno zdravlje Srbije „Dr Milan Jovanović Batut“. Zdravstveno-statistički godišnjak Republike Srbije 2023. Beograd: Institut za javno zdravlje Srbije „Dr Milan Jovanović Batut“; 2024.
9. Rašević M, Sedlecky K. Infertility and assisted reproductive technologies in Serbia. STNV. 2022; 60(1):19-36. doi: 10.2298/STNV220418002R

12. Emokpae MA, Brown SI. Effects of lifestyle factors on fertility: practical recommendations for modification. *Reprod Fertil.* 2021;2(1):R13-R26. doi: 10.1530/RAF-20-0046.
13. Milic N, Stanisavljevic D, Krstic M, Jovanovic V, Brcanski J, Kilibarda et al. Istraživanje zdravlja stanovništva Srbije 2019. godine. OMNIA BGD: Beograd; 2021.
14. Balercia G, Mancini A, Paggi F, Tiano L, Pontecorvi A, Boscaro M, et al. Coenzyme Q10 and male infertility. *J Endocrinol Invest.* 2009;32(7):626-32. doi: 10.1007/BF03346521.
15. Rato L, Alves MG, Cavaco JE, Oliveira PF. High-energy diets: a threat for male fertility? *Obes Rev.* 2014;15(12):996-1007. doi: 10.1111/obr.12226.
16. Chavarro JE. Carbohydrates and fertility: just the tip of the (fertility) iceberg. *Am J Clin Nutr.* 2020;112(1):1-2. doi: 10.1093/ajcn/nqaa039.
17. Vujkovic M, de Vries JH, Lindemans J, Macklon NS, van der Spek PJ, Steegers EA, et al. The preconception Mediterranean dietary pattern in couples undergoing in vitro fertilization/intracytoplasmic sperm injection treatment increases the chance of pregnancy. *Fertility Steril.* (2010) 94:2096–101.
18. NCD Portal (homepage on the Internet). Geneva: World Health Organization; c2020 (updated 2025 Mar 5; cited 2025 Mar 2). Available from: <https://ncdportal.org/>.
19. Frisch RE. The right weight: body fat, menarche and ovulation. *Baillieres Clin Obstet Gynaecol.* 1990;4(3):419-39. doi: 10.1016/s0950-3552(05)80302-5.
20. Schulte MM, Tsai JH, Moley KH. Obesity and PCOS: the effect of metabolic derangements on endometrial receptivity at the time of implantation. *Reprod Sci.* 2015;22(1):6-14. doi: 10.1177/1933719114561552.
21. Mendiola J, Torres-Cantero AM, Vioque J, Moreno-Grau JM, Ten J, Roca M, et al. A low intake of antioxidant nutrients is associated with poor semen quality in patients attending fertility clinics. *Fertil Steril.* 2010;93(4):1128-33. doi: 10.1016/j.fertnstert.2008.10.075.
22. Makhosida N, Shah J, Yan G, Fisch H, Shabsigh R. Hypogonadism and metabolic syndrome: implications for testosterone therapy. *J Urol.* 2005;174(3):827-34. doi: 10.1097/01.ju.0000169490.78443.59.
23. Łakoma K, Kukharuk O, Śliż D. The Influence of Metabolic Factors and Diet on Fertility. *Nutrients.* 2023 Feb;15(5):1180. doi: 10.3390/nu15051180.
24. Ajuogu PK, Al-Aqbi MA, Hart RA, Wolden M, Smart NA, McFarlane JR. The effect of dietary protein intake on factors associated with male infertility: A systematic literature review and meta-analysis of animal clinical trials in rats. *Nutr Health.* 2020 Mar;26(1):53-64. doi: 10.1177/0260106019900731.
25. Salas-Huetos A, James ER, Aston KI, Jenkins TG, Carrell DT. Diet and sperm quality: Nutrients, foods and dietary patterns. *Reprod Biol.* 2019;19(3):219-224. doi: 10.1016/j.repbio.2019.07.005.
26. Afeiche MC, Chiu YH, Gaskins AJ, et al. Dairy intake in relation to in vitro fertilization outcomes among women from a fertility clinic. *Hum Reprod.* 2016;31(3):563-571. doi: 10.1093/humrep/dev344.
27. Oostingh EC, Hall J, Koster MPH, Grace B, Jauniaux E, Steegers-Theunissen RPM. The impact of maternal lifestyle factors on periconception outcomes: a systematic review of observational studies. *Reprod Biomed Online.* 2019;38(1):77-94. doi: 10.1016/j.rbmo.2018.09.015.
28. Sharma R, Biedenharn KR, Fedor JM, Agarwal A. Lifestyle factors and reproductive health: taking control of your fertility. *Reprod Biol Endocrinol.* 2013;11:66. doi: 10.1186/1477-7827-11-66.
29. Maleki BH, Tartibian B, Vaamonde D. The effects of 16 weeks of intensive cycling training on seminal oxidants and antioxidants in male road cyclists. *Clin J Sport Med.* 2014 Jul;24(4):302-7. doi: 10.1097/JSM.0000000000000051.
30. WHO Guidelines on Physical Activity and Sedentary Behaviour. Geneva: World Health Organization; 2020.
31. Ukropina S, Milijašević D, Tomašević T, Jovanović VM, Čanković D, Dragnić N, et al. Predictors of high tobacco use prevalence among adults in Autonomous Province of Vojvodina, Serbia. *PLoS One.* 2025;20(4):e0320647. doi: 10.1371/journal.pone.0320647.
32. Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US); 2010.
33. Hull MG, North K, Taylor H, Farrow A, Ford WC. Delayed conception and active and passive smoking. The Avon Longitudinal Study of Pregnancy and Childhood Study Team. *Fertil Steril.* 2000;74(4):725-33. doi: 10.1016/s0015-0282(00)01501-6.
34. Practice Committee of the American Society for Reproductive Medicine. Smoking and infertility. *Fertil Steril.* 2004;81(4):1181-6. doi: 10.1016/j.fertnstert.2018.06.016.
35. Ramlau-Hansen CH, Thulstrup AM, Aggerholm AS, Jensen MS, Toft G, Bonde JP. Is smoking a risk factor for decreased semen quality? A cross-sectional analysis. *Hum Reprod.* 2007;22:188–196. doi: 10.1093/humrep/del364.
36. Vine MF, Margolin BH, Morrison HI, Hulka BS. Cigarette smoking and sperm density: a meta-analysis. *Fertil Steril.* 1994;61:35–43.
37. Silvestris E, Lovero D, Palmirotta R. Nutrition and Female Fertility: An Interdependent Correlation. *Front Endocrinol (Lausanne).* 2019;10:346. doi: 10.3389/fendo.2019.00346.
38. Li Y, Lin H, Li Y, Cao J. Association between socio-psychobehavioral factors and male semen quality: systematic review and meta-analyses. *Fertil Steril.* 2011;95(1):116-23. doi: 10.1016/j.fertnstert.2010.06.031.
39. Gaur DS, Talekar MS, Pathak VP. Alcohol intake and cigarette smoking: impact of two major lifestyle factors on male fertility. *Indian J Pathol Microbiol.* 2010;53(1):35-40. doi: 10.4103/0377-4929.59180.
40. Fronczak CM, Kim ED, Barqawi AB. The insults of illicit drug use on male fertility. *J Androl.* 2012 Jul-Aug;33(4):515-28.

10. Foucaut AM, Faure C, Julia C, Czernichow S, Levy R, Dupont C; ALIFERT collaborative group. Sedentary behavior, physical inactivity and body composition in relation to idiopathic infertility among men and women. *PLoS One*. 2019;14(4):e0210770. doi: 10.1371/journal.pone.0210770.
11. Kumar S, Thaker R, Verma V, Gor M, Agarwal R, Mishra V. 2018. Occupational, environmental exposure and lifestyle factors: declining male reproductive health. *Journal of Gynecology and Infertility* 1 1–5.
12. Emokpae MA, Brown SI. Effects of lifestyle factors on fertility: practical recommendations for modification. *Reprod Fertil*. 2021;2(1):R13-R26. doi: 10.1530/RAF-20-0046.
13. Milic N, Stanisavljevic D, Krstic M, Jovanovic V, Brcanski J, Kilibarda et al. Istraživanje zdravlja stanovništva Srbije 2019. godine. OMNIA BGD: Beograd; 2021.
14. Balercia G, Mancini A, Paggi F, Tiano L, Pontecorvi A, Boscaro M, et al. Coenzyme Q10 and male infertility. *J Endocrinol Invest*. 2009;32(7):626-32. doi: 10.1007/BF03346521.
15. Rato L, Alves MG, Cavaco JE, Oliveira PF. High-energy diets: a threat for male fertility? *Obes Rev*. 2014;15(12):996-1007. doi: 10.1111/obr.12226.
16. Chavarro JE. Carbohydrates and fertility: just the tip of the (fertility) iceberg. *Am J Clin Nutr*. 2020;112(1):1-2. doi: 10.1093/ajcn/nqaa039.
17. Vujkovic M, de Vries JH, Lindemans J, Macklon NS, van der Spek PJ, Steegers EA, et al. The preconception Mediterranean dietary pattern in couples undergoing in vitro fertilization/intracytoplasmic sperm injection treatment increases the chance of pregnancy. *Fertility Steril*. (2010) 94:2096–101.
18. NCD Portal (homepage on the Internet). Geneva: World Health Organization; c2020 (updated 2025 Mar 5; cited 2025 Mar 2). Available from: <https://ncdportal.org/>.
19. Frisch RE. The right weight: body fat, menarche and ovulation. *Baillieres Clin Obstet Gynaecol*. 1990;4(3):419-39. doi: 10.1016/s0950-3552(05)80302-5.
20. Schulte MM, Tsai JH, Moley KH. Obesity and PCOS: the effect of metabolic derangements on endometrial receptivity at the time of implantation. *Reprod Sci*. 2015;22(1):6-14. doi: 10.1177/1933719114561552.
21. Mendiola J, Torres-Cantero AM, Vioque J, Moreno-Grau JM, Ten J, Roca M, et al. A low intake of antioxidant nutrients is associated with poor semen quality in patients attending fertility clinics. *Fertil Steril*. 2010;93(4):1128-33. doi: 10.1016/j.fertnstert.2008.10.075.
22. Makhsida N, Shah J, Yan G, Fisch H, Shabsigh R. Hypogonadism and metabolic syndrome: implications for testosterone therapy. *J Urol*. 2005;174(3):827-34. doi: 10.1097/01.ju.0000169490.78443.59.
23. Łakoma K, Kukharuk O, Śliż D. The Influence of Metabolic Factors and Diet on Fertility. *Nutrients*. 2023 Feb;15(5):1180. doi: 10.3390/nu15051180.
24. Ajuogu PK, Al-Aqbi MA, Hart RA, Wolden M, Smart NA, McFarlane JR. The effect of dietary protein intake on factors associated with male infertility: A systematic literature review and meta-analysis of animal clinical trials in rats. *Nutr Health*. 2020 Mar;26(1):53-64. doi: 10.1177/0260106019900731.
25. Salas-Huetos A, James ER, Aston KI, Jenkins TG, Carrell DT. Diet and sperm quality: Nutrients, foods and dietary patterns. *Reprod Biol*. 2019;19(3):219-224. doi: 10.1016/j.repbio.2019.07.005.
26. Afeiche MC, Chiu YH, Gaskins AJ, et al. Dairy intake in relation to in vitro fertilization outcomes among women from a fertility clinic. *Hum Reprod*. 2016;31(3):563-571. doi: 10.1093/humrep/dev344.
27. Oostingh EC, Hall J, Koster MPH, Grace B, Jauniaux E, Steegers-Theunissen RPM. The impact of maternal lifestyle factors on periconception outcomes: a systematic review of observational studies. *Reprod Biomed Online*. 2019;38(1):77-94. doi: 10.1016/j.rbmo.2018.09.015.
28. Sharma R, Biedenharn KR, Fedor JM, Agarwal A. Lifestyle factors and reproductive health: taking control of your fertility. *Reprod Biol Endocrinol*. 2013;11:66. doi: 10.1186/1477-7827-11-66.
29. Maleki BH, Tartibian B, Vaamonde D. The effects of 16 weeks of intensive cycling training on seminal oxidants and antioxidants in male road cyclists. *Clin J Sport Med*. 2014 Jul;24(4):302-7. doi: 10.1097/JSM.0000000000000051.
30. WHO Guidelines on Physical Activity and Sedentary Behaviour. Geneva: World Health Organization; 2020.
31. Ukropina S, Milijašević D, Tomašević T, Jovanović VM, Čanković D, Dragnić N, et al. Predictors of high tobacco use prevalence among adults in Autonomous Province of Vojvodina, Serbia. *PLoS One*. 2025;20(4):e0320647. doi: 10.1371/journal.pone.0320647.
32. Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US); 2010.
33. Hull MG, North K, Taylor H, Farrow A, Ford WC. Delayed conception and active and passive smoking. The Avon Longitudinal Study of Pregnancy and Childhood Study Team. *Fertil Steril*. 2000;74(4):725-33. doi: 10.1016/s0015-0282(00)01501-6.
34. Practice Committee of the American Society for Reproductive Medicine. Smoking and infertility. *Fertil Steril*. 2004;81(4):1181-6. doi: 10.1016/j.fertnstert.2018.06.016.
35. Ramlau-Hansen CH, Thulstrup AM, Aggerholm AS, Jensen MS, Toft G, Bonde JP. Is smoking a risk factor for decreased semen quality? A cross-sectional analysis. *Hum Reprod*. 2007;22:188–196. doi: 10.1093/humrep/del364.
36. Vine MF, Margolin BH, Morrison HI, Hulka BS. Cigarette smoking and sperm density: a meta-analysis. *Fertil Steril*. 1994;61:35–43.
37. Silvestris E, Lovero D, Palmirotta R. Nutrition and Female Fertility: An Interdependent Correlation. *Front Endocrinol (Lausanne)*. 2019;10:346. doi: 10.3389/fendo.2019.00346.

doi: 10.2164/jandrol.110.011874.

41. Payne KS, Mazur DJ, Hotaling JM, Pastuszak AW. Cannabis and Male Fertility: A Systematic Review. *JUrol.*2019;202(4):674-681. doi: 10.1097/JU.0000000000000248.
42. Gundersen TD, Jørgensen N, Andersson AM, Bang AK, Nordkap L, Skakkebaek NE, et al. Association Between Use of Marijuana and Male Reproductive Hormones and Semen Quality: A Study Among 1,215 Healthy Young Men. *Am J Epidemiol.* 2015;182(6):473-81. doi: 10.1093/aje/kwv135.
43. Schlegel EC, Pickler RH, Tate JA, Alexander KA, Williams KP, Smith LH. 'Taking Care': A qualitative study of emerging adult-aged women's sexual and reproductive health definitions. *Sex Reprod Healthc.* 2023;37:100877. doi: 10.1016/j.srhc.2023.100877.
44. Tomašević T, Ukropina S, Jovanović VM, Kvrđić S, Čanković S, Milijašević D. Self-efficacy and Unwanted Sexual Intercourse: 'Reproductive Health Education Programme for High-school Students in Vojvodina'. *Zdr Varst.* 2022;61(2):93-100. doi: 10.2478/sjph-2022-0013.
45. Mijatović Jovanović V, Ukropina S, urednici. *Praktikum iz socijalne medicine.* Novi Sad: Medicinski fakultet; 2022.
46. Cairncross ZF, Ravindran S, Yoganathan S, Dennis CL, Enders J, Graves L, et al. Measurement of Preconception Health Knowledge: A Systematic Review. *Am J Health Promot.* 2019;33(6):941-954. doi: 10.1177/0890117119835518.
47. Tsevat DG, Wiesenfeld HC, Parks C, Peipert JF. Sexually transmitted diseases and infertility. *Am J Obstet Gynecol.* 2017;216(1):1-9. doi: 10.1016/j.ajog.2016.08.008.
48. Farsimadan M, Motamedifar M. Bacterial infection of the male reproductive system causing infertility. *J Reprod Immunol.* 2020;142:103183. doi: 10.1016/j.jri.2020.103183.
49. Fode M, Fusco F, Lipshultz L, Weidner W. Sexually Transmitted Disease and Male Infertility: A Systematic Review. *Eur Urol Focus.* 2016;2(4):383-393. doi: 10.1016/j.euf.2016.08.002.



License: This is an open access article under the terms of the Creative Commons Attribution 4.0 License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 Health Care.

Primljen: 15.08.2025. **Revizija:** 29.08.2025. **Prihvaćen:** 29.08.2025.

38. Li Y, Lin H, Li Y, Cao J. Association between socio-psychobehavioral factors and male semen quality: systematic review and meta-analyses. *Fertil Steril*. 2011;95(1):116-23. doi: 10.1016/j.fertnstert.2010.06.031.
39. Gaur DS, Talekar MS, Pathak VP. Alcohol intake and cigarette smoking: impact of two major lifestyle factors on male fertility. *Indian J Pathol Microbiol*. 2010;53(1):35-40. doi: 10.4103/0377-4929.59180.
40. Fronczak CM, Kim ED, Barqawi AB. The insults of illicit drug use on male fertility. *J Androl*. 2012 Jul-Aug;33(4):515-28. doi: 10.2164/jandrol.110.011874.
41. Payne KS, Mazur DJ, Hotaling JM, Pastuszak AW. Cannabis and Male Fertility: A Systematic Review. *JUrol*. 2019;202(4):674-681. doi: 10.1097/JU.0000000000000248.
42. Gundersen TD, Jørgensen N, Andersson AM, Bang AK, Nordkap L, Skakkebaek NE, et al. Association Between Use of Marijuana and Male Reproductive Hormones and Semen Quality: A Study Among 1,215 Healthy Young Men. *Am J Epidemiol*. 2015;182(6):473-81. doi: 10.1093/aje/kwv135.
43. Schlegel EC, Pickler RH, Tate JA, Alexander KA, Williams KP, Smith LH. 'Taking Care': A qualitative study of emerging adult-aged women's sexual and reproductive health definitions. *Sex Reprod Healthc*. 2023;37:100877. doi: 10.1016/j.srhc.2023.100877.
44. Tomašević T, Ukropina S, Jovanović VM, Kvirgić S, Čanković S, Milijašević D. Self-efficacy and Unwanted Sexual Intercourse: 'Reproductive Health Education Programme for High-school Students in Vojvodina'. *Zdr Varst*. 2022;61(2):93-100. doi: 10.2478/sjph-2022-0013.
45. Mijatović Jovanović V, Ukropina S, urednici. *Praktikum iz socijalne medicine*. Novi Sad: Medicinski fakultet; 2022.
46. Cairncross ZF, Ravindran S, Yoganathan S, Dennis CL, Enders J, Graves L, et al. Measurement of Preconception Health Knowledge: A Systematic Review. *Am J Health Promot*. 2019;33(6):941-954. doi: 10.1177/0890117119835518.
47. Tsevat DG, Wiesenfeld HC, Parks C, Peipert JF. Sexually transmitted diseases and infertility. *Am J Obstet Gynecol*. 2017;216(1):1-9. doi: 10.1016/j.ajog.2016.08.008.
48. Farsimadan M, Motamedifar M. Bacterial infection of the male reproductive system causing infertility. *J Reprod Immunol*. 2020;142:103183. doi: 10.1016/j.jri.2020.103183.
49. Fode M, Fusco F, Lipshultz L, Weidner W. Sexually Transmitted Disease and Male Infertility: A Systematic Review. *Eur Urol Focus*. 2016;2(4):383-393. doi: 10.1016/j.euf.2016.08.002..



License: This is an open access article under the terms of the Creative Commons Attribution 4.0 License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 Health Care.

Received: 08/15/2025 Revised: 08/29/2025 Accepted: 08/29/2025