

## Pretilost, lipoproteini i tjelesna aktivnost

### Obesity, lipoproteins and physical activity

Branka Salzer<sup>1</sup>, Željko Trnka<sup>2</sup>, Mate Sučić<sup>3</sup>

<sup>1</sup>Labor Centar – poliklinika za medicinsko laboratorijsku dijagnostiku, Zagreb

<sup>1</sup>Labor Centar, Polyclinic for Medical Biochemistry Diagnosis, Zagreb, Croatia

<sup>2</sup>Društvo za športsku rekreaciju Medveščak, Zagreb

<sup>2</sup>Society for Sport Recreation, Zagreb, Croatia

<sup>3</sup>Klinika za unutarnje bolesti, Klinička bolnica "Dubrava", Zagreb

<sup>3</sup>Department of Internal Medicine, Dubrava Clinical Hospital, Zagreb, Croatia

#### Sažetak

U pretilih osoba postoji velik rizik za nastanak hiperlipoproteinemije, šećerne bolesti, hipertenzije, koronarne srčane bolesti i degenerativnih bolesti. Štetni utjecaji prevelike tjelesne težine i pretilosti na zdravlje brojni su i različiti. Veća je opasnost od prerane smrti, uz niz posljedica koje izravno utječu na kakvoću života. Čimbenici rizika za razvoj bolesti srca su visoke koncentracije ukupnog i LDL kolesterola, a snižena koncentracija HDL kolesterola, povišena koncentracija triglicerida, glukoze, povišen arterijski krvni tlak, pušenje te neaktivni način života. Redovita tjelovježba može smanjiti i odgoditi obolijevanje od navedenih bolesti.

**Cljučne riječi:** pretilost, čimbenik rizika, lipoproteini, prevencija bolesti, tjelesna aktivnost

#### Summary

Obese persons are at a high risk to develop hyperlipoproteinemia, diabetes mellitus, hypertension, coronary disease, and degenerative diseases. Excessive body mass and obesity have numerous and diverse adverse effects on health. Along with many consequences directly influencing the quality of life, there is an increased risk of premature death. The risk factors for cardiac disease include elevated concentration of total and LDL cholesterol, a decreased concentration of HDL cholesterol, increased concentration of triglycerides and blood glucose, elevated arterial blood pressure, cigarette smoking and inadequate physical activity. Disease development can be prevented and delayed by regular physical activity.

**Key words:** obesity, risk factor, lipoproteins, disease prevention, physical activity

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#### Uvod

Štetni utjecaji prevelike tjelesne težine i pretilosti na zdravlje brojni su i različiti. To su povišena koncentracija masnoća u krvi, povišen arterijski krvni tlak, poremećena tolerancija inzulina te hipokinezija (nedovoljna tjelesna aktivnost). U razvijenim zemljama pretilost je povezana i s mnogim psihosocijalnim problemima koje pretilost ima zbog stigmatizacije. Posebnu pozornost zaslužuje abdominalna (visceralna, androidna ili muška) pretilost, koja je postala predmetom istraživanja posljednjih desetljeća (1). Abdominalna pretilost ima drugačije patogenetske mehanizme nastanka i štetnog djelovanja te je povezana s mnogo većim rizikom za zdravlje od periferne (ženska, genoidna) pretilosti. S abdominalnom pretilošću u muškaraca i žena povezana je viša stopa smrtnosti, moždanog udara, ishemijske bolesti srca, povišenoga krvnog tlaka, netolerancije glukoze i šećerne bolesti tipa 1 te povišena koncentracija serumskih lipida.

#### Introduction

Adverse effects of excessive body mass and obesity on health are numerous and varied; they include increased lipid concentration in the blood, elevated blood pressure, low insulin sensitivity, hypokinesia (insufficient physical activity). In developed countries, obesity is also associated with many psychosocial problems encountered by obese individuals due to stigmatization. Particular attention should be focused on abdominal (visceral, android or male) obesity which has become the topic of investigations during past decades (1). Abdominal obesity has different pathogenetic mechanisms and adverse effects and is related to a much higher health risk than peripheral (female, gynecoid) obesity. Abdominal obesity in men and women is associated with higher rates of mortality, stroke, ischemic heart disease, elevated blood pressure, glucose intolerance, diabetes type 1, and increased concentration of serum lipids.

## Definicija pretilosti i tjelesne mase

Pretilost je stanje u kojem višak masnog tkiva u tijelu može ugroziti zdravlje. Stupanj pretilosti i raspored masnog tkiva u tijelu imaju različit utjecaj na zdravlje među ljudima. Normalna količina masnog tkiva u muškaraca od 18 godina približno je 15–18%, a u žena od 20 godina 20–25% tjelesne težine. Postotak masnog tkiva obično se s godinama povećava. Spolne razlike u raspodjeli masnog tkiva zapažaju se već u ranijim godinama života. Žene imaju pretežito periferno raspoređeno masno tkivo (bokovi i stražnjica – genoidna pretilost), a muškarci centralno (prsni koš i trbuh – androidna pretilost). Utjecaj ovako različite raspodjele masnog tkiva na promjene u metabolizmu postaje očit ako se zna da je metabolizam masnih stanica različit u pojedinim dijelovima tijela. Ispitivanja su pokazala kako je omentalno masno tkivo podložnije djelovanju katekolamina nego potkožno periferno masno tkivo. Kako su katekolamini osnovni lipolitični čimbenici ljudskih masnih stanica, to će povećanje abdominalne mase izazvati veću lipolizu (2).

Androidna ili genoidna pretilost može se rano razlikovati pomoću omjera opsega struka i bokova (opseg struka u centimetrima podijeljen s opsegom bokova u centimetrima). Omjer opsega koji je za muškarce veći od 1, a za žene veći od 0,85 izražava abdominalnu (androidnu ili mušku) pretilost i upozorava na velik rizik za zdravlje čak i kod neznatno prevelike tjelesne mase. Posljednje su spoznaje pokazale da je već sam opseg pojasa (mjereno u srednjoj točki između donjeg ruba luka rebra i gornjeg dijela zdjelične kosti) dovoljno dobro mjerilo ugroženosti zbog abdominalne pretilosti. S promjenom opsega pojasa moguće je pratiti promjenu rizika od nastanka bolesti srca i krvožilnog sustava i drugih kroničnih bolesti (3).

## Pretilost i lipoproteini

Osnovni je utjecaj pretilosti na metabolizam lipoproteina povećano lučenje lipoproteina koji sadrže apolipoprotein B iz jetre. U pretilih osoba povećan je ukupan broj VLDL čestica koje su izlučene iz jetre. Nekoliko čimbenika može poticati povećano stvaranje i lučenje VLDL čestica iz jetre. To je ponajprije povećani utjecaj energetskih supstrata u jetri, što se događa ne samo nakon obroka, nego i za vrijeme gladi kada je povećan dotok slobodnih masnih kiselina koje se luče u plazmu iz povećanoga masnog tkiva. Visoka koncentracija slobodnih masnih kiselina u serumu rezultira njihovim povećanim ulaskom u jetru. To je osobito izraženo kod visceralne pretilosti, koja je češća u muškaraca nego u žena, budući da povećana količina slobodnih masnih kiselina neposredno ulazi u portalnu cirkulaciju jetre. Povećano stvaranje VLDL čestica koje postoje u pretilih osoba može, ali ne mora prouzročiti hipertrigliceridemiju. Općenito je koncentracija triglicerida i VLDL čestica u pretilih veća nego u mršavih osoba, ali koncen-

## Definition of obesity and body mass

Obesity is excess of fat tissue in the body reaching a stage when it becomes risk to health. The degree of obesity and fat tissue distribution in the body may have variable impact on health among individuals. Normal percentage of fat tissue in 18-year-old males is approximately 15–18%, and in 20-year-old women it is 20–25% of the body mass. The percentage of fat tissue usually rises with age. Sexual differences in fat tissue distribution can be observed even in the early years of life. The distribution of fat tissue is in women mostly peripheral (hips and buttocks – gynecoid obesity), and in men mostly central (chest and abdomen – android obesity). Effect of different fat tissue distribution on changes in metabolism becomes evident if the fact that fat tissue metabolism is different in different body parts is taken into consideration. Studies have shown the omental fat tissue to be more susceptible to catecholamine action than subcutaneous peripheral fat tissue. As catecholamines are the basic lipolytic factors of human lipid cells, the increase in abdominal mass induces enhanced lipolysis (2).

Early differentiation between android and gynecoid obesity is possible by waist-hip measurement ratio (waist measurement in centimeters divided with hip measurement in centimeters). The waist-hip measurement ratio higher than 1 and 0.85 for men and women, respectively, indicates abdominal (android or male) obesity and warns of a high health risk even at slightly increased body mass. Recent data have shown that the waist measurement (taken at the midpoint between the lower rib arch and upper segment of the hip bone) is itself a sufficiently good criterion to indicate risks due to abdominal obesity. By monitoring changes in waist measurement, it is possible to follow up changes in the risk for occurrence of cardiovascular and other chronic diseases (3).

## Obesity and lipoproteins

Basic effect of obesity on lipoprotein metabolism is enhanced secretion of lipoproteins containing apolipoprotein B from the liver. The total number of VLDL particles secreted from the liver is elevated in obese individuals. Several factors may stimulate increased formation of VLDL particles in the liver and liver secretion, with enhanced effect of energy substrates in the liver being among the most important ones. This increased formation occurs not only after meals but also during fasting due to increased uptake of free fatty acids secreted in the plasma from increased fat tissue. High concentration of serum free fatty acids results in their increased intake in the liver. This phenomenon is particularly pronounced in visceral obesity, which is more frequent in men than women because increased quantities of free fatty acids directly reach hepatic portal circulation. Increased production of VLDL particles in obese individuals may, but does not ha-

tracija triglicerida ne mora biti iznad preporučene vrijednosti. Ako osoba ima relativno malu aktivnost lipoproteinske lipaze ili ta aktivnost nije povećana s povećanjem tjelesne mase, povećano stvaranje VLDL-triglicerida nadilazi mogućnost lipolitičkog sustava i izaziva povišenje koncentracije triglicerida u serumu. U tom slučaju rezultat je hipertrigliceridemija. Ona je najčešći poremećaj lipidnog statusa u pretilih osoba. Zbog hipertrigliceridemije u tih je osoba povećan rizik za nastanak koronarne srčane bolesti (4).

Klinička ispitivanja pokazuju da je pretilost odgovorna i za hiperkolesterolemiju. Uzrok može biti povećani unos zasićenih masnih kiselina i kolesterola, što smanjuje aktivnost LDL-receptora i uzrokuje povišenje koncentracije LDL-kolesterola. Drugi uzrok je povećano stvaranje lipoproteina koji sadrže apoprotein B u pretilih osoba, čime se povećava koncentracija LDL-kolesterola i pretvorba VLDL u LDL-čestice. Potrebno je naglasiti da hiperkolesterolemiju nemaju sve pretili osobe. Daljnji je utjecaj pretilosti snižena koncentracija HDL-kolesterola u serumu. Izgleda kako niska koncentracija HDL, nađena u većine pretilih osoba, ima dva izvora. Prvo, visoka koncentracija triglicerida, koja je česta u pretilih osoba, snižava koncentraciju HDL-kolesterola. Drugo, izgleda da pretilost snižava koncentraciju HDL kolesterola neovisno o razini triglicerida, što može biti uzrokovano povećanim katabolizmom HDL-čestica. Varijacije u metabolizmu lipoproteina pokazale su da potkožni trbušni adipociti vežu HDL aktivnije nego omentalne masne stanice, a vezanje HDL čestica za adipocite povećava se s veličinom masnih stanica (5). U pretilosti je povećano vezanje HDL za adipocite, osobito u abdominalnom potkožnom dijelu. Smanjenjem tjelesne mase vezanje HDL za masne stanice je smanjeno i može biti razlog za recipročno povišenje koncentracije HDL-kolesterola što je uočeno kod pretilih osoba koje su smanjile tjelesnu masu (6).

Postoji negativna korelacija između HDL-kolesterola i indeksa tjelesne težine. Niska koncentracija HDL, koja predstavlja osobit rizik za nastanak ateroskleroze, donekle je povezana s omjerom opsega struk/bokovi i indeksom tjelesne težine. Smanjenjem tjelesne težine koncentracija HDL može se u početku smanjiti, ali se obično povećava i to više u muškaraca nego u žena.

Kada pretili osobe počnu smanjivati svoj energetski unos, koncentracija HDL kolesterola može lagano porasti kao rezultat sniženja razine triglicerida, ali se koncentracija HDL ne vraća na normalu još dugo nakon smanjenja tjelesne mase. Općenito se vrijednosti HDL-kolesterola većine pretilih osoba smanjuju od 0,13–0,26 mmol (7).

### Lipidi i tjelovježba

Pitanje je predstavlja li rano započeto tjelesno vježbanje prevenciju pojave pretilosti, povišene koncentracije mas-

ve to, cause hypertriglyceridemia. Generally, the level of triglycerides and VLDL particles is higher in obese than in thin individuals, yet the triglyceride level may not necessarily exceed recommended values in the obese. If a person has a relatively low activity of lipoprotein lipase or this activity is not increased with body mass increase, enhanced VLDL and triglyceride formation surpasses the capacity of the lipolytic system and induces an increase in serum triglyceride concentration. The result of such increase is hypertriglyceridemia which is the most frequent disorder of the lipid metabolism in obese individuals. Due to hypertriglyceridemia, these individuals are at increased risk for development of coronary disease (4).

Clinical trials have demonstrated that obesity is also responsible for hypercholesterolemia. This fact may be accounted for by the increased intake of saturated fatty acids and cholesterol, which reduces the activity of LDL-receptor and brings about an increase in LDL-cholesterol level. Another cause is enhanced production of apoprotein B-containing lipoproteins in obese individuals, which enhances VLDL to LDL conversion and increases LDL-cholesterol concentration. Still, it should be emphasized that cholesterolemia is not found in all obese individuals. Further effect of obesity is lowered serum HDL-cholesterol concentration. It seems that low HDL concentration, found in most obese persons, is of two origins. First, the high triglyceride level frequently found in obese individuals reduces HDL-cholesterol concentration. Second, it seems that obesity lowers the concentration of HDL particles independently of the triglyceride concentration, which may be due to enhanced catabolism of HDL particles. Variations in lipoprotein metabolism demonstrated that subcutaneous abdominal adipocytes bind to HDL more actively than omental fatty acids and that HDL binding to adipocytes increases with the size of lipid cells (5). Increased HDL binding to adipocytes is found in obesity, particularly in abdominal subcutaneous area. Reduction in body mass results in decreased HDL binding to lipid cells, which can account for reciprocal increase in HDL-cholesterol concentration found in obese individuals who reduced their body mass (6). Negative correlation has been established between HDL cholesterol and body mass index. Low HDL concentration, which represents particular risk for the development of atherosclerosis, is to some extent related to waist-hip measurement ratio and body mass index. After body mass reduction, HDL concentration may initially decrease but it usually increases; it increases more in men than in women.

When obese individuals begin to reduce their energy intake, their HDL cholesterol may slightly increase, as a result of decline in triglyceride concentration, but HDL cholesterol concentration does not return to normal long after body mass reduction. In general, HDL cholesterol in most obese individuals diminishes from 0.13 to 0.26 mmol (7).

noće u krvi, povišenoga arterijskoga krvnog tlaka i niske osjetljivosti za inzulin. Nedovoljna tjelesna aktivnost čimbenik je rizika za razvoj ateroskleroze. Čimbenici rizika za nastanak bolesti srca i krvožilnog sustava na koje se može utjecati tjelesnom aktivnošću su:

- tjelesna masa, koja regulira potrošnju kalorija
- arterijska hipertenzija, gdje tjelesna aktivnost spada u mjere za sprječavanje i liječenje hipertenzije
- šećerna bolest, jer se kod tjelesnog napora razina šećera u krvi snižava
- pušenje i alkohol, tjelesno razgiban i na rekreaciju usmjeren čovjek ima manju želju za cigaretama i alkoholom
- stres, jer rekreacija ublažava stresnu napetost
- lipidi, jer tjelovježba snižava koncentraciju ukupnog kolesterola, LDL-kolesterola, a većinom i triglicerida, dok ponajprije povisuje koncentraciju HDL-kolesterola koji štiti od ateroskleroze (8, 9).

Uzrok za povišenje koncentracije HDL-kolesterola su i povećana aktivnost lipoproteinske lipaze, koje se nalaze pretežito u masnom tkivu i u skeletnim mišićima. Kod žena je razmjerno veća aktivnost lipoproteinske lipaze u masnom i mišićnom tkivu žena uzrok više koncentracije HDL i niže koncentracije VLDL-kolesterola. Slično kao injekcija heparina, redovito uzimanje alkohola uzrokuje povećanje aktivnosti lipoproteinske lipaze iz masnog tkiva, a tjelesna aktivnost povećanje aktivnosti tog enzima iz skeletnih mišića. U oba se slučaja povisuje koncentracija HDL-kolesterola (10).

Aerobnim vježbanjem (npr. trčanjem, vožnjom bicikla, veslanjem ili plivanjem) snižava se koncentracija triglicerida, ukupnog kolesterola i LDL-kolesterola, te primjetno povisuje koncentracija HDL-kolesterola. Ove promjene ovise o intenzivnosti tjelesne aktivnosti.

Veći utjecaj tjelesne aktivnosti na koncentraciju HDL-kolesterola primijećen je kod mlađih muškaraca nego kod starijih, a kod žena manje od muškaraca, i to više kod mlađih nego starijih. Uzimanje kontracepcijskih sredstava koči povišenje HDL-kolesterola u tjelesno aktivnih žena. Pri umjerenom pijenju alkoholnih pića (2 dl vina na dan) koncentracija HDL-kolesterola povisuje se slično kao kod tjelesne aktivnosti, dok se pri pretjeranom uzimanju alkoholnih pića povisuje koncentracija triglicerida. Koncentracija HDL-kolesterola povisuje se kod trčanja i plivanja. U muškaraca i žena od 50 do 65 godina potrebne su dvije godine sustavne intenzivne rekreacije za postizanje promjene u lipidnom statusu (11).

Manje je podataka o sniženju koncentracije LDL-kolesterola pri tjelesnoj aktivnosti.

Debljina je obrnuto povezana s razinom tjelovježbe. Tjelovježba bez redukcijske dijeta rijetko je dovoljna za smanjenje tjelesne mase. Međutim, tjelovježba uz smanjenje

### Lipids and physical training

It is debatable whether early physical training involves prevention of the occurrence of obesity, elevated blood lipid concentration, elevated arterial blood pressure and low insulin tolerance. Insufficient physical activity is a risk factor for early atherosclerosis. Risk factors for the occurrence of cardiovascular disease that are affected by physical activity are as follows:

- body mass that regulates calorie consumption
- arterial hypertension, with physical activity being one of the measures for hypertension prevention and therapy
- diabetes mellitus, as the glucose level declines during physical effort
- smoking and alcohol – desire for smoking and alcohol consumption is lesser in persons who work out and engage in recreational activities
- stress – recreation reduces stress
- lipids – physical exercise decreases the concentrations of total cholesterol, LDL-cholesterol, and mostly also of triglycerides, while primarily increasing HDL-cholesterol concentration which protects against atherosclerosis (8, 9).

The causes of increase in HDL-cholesterol concentration are also activities of lipoprotein lipase found mainly in fat tissue and skeletal muscles. Relatively increased lipoprotein lipase in women's fat and muscle tissue accounts for higher HDL-cholesterol level and lower VLDL concentration. Similarly to heparin injection, regular alcohol consumption causes heightened activity of lipoprotein lipase from the fat tissue, while physical activity enhances the activity of this enzyme from skeletal muscles. In both cases, HDL-cholesterol concentration is elevated (10).

Aerobic exercises (e.g., running, cycling, rowing or swimming) lower the levels of triglycerides, total cholesterol and LDL-cholesterol, and elevate noticeably HDL-cholesterol concentration. These changes depend on intensity of physical activity.

Younger men benefit more from physical activity regarding HDL-cholesterol than the older ones, women benefit less than men, but younger women benefit more than the older ones. The use of contraceptive pills inhibits HDL-cholesterol increase in physically active women. Moderate drinking of alcohol (2 dl wine daily) contributes to HDL-concentration increase in the similar manner as physical activity, while excessive intake of alcoholic beverages elevates triglyceride concentration and exerts harmful effects.

HDL-cholesterol concentration rises during running or swimming. Men and women aged 50–65 years need two years of systematic intense recreation to achieve changes in the lipid status (11).

tjelesne mase omogućava održavanje ili čak povećanje nemasne mase tijela, smanjujući omjer opsega trbuha i opsega bokova, koji su povezani s povećanjem obolijevanja od koronarne bolesti srca, šećerne bolesti i arterijske hipertenzije. Tjelovježba poboljšava podnošenje glukoze.

Većina se istraživača slaže da je umjerena tjelesna aktivnost dovoljna za smanjenje pojedinih čimbenika rizika. Pritom je važnija redovitost, učestalost i trajanje aerobne aktivnosti nego njen intenzitet. Prema rezultatima istraživanja utjecaja tjelovježbe u sekundarnoj prevenciji koronarne bolesti, trend manjeg obolijevanja i smrtnosti opaža se u redovito aktivnih osoba koje tjedno imaju 300 do 400 kcal dodatnog utroška energije pri hodu, vježbanju ili radu umjerenog intenziteta (12).

Sekundarna prevencija koronarne ateroskleroze temelji se na redovitom vježbanju i dijetnoj prehrani.

Danas se smatra kako umjerena tjelesna aktivnost koja se redovito provodi u slobodnom vremenu, a koja nužno ne dovodi do velikog poboljšanja tjelesne spremnosti organizma, može biti dovoljna u primarnoj prevenciji koronarne bolesti srca. U tom slučaju preporuča se aerobna aktivnost koja ima veći utjecaj na promjenu rizičnih čimbenika od ostalih vrsta aktivnosti. Aerobne aktivnosti koje uključuju rad velikih mišićnih skupina tijekom duljeg vremena odabiru se prema zdravstvenom stanju i sklonostima osobe, odnosno bolesnika (pješačenje, brzo hodanje, plivanje, trčanje, vožnja biciklom itd.) (13).

U primarnoj prevenciji koronarne bolesti srca treba se pridržavati općih preporuka o vrsti, intenzitetu, trajanju i učestalosti vježbanja. Preporuka je da aerobna aktivnost bude 65% maksimalne srčane frekvencije, odnosno 50% maksimalnog primitka kisika tijekom 15 do 60 minuta, tri do pet puta na tjedan. Sve navedene odrednice vježbanja definirane su i funkcijskim statusom pojedinca, a svakoj aktivnosti treba prethoditi zagrijavanje, postupno uvođenje u aktivnost i postupni prestanak aktivnosti.

Važno je poučiti i zdrave osobe, a osobito bolesnike, koje se uključuju u tjelesno vježbanje o tome kako prepoznati znakove razvoja srčanih komplikacija, te ih upozoriti na važnost postupnog uključivanja u aktivnost.

Uključivanje u tjelesnu aktivnost započinje organiziranim nadziranim programima u specijaliziranim ustanovama. Svakom vježbanju treba prethoditi 5 do 10 minuta zagrijavanja, vježba istezanja ili hodanja. Istovrstan postupak treba slijediti i na završetku vježbanja. Ovo pravilo važno je poštovati osobito u starijih osoba. Propisano vježbanje i u primarnoj i sekundarnoj prevenciji koronarne bolesti srca mora biti umjereno ugodno, individualno koncipirano, sigurno, opuštajuće, izotonično, kontrolirano i zabavno, kako bi se odustajanje od daljnjeg vježbanja svelo na najmanju mjeru.

There have been few reports on HDL-concentration decline during physical activity. Obesity is inversely proportional to the level of physical exercise. Physical activity without reduction diet is seldom sufficient to achieve body mass reduction. Nevertheless, along with body mass reduction, physical exercise allows maintenance or even increase in non-fat body mass, leading to reduced waist-hip measurement ratio which is otherwise related to increased development of coronary disease, diabetes mellitus and arterial hypertension. Physical training also improves glucose tolerance.

Most researchers agree that moderate physical activity is sufficient to reduce individual risk factors. In this regard, regularity, frequency and duration of aerobic activity is more important than its intensity. According to results of studies on effect of physical training in secondary prevention of coronary disease, the tendency of lower morbidity and mortality was observed in regularly active individuals with 300–400 kcal of weekly additional energy consumption during walking, exercises or work of moderate intensity (12).

Secondary prevention of coronary atherosclerosis is based on regular exercise performance and low-calorie diet.

Current opinion is that moderate physical activity, performed regularly during spare time, may not necessarily lead to substantial improvement in body fitness but may be sufficient in primary prevention of coronary disease. In this case, aerobic activity is recommended as it has more substantial impact on changes in risk factors than other types of activities. Aerobic activities that involve action of large muscle groups during a prolonged period are selected according to medical condition and preferences of an individual, i.e. patient (hiking, race walking, swimming, jogging, cycling, etc.) (13).

Primary prevention of coronary disease implies adherence to general recommendations on the type, intensity, duration and frequency of exercise. It is recommended that aerobic activity be 65% of maximum cardiac frequency, i.e. 50% of the maximum oxygen intake during 15–60 minutes three to five times a day. All these exercise guidelines are also determined by individual's functional status, and every exercise should be composed of initial warming up, gradual introduction of activity and its gradual termination.

It is important to instruct both healthy individuals and particularly patients who are to take part in physical exercise on how to recognize the signs of developing cardiac complications and warn them of the importance of gradual involvement in physical activity.

Participation in physical activity begins with organized and supervised programs in specialized institutions. Each exercise should be preceded by 5–10 minutes of warming up, stretching exercises or walking. The same procedure should be followed also at the end of exercises. Elderly

## Zaključak

Povišenje koncentracije serumskog kolesterola i krvnog tlaka, debljina, pušenje, tjelesna neaktivnost i šećerna bolest neovisni su činitelji koji povećavaju rizik od kardiovaskularne bolesti. Danas se zna da je njihovom kontrolom moguće smanjiti obolijevanje i usporiti napredovanje bolesti. To podrazumijeva i provođenje dijetne prehrane sa smanjenim ukupnim unosom masnoća (oko 30% energije) i promicanje zdrave tjelesne aktivnosti primjerene dobi. Utvrđuje se kako tjelesna aktivnost ima značajan pozitivni korektivni i preventivni utjecaj na sve čimbenike rizika, što je sa zdravstvenog stajališta najznačajnije.

persons should be particularly observant of this rule. The exercises required both in primary and secondary prevention of coronary disease must be moderately pleasant, outlined individually, safe, relaxing, isotonic, controlled and funny in order to minimize withdrawal from training.

## Conclusion

Increase in serum cholesterol concentration and blood pressure, obesity, smoking, physical inactivity and diabetes are independent factors that enhance the risk for cardiovascular disease. Presently it is known that the disease incidence could be reduced and its progression retarded by controlling these factors. The control also involves adherence to the low calorie diet with reduced total fat intake (approximately 30% of energy) and promotion of healthy physical activity appropriate to age. It may be concluded that physical activity has significant positive corrective and preventive effect on all the above risk factors, which is the most important conclusion from the aspect of health care

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