Indeks tjelesne mase populacija istočne obale Jadrana od antike do novog vijeka

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SADRŽAJ / CONTENTS

INDEKS TJELESNE MASE POPULACIJA ISTOČNE OBALE JADRANA OD ANTIKE DO NOVOG VIJEKA

BODY MASS INDEX IN THE POPULATIONS OF THE EASTERN ADRIATIC COAST FROM ANTIQUITY TO THE MODERN PERIOD

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Indeks tjelesne mase arheoloških populacija dobar je indikator nutritivnog opterećenja organizma te može uputiti na kvalitetu života i zdravlje pojedine populacije i služiti kao usporedba među populacijama. U radu su analizirani koštani ostatci s arheoloških nalazišta s područja istočne obale Jadrana datirani u razdoblja od antike do novog vijeka. Iako je riječ o relativno malom uzorku, rezultati istraživanja pokazali su smanjenje kvalitete života, odnosno tjelesne mase u muškaraca, i to u razdobljima razvijenog i kasnog srednjeg vijeka, a što je u skladu s prethodnim istraživanjima hrvatske populacije. Žene su tijekom svih razdoblja imale sličnu, konstantnu tjelesnu masu, što se osim raspodjelom rada i dostupnosti hrane može objasniti i hormonskim utjecajima te drukčijim metabolizmom masti. Indeks tjelesne mase pokazao se kao dobar indikator za dopunu spoznaja o kvaliteti života i zdravlju arheoloških populacija.

Key words:
body mass index, eastern coast of the Adriatic, antiquity, Middle Ages, Modern Period, quality of life

Body mass index in archaeological populations is a good indicator of the nutritional load of the organism. It can suggest the quality of life and health of a certain population, or it can be used for comparing populations. Bone remains from archaeological sites on the eastern coast of the Adriatic, dated to the period from antiquity to the Modern Period, were analyzed in the paper. Although it is a relatively small sample, the results of the research showed a decrease in the quality of life, that is, body mass for males, in the periods of the High and Late Middle Ages, which is in line with previous research into Croatian population. During all periods, females had similar, constant body mass, which can be explained not only by the division of labor and availability of food, but also by hormonal influences and different fat metabolism. Body mass index proved to be a good indicator for supplementing knowledge about the quality of life and health of archaeological populations.

UVOD

Razvoj metoda za izračun tjelesne mase (TM) te samim time i indeksa tjelesne mase (ITM) iz koštanih ostataka arheoloških populacija omogućio je nove vrste analiza iz kojih se može doznati više o kvaliteti života i zdravlju povijesnih populacija. Ovakve analize dopuna su grobnim prilozima i načinima ukopa u spoznajama o društvenom statusu pojedinca i populacije jer se smatra da je ITM dobar indikator nutritivnog opterećenja.[1]

Kako bi se procijenio utjecaj životnog stila na kostur i zube, antropolozi se služe brojnim indikatorima, poput izraženosti mišićnih hvatišta, osteoartritisa, bolesti zuba i alveola, pokazatelja subadultnog stresa, patoloških promjena i sl., no jedan od važnih indikatora je i tjelesna masa jer je upravo ona jedna od sila koje djeluju na kostur i utječu na njegove promjene. Na povećanje ili smanjenje tjelesne mase utječu ishrana, aktivnosti i ponašanje čovjeka.[2] Većina istraživača smatra da tjelesna masa utječe više na kostur donjih udova nego gornjih,[3] te da su dimenzije zglobnih ploha bolji indikator promjena u tjelesnoj masi od drugih mjera kostiju, poput širine dijafiza dugih kostiju.[4] U skladu s Wolffovim zakonom[5] kost će se tijekom života remodelirati kao odgovor na sile koje na nju utječu, a među te sile mogu se ubrojiti tjelesna težina, duljina kosti, aktivnosti i sl.[6]

Istraživanja TM-a i ITM-a na arheološkim populacijama u svijetu su brojna. Sva istraživanja proizlaze iz postojećih metoda te brojnih evaluacijskih metoda postojećih formula za izračun navedenih vrijednosti. Tako su istraživanja pokazala da okrugliji oblik bedrene i goljenične kosti na razini hranidbenog otvo-

1 COLE 1991: 83–111; FERRO-LUZZI et al. 1992: 173–186.
2 DANESHVARI 2011: 26.
3 AIELLO, DEAN 1994: 257–268; RUFF 2000: 269–290.
4 RUFF 1991: 81–105; RUFF, TRINKAUS, HOLLIDAY 1997: 173–176; TRINKAUS, CHURCHILL, RUFF 1994: 1–34.
5 WOLF 1870: 389–453.
6 DAMUTH, MACFADDEN 1990: 1–10; DANESHVARI 2011: 26.

INTRODUCTION

The development of methods for calculating body mass (BM) and thus also body mass index (BMI) from the bone remains of archaeological populations has enabled new types of analysis revealing more about the quality of life and health of historical populations. Such analyses complement the grave goods and methods of burial regarding the knowledge about the social status of an individual and population, because it is considered that BMI is a good indicator of nutritional load.[1]

In order to assess the influence of lifestyle on the skeleton and teeth, anthropologists use numerous indicators, such as the characteristics of muscle attachment sites, osteoarthritis, diseases of the teeth and alveoli, indicators of subadult stress, pathological changes, etc., but one of the important indicators is body mass because it is one of the forces that act on the skeleton and influence its changes. The increase or decrease in body weight is influenced by diet, activities and human behavior.[2] Most researchers believe that body mass affects the skeleton of the lower limbs more than the upper ones,[3] and that the dimensions of the joint surfaces are a better indicator of changes in body mass than other bone measurements, such as the width of the diaphyses of long bones.[4] According to Wolff's law,[5] bone will be remodeled over time in response to the forces affecting it, and these forces can include body weight, bone length, activities, etc.[6]

There are numerous studies of BM and BMI in archaeological populations in the world. All the research stems from the existing methods and numerous evaluation methods of existing formulas for calculating the specified values. Thus, research has shown that the rounder shape of the femur and

1 COLE 1991: 83–111; FERRO-LUZZI et al. 1992: 173-186.
2 DANESHVARI 2011: 26.
3 AIELLO, DEAN 1994: 257-268; RUFF 2000: 269-290.
4 RUFF 1991: 81-105; RUFF, TRINKAUS, HOLLIDAY 1997: 173-176; TRINKAUS, CHURCHILL, RUFF 1994: 1–34.
5 WOLF 1870: 389-453.
6 DAMUTH, MACFADDEN 1990: 1-10; DANESHVARI 2011: 26.

ra upućuje na povećanje mehaničkog stresa, a koje Bennett[7] povezuje s povećanjem tjelesne mase pri prelasku na poljoprivredu. Ova teorija nije općeprihvaćena jer su neki istraživači[8] zamijetili upravo suprotan učinak, odnosno da se okrugliji oblik kosti javlja u osoba koje su izložene nižem mehaničkom stresu. Larsen[9] je zamijetio da se u vrijeme prelaska na poljoprivredu smanjuje prosječna tjelesna visina zbog većeg nutricionalnog stresa, a u korelaciji s većim fiziološkim stresom i nekvalitetnijom prehranom zamijetio je i povećanje broja karioznih lezija, veću učestalost periostitisa i osteoartritisa. Kao kod Larsena, i kod Williamsona[10] zamijećena je veća količina osteoartritisa u pred-poljoprivrednim društvima nego nakon prelaska na poljoprivredu, što upućuje na fizički znatno zahtjevniji život lovaca – sakupljača.[11] Isto tako, zamijećen je i pad prosječne tjelesne visine, i to više u žena, odnosno manje dimenzije postkranijalnog kostura kod poljoprivrednih društava za razliku od pred-poljoprivrednih.[12]

Larsen[13] smatra da su čimbenici koji su utjecali na smanjenje dimenzija postkranijalnog kostura te posljedično pad prosječne tjelesne visine: niži mehanički stres (što objašnjava i zamijećeno smanjenje osteoartritisa) te povećani nutricionalni stres. Niži mehanički stres na organizam utječe na smanjenje prosječne tjelesne visine i smanjenje robusnosti kosti. Nutricionalni stres najvjerojatnije je posljedica povećanja prehrane temeljene na uglikohidratima te smanjenja unosa proteina koji utječu na metabolizam i razvoj kostura.[14] S povećanjem gustoće populacije koja je pratila poljoprivredna društva povećava se i izloženost uzročnicima bolesti te kombinacija svih navedenih stresora doprinosi smanjenju prosječne

[7] DANESHVARI 2011: 148 *prema* BENNETT 1973.
[8] LOVEJOY, TRINKAUS 1980: 465–470.
[9] LARSEN 1982: 241–245.
[10] WILLIAMSON 2000: 890–900.
[11] DANESHVARI 2011: 26, 148.
[12] LARSEN 1982: 241–245.
[13] LARSEN 1982: 241–245.
[14] STINI 1969: 417–426; FRISANCHO et al. 1973: 255–262.

tibia at the level of the nutrient foramen indicates an increase in mechanical stress, which Bennett[7] associates with an increase in body weight when transition to agriculture happened. This theory is not generally accepted because some researchers[8] have noticed the exact opposite effect, namely that a rounder bone shape occurs in persons who are exposed to lower mechanical stress. Larsen[9] noticed that at the time of the transition to agriculture, the average body height decreased due to higher nutritional stress, and in correlation with higher physiological stress and poorer nutrition, he also noticed an increase in the number of carious lesions, a higher incidence of periostitis and osteoarthritis. As with Larsen and Williamson,[10] higher incidence of osteoarthritis was observed in pre-agricultural societies than after the transition to agriculture, suggesting much more physically demanding life of hunter-gatherers.[11] Likewise, a drop in average body height was observed, more so in females, that is, smaller dimensions of the postcranial skeleton in agricultural societies, as opposed to pre-agricultural ones.[12]

Larsen[13] believes that factors that influenced the reduction of the dimensions of the postcranial skeleton and the consequent drop in average body height are: lower mechanical stress (which also explains the observed decrease in osteoarthritis) and increased nutritional stress. Lower mechanical stress affects the reduction of the average body height and the reduction of bone robustness. Nutritional stress is most likely the result of an increase in carbohydrate-based diet and a decrease in protein intake, which affect metabolism and skeletal development.[14] With the increase in population density that accompanied agricultural societies, the exposure to disease-causing agents also increased, and the combination of all the above-mentioned stressors contributed to a

[7] DANESHVARI 2011: 148 according to BENNETT 1973.
[8] LOVEJOY, TRINKAUS 1980: 465-470.
[9] LARSEN 1982: 241-245.
[10] WILLIAMSON 2000: 890-900.
[11] DANESHVARI 2011: 26, 148.
[12] LARSEN 1982: 241-245.
[13] LARSEN 1982: 241-245.
[14] STINI 1969: 417-426; FRISANCHO et al. 1973: 255-262.

tjelesne visine.[15]

Kada se promotre istraživanja na hrvatskim populacijama, zamjetno je da prelazak na poljoprivredu odnosno povećanje unosa ugljikohidrata utječe na zdravlje populacije, osobito na žene, koje su jele više ugljikohidratnih obroka dnevno, dok su muškarci jeli manje obroka, ali bogatijih proteinima, što je izravno utjecalo na pojavnost pojedinih bolesti, poput zubnog karijesa.[16]

S prijelazom na poljoprivredu postojala je mogućnost prikupljanja i pohrane namirnica, što je omogućilo dostupnost hrane tijekom cijele godine te smanjilo oscilacije u težini i pridonijelo povećanju tjelesne mase. Nadalje, to je pridonijelo i stratifikaciji stanovništva na one koji su imali više zaliha hrane i bolju dostupnost od drugih u istoj zajednici,[17] a što se očitovalo i u tjelesnoj masi.[18]

No, nije samo vrsta prehrane utjecala na promjene u tjelesnoj masi i tjelesnoj visini, na njih su utjecale i dostupnost i količina hrane, te je moguće općenito kazati da nedostupnost hrane utječe na smanjenje tjelesne težine, a dostupnost na njezino povećanje.[19] U jednom je istraživanju pokazano kako se ženama prelaskom na prehranu temeljenu većinom na ugljikohidratima povećala tjelesna masa (u istraživanju je zamijećen veći broj žena s ITM > 30), a također je zamijećeno povećanje zubnog karijesa, što oboje može upućivati na veću dostupnost ugljikohidrata.[20]

Do sada u hrvatskoj populaciji nisu rađena istraživanja ITM-a ni na jednom arheološkom nalazištu, niti su ona uspoređena uzevši u obzir prostorno-vremenske okolnosti. No, s druge su se strane brojna istraživanja bavila kvalitetom života i zdravljem hrvatskih populacija, te čine vrijedan izvor spoznaja o životima naših predaka. Tako istraživači zamjećuju

[15] LARSEN 1982: 241–245.
[16] ŠLAUS 2006: 110–117; ANTERIĆ 2014: 259–286.
[17] DANESHVARI 2011: 11–12.
[18] DANFORTH 1999: 10–15.
[19] LARSEN 1982: 241–245.
[20] LARSEN 1982: 241–245; DANESHVARI 2011: 159.

decrease in average body height.[15]

When looking at research into Croatian populations, it is noticeable that the transition to agriculture, i.e. the increase in carbohydrate intake, affects the health of the population, especially women, who ate more carbohydrate meals per day, while men ate fewer meals, but more protein-rich, which directly affected incidence of certain diseases, such as dental caries.[16]

With the transition to agriculture, there was the possibility of collecting and storing food, which enabled the availability of food throughout the year and reduced fluctuations in weight and also contributed to an increase in body mass. Furthermore, this contributed to the stratification of the population into those who had more food supplies and better food availability than others in the same community,[17] which was also reflected in body mass.[18]

However, not only the type of diet influenced changes in body weight and body height, they were also influenced by the availability and quantity of food, and it is possible to say in general that the unavailability of food affects the reduction of body weight, while the food availability increases it.[19] One study showed that when women switched to a diet based mostly on carbohydrates, their body mass increased (in the study, a greater number of women with a BMI>30 were observed), and an increase in dental caries was also observed, which both may indicate a greater availability of carbohydrates.[20]

Until now, there have been no studies of BMI in the Croatian population at archaeological sites, nor have they been compared taking into account the spatial and chronological circumstances. However, on the other hand, numerous studies have dealt with the quality of life and health of the Croatian populations, and constitute a valuable source of knowledge about the

[15] LARSEN 1982: 241-245.
[16] ŠLAUS 2006: 110-117; ANTERIĆ 2014: 259-286.
[17] DANESHVARI 2011: 11-12.
[18] DANFORTH 1999: 10-15.
[19] LARSEN 1982: 241-245.
[20] LARSEN 1982: 241-245; DANESHVARI 2011: 159.

veću pojavnost zubnog karijesa i drugih zubnih oboljenja u srednjem vijeku u odnosu na antiku, veću zastupljenost hipoplazije zubne cakline i *cribra orbitalia* u kasnoantičkom i kasnosrednjovjekovnom uzorku nego u starohrvatskome, veću zastupljenost periostitisa u kasnosrednjovjekovnom razdoblju u odnosu na kasnoantički i starohrvatsku populaciju te veću smrtnost u kasnosrednjovjekovnom razdoblju nego u starohrvatskom razdoblju.[21] Kako bi se ova istraživanja upotpunila i uputilo na mogućnost uporabe još jedne varijable u proučavanju arheoloških populacija, cilj je ovog istraživanja upotpuniti dosadašnje spoznaje o životu hrvatskih populacija, sagledavajući promjene među populacijama s pomoću indeksa tjelesne mase.

MATERIJALI I METODE

Materijali

U istraživanje su uključeni nalazi sa sljedećih lokaliteta iz antike: Dominisova 5,[22] Slano,[23] Solin EVN, Solin – Smiljanovac[24] i Solin – Sv. Duje cesta.[25] Iz ranosrednjovjekovnog razdoblja analizirani su koštani ostatci s nalazišta Donja Rupotina – Vlačine,[26] Trogir – Trpimirova, Otres,[27] Rižinice,[28] Svećurje – Žestinj,[29] Ostrovica – Greblje[30] i Bijaći – Stombrate.[31] Groblja koja su dijelom svojom datacijom zahvaćala i rani i kasni srednji vijek, ali su pretežito bila u razvijenom srednjem vijeku, za potrebe ovog rada svrstana su u razvijeni srednji vijek: Jagnilo Greblje, Strožanac – Gospa u Siti[32] i

lives of our ancestors. Thus, the researchers note a higher incidence of dental caries and other dental diseases in the Middle Ages compared to antiquity, a higher prevalence of tooth enamel hypoplasia and *cribra orbitalia* in the late antique and late medieval sample than in the old Croatian one, a higher prevalence of periostitis in the late medieval period compared to the late antique and old Croatian population and higher mortality in the late medieval period than in the old Croatian period.[21] In order to complete this research and point to the possibility of using another variable in the study of archaeological populations, the goal of this research is to complement the previous knowledge about the life of Croatian populations, observing the changes between populations reflected in body mass index.

MATERIALS AND METHODS

Materials

The research included finds from the following sites dating to antiquity: Dominisova 5,[22] Slano,[23] Solin EVN, Solin-Smiljanovac[24] and Solin-Sv. Duje road.[25] Bone remains from the early medieval period were analyzed from the sites of Donja Rupotina-Vlačine,[26] Trogir-Trpimirova, Otres,[27] Rižinice,[28] Svećurje-Žestinj,[29] Ostrovica-Greblje[30] and Bijaći-Stombrate.[31] The cemeteries, which in part date to the Early and Late Middle Ages, but predominantly belong to the High Middle Ages, for the purposes of this paper were classified into the High Middle Ages: Jagnilo Greblje, Strožanac-Gospa u Siti[32] and

21 ŠLAUS 2006: 98–107, 110–117, 135–138; ANTERIĆ 2014: 259–286.
22 KATUNARIĆ KIRJAKOV 2018.
23 MAROVIĆ 1956: 9–30.
24 GALIOT 2011.
25 KATAVIĆ, JERONČIĆ 2014: 81–112.
26 JELOVINA 1976.
27 ZEKAN 1983: 33–34.
28 GUDELJ 2014: 573–574.
29 BURIĆ 2015: 165–208.
30 ANTERIĆ et al. 2015: 14.
31 BURIĆ 1992: 55–57.
32 BLAŽEVIĆ 2017.

21 ŠLAUS 2006: 98-107, 110-117, 135-138; ANTERIĆ 2014: 259-286.
22 KATUNARIĆ KIRJAKOV 2018.
23 MAROVIĆ 1956: 9-30.
24 GALIOT 2011.
25 KATAVIĆ JERONČIĆ 2014: 81-112.
26 JELOVINA 1976.
27 ZEKAN 1983: 33-34.
28 GUDELJ 2014: 573-574.
29 BURIĆ 2015: 165-208.
30 ANTERIĆ et al. 2015: 14.
31 BURIĆ 1992: 55-57.
32 BLAŽEVIĆ 2017.

Solin Rupotine – Crkvine.[33] U kasni srednji vijek svrstani su: Martinovići – Velika Gospa,[34] Gornji Koljani – Crkvina,[35] Šopot Benkovac[36] i Kamenmost – Kaldrma.[37] U rani novi vijek svrstani su: Otok – Vuletina Rupa Grebčine[38] i Dominikanski samostan svete Katarine. U kasni novi vijek svrstana je Bračević Kapelica. Naknadno su zbog malog uzorka spojeni ranonovovjekovni i kasnonovovjekovni lokaliteti.

Metode

Koštani ostatci oprani su, postavljeni u anatomski položaj, izmjereni standardnim osteološkim mjerama te su im procijenjeni spol, dob, patološke i traumatske promjene.[39] U analizu su uvršteni kosturi koji su završili rast, koji su bili izvrsno očuvani te im je bilo moguće procijeniti spol i izmjeriti mjere bedrene kosti. Također su za ovo istraživanje odabrani samo kosturi bez patoloških i traumatskih promjena koje bi mogle utjecati na mjerenja i procjenu spola.

Mjere kostiju u centimetrima (duljina bedrene kosti i promjer glave bedrene kosti), uvrštene su u jednadžbe za izračun TM-a, odnosno prosječne tjelesne visine te ITM-a. ITM je korišten kao heuristički postupak za proučavanje razlika u težini s obzirom na prosječnu tjelesnu visinu. Tjelesna masa izračunana je na temelju promjera glave bedrene kosti prema Ruffovoj metodi, kako slijedi:

Tjelesna masa žene =
2,18 x promjer bedrene kosti – 35,8

Tjelesna masa muškarci =
2,18 x promjer bedrene kosti – 66,7[40]

Solin Rupotine-Crkvine.[33] The following sites were classified into the Late Middle Ages: Martinovići-Velika Gospa,[34] Gornji Koljani-Crkvina,[35] Šopot Benkovac[36] and Kamenmost-Kaldrma.[37] The following sites were classified into the Early Modern Period: Otok-Vuletina Rupa Grebčine[38] and the Dominican monastery of St. Catherine. Bračević Kapelica is dated to the Late Modern Period. Subsequently, Early and Late Modern Period sites were joined due to the small sample.

Methods

Bone remains were washed, placed in anatomical position, measured according to osteological standards, and their sex, age, pathological and traumatic changes were assessed.[39] The analysis included skeletons that had completed growth, were excellently preserved, and it was possible to assess their sex and measure the femur measurements. Also, only skeletons without pathological and traumatic changes that could affect measurements and sex assessment were selected for this research.

Bone measurements in centimeters (femur length and diameter of the femoral head) were included in the equations for calculating BM, that is, average body height and BMI. BMI was used as a heuristic procedure to study differences in weight with respect to average body height. Body mass was calculated based on the femoral head diameter according to Ruff's method, as follows:

Body mass, females =
2.18 x femoral head diameter – 35.8

Body mass, males =
2.8 x femoral head diameter – 66.7[40]

33 ŠARIĆ 1992: 118–120.
34 PERKIĆ, PERKIĆ 1998.
35 JURČEVIĆ 2008: 135–150.
36 BURIĆ 1994: 45–50.
37 ANĐELINOVIĆ et al. 2009.
38 LIBRENJAK 2012.
39 AUFDERHEIDE, RODRÍGUEZ-MARTÍN, LANGSJOEN 1998; ISCAN, STEYN 2013.
40 RUFF et al. 2012: 11.

33 ŠARIĆ 1992: 118-120.
34 PERKIĆ, PERKIĆ 1998.
35 JURČEVIĆ 2008:135-150.
36 BURIĆ 1994: 45-50.
37 ANĐELINOVIĆ et al. 2009.
38 LIBRENJAK 2012.
39 AUFDERHEIDE, RODRÍGUEZ-MARTÍN, LANGSJOEN 1998; ISCAN, STEYN 2013.
40 RUFF et al. 2012: 11.

Prosječna tjelesna visina također je izračunana prema Ruffovim jednadžbama:[41]

Prosječna tjelesna visina muškaraca =
2,72 x duljina bedrene kosti + 42,85 ± 3,21

Prosječna tjelesna visina žena =
2,69 x duljina bedrene kosti + 43,56 ± 2,92

Navedene su jednadžbe za izračun prosječne tjelesne visine odabrane jer je Ruff svoje istraživanje temeljio na europskim populacijama u širem vremenskom razdoblju od mezolitika do 20. stoljeća[42] te za razliku od ostalih jednadžbi, ne procjenjuju prosječnu tjelesnu visinu. S druge strane, često primjenjivane formule Trottera i Glessera[43] napravljene su za američku bjelačku populaciju, te se smatra da su zamijećene pogreške u izračunu visine rezultat drukčijih proporcija među udovima i visinom.[44] Slično je i s jednadžbama Sjøvolda[45] te Formicola i Franceschija[46] koji su radili na europskoj neolitičkoj populaciji.[47]

Indeks tjelesne mase izračunan je prema formuli dostupnoj na stranici Svjetske zdravstvene organizacije (WHO), kako slijedi:[48]

$$ITM = \frac{tjelesna\ težina\ (kg)}{(tjelesna\ težina\ (m))^2}$$

Ne uzimajući u obzir spol i dob, ITM može se podijeliti u sljedeće kategorije: < 18,5 pothranjenost, 18,5 – 24,9 normalna (idealna) tjelesna težina, 25,0 – 29,9 prekomjerna tjelesna težina, 30,0 – 34,9 pretilost tipa I, 35,0 – 39,9 pretilost tipa II, > 40 pretilost tipa III.

Za utvrđivanje razlika među pojedinim gru-

Average body height was also calculated according to Ruff's equations:[41]

Average height, males =
2.72 x femur length + 42.85 ± 3.21

Average height, females =
2.69 x femur length + 43.56 ± 2.92

The above equations for calculating the average body height were chosen because Ruff based his research on European populations in a wider time span from the Mesolithic to the 20th century, [42] and unlike other equations, they do not overestimate the average body height. On the other hand, the frequently applied formulas of Trotter and Glesser[43] were made for the American white population, and it is considered that the observed errors in height calculation are the result of different proportions between limbs and height.[44] It is similar with the equations of Sjøvold[45] or Formicolo and Franceschi[46] who worked on the European Neolithic population.[47]

Body mass index was calculated according to the formula available on the World Health Organization (WHO) website, as follows:[48]

$$BMI = \frac{body\ weight\ (kg)}{(body\ height\ (m))^2}$$

Without considering sex and age, BMI can be divided into the following categories: <18.5 underweight, 18.5 – 24.9 normal (ideal) body weight, 25.0 – 29.9 overweight, 30.0 – 34.9 type I obesity, 35.0 –39.9 type II obesity, > 40 type III obesity.

Analysis of variance (ANOVA) was used

41 RUFF et al. 2012: 6.
42 RUFF et al. 2012: 1–17.
43 TROTTER, GLESER 1952: 463–514.
44 FORMICOLA 1993: 351–358.
45 SJØVOLD 1990: 431–447.
46 FORMICOLA, FRANCESCHI 1996: 83–88.
47 RUFF et al. 2012: 6–7.
48 WHO 2023.

41 RUFF et al. 2012: 6.
42 RUFF et al. 2012: 1-17.
43 TROTTER, GLESER 1952: 463-514.
44 FORMICOLA 1993: 351-358.
45 SJØVOLD 1990: 431-447.
46 FORMICOLA, FRANCESCHI 1996: 83-88.
47 RUFF et al. 2012: 6-7.
48 WHO 2023.

pama (spol i razdoblje) korištena je analiza varijance (ANOVA). Razina statističke značajnosti postavljena je na $P \leq 0,05$.

to determine differences between individual groups (sex and period). The level of statistical significance was set at $P \leq 0.05$.

REZULTATI

U tablici 1 prikazani su podatci o indeksu tjelesne mase po razdobljima.

RESULTS

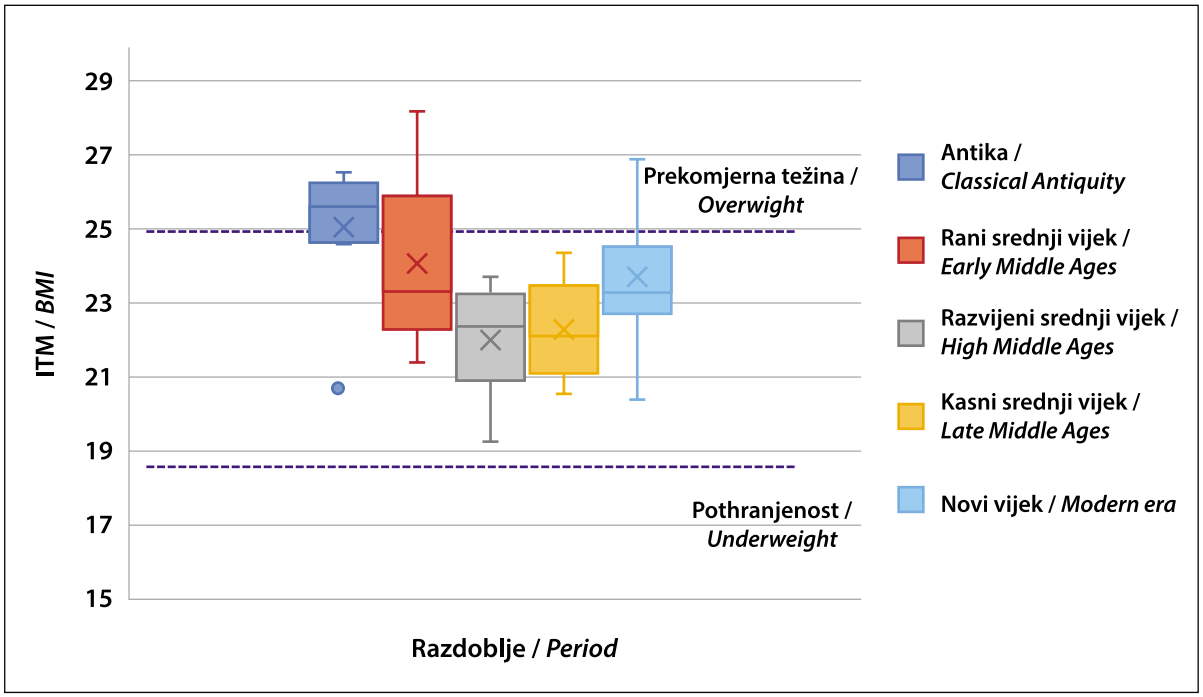
Table 1 shows data on body mass index by period.

TABLICA 1. *Indeks tjelesne mase od antike do novog vijeka* (izradila: Ž. Bašić)
TABLE 1 *Body mass index from antiquity to the Modern Period* (made by: Ž. Bašić)

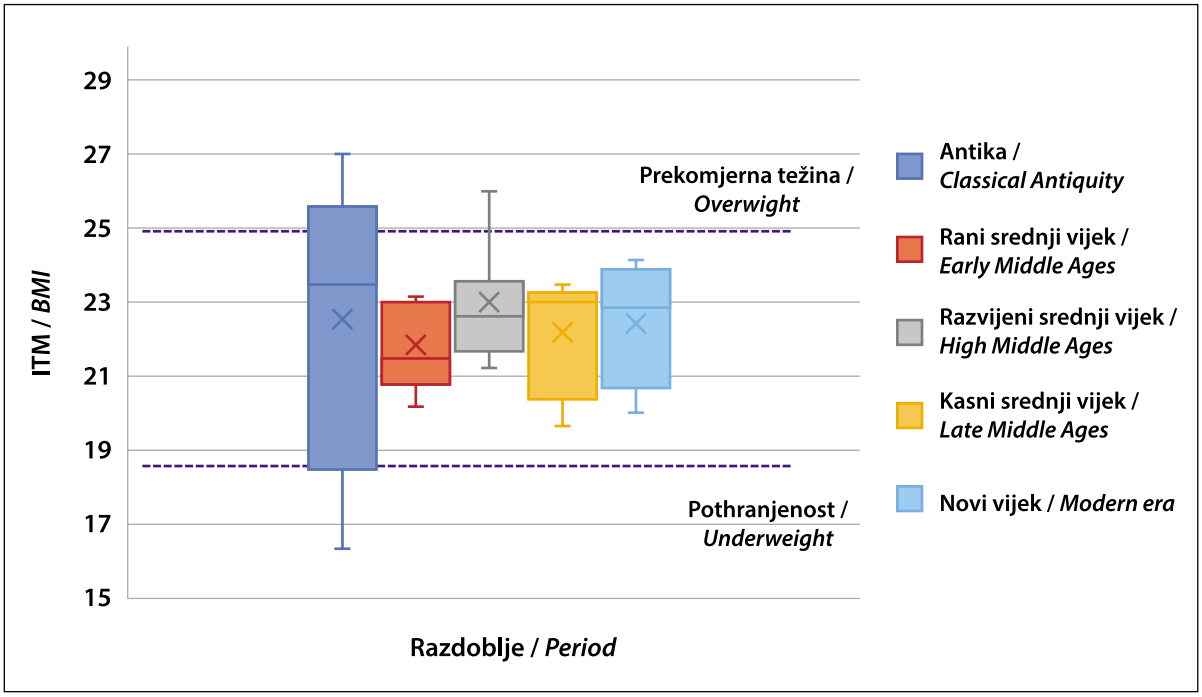
Razdoblje / *Period*	**Medijan ITM muškarci (raspon); n / *Median BMI men (range); n***	**Medijan ITM žene (raspon); n / *Median BMI women (range); n***	**Medijan ITM ukupno (raspon); n / *Median BMI total (range); n***
Antika / *Classical Antiquity*	26,2 (21,7–27,9); 10	22,1 (16,5–27,5); 5	25 (16,5–27,9); 15
Rani srednji vijek / *Early Middle Ages*	25,1 (21,8–29,4); 16	22,1 (20,5–23,8); 9	24 (20,5–29,4); 25
Razvijeni srednji vijek / *High Middle Ages*	22,7 (19,7–24,6); 10	23,2 (21,6–26,6); 9	22,9 (19,7–26,6); 19
Kasni srednji vijek / *Late Middle Ages*	23,0 (21,4–24,8); 8	22,4 (19,9–24,0); 5	22,8 (19,9–24,8); 13
Novi vijek / *Modern era*	24,5 (2,74–28,4); 11	22,8 (20,3–24,6); 4	24,0 (20,3–28,4); 15

Grafički su prikazane promjene u indeksu tjelesne mase u promatranim razdobljima (Sl. 1 i 2).

Changes in body mass index in the observed periods are shown graphically (Fig. 1 and 2).



SLIKA 1. *Indeks tjelesne mase muškaraca od antike do novog vijeka* (izradila: Ž. Bašić)
FIGURE 1 *Body mass index for males from antiquity to the Modern Period* (made by: Ž. Bašić)



Slika 2. *Indeks tjelesne mase žena od antike do novog vijeka* (izradila: Ž. Bašić)
Figure 2 *Body mass index for females from antiquity to the Modern Period* (made by: Ž. Bašić)

Vidljiva je statistički značajna razlika u ITM-u za muškarce među razdobljima antike i razvijenog i kasnog srednjeg vijeka (F = 5,282, P = 0,001) (tab. 2).

A statistically significant difference in BMI for males is visible between the periods of antiquity and the High and Late Middle Ages (F = 5.282, P = 0.001) (Tab. 2).

Tablica 2. *Rezultati Post Hoc Tukey testa za muškarce u različitim razdobljima* (izradila: Ž. Bašić)
Table 2 *Post Hoc Tukey test results for males in different periods* (made by: Ž. Bašić)

Usporedba po parovima (medijan) / *Pairwise comparison (median)*		**$HSD_{0,05}$ = 2,469 $HSD_{0,01}$ = 2,999**	**$Q_{0,05}$ =4,002 $Q_{0,01}$ = 4,862**
Antika: Rani srednji vijek / *Classical Antiquity: Early Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 26,20 $M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 25,07	1,13	Q = 1,83 (*P* = 0,695)
Antika: Razvijeni srednji vijek / *Classical Antiquity: High Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 26,20 $M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,73	3,47	Q = 5,62 (*P* = 0,002)*
Antika: Kasni srednji vijek / *Classical Antiquity: Late Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 26,20 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,96	3,24	Q = 5,25 (*P* = 0,005)*
Antika: Novi vijek / *Classical Antiquity: Modern era*	M_{Antika} / $M_{Classical\ Antiquity}$ = 26,20 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,51	1,69	Q = 2,74 (*P* = 0,311)
Rani srednji vijek: Razvijeni srednji vijek / *Early Middle Ages: High Middle Ages*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 25,07 $M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,73	2,34	Q = 3,79 (*P* = 0,071)
Rani srednji vijek: Kasni srednji vijek / *Early Middle Ages: Late Middle Ages*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 25,07 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,96	2,11	Q = 3,41 (*P* = 0,128)
Rani srednji vijek: Novi vijek / *Early Middle Ages: Modern era*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 25,07 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,51	0,56	Q = 0,91 (*P* = 0,967)
Razvijeni srednji vijek: Kasni srednji vijek / *High Middle Ages: Late Middle Ages*	$M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,73 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,96	0,23	Q = 0,38 (*P* = 0,999)
Razvijeni srednji vijek: Novi vijek / *High Middle Ages: Modern era*	$M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,73 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,51	1.78	Q = 2,88 (*P* = 0,263)
Kasni srednji vijek: Novi vijek / *Late Middle Ages: Modern era*	$M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,96 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,51	1,55	Q = 2,51 (*P* = 0,401)

tablica 3. *Rezultati Post Hoc Tukey testa za žene u različitim razdobljima* (izradila: Ž. Bašić)
table 3 *Post Hoc Tukey test results for females in different periods* (made by: Ž. Bašić)

Usporedba po parovima / *Pairwise comparison (median)*		**$HSD_{0,05}$ = 2,215 $HSD_{0,01}$ = 2,672**	**$Q_{0,05}$ =3,945 $Q_{0,01}$ = 4,759**
Antika: Rani srednji vijek / *Classical Antiquity: Early Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 25,00 $M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 23,98	1,02	Q = 1,81 (*P* = 0,704)
Antika: Razvijeni srednji vijek / *Classical Antiquity: High Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 25,00 $M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,94	2,06	Q = 3,67 (*P* = 0,080)
Antika: Kasni srednji vijek / *Classical Antiquity: Late Middle Ages*	M_{Antika} / $M_{Classical\ Antiquity}$ = 25,00 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,76	2,24	Q = 3,99 (*P* = 0,046)*
Antika: Novi vijek / *Classical Antiquity: Modern era*	M_{Antika} / $M_{Classical\ Antiquity}$ = 25,00 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,06	0,94	Q = 1,67 (*P* = 0,760)
Rani srednji vijek: Razvijeni srednji vijek / *Early Middle Ages: High Middle Ages*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 23,98 $M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,94	1,05	Q = 1,86 (*P* = 0,680)
Rani srednji vijek: Kasni srednji vijek / *Early Middle Ages: Late Middle Ages*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 23,98 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,76	1,22	Q = 2,18 (*P* = 0,540)
Rani srednji vijek: Novi vijek / *Early Middle Ages: Modern era*	$M_{Rani\ srednji\ vijek}$ / $M_{Early\ Middle\ Ages}$ = 23,98 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,06	0,08	Q = 0,14 (*P* = 0,999)
Razvijeni srednji vijek: Kasni srednji vijek / *High Middle Ages: Late Middle Ages*	$M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,94 $M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,76	0,18	Q = 0,31 (*P* = 0,999)
Razvijeni srednji vijek: Novi vijek / *High Middle Ages: Modern era*	$M_{Razvijeni\ srednji\ vijek}$ / $M_{High\ Middle\ Ages}$ = 22,94 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,06	1,12	Q = 2,00 (*P* = 0,620)
Kasni srednji vijek: Novi vijek / *Late Middle Ages: Modern era*	$M_{Kasni\ srednji\ vijek}$ / $M_{Late\ Middle\ Ages}$ = 22,76 $M_{Novi\ vijek}$ / $M_{Modern\ era}$ = 24,06	1,30	Q = 2,31 (*P* = 0,480)

Kod žena nije bila vidljiva razlika u ITM-u među razdobljima (F = 2,474, P = 0,051) osim između antike i kasnog srednjeg vijeka, gdje je vidljiva nešto manja, ali još uvijek statistički značajna razlika (p = 0,046) (tab. 3).

U antici je jedan muškarac s normalnom tjelesnom težinom, a deset s prekomjernom; u ranom srednjem vijeku deset s normalnom i šest s prekomjernom, u razvijenom srednjem vijeku deset s normalnom, u kasnom srednjem vijeku osam s normalnom, a u novom vijeku osam s normalnom i tri s prekomjernom. Od žena u antici tri su imale normalnu, a po jedna prekomjernu tjelesnu težinu i pothranjenost, a u svim ostalim razdobljima sve su žene imale normalnu tjelesnu težinu (devet u ranom, osam u razvijenom, pet u kasnom srednjem vijeku, te četiri u novom vijeku) (sl. 1 i 2).

There was no visible difference in BMI for females, between the periods (F = 2.474, P = 0.051), except between antiquity and the Late Middle Ages, where a slightly smaller, but still statistically significant difference was visible (p = 0.046) (Tab. 3).

In the antiquity sample, there was one male with a normal body weight, and ten were overweight; in the Early Middle Ages sample ten males had normal weight and six were overweight, in the High Middle Ages ten had normal weight, in the Late Middle Ages eight had normal weight, and in the Modern Period eight had normal weight and three were overweight. Of the females in the antiquity sample, three had normal weight, and one each was overweight and underweight, and in all other periods all females had normal body weight (9 in the Early Middle Ages, 8 in the High Middle Ages, 5 in the Late Middle Ages, and four in the Modern Period) (Figs. 1 and 2).

RASPRAVA

Ovo je istraživanje, iako preliminarno u smislu veličine uzorka, pokazalo važnost izračuna prosječne tjelesne mase s ciljem sagledavanja kvalitete života i zdravlja arheoloških populacija. Istraživanje je pokazalo statistički značajne razlike između muškaraca u antici i muškaraca u razvijenom i u kasnom srednjem vijeku. Naime, indeks tjelesne mase muškaraca statistički se značajno smanjio u razvijenom i kasnom srednjem vijeku u odnosu na antiku. Ovaj rezultat nije očekivan s obzirom na to da je došlo do promjene u indeksu tjelesne mase dolaskom novih populacija na ove prostore na prijelazu iz antike u rani srednji vijek, a isto tako i smanjenjem životnog standarda i gubitkom pojedinih civilizacijskih dosega. Razdoblje antike u Dalmaciji bilo je razdoblje relativnog mira i prosperiteta što se mijenja tijekom kasne antike dolaskom Avara i Slavena. Istraživanje prehrambenih navika antičke i ranosrednjovjekovne populacije pokazalo je kako antička populacija uvodi u svoju prehranu ribu (pod utjecajem rimskog načina života), dok se tijekom ranog srednjeg vijeka ta navika gubi, a uvodi se učestala konzumacija prosa. Općenito, smanjuje se konzumacija proteina, a povećava konzumacija ugljikohidrata.[49] No, čini se da se pad indeksa tjelesne mase zamjećuje tek u razvijenom i kasnom srednjem vijeku, dok se indeks tjelesne mase nije statistički značajno promijenio u antici i ranom srednjem vijeku. Uz iznimku ovih dvaju razdoblja, vidljivo je da se tjelesna masa u ostalim trima promatranim razdobljima nije značajno mijenjala. Ovo je u skladu s nekim rezultatima prethodnih istraživanja, pa je, primjerice, M. Šlaus zamijetio da je u kasnosrednjovjekovnom razdoblju povećana količina periostitisa te veća smrtnost nego u kasnoantičkoj i starohrvatskoj

[49] LIGHTFOOT, ŠLAUS, O'CONNELL 2012: 534, 544, 549–552.

DISCUSSION

This research, although preliminary in terms of sample size, showed the importance of calculating the average body mass with the aim of assessing the quality of life and health of archaeological populations. The research showed statistically significant differences between males in antiquity and males in the High and Late Middle Ages. Namely, body mass index for males statistically significantly decreased in the High and Late Middle Ages compared to antiquity. This result was not expected considering that a change in body mass index would have been expected at the transition from antiquity to the Early Middle Ages due to the arrival of new populations in these areas, as well as a decrease in the standard of living and the loss of certain civilizational achievements. The period of antiquity in Dalmatia was a period of relative peace and prosperity, which changed during late antiquity with the arrival of the Avars and Slavs. Research into the dietary habits of the ancient and early medieval population showed that the ancient population introduced fish into their diet (under the influence of the Roman way of life), while during the Early Middle Ages this habit was lost and frequent consumption of millet was introduced. In general, the consumption of proteins decreases and the consumption of carbohydrates increases.[49] However, it seems that the decline of body mass index is noticed only in the High and Late Middle Ages, while body mass index did not change with statistical significance in antiquity and the Early Middle Ages. With the exception of these two periods, it is evident that body mass did not change significantly in the other three observed periods. This is in accordance with some results of previous research, for example, M. Šlaus noticed that in the late medieval period, the frequency of periostitis as well as the

[49] LIGHTFOOT, ŠLAUS, O'CONNELL 2012: 534, 544, 549-552.

populaciji. Istraživači zamjećuju veću pojavnost zubnog karijesa i drugih zubnih oboljenja u srednjem vijeku u odnosu na antiku,[50] veću zastupljenost hipoplazije zubne cakline i *cribra orbitalia* u kasnoantičkom i kasnosrednjovjekovnom uzorku, nego u starohrvatskom, veću zastupljenost periostitisa u kasnosrednjovjekovnom razdoblju u odnosu na kasnoantičku i starohrvatsku populaciju, te veću smrtnost u kasnosrednjovjekovnom razdoblju nego u starohrvatskom razdoblju.[51] To se može objasniti mnogim čimbenicima. Naime, kako je prethodno istaknuto, riječ je o relativno malom uzorku. To je, nažalost, čest slučaj kada je riječ o arheološkim populacijama gdje su koštani ostatci često loše očuvani te je samo dio pronađenih osoba dostupan za analize i mjerenje. Tako se gubi dio uzorka i teže je donositi zaključke koji bi se mogli poopćiti na čitavo razdoblje srednjeg vijeka. No, s druge strane, upravo i nalazi drugih istraživanja[52] pokazuju da je došlo do značajnog pogoršanja dijela pokazatelja kvalitete života u kasnosrednjovjekovnom razdoblju, a to su periostitis i smrtnost. Ovakvi se rezultati mogu objasniti i političkim i gospodarskim prilikama odnosno širenjem stanovništva s istočne obale Jadrana u druge krajeve, što je sasvim sigurno utjecalo i na stanovništvo koje kreće u osvajanje novih krajeva, ali i na stanovništvo koje ostaje u svojem habitusu. Moguće je da dolazi do smanjenja dostupnosti hrane jer se smanjuje i dostupna radna snaga, što izravno, uz ljudske gubitke u sukobima, dovodi i do povećanog broja infekcija i veće smrtnosti. Upravo je i Šlaus pokazao da je, u njegovu slučaju, u kontinentalnoj Hrvatskoj došlo do smanjenja kvalitete života što se ogledalo kroz povećanje pokazatelja zaraznih bolesti, teškog fizičkog rada i trauma, a osobito se to od-

mortality rate were higher than in the late antique and old Croatian population. Thus, the researchers note a higher incidence of dental caries and other dental diseases in the Middle Ages compared to antiquity,[50] a higher prevalence of tooth enamel hypoplasia and *cribra orbitalia* in the late antique and late medieval sample than in the old Croatian one, a higher prevalence of periostitis in the late medieval period compared to the late antique and old Croatian population, and higher mortality in the late medieval period than in the old Croatian period.[51] This can be explained by many factors. Namely, as previously emphasized, this is a relatively small sample. Unfortunately, this is often the case when it comes to archaeological populations where bone remains are frequently poorly preserved and only a part of the individuals found is available for analysis and measurement. Thus, part of the sample is lost and it is more difficult to draw conclusions that could be generalized to the entire period of the Middle Ages. But, on the other hand, the findings of other researchers[52] also show that there was a significant deterioration of some indicators of the quality of life in the late medieval period, namely periostitis and mortality. Such results can be explained by political and economic conditions, i.e. the expansion of the population from the eastern coast of the Adriatic to other regions, which most certainly affected the population that sets out to conquer new regions, but also the population that remains in its habitus. It is possible that there is a decrease in the food availability because the available labor force also decreases, which directly, in addition to human losses in conflicts, leads to an increased number of infections and higher mortality. In one of his studies, M. Šlaus showed that there was a decrease in the quality of life in continental Croatia, which was reflected in the increase in the

[50] ŠLAUS et al. 2011: 588.
[51] ŠLAUS 2006: 103–106, 116–117, 121–123, 126 –128, 136–137; ŠLAUS, KOLLMANN, NOVAK, NOVAK 2002: 603.
[52] ŠLAUS 2006: 106, 107, 127, 164, 214.

[50] ŠLAUS et al. 2011: 588.
[51] ŠLAUS 2006: 103-106, 116-117, 121-123, 126-128, 136-137; ŠLAUS, KOLLMANN, NOVAK, NOVAK 2002: 603.
[52] ŠLAUS 2006: 106, 107, 127, 164, 214.

nosilo na muškarce,[53] što je slučaj i u ovom istraživanju.

S druge strane, u žena je nađena mala, ali statistički značajna razlika, i to samo između dvaju razdoblja, između antike i kasnog srednjeg vijeka. S obzirom na veličinu uzorka, moguće je da je ovaj nalaz na razini pogreške, te se može zaključiti da su žene od antike do novog vijeka imale relativno nepromijenjen indeks tjelesne mase. Razlozi mogu biti mnogobrojni, a jedan od mogućih razloga je i drukčiji životni stil žena. Naime, žene su i u drugim istraživanjima imale tendenciju zadržavanja ili povećavanja tjelesne mase, i to iz mnogih razloga: povećane količine fizičkog rada i/ili promjene u podjeli rada (koji utječe na povećanje mišićnih hvatišta), veće dostupnosti hrane temeljene na ugljikohidratima te većeg broja obroka i, naposljetku, smanjenja prosječne tjelesne visine, a zadržavanja slične ili iste tjelesne mase.[54] Istraživanje ranosrednjovjekovne hrvatske populacije koje je bilo usmjereno na socioekonomske razlike promatrane kroz razlike u grobnoj arhitekturi pokazalo je da te razlike nisu vidljive i u pokazateljima fiziološkog stresa, dok su bile vidljive među spolovima, neovisno o socioekonomskom statusu, što je najvjerojatnije posljedica razlika u prehrani.[55] Isto tako, u jednom je istraživanju zamijećeno da postoji veći broj žena s indeksom tjelesne mase većim od prosjeka (> 30) te iako razlike nisu bile statistički značajne, taj je nalaz objašnjen povećanim unosom hrane bazirane na ugljikohidratima.[56] I genetska istraživanja također podupiru ove nalaze; naime, utvrđeno je da su žene (u mezolitiku i neolitiku) imale veći broj reproduktivno sposobnih jedinki (engl. *effective population size*) što se objašnjava društvenim čimbenicima, sjedilačkim načinom života te

[53] ŠLAUS 2006: 107.
[54] LARSEN 1982: 241–245.
[55] VYROUBAL et al. 2020: 92.
[56] DANESHVARI 2011: 180.

indicators of infectious diseases, hard physical work and trauma, and this particularly applied to men,[53] which is also the case in this study.

On the other hand, a small but statistically significant difference was found in females, and only between two periods, between antiquity and the Late Middle Ages. Considering the size of the sample, it is possible that this finding is on the margin of error, and it can be concluded that females from antiquity to the Modern Period had a relatively unchanged body mass index. There can be many reasons, and one of the possible reasons is the different lifestyle of women. Namely, in other studies, women also had a tendency to maintain or increase their body mass, for many reasons: increased amount of physical work and/or changes in the division of labor (which affects the enlargement of muscle attachment sites), greater availability of food based on carbohydrates and a greater number of meals, and finally, reducing the average body height, while maintaining a similar or the same body mass.[54] A study of the early medieval Croatian population that was focused on socioeconomic differences observed through differences in grave architecture showed that these differences were not visible in indicators of physiological stress, while they were visible between the sexes, regardless of socioeconomic status, which is most likely a consequence of differences in nutrition.[55] Likewise, in one study, it was noticed that there is a greater number of females with body mass index higher than average (>30), and although the differences were not statistically significant, this finding was explained by the increased intake of food based on carbohydrates.[56] Genetic research also supports these findings, namely it was determined that there was a larger effective population size among women (in the Mesolithic and Neolithic), which is explained by social factors, a sedentary lifestyle, monogamy and patrilocali-

[53] ŠLAUS 2006: 107.
[54] LARSEN 1982: 241-245.
[55] VYROUBAL et al. 2020: 92.
[56] DANESHVARI 2011: 180.

monogamijom i patrilokalnošću.[57] Zanimljiv je i podatak iz istraživanja moderne populacije; naime, žene tijekom reproduktivnog razdoblja bolje održavaju tjelesnu masnoću od muškaraca. Moguće objašnjenje leži u tome da žene inicijalno imaju veći postotak tjelesne masnoće od muškaraca, a zbog djelovanja estrogena nakon obroka se energija lakše pretvara u masti, a osobito tijekom trudnoće. Ženama se u prvom tromjesečju trudnoće povećava tjelesna masa, čak i bez unosa dodatne energije ili smanjenja fizičke aktivnosti.[58] Također, pokazano je da žene troše manje masti od muškaraca, kada su u sličnom energetskom deficitu. To im tijekom vježbanja daje više energije, a u vremenu neaktivnosti omogućava da uspješnije skladište masno tkivo.[59]

Zanimljivo je i da su žene tijekom svih razdoblja u većini slučajeva imale normalnu tjelesnu težinu, dok su muškarci u razvijenom i kasnom srednjem vijeku imali statistički značajno manje osoba prekomjerne težine nego što su to imali u prethodnim i idućim razdobljima. Nadalje, iako se moglo očekivati da će biti znatno veći broj osoba u uzorku koje su pothranjene, to nije bio slučaj. Samo je jedna žena, u antici, imala ITM koji se može svrstati u pothranjenost (ITM = 16,5). Ovaj rezultat treba uzeti s oprezom s obzirom na to da je riječ o relativno malom uzorku, no isto tako važno je napomenuti da i povećana količina fizičkog rada ipak može utjecati i na mjere dijafiza kostiju,[60] te da veća količina mišićne mase može svrstati osobu i u kategoriju prekomjerne tjelesne težine, unatoč izgledu prosječne (normalne) tjelesne težine.[61] Kao što je prethodno rečeno, ITM se na koštanim ostatcima ne bi trebao gledati pojedinačno za osobu, već se poopćavati za

ty.[57] The information from the research of the modern population is also interesting, namely that women during the reproductive period maintain body fat better than men. A possible explanation lies in the fact that women initially have a higher percentage of body fat than men, and due to the effect of estrogen after a meal, energy is more easily converted into fat, especially during pregnancy. Women gain weight in the first trimester of pregnancy, even without consuming additional energy or reducing physical activity.[58] Also, it has been shown that women use less fat than men when they are in a similar energy deficit. This gives them more energy during exercise, and allows them to store fat tissue more successfully during periods of inactivity.[59]

It is interesting that females during all periods in most cases had a normal body weight, while in the High and Late Middle Ages the number of overweight individuals among males was statistically significantly smaller than in the previous and subsequent periods. Furthermore, although it could have been expected that there would be a significantly higher number of persons in the sample who were underweight, this was not the case. Only one woman, in the antiquity sample, had a BMI that could be classified as underweight (BMI=16.5). This result should be interpreted with caution considering that it is a relatively small sample, but it is also important to note that an increased amount of physical work can still affect the measurements of the bone diaphyses,[60] and that a larger amount of muscle mass can place a person in the overweight category, despite the appearance of average (normal) body weight.[61] As previously stated, BMI on bone remains should not be viewed individually for a person, but should

57 SZÉCSÉNYI-NAGY et al. 2015: 7.
58 WU, O'SULLIVAN 2011: 2–4.
59 CORTRIGHT et al. 1998: 108–110; WU, O'SULLIVAN 2011: 2.
60 AGOSTINI, HOLT, RELETHFORD 2018: 720.
61 ETCHISON et al. 2011: 250.

57 SZÉCSÉNYI-NAGY et al. 2015: 7.
58 WU, O'SULLIVAN 2011: 2-4.
59 CORTRIGHT et al. 1998: 108-110; WU, O'SULLIVAN 2011: 2.
60 AGOSTINI, HOLT, RELETHFORD 2018: 720.
61 ETCHISON et al. 2011: 250.

populaciju jer se tada moguće greške u procjeni ITM-a smanjuju. Ovo je istraživanje pokazalo da je u žena indeks tjelesne mase konstantan tijekom svih promatranih razdoblja, dok se u muškaraca on smanjio u dvama razdobljima srednjeg vijeka, a ove nalaze podupiru i druga istraživanja[62] na ovim prostorima koja pokazuju pad kvalitete života, i to osobito muškaraca, u kasnom srednjem vijeku.

Sagledavajući nalaze istraživanja u povijesnom i arheološkom kontekstu, indeks tjelesne mase pokazao se kao dobar pokazatelj kvalitete života i može se rabiti kao dodatna metoda u proučavanju života arheoloških populacija. Pri tome se trebaju holistički sagledati povijesni događaji, arheološki nalazi, karakteristike ukopa, te svi ostali pokazatelji zdravlja i kvalitete života, kako bi se mogli donijeti precizniji zaključci o pojedinim populacijama.

[62] ŠLAUS 2006: 98–107, 110–117, 135–138.

be generalized to the population because then possible errors in BMI estimation are reduced. This research showed that body mass index for females was constant during all observed periods, while for males it decreased in two periods of the Middle Ages, and these findings are supported by other research[62] in these regions that show a decline in the quality of life, especially for males, in the Late Middle Ages.

Considering the research results in the historical and archaeological context, body mass index proved to be a good indicator of quality of life and can be used as an additional method in the study of life of archaeological populations. Historical events, archaeological finds, characteristics of burials, and all other indicators of health and quality of life should be looked at holistically, in order to be able to draw more precise conclusions about certain populations.

Translation: Marija Kostić

[62] ŠLAUS 2006: 98-107, 110-117, 135-138.

Literatura / References

AGOSTINI, G., HOLT, B. M., RELETHFORD, J. H. 2018, Bone functional adaptation does not erase neutral evolutionary information, *American Journal of Physical Anthropology*, 166(3), 708–729.

AIELLO, L., DEAN, C. 1994, *An Introduction to: Human Evolutionary Anatomy*, London: Academic Press.

ANĐELINOVIĆ, Š., ANTERIĆ, I., BALIĆ, E., BEČIĆ, K., DRNASIN, Ž. 2010, Antropološka analiza osteološkog materijala kasnosrednjovjekovnog nalazišta Kamen Most - Kaldrma, u/in: *Zbornik Stjepan Gunjača i hrvatska srednjovjekovna povijesno-arheološka baština 1,* Zbornik radova sa Znanstvenog skupa "Stjepan Gunjača i hrvatska srednjovjekovna povijesno-arheološka baština": u povodu 100. obljetnice rođenja akademika Stjepana Gunjače, Split, 3.– 6. studenog 2009., Šeparović, T. (ur./ed.), Muzej hrvatskih arheoloških spomenika, Split, Split, 451–462.

ANTERIĆ, I. 2014, *Antropološka analiza srednjovjekovnih groblja s područja srednje Dalmacije*, neobjavljena disertacija/unpublished PhD thesis, Zadar: Sveučilište u Zadru.

ANTERIĆ, I., BEČIĆ, K., BAŠIĆ, Ž., JERKOVIĆ, I., DEFINIS-GOJANOVIĆ, M., ANĐELINOVIĆ, Š. 2015, Ostrovica – Greblje u svjetlu ostalih ranosrednjovjekovnih grobalja s područja južne Hrvatske, *Rezultati arheoloških istraživanja na prostoru Šibensko-kninske županije*, Šibenik, 6.- 9. listopada 2015., knjiga sažetaka/ *Abstract book*, Šibenik, 14.

AUFDERHEIDE, A. C., RODRÍGUEZ-MARTÍN, C., LANGSJOEN, O. 1998, *The Cambridge Encyclopedia of Human Paleopathology*, Cambridge: Cambridge University Press.

BENNETT, K. A. 1973, *The Indians of Point of Pines, Arizona: a comparative study of their physical characteristics*, Tucson: University of Arizona Press.

BLAŽEVIĆ, I. 2017, *Antropološka analiza kosturnih ostataka s nalazišta Gospe u Siti, Strožanac*, neobjavljeni diplomski rad/unpublished master thesis, Split: Sveučilište u Splitu, Sveučilišni odjel za forenzične znanosti.

BURIĆ, T. 1992, Bijaći – Stombrate (novo starohrvatsko groblje u kliškoj županiji – zaštitno sondiranje), *Obavijesti Hrvatskog arheološkog društva,* 24/2, 55–57.

BURIĆ, T. 1994, Crkvina u Šopotu kod Benkovca, *Benkovački ljetopis: časopis za kulturu*, 2, 45–50.

BURIĆ, T. 2015, Starohrvatsko groblje na položaju Svećurje u predjelu Rudine u Kaštel Novom, *Starohrvatska prosvjeta*, 3. ser., 42, 165–208.

COLE, T. J. 1991, Weight-stature indices to measure underweight, overweight and obesity, u/in: Himes, J. H. (ur./ed.), *Assessment of Nutritional Status*, New York: Wiley-Liss.

CORTRIGHT, R. N., CHANDLER, M. P., LEMON, P. W., DICARLO, S. E. 1997, Daily exercise reduces fat, protein and body mass in male but not female rats, *Physiology & Behavior*, 62(1), 105–111.

DAMUTH, J., MACFADDEN, B. J. 1990, Introduction: Body Size and its Estimation, u/in: *Body Size in Mammalian Paleobiology*, Damuth, J., Macfadden, B. J. (ur./eds.), Cambridge: Cambridge University Press, 1–10.

DANESHVARI, S. 2011, *Predicting Body Mass from the Skeleton with an Application to the Georgia Coast*, neobjavljena disertacija/unpublished PhD thesis, Albuquerque: University of New Mexico.

DANFORTH, M. E. 1999, Nutrition and politics in prehistory, *Annual Review of Anthropology*, 28, 1–25.

ETCHISON, W. C., BLOODGOOD, E. A., MINTON, C. P., THOMPSON, N. J., COLLINS, M. A., HUNTER, S. C., DAI, H. 2011, Body mass index and percentage of body fat as indicators for obesity in an adolescent athletic population, *Sports health*, 3(3), 249–252.

FERRO-LUZZI, A., SETTE, S., FRANKLIN, M., JAMES, W. P. 1992, A simplified approach of assessing adult chronic energy deficiency, *European Journal of Clinical Nutrition*, 46(3), 173–186.

FORMICOLA, V. 1993, Stature reconstruction from long bones in ancient population samples: an approach to the problem of its reliability, *American Journal of Physical Anthropology*, 90, 351–358.

FORMICOLA, V., FRANCESCHI, M. 1996, Regression equations for estimating stature from long bones of early holocene European samples, *American Journal of Physical Anthropology*, 100, 83–88.

FRISANCHO, A. R., SANCHEZ, J., PALLARDEL, D., YANEZ, L. 1973, Adaptive significance of small body size under poor socio-economic conditions in southeastern Peru, *American Journal of Physical Anthropology*, 39, 255–262.

GALIOT, S. 2011, *Zaštitna arheološka istraživanja na lokalitetu Solin – Smiljanovac*, (stručni izvještaj /professional report).

GUDELJ, LJ. 2014, Rupotina - Rižinice (zadužbina kneza Trpimira), *Hrvatski arheološki godišnjak*, 10, 573–574.

ISCAN, M. Y., STEYN, M. 2013, *The human skeleton in forensic medicine*, Illinois: Charles C Thomas.

JELOVINA, D. 1976, Starohrvatske nekropole na području između rijeka Zrmanje i Cetine, Čakavski sabor.

JURČEVIĆ, A. 2008, Groblje na Crkvini u Gornjim Koljanima – istraživanja godine 2007, *Starohrvatska prosvjeta*, 3. ser., 35, 135–150.

KATAVIĆ, V., JERONČIĆ, T. 2014, Kasnoantičko groblje na Bencunušama kod Manastirina. *Tusculum: časopis za solinske teme*, 7, 81–112.

KATUNARIĆ KIRJAKOV, J. T. 2018, *Zaštitno arheološko istraživanje sjeverne građevine Dioklecijanove palače, ul. Dominisova 5*, (rukopis/draft report).

LARSEN, C. S. 1982, *The anthropology of St. Catherine Island: 3. Prehistoric human biological adaptation*, New York: Anthropological papers of the American Museum of Natural History.

LIBRENJAK, A. 2012, *Report on the archeological research at the site of Grebčine-Vuletina rupa in Otok*, Sinj: Muzej cetinske krajine.

LIGHTFOOT, E., ŠLAUS, M., O'CONNELL, T. C. 2012, Changing cultures, changing cuisines: cultural transitions and dietary change in Iron Age, Roman, and Early Medieval Croatia, *American Journal of Physical Anthropology*, 148(4), 543–556.

LOVEJOY, C. O., TRINKAUS, E. 1980, Strength and robusticity of the Neanderthal tibia, *American Journal of Physical Anthropology*, 53, 465–470.

MAROVIĆ, I. 1956, Arheološka istraživanja u okolici Dubrovnika, *Anali Historijskog instituta Jugoslavenske akademije znanosti i umjetnosti u Dubrovniku*, 4-5, 9–30.

PERKIĆ, D., PERKIĆ, M. 1998, Martinovići – Crkva Velike Gospe, *Hrvatski arheološki godišnjak*, 6, 708–711.

RUFF, C. B. 1991, Climate and body shape in hominid evolution, *Journal of Human Evolution*, 21(2), 81–105.

RUFF, C. B., TRINKAUS, E., HOLLIDAY, T. W. 1997, Body mass and encephalization in Pleistocene Homo, *Nature*, 387.6629, 173–176.

RUFF, C. B. 2000b, Body Size, Body Shape, and Long Bone Strength in Modern Humans, *Journal of Human Evolution*, 38, 269–290.

RUFF, C. B., HOLT, B. M., NISKANEN, M., SLADEK, V., BERNER, M., GAROFALO, E., GARVIN, H. M., HORA, M., MAIJANEN, H., NIINIMAKI S., SALO, K., SCHUPLEROVA, E., TOMPKINS, D. 2012, Stature and body mass estimation from skeletal remains in the European Holocene, *American Journal of Physical Anthropology*, 148(4), 601–617.

SJØVOLD, T. 1990, Estimation of stature from long bones utilizing the line of organic correlation, *Journal of Human Evolution*, 5, 431–447.

STINI, W. A. 1969, Nutritional stress and growth: sex difference in adaptive response, *American Journal of Physical Anthropology*, 31, 417–426.

SZÉCSÉNYI-NAGY, A., BRANDT, G., HAAK, W., KEERL, V., JAKUCS, J., MÖLLER-RIEKER, et al. 2015, Tracing the genetic origin of Europe's first farmers reveals insights into their social organization, *Proceedings of the Royal Society B: Biological Sciences*, 282(1805), 1–9.

ŠARIĆ, A. 1992, Crikvine – Ilijino vrilo, u/in: *Starohrvatski Solin*, Marin, E., (ur./ed.), Split: Arheološki muzej Split, 118–120.

ŠLAUS, M. 2006, *Bioarheologija: demografija, zdravlje, traume i prehrana starohrvatskih populacija*, Zagreb: Školska knjiga.

ŠLAUS, M., KOLLMANN, D., NOVAK, S. A., NOVAK, M. 2002, Temporal trends in demographic profiles and stress levels in medieval (6th-13th century) population samples from continental Croatia, *Croatian Medical Journal*, 43(5), 598–605.

ŠLAUS, M., BEDIĆ, Ž., RAJIĆ ŠIKANJIĆ, P., VODANOVIĆ, M., DOMIĆ KUNIĆ, A. 2011, Dental health at the transition from the Late Antique to the early Medieval period on Croatia's eastern Adriatic coast, *International Journal of Osteoarchaeology*, 21(5), 577–590.

TRINKAUS, E., CHURCHILL, S. E., RUFF, C. B. 1994, Postcranial Robusticity in Homo III: Humeral Bilateral Asymmetry and Bone Plasticity, *American Journal of Physical Anthropology*, 93, 1–34.

TROTTER, M., GLESER, C. G. 1952, Estimation of stature from long bones of American whites and negroes, *American Journal of Physical Anthropology*, 10, 463–514.

VYROUBAL, V., BEDIĆ, Ž., ADAMIĆ HADŽIĆ, A., ŠLAUS, M. 2020, Correlation Between Social Status and Health in Early Medieval Dalmatia, *Collegium Antropologicum*, 44(2), 87–94.

WILLIAMSON, M. A. 2000, A comparison of degenerative joint disease between upland and coastal prehistoric agriculturalists from Georgia, u/in: *Bioarchaeological Studies of Life in the Age of Agriculture: a view from the Southeast*, Lambert, P. (ur./ed.), Tuscaloosa: University of Alabama Press, 890–900.

WOLFF, J. 1870, Über die innere architekture der knoches und ihre bedeutung für die frage vom Knochenwachstum, *Archiv für Anatomie, Physiologie und Wissenschaftliche Medicin*, 50, 389–453.

WU, B. N., O'SULLIVAN, A. J. 2011, Sex differences in energy metabolism need to be considered with lifestyle modifications in humans, *Journal of Nutrition and Metabolism*, 2011(5), 1–6.

ZEKAN, M. 1983, Otres kod Bribira, *Obavijesti Hrvatskog arheološkog društva*, 15(3), 33–34.

Internetski izvori / Internet sources

WORLD HEALTH ORGANISATION (WHO), A healthy lifestyle - WHO recommendations. https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations (6. 11. 2023)