

# Jutarnjost-večernjost i umor u adolescenciji

## */ Morningness-eveningness and Fatigue in Adolescence*

Adrian Štark, Anita Vulić-Prtorić

Sveučilište u Zadru, Odjel za psihologiju, Zadar, Hrvatska

*/ University of Zadar, Department of Psychology, Zadar, Croatia*

Obrasci spavanja u adolescenciji povezani su s brojnim biološkim i psihosocijalnim promjenama koje sa sobom nose pubertalno sazrijevanje, a koje utječu na veću sklonost večernjosti u tom razdoblju života. Kako taj novonastali ritam i učestalije deprivacije spavanja često nisu u skladu sa svakodnevnim školskim i vanškolskim obvezama, adolescenti mogu doživljavati izražene simptome umora.

Cilj provedenog istraživanja bio je ispitati obrasce spavanja i umor s obzirom na spol, kronološku dob i pubertalnu zrelost adolescenata, a pritom su korištene Ljestvica pubertalnog razvoja, Ljestvica jutarnjosti-večernjosti i Multidimenzionalna ljestvica umora. Ispitivanje je provedeno u uzorku od 233 adolescenta i 206 adolescentica u dobi od 10 do 18 godina.

Rezultati su pokazali da veću sklonost večernjosti i više simptoma umora imaju stariji i pubertalno zreliji ispitanici te da adolescentice imaju veći stupanj pubertalne zrelosti, veću sklonost večernjosti i doživljavaju više simptoma umora. Rezultati regresijske analize pokazuju da je starija kronološka dob značajni prediktor sklonosti večernjosti, a ženski spol i starija kronološka dob prediktori su doživljavanja simptoma umora. Pubertalna zrelost nije se pokazala značajnom za jutarnjost-večernjost i doživljavanje umora. Naposljetku je naglašena potreba analize dobivenih obrazaca povezanosti između jutarnjosti-večernjosti i umora s obzirom na biološke i psihosocijalne čimbenike razvojnih promjena u adolescenciji.

*/ Sleep patterns in adolescence are associated with biological and psychosocial changes as a part of pubertal development, which leads to greater preference towards eveningness. This newly formed rhythm and frequent sleep deprivation are not coordinated with school and extracurricular activities and can lead to greater fatigue symptoms. The aim of this study was to assess sleep patterns and symptoms of fatigue with regards to sex, chronological age, and pubertal maturity of adolescents. A group of 233 adolescent boys and 206 girls aged between 10 and 18 years participated in the study and were assessed using the Pubertal Development Scale, Morningness-Eveningness Scale for Children, and Multidimensional Fatigue Scale. Results indicated that older and pubertally matured adolescents had greater preference towards eveningness and fatigue symptoms. Furthermore, girls were more evening oriented, more pubertally mature, and reported more fatigue symptoms. Results of regression analysis indicated older chronological age as a significant predictor of greater eveningness. Also, female sex and older chronological age were predictors of fatigue symptoms. Pubertal maturity was not a predictor of morningness-eveningness and fatigue. Finally, we emphasize the need to include biological and psychosocial aspects of developmental changes in adolescence with regard to morningness-eveningness and fatigue in this period of life.*

**ADRESA ZA DOPISIVANJE /****CORRESPONDENCE:**

Prof. dr. sc. Anita Vulić-Prtorić

Odjel za psihologiju Sveučilišta u Zadru /

*Department of Psychology, University of**Zadar*

Obala kralja Petra Krešimira IV. 2

23 000 Zadar, Hrvatska

E-pošta: avulic@unizd.hr

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U posljednja dva desetljeća sve više mladih u razdoblju adolescencije izvještava o kroničnom nedostatku spavanja i umoru. Saxena, Koreti i Gaur (1) navode da se u istraživanjima, kao i u intervjuima s adolescentima i njihovim roditeljima, uočava tendencija među mladima da kasno-večernje sate provode u budnom stanju, najčešće na socijalnim mrežama na internetu. Radi se o trendovima u navikama spavanja i povećanom umoru koji nisu rezultat samo bioloških promjena u pubertetu, već isto tako promjena u životnom stilu. U longitudinalnom istraživanju koje su u razdoblju od 1984. do 2011. godine proveli Kronholm i sur. (2) praćeni su odnosi između simptoma nesanice, umora i školskog uspjeha adolescenata. Uočeno je gotovo dvostruko povećanje broja simptoma nesanice i umora od sredine devedesetih do 2008. godine, i to podjednako u svim dobnim i spolnim skupinama ispitanika. Očekivano, umor i nesanica bili su značajno povezani sa školskim neuspjehom. Pokazalo se da je školsko postignuće kronično umornih učenika iz generacije u generaciju sve lošije, a više je i komorbidnih problema nego prije. Loša kvaliteta spavanja značajna je za pojavu klinički značajnih simptoma anksioznosti, poremećaja raspoloženja, poremećaja spavanja i drugih psihijatrijskih poremećaja kasnije u životu. Brojni čimbenici mogu negativno utjecati na kvalitetu i kvantitetu spavanja u adolescenciji, podjednako

**INTRODUCTION**

In the last two decades, an increasing number of adolescents has been suffering from chronic sleep deprivation and fatigue. Saxen, Koreti, and Gaur (1) stated that studies and interviews with adolescents and their parents showed a tendency among young people to spend late night hours awake, most commonly on social networks and the Internet. These are trends in sleep habits and increased fatigue that are not only the result of biological changes during puberty, but also lifestyle changes. In the longitudinal study carried out by Kronholm *et al.* (2) in the period from 1984 to 2011, the relationship between insomnia symptoms, fatigue, and school performance among adolescents was investigated. A twofold increasing trend in insomnia symptoms and fatigue was found in the period from the mid-1990s to the end of the 2000s, and the increase was evident in all age groups and in both sexes. As expected, fatigue and insomnia were significantly associated with poor school performance. The study showed that school performance of chronically fatigued students worsened from generation to generation and there were more comorbid problems than before. Poor quality of sleep is significant for the occurrence of clinically significant symptoms of anxiety, mood disorders, sleep disorders, and other psychiatric disorders later in life. Numerous factors can negatively

internalni (pubertalni status, osobine ličnosti) kao i eksternalni čimbenici (raspored školskih i izvanškolskih aktivnosti, druženje s vršnjacima i noćni izlasci, aktivnosti na internetu i sl.).

Najuočljivije promjene povezane sa spavanjem u adolescenciji vide se u preferenciji kasnijeg odlaska na spavanje i u razlikama u rasporedu spavanja i buđenja između radnog tjedna i vikenda (3-7). Ispitivanja pokazuju da samo 15 % adolescenata spava oko 8 sati tijekom radnih dana kada moraju ići u školu, a oko 26 % adolescenata izjavljuje da spava oko 6 sati ili manje, te da nedostatak spavanja nastoje kompenzirati spavajući duže vikendom (8). Wolfson i Carskadon (9) navode da adolescenti u dobi između deset i četrnaest godina vikendom spavaju 30 do 60 minuta duže nego tijekom radnih dana, te da se te razlike povećaju za čak dva sata do njihove osamnaeste godine. Preferencije vremena buđenja i vremena odlaska na spavanje opisuju se na dimenziji jutarnjosti-večernjosti. Za jutarnje je tipove karakteristično da ujutro lako ustaju, alertniji su u jutarnjim satima, teško im pada kasni odlazak na spavanje i brzo usnivaju. Suprotno vrijedi za večernje tipove, tj. ujutro mogu dugo spavati, alertniji su navečer, potrebno im je duže vremena da bi navečer zaspali, te se češće žale da se nisu dovoljno naspavali (10). Sklonost jutarnjosti uglavnom je više povezana s emocionalnom stabilnošću, zdravijim životnim stilom, te s manjim brojem psiholoških i psihosomatskih poteškoća. Večernjost je više povezana s depresivnim tendencijama, bulimičnim ponašanjem i manjim zadovoljstvom životom (10,11).

Razlike između jutarnjih i večernjih tipova potvrđene su u mnogim dosadašnjim ispitivanjima, te se pokazalo da su djelomično naslijeđene i da osobito dob, spol, kulturalni i socijalni čimbenici pridonose kronotipologiji (12,13). Promjene u jutarnjosti-večernjosti događaju se tijekom cijelog života: u mlađoj dobi djeca pokazuju veću preferenciju prema jutarnjosti, u adolescenciji, osobito u dobi između dvanaeste i četrnaeste godine uočava se promjena prema

affect the quality and quantity of sleep, both internal (pubertal status, personality traits) as well as external factors (schedule of curricular and extracurricular activities, socializing with peers and nights out, Internet activities, etc.).

The most obvious changes associated with sleeping in adolescence are seen in the preference for late bedtimes and in the differences of the sleep-wake schedule between the weekdays and weekends (3-7). Studies show that only 15% of adolescents sleep as long as eight and a half hours on school nights, and 26% say they usually sleep six and a half hours or less. They try to compensate on the weekends by sleeping longer (8). Wolfson and Carskadon (9) reported that adolescents aged 10 to 14 sleep 30 to 60 minutes more during weekends than on school nights, and those differences increase by two hours until they are 18. Morning types awaken early and are more alert in the morning, and have a hard time with late bedtimes and fall asleep quickly. The opposite is true for evening types: they wake up later and are more alert in the evening, it takes them more time to fall asleep, and they often complain of being sleep deprived (10). Morningness preference is more associated with emotional stability, a healthy lifestyle, and a smaller number of psychological and psychosomatic problems. Eveningness is more associated with depressive tendencies, bulimic behavior, and lower life satisfaction (10,11).

The differences between morning and evening types have been confirmed in many previous studies, and have proved to be partially hereditary, and that age, sex, cultural, and social factors contribute to chronotypology (12,13). Changes in morningness-eveningness occur throughout life: at a younger age, children show a greater morningness preference; in adolescence, especially between ages twelve and fourteen, the change toward eveningness is observed, which will revert to a morningness preference in adulthood (10,13). In this respect,

6 večernjosti, da bi se u odrasloj dobi ponovno vratila preferencija jutarnjosti (10,13). U tom smislu, adolescenti su u svojevrsnom tranzicijskom razdoblju između obrasca spavanja tijekom djetinjstva i odrasle dobi. Nadalje, u većini istraživanja dobiva se veća preferencija večernjosti kod djevojčica, premda nalazimo istraživanja u kojima je dobivena veća preferencija večernjosti u dječaka (7), kao i istraživanja u kojima ta razlika nije potvrđena (3,14). Djevojke također izvještavaju o više problema sa spavanjem, a k tome se ti problemi u njih manifestiraju u ranijoj dobi nego u dječaka. Razlike između adolescenata i adolescentica u obrascima spavanja i problemima sa spavanjem najčešće se pripisuju fiziološkim i psihosocijalnim promjenama povezanim sa pubertetom (15). Naime, u većine dječaka pubertet započinje oko dvanaeste godine, a kod djevojčica dvije godine ranije, tako da je većina djevojčica u dobi od četrnaeste godine bliže završnim fazama puberteta, dok dječaci tek tada pokazuju prve znakove puberteta (3). Početak puberteta je ujedno početak fizioloških i psiholoških čimbenika koji djeluju na spavanje (16). Proces spavanje-budnost u adolescenciji prolazi u procesu reorganizacije i to se najčešće uočava u odgođenom spavanju prema večernjosti, skraćenom ukupnom vremenu spavanja, razvoju neredovitih obrazaca spavanja, te pojavi razlike u obrascima spavanja između radnih dana i vikenda. Malobrojna longitudinalna istraživanja daju neke nove uvide u rezultate na tom području. Tako su Sadeh i sur. (16) utvrdili da promjene u spavanju tipične za pubertet (odgođeno spavanje prema večernjim satima i spavanje s prekidima) ustvari prethode tjelesnim promjenama povezanim s pubertetom. To znači da se promjene u obrascu spavanja javljaju prije pubertalnih tjelesnih promjena. Autori smatraju da je dobivene rezultate potrebno promatrati u svjetlu neurobioloških promjena povezanih sa spolnim hormonima, koje mogu biti prepoznate u mjerama organizacije spavanja prije nego što se manifestiraju u tjelesnim promjenama povezanim s pubertetom.

adolescents are in a certain transitional period between sleeping patterns during childhood and adulthood. Furthermore, in most studies, a greater morningness preference is found in girls, although there are studies where greater morningness preference is found in boys (7) as well as studies where there were no significant differences (3,14). Girls also report more on sleep problems, and these problems also manifest at an earlier age than in boys. Differences in sleep patterns between adolescent boys and girls are most often attributed to the physiological and psychosocial changes associated with puberty (15). In fact, puberty in most boys begins around the age of twelve and two years earlier in girls, so most girls are approaching the end stages of puberty at the age of fourteen, while boys are only showing the first signs of puberty (3). The onset of puberty is also the beginning of the physiological and psychological factors that affect sleep (16). In adolescence, the process of sleep and wakefulness undergoes reorganization, and this is most commonly observed in sleep delayed toward eveningness, development of irregular sleep patterns, and differences in sleep patterns between weekdays and weekends. A few longitudinal studies give some insight into results from this field of study. Sadeh *et al.* (16) found that sleep changes typical for puberty (sleep delayed toward evening and interrupted sleep) actually precede the physical changes associated with puberty. This means that changes in sleep patterns occur before the physical changes of puberty. The authors believe that the obtained results should be observed in the light of neurobiological changes associated with sex hormones which can be recognized in sleep organization before they are manifested in body-related changes associated with puberty.

Whether or not the changes in sleep patterns and sleep difficulties are a result of biological changes, overloaded daily schedule, or adolescent lifestyle, they usually result in fatigue and

Promjene u obrascu spavanja i teškoće sa spavanjem, bez obzira jesu li rezultat bioloških promjena, pretrpanog dnevnog rasporeda, ili životnog stila adolescenta, najčešće za posljedicu imaju umor i oslabljeno svakodnevno funkcioniranje (9,17). Umor označava osjećaj abnormalne iscrpljenosti nakon inače uobičajenih aktivnosti. Ako umor potraje dulje od šest mjeseci može se govoriti o sindromu kroničnog umora koji može biti povezan s drugim somatskim simptomima. Procjenjuje se da u općoj populaciji 15 % do 30 % adolescenata često doživljava simptome umora, a 0,5 do 2 % ispunjava kriterije za kronični umor (18). Umor može nastati zbog već spomenutih promjena u obrascu i arhitekturi spavanja i njihove neusklađenosti sa školskim i drugim obvezama tijekom radnih dana i vikendom. Budući da se cirkadiurni sustav sporo adaptira na ove promjene produženo spavanje tijekom vikenda može uzrokovati simptome *jet lag*-a u početku radnog tjedna, osobito ako je nastava u jutarnjoj smjeni (19). Očekivano je da mnogi adolescenti tada osjete izražene simptome umora jer se nastoje probuditi u vrijeme kada njihovo tijelo nije spremno za buđenje i aktivnost, tj. kada je temperatura njihova tijela najniža. Općenito, zanemareni signali umora tijekom adolescencije mogu imati brojne dugoročne negativne posljedice na zdravlje i kvalitetu života.

Unatoč naprijed navedenim nalazima uočava se da obrasci spavanja i umor u adolescenciji nisu istraživani u mjeri u kojoj bi to bilo očekivano (20). Stoga smo ovim istraživanjem nastojali ispitati preferenciju jutarnjosti-večernjosti i doživljavanje umora u adolescenciji u odnosu na spol, dob i pubertalni status ispitanika. Zbog brojnih interindividualnih razlika u početku i trajanju pubertalnih promjena u ovom istraživanju je uz kronološku dob u obzir uzeta i mjera pubertalne zrelosti. Naime, Keresteš, Brković i Kuterovac Jagodić (21,22) navode da stručnjaci na području psihologije adolescencije upozoravaju da zbog velikih razlika u vremenu

impaired daily functioning (9,17). Fatigue is indicated by a feeling of abnormal exhaustion after otherwise normal activities. If fatigue lasts for longer than six months, chronic fatigue syndrome that may be related to other somatic symptoms should be considered. It is estimated that around 15 to 30% of adolescents in the general population often experience symptoms of fatigue, and 0.5 to 2% meet the criteria of chronic fatigue (18). Fatigue may arise due to the already mentioned changes in the pattern and architecture of sleep and inconsistency of school and other responsibilities during weekdays and weekends. Since the circadian system adapts to these changes slowly, extended sleep over the weekend may cause jet lag symptoms at the beginning of the work week, especially if classes are in the morning shift (19). It is expected that many adolescents experience pronounced fatigue symptoms as they try to wake up on time and their bodies are not prepared for waking and activity, i.e. their body temperature is at its lowest level. In general, neglected fatigue symptoms during adolescence may have long-term negative consequences on health and quality of life.

Despite the above findings, it has been noticed that sleep patterns and fatigue in adolescence have not been investigated to the expected extent (20). With this study we have therefore tried to investigate the morningness-eveningness preference and experience of fatigue in adolescence in relation to sex, age, and the pubertal status of the respondents. Due to the numerous interindividual differences and the duration of pubertal changes, measures of pubertal maturity besides chronological age were taken into account in this study. In fact, Keresteš, Brković, and Kuterovac Jagodić (21,22) state that experts in the field of adolescent psychology warn that because of large variations in the onset of puberty and the rate of change and maturation, chronological age is not a sufficient indicator of the degree of phys-

početka puberteta, te brzine promjena i sazrijevanja, kronološka dob nije dovoljan pokazatelj stupnja tjelesne zrelosti. To je osobito izraženo u razdoblju rane adolescencije kada su promjene povezane s pubertetom najizraženije. Iako je stupanj pubertalne zrelosti u korelaciji s kronološkom dobi, povezanost je umjerene veličine te autori smatraju da je to nedovoljno da bi se opravdalo korištenje kronološke dobi kao pokazatelja pubertalne zrelosti adolescenata.

U skladu s navedenim, glavni cilj ovoga istraživanja je ispitati povezanost između spola, kronološke dobi, pubertalnog statusa, te jutarnjosti večernjosti i simptoma umora. Pri tome se pošlo od pretpostavke da će pubertalno zreliji adolescenti pokazivati veću tendenciju ka večernjosti, te da će doživljavati veće razine umora. Također, provjereno je postoji li razlika između adolescenata i adolescentica u pubertalnoj zrelosti, obrascu spavanja i doživljavanju simptoma umora, jer podatci iz dosadašnjih istraživanja uglavnom pokazuju da su djevojke pubertalno zrelije i sklonije večernjosti, te shodno tome izvještavaju o više simptoma umora. Na kraju, ispitano je u kojoj mjeri kronološka dob i pubertalni status mogu objasniti jutarnjost-večernjost i umor kada se kontrolira varijabla spola ispitanika. S obzirom da se u dosadašnjim istraživanjima dobivaju značajne pozitivne korelacije između kronološke dobi i pubertalne zrelosti, bilo je zanimljivo ispitati koliki je samostalni doprinos svake varijable u objašnjenju jutarnjosti-večernjosti i umora u adolescenciji.

## METODA

### Ispitanici

Ispitivanje je provedeno u osnovnoj školi i dvije gimnazije u Zadru. U istraživanju je sudjelovalo 439 učenika u dobi od 10 do 18 godina, od toga 233 adolescenta i 206 adolescentica. U osnovnoj su školi ispitani učenici 5., 6., 7. i 8. razreda ( $N=248$ ), a u srednjim školama 1., 2. i 3. razre-

ical maturity. This is particularly visible in early adolescence when pubertal changes are most pronounced. Although the degree of pubertal maturity is in correlation with chronological age, the relationship is moderate in size and the authors consider that it is insufficient to justify the use of chronological age as an indicator of pubertal maturity in adolescents.

Accordingly, the main objective of this study was to examine the correlation between sex, chronological age, pubertal status, as well as the morningness-eveningness and symptoms of fatigue. We started from the hypothesis that adolescents with higher pubertal maturity will show a greater tendency toward eveningness and will experience higher levels of fatigue. It was also ascertained whether there was a difference between adolescent boys and girls in pubertal maturity, sleep patterns, and fatigue symptoms experience, as data from previous studies showed that girls are more mature and prone to eveningness and therefore have more fatigue symptoms. Finally, we examined to what extent chronological age and pubertal status can explain the morningness-eveningness preference and fatigue when the sex variable of the respondents is controlled. Given that significant positive correlations between chronological age and pubertal maturity were found in previous studies, it was interesting to examine the individual share of each variable in the explanation of the morningness-eveningness and fatigue in adolescence.

## METHOD

### Respondents

The study was conducted at an elementary school and two grammar schools in Zadar. The study included 439 students 10-18 years old, of which 233 were adolescent boys and 206 adolescent girls. The respondents from elementary school were 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, and 8<sup>th</sup> grade students

da ( $N=188$ ). Prosječna dob ispitanika u ovom uzorku iznosila je  $M=14,33$  godine ( $SD=1,97$ ), a adolescentice i adolescenti nisu se razlikovali s obzirom na kronološku dob ( $M_M=14,29$ ;  $SD_M=1,95$ ;  $M_Z=14,38$ ;  $SD_Z=1,99$ ).

## Mjerni instrumenti

*Ljestvica pubertalnog razvoja (Pubertal Development Scale, PDS, Petersen i sur., 1988; 21,22)* je samoizvještajna metoda koja se sastoji od pet čestica kojima su opisane tjelesne promjene koje se događaju u pubertetu. Tri su čestice zajedničke i adolescenticama i adolescentima, dok su dvije čestice specifične za pojedini spol. Na pitanja se odgovara na ljestvici od 4 stupnja: 1 „označava to mi se još nije počelo događati“, 2 „to mi se počelo događati“, 3 „to mi se već neko vrijeme događa“, i 4 „to je kod mene već završeno“. U upitniku je bio ponuđen i odgovor 5 koji je označavao „ne znam“ i koji se nije bodovao. Ukupni rezultat na PDS-u određuje se kao prosječan rezultat na pet čestica upitnika, a na temelju tog rezultata određene su kategorije pubertalnog statusa: prepubertet (rezultat 0 – 1,7), početak puberteta (rezultat 1,8 – 2,4), sredina puberteta (rezultat 2,5 – 3), podmakli pubertet (rezultat 3,1 – 3,6) i postpubertet (rezultat 3,7 – 4). Za primjenu u našoj populaciji ljestvicu su prilagodile Keresteš i suradnice (21,22), a rezultati pokazuju kako je riječ o pouzdanoj i valjanoj mjeri pubertalnog razvoja koja značajno korelira s liječničkim procjenama Tannerovih stadija pubertalnog razvoja.

*Ljestvica jutarnjosti-večernjosti (Morningness-Eveningness Scale for Children, MESC; 4,12)* namijenjena je ispitivanju jutarnjosti-večernjosti u djece osnovnoškolske i srednjoškolske dobi. Sastoji se od 10 pitanja, a zadatak ispitanika je označiti onaj odgovor koji se najviše odnosi na njega. Bodovanje je u rasponu od 1 do 4 ili 5, ovisno o broju ponuđenih odgovora, a ukupni se rezultat na ljestvici dobije zbrajanjem bodova na pojedinim česticama. Raspon rezultata

( $N=248$ ), and in grammar schools they were 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> grade students ( $N=188$ ). The average age of the respondents in this sample was  $M=14.33$  years ( $SD=1.97$ ), and there were no differences in terms of the chronological age of adolescent boys and girls ( $MM = 14.29$ ,  $SDM = 1.95$ ,  $M = 14.38$ ;  $SDF = 1.99$ ).

## Measuring instruments

*Pubertal Development Scale (PDS, Petersen et.al., 1988; 21,22)* is a self-report instrument, and it consists of five items that describe the physical changes in puberty. Three items are shared by both adolescent boys and girls, while two are specific to each sex. Questions are answered by a four-degree scale: 1 indicates “this has not yet happened to me”, 2 “this started to happen to me”, 3 “this has been happening to me for some time”, 4 “this already ended for me”. The questionnaire also offered a 5<sup>th</sup> option, “I do not know”, which was not scored. The total result on the PDS was determined as an average result on the five items of the questionnaire, and five categories identifying different the pubertal status were labeled on the basis of that result: pre-puberty (score 0-1.7), onset of puberty (score 1.8-2.4), mid-puberty (score 2.5-3), advanced puberty (3.1-3.6) and post-puberty (score 3.7-4). Keresteš et.al. (21,22) adjusted the scale for the application on our population, and the results show that it is a reliable and valid measure of pubertal development that significantly correlates with medial assessment of the Tanner scale of physical development.

*Morningness-eveningness Scale for Children (MESC; 4,12)* is used to assess morningness-eveningness in children of elementary and secondary school age. It is composed of 10 questions, and the respondents were asked to mark the answer that relates to them. Scoring was in the range from 1 to 4 or 5, depending on the number of offered answers, and the final

se kreće od 10 do 43 pri čemu veći rezultat na ljestvici ukazuje na veću jutarnjost. U prvoj primjeni ove ljestvice na našoj populaciji dobiven je Cronbachov alfa  $\alpha = .74$  (3)

*Multidimenzijaska ljestvica umora (Multidimensional Fatigue Scale, MFS, Varni i sur., 2002; 23)* sastoji se od 18 čestica, a služi za samoprocjenu umora (za dob od 5 do 18 godina). Ispitanici na ljestvici od 5 stupnjeva procjenjuju koliko ih često muče određeni simptomi povezani s umorom. Raspon odgovora kreće se od *nikad* (koje se boduje kao 100) do *gotovo uvijek* (koje se boduje kao 0). Rezultati u ljestvici MFS mogu se analizirati na razini ukupnog rezultata i/ili na razini 3 podljestvice: umora, spavanja i kognitivnog umora. Za potrebe ovog rada, kao pokazatelj doživljavanja umora, korišten je samo ukupni rezultat. Veći rezultat na ljestvici ukazuje na bolju kvalitetu života povezanu sa zdravljem i manje simptoma umora. Psihometrijskom evaluacijom ljestvice uglavnom se dobivaju pokazatelji pouzdanosti u rasponu od 0.77 do 0.93 (23).

Prema deskriptivnim parametrima i koeficijentima pouzdanosti (tablica 1) sva tri instrumenta imaju zadovoljavajuće psihometrijske kvalitete, a dobiveni pokazatelji u skladu su s nalazima u dosadašnjim primjenama.

## Postupak

Uпитnici su primijenjeni skupno u vrijeme održavanja redovite nastave. Sudjelovanje u istraživanju bilo je dobrovoljno i anonimno, a provedeno je uz dozvolu ravnatelja škola. Uпитnike su primijenili školski psiholog i apsolvant psihologije. Prije primjene upitnika svim je

result on the scale was obtained by adding the scores from each of the items. The range of the result was from 10 to 43, where a higher score on the scale indicated a higher morningness. In the first application of this scale on our population, we obtained a Cronbach's alpha  $\alpha = .74$  (3).

*Multidimensional Fatigue Scale (MFS, Varni et.al. 2002; 23)* consists of 18 items and measures fatigue (age 5-18). On a scale from 1 to 5, the respondents assess how often certain symptoms are associated with fatigue. The range starts with *never* (100 points) to *nearly always* (0 points). The results in the MF scale can be analyzed on the overall score and/or on subscales: General Fatigue, Sleep/Rest Fatigue, and Cognitive Fatigue. A higher result on the scale indicates a better quality of life associated with health and fewer fatigue symptoms. The reliability index ranging from 0.77 to 0.93 (23) is usually obtained by the psychometric evaluation of the scale.

According to the descriptive parameters and reliability coefficients (Table 1), all three instruments have satisfactory psychometric qualities, and obtained indexes are in accordance with findings from previous applications.

## Procedure

The questionnaires were administered during regular classes. Participation in the study was voluntary and anonymous and it was conducted with the approval from the school principals. Prior to the application of the questionnaire, the respondents were given instructions for completing the questionnaire. The respondents were asked to read each statement and then circle the corresponding number on the

**TABLE 1.** Descriptive indexes of the applied measuring instruments (N=439)

Scale		Number of items	Range	Arithmetic mean (M)	Standard deviation (SD)	Cronbach alpha	Average $r_{it}$
MESC	Morningness-eveningness Scale for Children	10	10-43	26.46	5.42	.80	.28
PDS	Pubertal Development Scale	5	0-4	2.75	.75	.83	.50
MFS	Multidimensional Fatigue Scale	18	0-100	69.19	15.60	.89	.31



ispitanicima objašnjen cilj ispitivanja, a zatim im je pročitana uputa o načinu popunjavanja upitnika. Zadatak ispitanika bio je da nakon što pročitaju svaku tvrdnju zaokruže odgovarajući broj s desne strane. Vrijeme rješavanja nije bilo ograničeno, a u prosjeku je trajalo oko 15 minuta.

## Statistička analiza

Kako bi se odgovorilo na postavljene ciljeve, u obradi rezultata primijenjeni su t-testovi, korelacije i regresijske analize. T-testovi su primijenjeni u ispitivanju razlika u kronološkoj dobi adolescenata i adolescentica u pojedinim kategorijama pubertalnog statusa te u ispitivanju razlika u ispitivanim varijablama između adolescenata i adolescentica. Pearsonovim koeficijentima korelacije određen je stupanj povezanosti između varijabli korištenih u istraživanju.

Kako bismo odgovorili na treći cilj ovoga istraživanja primijenjena je hijerarhijska regresijska analiza te smo provjerili u kojoj mjeri spol, kronološka dob i pubertalni status mogu objasniti jutarnost-večernost i doživljavanje umora u adolescenciji. U prediktorski skup varijabli uključeni su spol, kronološka dob i stupanj pubertalne zrelosti, a kriterijska varijabla u prvoj analizi bila je jutarnost-večernost, a u drugoj doživljavanje umora. Provedene su po dvije hijerarhijske regresijske analize za svaki kriterij s ciljem provjere razlika u samostalnom doprinosu kronološke dobi i pubertalnog statusa (variranjem redoslijeda unošenja tih dviju varijabli u regresijsku jednadžbu) objašnjenju varijance jutarnosti-večernosti, odnosno doživljavanja umora.

## REZULTATI

Prije naprijed navedenih statističkih analiza provjeren je pubertalni status ispitanika u ovom uzorku. Pet kategorija pubertalnog sta-

right side. There was no time limit, and it took an average of 15 minutes.

## Statistical analysis

T-tests, correlations, and regression analyses were used for data processing in order to verify the set objectives. T-tests were used to test the differences in the chronological age of adolescent boys and girls in certain categories of the pubertal status and differences in the tested variables between adolescent boys and girls. The Pearson correlation coefficient determined the relationship between the variables used in the study.

In order to fulfill the third objective of the study, a hierarchy regression analysis was applied, and we were able to ascertain to what degree sex, chronological age, and pubertal status can explain morningness-eveningness and experience of fatigue in adolescence. The predictor variables included sex, chronological age, and the degree of pubertal maturity, and the criterion variable in the first analysis was morningness-eveningness while it was the experience of fatigue in the second analysis. Two hierarchy regression analyses were conducted for each criterion to ascertain the differences in the independent contribution of the chronological age and pubertal status (variance of the entry order of these two variables in the regression equation) in explaining the variance of the morningness-eveningness and experience of fatigue.

## RESULTS

The pubertal status of the respondents in this sample was verified before the abovementioned statistical analysis. Five categories of pubertal status were determined according to the criteria described in the chapter on measuring instruments: pre-puberty, onset of puberty, mid-puberty, advanced puberty, and

tusa određeno je prema kriterijima opisanim u poglavlju o mjernim instrumentima: pretpubertet, početak puberteta, sredina puberteta, poodmakli pubertet i postpubertet. Deskriptivni pokazatelji za tih pet kategorija, te pripadajući podaci o kronološkoj dobi ispitanika u svakoj kategoriji prikazani su u tablici 2.

Rezultati t-testa pokazali su da se adolescenti i adolescentice značajno razlikuju s obzirom na prosječnu kronološku dob u četiri od pet ispitivanih kategorija pubertalne zrelosti. Premda se radi o vrlo malim razlikama u prosječnoj kronološkoj dobi, one su značajne i pokazuju da su u svim kategorijama adolescenti nešto stariji od adolescentica, tj. da su pubertalno nezreliji od adolescentica. Rezultati prikazani na sl. 1. daju precizniji uvid u dobivene razlike. Prikazan je postotak ispitanika u svakoj kategoriji pubertalnog statusa. Kao što se moglo i očekivati, u usporedbi sa svojim muškim vršnjacima, adolescentice su uglavnom pubertalno zrelije. Npr. u prve tri kategorije (pretpubertet, početak puberteta i sredina puberteta) nalazi se 75,53 % adolescenata i 43,21 % adolescentica, dok se u zadnje dvije kategorije (poodmakli pubertet i postpubertet) nalazi 24,46 % adolescenata i čak 56,8 % adolescentica. Treba podsjetiti da se adolescenti i adolescentice u ovom istraživanju nisu značajno razlikovali s obzirom na prosječnu kronološku dob.

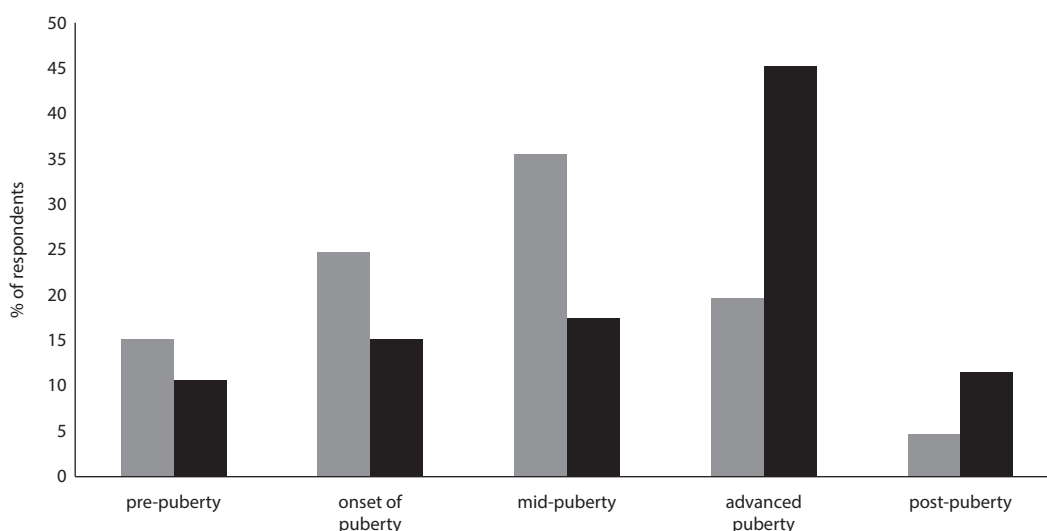
post-puberty. Descriptive indexes for these five categories and the associated results on the chronological age of the respondents in each category are shown in Table 2.

The results of the t-test showed significant differences between adolescent boys and girls with respect to chronological age in four out of five tested categories of pubertal maturity. Although the differences were very small in average chronological age, they were significant and showed that adolescent boys were slightly older than adolescent girls in all categories, i.e. they had a lower pubertal maturity than adolescent girls. The results shown in Figure 1 offer a more precise insight of the obtained differences. The percentage of the respondents for each category of the pubertal status is shown in Figure 1. As expected, when compared to their male peers, adolescent girls had a higher pubertal maturity. For example, in the first three categories (pre-puberty, onset of puberty, and mid-puberty) there were 75.53% of adolescent boys and 43.21% of adolescent girls, while in the last two categories (advanced puberty and post-puberty) there were 24.46% of adolescent boys and 56.8% of adolescent girls. It should be mentioned that there were no significant differences in regard to average chronological age between adolescent boys and girls.

**TABLE 2.** Arithmetic means, standard deviations, t-values, and statistical significance in chronological age of adolescent boys and girls in each category of the pubertal status

		Chronological age						t-test
		Adolescent boys (N=233)			Adolescent girls (N=206)			
		M	SD	N	M	SD	N	
Categories of pubertal status	Pre-puberty	11.96	0.86	35	11.78	0.77	22	.81
	Onset of puberty	13.26	1.45	58	12.31	0.96	31	3.29**
	Mid-puberty	14.64	1.48	83	13.60	1.40	36	3.58**
	Advanced puberty	16.04	1.12	46	15.43	1.34	93	2.68**
	Post-puberty	17.24	0.45	11	16.50	1.09	24	2.16*

\*p<.05, \*\*p<.01



**FIGURE 1.** Percentage of adolescent boys (light grey) and percentage of adolescent girls (dark grey) in each category of the pubertal status (N=439)

## Povezanosti između ispitivanih varijabli

Provjerom stupnja povezanosti između ispitivanih varijabli utvrđene su statistički značajne korelacije između gotovo svih ispitivanih varijabli ( $p < .05$ ).

Iz tablice 3 je vidljivo da su najniže korelacije dobivene između spola i ispitivanih varijabli. Očekivano, najviša korelacija utvrđena je između kronološke dobi i pubertalnog statusa ( $r = .76$ ). Rezultati na ljestvici jutarnjosti-večernjosti bili su podjednako povezani s kronološkom dobi ( $r = -.34$ ) i pubertalnim statusom ( $r = -.36$ ). Slične relacije dobivene su između doživljavanja umora i kronološke dobi ( $r = -.37$ ), te umora i pubertalnog statusa ( $r = -.33$ ). Umjeren visoka korelacija dobivena je između rezul-

## Relationship between examined variables

Statistically significant correlations between virtually all examined variables were established after the verification of the relationships between them ( $p < .05$ ).

Table 3 shows the lowest correlations are between sex and the examined variables. As expected, the highest correlation was between chronological age and pubertal status ( $r = .76$ ). The results on the Morningness-eveningness Scale were equally associated with chronological age ( $r = -.34$ ) and pubertal status ( $r = -.36$ ). Similar relationships were obtained between the experience of fatigue and chronological age ( $r = -.37$ ) and fatigue and pubertal status ( $r = -.33$ ). A moderately high correlation was

**TABLE 3.** Pearson correlation coefficient between examined variables (N=439)

	Sex	Chronological age	PDS	MESC
Sex				
Chronological age	.02			
PDS Pubertal Development Scale	.24*	.76*		
MESC Morningness-eveningness Scale for Children	-.09*	-.34*	-.36*	
MFS Multidimensional Fatigue Scale	-.13*	-.37*	-.33*	.51*

tata na ljestvici jutarnjosti-večernjosti i ljestvici umora i iznosila je  $r=.51$ .

## Razlike u ispitivanim varijablama s obzirom na spol ispitanika

Adolescenti i adolescentice u ovom istraživanju bili su gotovo identične prosječne dobi, ali su se statistički značajno razlikovali u rezultatima na ljestvici pubertalnog razvoja, ljestvici jutarnjosti-večernjosti i multidimenzionalnoj ljestvici umora (tablica 4).

Uvidom u dobivene pokazatelje može se uočiti da su adolescentice bile pubertalno zrelije, imale su veću sklonost večernjosti i osjećale su se umornije od adolescenata.

## Rezultati hijerarhijske regresijske analize

U tablici 5 prikazani su rezultati provedenih analiza za kriterijsku varijablu jutarnjost-večernjost. Analiza je provedena u tri koraka, a redoslijed uvrštavanja pojedinih prediktorskih varijabli u regresijsku jednadžbu bio je sljedeći: u prvom koraku uvrštena je varijabla spola, u drugom je dodana varijabla pubertalnog statusa i u trećem varijabla kronološke dobi. Nakon toga, provedena je hijerarhijska analiza s istom kriterijskom varijablom (jutarnjost-večernjost) s promijenjenim redoslijedom uvrštavanja prediktorskih varijabli u regresijsku jednadžbu: u prvom koraku opet je uvrštena varijabla spola, a zatim je u drugom dodana

found between the results on the Morningness-eveningness Scale and Fatigue scale,  $r=.51$ .

## Differences in examined variables with regard to the sex of the respondents

Adolescent boys and girls in this study had almost identical average age, but statistically significant differences were found in results on the Pubertal Development Scale, Morningness-eveningness Scale, and Multidimensional Fatigue Scale (Table 4).

After examining the obtained indicators, it can be observed that adolescent girls had a higher score of pubertal maturity, a higher eveningness preference, and were more fatigued than adolescent boys.

## Results of hierarchy regression analysis

Table 5 shows results of the analysis for the criterion variable of morningness-eveningness. The analysis was carried out in three steps, and the order of inclusion of certain predictor variables into the regression equation was the following: in the first step, the sex variable was included, the variable of pubertal status in the second step, and the variable of chronological age in the third step. After this, a hierarchy analysis was conducted, with the same criterion variable (morningness-eveningness) but a different order of inclusion of predictor varia-

**TABLE 4.** Arithmetic means, standard deviations, t-values, and statistical significance of the examined variables between adolescent boys and girls

		Adolescent boys (N=233)		Adolescent girls (N=206)		t-test
		M	SD	M	SD	
PDS	Pubertal Development Scale	2.74	1.08	3.32	1.18	5.34**
MESC	Morningness-eveningness Scale for Children	26.94	5.26	25.91	5.57	-1.99*
MFS	Multidimensional Fatigue Scale	71.03	15.09	67.11	15.93	-2.64**

\* $p<.05$ , \*\* $p<.01$

**TABLE 5.** Results of the hierarchy regression analysis for the morningness-eveningness criterion with the variables of sex, chronological age, and pubertal status as predictor variables (N=439)

Morningness-eveningness				
Step	Predictors	$\beta$	R <sup>2</sup>	$\Delta$ R <sup>2</sup>
1st Step	Sex	-.094*	.009	-
2nd Step	Sex Chronological age	-.088 -.341**	.125**	.116**
3rd Step	Sex Chronological age Pubertal status	-.069 -.280** -.083	.128**	.003
Morningness-eveningness				
Step	Predictors	$\beta$	R <sup>2</sup>	$\Delta$ R <sup>2</sup>
1st Step	Sex	-.094*	.009*	-
2nd Step	Sex Pubertal status	-.019 -.304**	.096	.086**
3rd Step	Sex Pubertal status Chronological age	-.069 -.083 -.280**	.128**	.032**

\*p&lt;.05, \*\*p&lt;.01

kronološka dob i u trećem varijabla pubertalnog statusa.

Rezultati hijerarhijske regresijske analize pokazuju da se opisanim setom prediktora (spol, kronološka dob i pubertalni status) može objasniti 12,8 % varijance jutarnjosti-večernjosti, pri čemu se pubertalni status nije pokazao značajnim prediktorom. Spol je bio značajni prediktor u prvom koraku obje analize, a rezultat ukazuje da su adolescentice značajno sklonije večernjosti od adolescenata. No, kada se u drugom koraku analize kontrolira doprinos spola objašnjenju varijance jutarnjosti-večernjosti i doda kronološka dob, spol više nije značajan prediktor, a samostalni dodatni doprinos kronološke dobi u tom drugom koraku iznosi 11,6 %. Nakon kontrole doprinosa spola i kronološke dobi u trećem koraku provjeren je samostalni doprinos varijable pubertalni status. Pokazalo se da taj doprinos nije statistički značajan.

U drugom slučaju hijerarhijske regresijske analize promijenjen je redoslijed dodavanja prediktora u regresijsku jednadžbu. Kao što se može vidjeti u tablici 5, u drugom koraku, kada je kontroliran doprinos varijable spola, pubertal-

bles into the regression equation: the sex variable was included again in the first step, after which chronological age in the second step and the variable of pubertal status in the third step.

The results of the hierarchy regression analysis show that the described set of predictors (sex, chronological age, and the pubertal status) can explain 12.8% of the variance in the morningness-eveningness, where the pubertal status was not a significant predictor. Sex was a significant predictor in the first step in both of the analyses, and the results indicated that adolescent girls had a higher eveningness preference than adolescent boys. However, when, in the second step of the analysis, the contribution of sex was controlled in the explanation of the morningness-eveningness and chronological age, then sex was no longer a significant predictor, and the independent contribution of chronological age in the second step was 11.6%. After control of the contribution of sex and chronological age in the third step, the independent contribution of the pubertal status variable was ascertained. The contribution of the pubertal status was not statistically significant.

In the second hierarchy analysis, the order of inclusion of predictor variables into the regres-

ni status je imao značajan dodatni samostalni doprinos varijanci jutarnjosti-večernjosti i iznosio je 8,6 %. No, u trećem koraku, kada je dodana kronološka dob, pubertalni status više nije bio značajan, a samostalni doprinos kronološke dobi objašnjenju varijance jutarnjosti-večernjosti bio je 3,2 %. Na temelju provedenih analiza može se zaključiti da je kronološka dob „jači“ prediktor jutarnjosti-večernjosti od pubertalnog statusa.

Isti postupak ponovljen je i za kriterijsku varijablu umora. Rezultati (tablica 6) upućuju na to da se setom prediktora (spol, kronološka dob i pubertalni status) može objasniti 14,9 % varijance umora, a pubertalni status ni u ovoj analizi nije bio značajni prediktor.

Spol je značajni prediktor u sva tri koraka analize, a rezultat ukazuje da su adolescentice značajno sklonije doživljavanju simptoma umora od adolescenata. Kada se u drugom koraku analize kontrolira doprinos spola objašnjenju varijance umora, samostalni dodatni doprinos kronološke dobi iznosi 13,4 %. Nakon kontrole doprinosa spola i kronološke dobi u trećem koraku, samostalni doprinos varijable pubertalni status nije se pokazao statistički značajnim. U nastavku, promijenjen je redoslijed dodavanja prediktora u regresijsku jednadžbu (drugi dio tablice 6). Uz kontrolu spola, u drugom koraku analize, pubertalni status je imao značajan dodatni samostalni doprinos varijanci doživljavanja umora i iznosio je 7,6 %. No, u trećem koraku, kada je dodana kronološka dob, pubertalni status više nije bio značajan, a kronološka dob samostalno je doprinijela objašnjenju varijance umora za dodatnih 5,7 %.

Zaključno, može se reći da se opisanim setom prediktorskih varijabli (spol, kronološka dob, pubertalni status) može objasniti 12,8 % ukupne varijance jutarnjosti-večernjosti i 14,9 % ukupne varijance umora. Treba napomenuti da uvođenjem varijable kronološke dobi varijabla pubertalne zrelosti postaje statistički neznčajna. Na temelju dobivenih rezultata može se

regresijska jednačina bila izmijenjena. Kao što možemo vidjeti u Tablici 5, u drugom koraku, kada je doprinos varijable spola kontroliran, pubertalni status imao je značajnu dodatnu doprinos u varijanci jutarnjosti-večernjosti, 8,6%. Međutim, u trećem koraku, kada je kronološka dob dodana, pubertalni status više nije bio značajan, a dodatni doprinos kronološke dobi objašnjenju varijance jutarnjosti-večernjosti bio je 3,2%. Na temelju provedenih analiza možemo zaključiti da je kronološka dob „jači“ prediktor jutarnjosti-večernjosti od pubertalnog statusa.

Isti postupak ponovljen je i za kriterijsku varijablu umora. Rezultati (tablica 6) upućuju na to da se setom prediktora (spol, kronološka dob i pubertalni status) može objasniti 14,9 % varijance umora, a pubertalni status ni u ovoj analizi nije bio značajni prediktor. Spol je značajni prediktor u sva tri koraka analize, a rezultat ukazuje da su adolescentice značajno sklonije doživljavanju simptoma umora od adolescenata. Kada se u drugom koraku analize kontrolira doprinos spola objašnjenju varijance umora, samostalni dodatni doprinos kronološke dobi iznosi 13,4 %. Nakon kontrole doprinosa spola i kronološke dobi u trećem koraku, samostalni doprinos varijable pubertalni status nije se pokazao statistički značajnim. U nastavku, promijenjen je redoslijed dodavanja prediktora u regresijsku jednadžbu (drugi dio tablice 6). Uz kontrolu spola, u drugom koraku analize, pubertalni status je imao značajan dodatni samostalni doprinos varijanci doživljavanja umora i iznosio je 7,6 %. No, u trećem koraku, kada je dodana kronološka dob, pubertalni status više nije bio značajan, a kronološka dob samostalno je doprinijela objašnjenju varijance umora za dodatnih 5,7 %.

Zaključno, može se reći da se opisanim setom prediktorskih varijabli (spol, kronološka dob, pubertalni status) može objasniti 12,8 % ukupne varijance jutarnjosti-večernjosti i 14,9 % ukupne varijance umora. Treba napomenuti da uvođenjem varijable kronološke dobi varijabla pubertalne zrelosti postaje statistički neznčajna. Na temelju dobivenih rezultata može se

**TABLE 6.** Results of hierarchy regression analysis for the fatigue criterion with variables of sex, chronological age, and the pubertal status with predictor variables (N=439)

Fatigue				
Step	Predictors	$\beta$	R <sup>2</sup>	$\Delta R^2$
1st Step	Sex	-.125**	.016	
2nd Step	Sex Chronological age	-.118** -.366**	.149	.134**
3rd Step	Sex Chronological age Pubertal status	-.120** -.372** .009	.149	.000
Fatigue				
Step	Predictors	$\beta$	R <sup>2</sup>	$\Delta R^2$
1st Step	Sex	-.125	.016	
2nd Step	Sex Pubertal status	-.055 -.286**	.092	.076**
3rd Step	Sex Pubertal status Chronological age	-.120** .008 -.372**	.149	.057**

\*p&lt;.05, \*\*p&lt;.01

zaključiti da su u ovom uzorku ispitanika jutarnost-večernost i umor povezani s pubertalnim statusom preko varijable kronološke dobi.

## RASPRAVA

Dobiveni rezultati provjere odnosa pubertalnog statusa, kronološke dobi i spola u skladu su s očekivanjima: u usporedbi s adolescentima, adolescentice su uglavnom pubertalno zrelije. Na to ukazuju dva pokazatelja: 1) adolescentice u svim kategorijama pubertalne zrelosti su kronološki mlađe od adolescenata i 2) u kategorijama veće pubertalne zrelosti više je adolescentica. Dobiveni rezultati u skladu su s dosadašnjim nalazima prema kojima pubertalne promjene kod djevojčica najčešće započinju ranije nego kod dječaka. Nadalje, pokazalo se da kronološka dob i pubertalna zrelost visoko koreliraju i značajno su povezane sa sklonosti večernosti i doživljavanjem umora. Adolescenti i adolescentice s dobi razvijaju večernji obrazac spavanja i doživljavaju sve više simptoma umora. Sve tri ispitivane varijable (ženski spol, starija kronološka dob i veća pubertalna zrelost) zajedno objašnjavaju 12,8 % varijan-

overall morningness-eveningness variance and 14.9% overall fatigue variance. It should be noted that by introducing the chronological age variable, the pubertal maturity became statistically insignificant. Based on the obtained results, we can conclude that morningness-eveningness and fatigue were associated with pubertal status through the variable of chronological age in the respondents from this sample.

## DISCUSSION

The results from the relationship of the pubertal status, chronological age, and sex are in line with the expectations: when compared to adolescent boys, adolescent girls have higher pubertal maturity. Two indicators point to this: 1) in all of the categories of pubertal maturity, adolescent girls are chronology younger than adolescent boys, and 2) there are more adolescent girls in categories of higher pubertal maturity. The obtained results are in concordance with other findings so far, according to which the pubertal changes in girls start earlier than in boys. Furthermore, it has been shown that the chronological age and pubertal maturity are highly

ce jutarnjosti-večernjosti i 14,9 % varijance umora. Biološki čimbenici koji u adolescenciji pridonose pomaku k večernjosti vezani su za pomak u fazi endogenih cirkadiurnih ritmova i sporiju akumulaciju homeostatskog pritiska spavanja (12). No, biološki uvjetovane promjene u stalnoj su interakciji s brojnim psihosocijalnim čimbenicima. Ulaskom u pubertet adolescenti su skloniji u večernjim satima baviti se aktivnostima svojstvenim odraslima (kasniji izlasci, druženja s prijateljima, gledanje televizije), za razliku od ranijih razdoblja života. Nadalje, roditeljski nadzor se smanjuje u brojnim aspektima života mlade osobe, pa tako i nad vremenom odlaska na spavanje i načinom provođenja vremena prije spavanja (5,7). Nemali broj adolescenata do kasnih noćnih sati provodi vrijeme na internetu ili čak ostavljaju tijekom noći uključen mobitel kako bi u svakom trenutku bili dostupni vršnjacima (12), a istraživači naglašavaju da upravo gledanje TV-a i socijalno druženje na internetu neposredno prije spavanja može povećati fiziološku pobuđenost i otežati uspjavanje (24).

Dok je progresivna tendencija večernjosti u funkciji dobi potvrđena gotovo u svim dosadašnjim istraživanjima, nalazi o razlikama s obzirom na spol manje su konzistentni (4,25-27). Najčešće se veća sklonost večernjosti utvrđuje u adolescentica, premda u nekim istraživanjima nisu dobivene razlike u cirkadiurnim preferencijama s obzirom na spol. U ovom istraživanju utvrđene su značajne razlike: adolescentice su bile značajno sklonije večernjosti od adolescenata. Dobiveni nalazi najčešće se tumače ranijim početkom puberteta kod djevojčica i njihovim ranijim doživljavanjem bioloških promjena koje sudjeluju u cirkadiurnoj regulaciji (3,6,7,27). Adolescentice općenito radnim danom idu kasnije na spavanje i ustaju ranije, ali to onda nadoknađuju vikendom kada je duže spavanje više u skladu s njihovim cirkadiurnim preferencijama (26). Zanimljivi rezultati u vezi nadoknade spavanja vikendom

correlated and are significantly associated with the eveningness preference and experience of fatigue. Adolescent boys and girls develop an evening sleep pattern and experience more symptoms of fatigue. The three tested variables (female sex, older chronological age, and higher pubertal maturity) jointly explain the 12.8% of the morningness-eveningness variance and 14.9% of the fatigue variance. Biological factors in adolescence that contribute to the shift towards eveningness are associated with the shift in the endogenous circadian rhythm phases and the slower accumulation of homeostatic sleep pressure (12). However, the biologically driven changes are in constant interaction with numerous psychosocial factors. With the onset of puberty, adolescents are more likely to engage in adult activities (late nights out, socializing with friends, watching television) as opposed to their previous periods of life. Furthermore, parental supervision is reduced in many aspects of life of the young person and thus also in the control of bedtime and the time spent before it (5,7). A large number of adolescents spend late night hours on the Internet or even leave their cell phones turned on during the night to be available at all times (12), and researchers point out that watching television and socializing on the Internet before bed can increase psychological arousal and cause sleep difficulties (24).

While the progressive tendency toward eveningness as a function of age was confirmed in almost all of the previous studies, findings on sex differences are less consistent (4,25-27). A higher eveningness preference is found in adolescent girls, although in some studies, differences in the circadian preferences with regard to sex were not found. In this study, significant differences were found: adolescent girls had a higher eveningness preference compared with adolescent boys. The acquired results are most often interpreted as a consequence of the earlier onset of puberty in girls and earlier biological changes involved in the regulation of the



dobiveni su ispitivanju Wolfsona i Carskadon (9). U njihovom istraživanju nisu utvrđene razlike u jutarnjosti-večernjosti između adolescentica i adolescenata, no pokazalo se da su tijekom vikenda, kada nema nastave i kada su svi slobodni prilagođavati se vlastitom ritmu i potrebama za spavanjem, adolescentice ipak kasnije odlazile na spavanje i kasnije ujutro ustajale. Osim bioloških, brojni psihosocijalni čimbenici također mogu objasniti dio ovih spolnih razlika. Tako, na primjer, autori Gaina i sur. (28) ističu razlike u provođenju slobodnog vremena i smatraju da su adolescenti skloniji jutarnjosti, jer se općenito više bave sportskim aktivnostima i više vremena provode izloženi danjem svjetlu. Nadalje, nalaz dobiven u ovom istraživanju, da se s dobi i pubertalnim sazrijevanjem adolescenti osjećaju sve umornijima, te da adolescentice doživljavaju više simptoma umora od adolescenata, očekivan je i konzistentan s rezultatima u drugim istraživanjima (29-31). U istraživanju provedenom u Hrvatskoj, ispitivana je učestalost doživljavanja somatskih simptoma u uzorku adolescenata u dobi od 10 do 25 godina. Pokazalo se da 69,5 % mladića i 83,4 % djevojaka izvještava o doživljavanju simptoma umora u posljednja 3 mjeseca, te da je s dobi umor sve učestaliji (32). Slični rezultati dobiveni su na širem dobnom uzorku od 14 do 92 godine s gotovo linearnim rastom doživljavanja umora kod ispitanika (33). Zajednički zaključak je da su žene općenito sklonije doživljavati i izvještavati o psihološkim i somatskim simptomima, pa tako i o simptomima umora (31,34,35). Longitudinalne studije pokazuju da se povećanje broja psiholoških i somatskih simptoma kod žena događa upravo tijekom adolescencije (31). U interpretacijama dobivenih razlika najčešće se koriste dva tumačenja: jedno, prema kojem raniji ulazak djevojaka u pubertet realno povećava broj tjelesnih simptoma općenito, pa tako i umora, i drugo, prema kojem djevojke imaju općenito veću interosceptivnu osjetljivost na tjelesne simptome, pa tako i simptome umora. Ovo drugo tumačenje

circadian rhythm (3,6,7,27). Adolescent girls have later bedtimes and rise earlier on weekdays, but they have longer sleep lengths on weekends that are in accordance with their circadian preferences (26). A study by Wolfson and Carskadon (9) revealed some interesting results regarding sleep compensation on weekends. In their study, adolescent boys and girls did not differ in morningness-eveningness preference, but on weekends when there was no school and everyone was free to adjust to their own rhythm and sleeping needs, girls had later bedtimes and rise times. In addition to biological factors, psychosocial factors can also explain some of the sex differences. Thus, for example, Gaina *et al.* (28) point to differences in leisure time and believe that adolescent boys have a greater tendency towards morningness because they are generally more engaged in sports and spend more time exposed to daylight. Furthermore, the finding in this study that adolescents feel more fatigue with age and pubertal maturity and that girls experience more fatigue symptoms than boys is expected and consistent with findings from other studies (29-31). In the study conducted in Croatia, the frequency of somatic symptoms was investigated in a sample of adolescents between ages 10 and 25. The study showed that 69.5% of adolescent boys and 83.4% of adolescent girls experienced fatigue symptoms in the last three months and that fatigue increased with age (33). Similar results were obtained in a broader age sample, ages 14 to 92, with almost a linear rise in experience of fatigue in respondents (33). A common conclusion is that women are generally more prone to experience fatigue and report on psychological and somatic symptoms, including symptoms of fatigue (31,34,35). Longitudinal studies show that an increase in the number of psychological and somatic symptoms in women occurs during adolescence (31). Two interpretations are most commonly used to explain these differences: first, earlier onset of puberty in girls realistically increases the number of physical symptoms in general, including fatigue, second,

nalazi svoje uporište u *teoriji percepcije simptoma* (36,37) koja uzrok razlika u percepciji simptoma vidi u socijalnim utjecajima i očekivanjima koja se stavljaju pred žene, te općenito u većoj tendenciji žena da internaliziraju svoje psihološke i socijalne probleme. Wolbeek i sur. (31) smatraju da vrlo slični procesi dovode do umora u adolescenata i adolescentica, ali su adolescentice osjetljivije na tjelesne simptome, pa ih stoga procjenjuju intenzivnijima. Nadalje, dobiveni rezultati mogu se povezati s već spomenutom značajnom razlikom između adolescentica i adolescenata na dimenziji jutarnjosti-večernjosti. Moguće je da se umor općenito češće javlja u adolescentica kao posljedica češće deprivacije spavanja zbog veće sklonosti večernjosti. Također, kao i u slučaju jutarnjosti-večernjosti, i na te biološki uvjetovane promjene značajno utječu brojni psihosocijalni čimbenici. Moguće je da se u danima kada je nastava u jutarnjoj smjeni adolescentice ustaju ranije od adolescenata zbog jutarnjih rutina povezanih s njihovom rodnom ulogom (npr. više vremena provode u oblačenju i dotjerivanju).

Naposljetku, u ovom istraživanju dobiven je neočekivan nalaz o ulozi pubertalne zrelosti u objašnjenju varijance jutarnjosti-večernjosti kao i varijance umora. Naime, u većini dosadašnjih istraživanja naglašava se specifična povezanost spavanja i umora s pubertalnim sazrijevanjem. Još od prvih istraživanja autorice Carskadon i sur. (4) smatra se da javljanje puberteta ima snažniji učinak na promjene u cirkadiurnim preferencijama od psihosocijalnih čimbenika. Tome u prilog idu brojni nalazi o pomaku prema večernjosti 12 mjeseci nakon javljanja prve menstruacije u djevojčica (38), kao i nalazi o povećanim razinama umora u sklopu predmenstrualnog sindroma. Premda je pubertalno sazrijevanje povezano sa smanjivanjem ukupnog vremena spavanja kod ispitanika oba spola, samo je u djevojaka to bilo povećani rizik za javljanje insomnije i umora čak i u onim situacijama kada postoji nadoknada

girls have a generally higher interoceptive sensibility to physical symptoms, including fatigue. This second interpretation is grounded in the *symptom perception theory* (36,37) which sees the cause of differences in the perception of symptoms due to the social influences and expectations that are placed on women, and in the generally higher tendency of women to internalize their psychological and social problems. Wolbeek *et al.* (31) believe that very similar processes lead to fatigue in both boys and girls, but that girls are more sensitive to physical symptoms and therefore assess them as more intense. Furthermore, the obtained results could be associated to the already mentioned significant difference between adolescent boys and girls in the morningness-eveningness dimension. It is possible that fatigue is more common in girls as a consequence of a higher level of sleep deprivation due to their greater tendency toward eveningness. Additionally, as in the case of morningness-eveningness, numerous psychosocial factors significantly influence these biologically conditioned changes. It is possible that girls rise earlier than boys on school days because of morning routines associated with their gender (for example, they spend more time on dressing and getting ready).

Finally, this study obtained an unexpected finding on the role of pubertal maturity in the explanation of the morningness-eveningness and fatigue variance. Namely, most of the studies so far empathize the specific association of sleep and fatigue with pubertal maturation. Since the first study by Carskadon *et al.* (4), it was thought that puberty has a stronger effect on the changes in the circadian preferences than psychosocial factors. In addition to this, there are numerous findings about the shift toward eveningness in girls 12 months after their first period (38), as well as findings on increased levels of fatigue as a part of the premenstrual syndrome. Although pubertal maturation is associated with a reduction in the overall sleep time in both sexes, only in girls was there an

sna. Taj nalaz se povezuje i s većom učestalosti depresije u djevojaka pri čemu poremećaji spavanja i umor prethode prvim epizodama velikog depresivnog poremećaja (38).

Iako su navedena istraživanja pokazala nesumnjivu povezanost pubertalnog statusa i umora, te pubertalnog statusa i jutarnjosti-večernjosti, rezultati našeg istraživanja upozoravaju da je prigodom istraživanja na ovom području potrebno voditi računa da brojne varijable, poput kronološke dobi i pubertalnog statusa u ovom slučaju, uključuju niz tjelesnih pokazatelja koji se međusobno preklapaju, a da su istovremeno odvojeni biološki procesi. K tome, za razumijevanje odnosa obrazaca spavanja i umora neophodno je uzimati u obzir s njima povezane biološke i psihosocijalne čimbenike, te njihovu međusobnu interakciju. Svi ti čimbenici međusobno su snažno povezani - biološke promjene tijekom puberteta u stalnoj su interakciji s promjenama na planu ponašanja, kao i s kognitivnim i socijalnim sazrijevanjem. U tom smislu, pubertalni status daje važnu, ali nedovoljnu informaciju o promjenama u obrascu spavanja ili doživljavanju umora. Kronološka dob je, s druge strane, puno sveobuhvatniji pokazatelj jer određuje psihološko i socijalno funkcioniranje vezano za neku dobnu skupinu, a psihosocijalni čimbenici su možda više povezani sa samom kronološkom dobi adolescenata. Kronološka dob određuje neke ključne normativne promjene (npr. prijelaz iz osnovne u srednju školu) koje se uvelike mogu odraziti na psihološko i socijalno funkcioniranje adolescenata, a time i na pojačano doživljavanje umora kod njih. Velik broj istraživanja upozorava na zdravstvene tegobe koje se javljaju zbog neusklađenosti razvojnih potreba učenika i karakteristika socijalne okoline vezane za obrazovno okruženje (39). S obzirom na utvrđenu povezanost umora i sklonosti večernjosti otvara se mogućnost preventivnog djelovanja u školskom kontekstu na način da se napravi vremenski pomak u početku nastave u jutarnjem terminu. Naime,

increased risk for insomnia and fatigue, even in situations where there was sleep compensation. This finding is also associated with a greater incidence of depression in girls, where sleep disorders and fatigue precede the first stages of the major depressive disorder (38).

Although the abovementioned studies have shown an unquestionable association between pubertal status and fatigue and pubertal status and morningness-eveningness, the results of our study show that it is important in this research field to bear in mind that numerous variables, such as the chronological age and pubertal status, include a number of physical indicators that mutually overlap but are at the same time separate biological process. Additionally, in order to understand the relationship between sleep patterns and fatigue, it is necessary to take into account biological and psychosocial factors related to them and their interaction. All of these factors are strongly related – biological changes in puberty are in constant interaction with the behavioral changes as well as with cognitive and social maturation. In this regard, pubertal status provides important but insufficient information on the changes in sleep patterns or experience of fatigue. Chronological age, on the other hand, is a more comprehensive indicator because it determines the psychological and social function of a certain age group, and psychosocial factors may be more related to the chronological age of the adolescents. Chronological age determines some key normative changes (for example transition from elementary to secondary school) that can greatly affect the psychological and social functioning of adolescents and thus increase the experience of fatigue among them. Numerous studies warn of health problems that manifest due to the incompatibility between developmental needs of students and characteristics of the social environment related to the educational environment (39).

Given the established association of fatigue and eveningness preference, there is a possibility for

Bregers, Gable i Owens (40) su u svom istraživanju potvrdili da pomak u početku nastave (i onda kada se radi o samo 25 minuta) dovodi do smanjenja deprivacije spavanja, dnevnog umora i pospanosti, poboljšanja raspoloženja, te smanjenog unosa kofeina. Seriju istraživanja o toj temi u Hrvatskoj su proveli autori Koščec, Radošević-Vidaček i Bakotić (12,41-44). Rezultati pokazuju da su i u dvosmjenskom sustavu nastave večernje preferencije povezane s nepravilnostima u rasporedu spavanja i s kraćim spavanjem adolescenata u jutarnjoj smjeni. Također navode da su kod starijih adolescenata razlike u spavanju između radnog tjedna i vikenda bile veće, osobito u tjednu kada se nastava održavala u jutarnjoj smjeni te je akumulacija duga u spavanju bila veća za taj tjedan. Nadalje, neregularnost u vremenu odlaska na spavanje u jutarnjoj smjeni bila je povezana s pospanošću, a pospanost je također bila povezana i s izraženijim večernjim preferencijama. Dobiveni rezultati pokazuju da se prilagodbama školskog rasporeda obrascu spavanja u adolescenciji mogu postići višestruki pozitivni utjecaji na kvalitetu života adolescenata.

Provedeno istraživanje ima i određena ograničenja. Kao prvo, radi se o transversalnom nacrtu istraživanja pa se ne mogu donositi zaključci o vremenu kada se točno događaju promjene na dimenziji jutarnjosti-večernjosti. Nadalje, u ovom istraživanju nisu uzeti u obzir vanjski čimbenici koji su presudni za bolje razumijevanje relacija između ispitivanih varijabli. Na primjer, u ispitivanjima na ovom području svakako je potrebno uključiti informacije o kasnonoćnom korištenju raznih zabavnih medija i socijalnih mreža na internetu, kako bi se kontrolirao njihov utjecaj na psihološku pobuđenost i kvalitetu spavanja. I pored toga, istraživanje umora u adolescenciji može biti težak zadatak jer se radi o procesu koji je pod utjecajem različitih čimbenika karakterističnih za tu dobnu skupinu: tjelesnih (hormonske i pubertalne promjene u tjelesnom izgledu i

preventive action in schools, which is to delay school starting time in morning shifts. Bregers, Gable, and Owens (40) confirmed in their study that such a shift in the beginning of classes (even when it is only 25 minutes) leads to a reduction of sleep deprivation, daytime fatigue and drowsiness, mood improvement, and reduction of caffeine intake. Koščec, Radošević-Vidaček, and Bakotić (12,41-44) conducted a series of studies on this topic in Croatia. The results show that in the two-shift school system, eveningness preferences are associated with inconsistencies in the sleeping schedule and shorter sleep patterns of adolescents in morning shifts. The results also show that sleep differences in older adolescents were higher between weekdays and weekends, especially during the week when classes were held in the morning shift and the accumulation of sleep "debt" was higher during that week. Furthermore, irregularities in bedtime in the morning shift were associated with drowsiness, and drowsiness was also associated with a greater preference toward eveningness. The obtained results show that adjustment of the school schedule to the sleep pattern in adolescence can have multiple positive effects on the quality of life of adolescents.

The present study has certain limitations. First, this is a transversal outline of the study, so no conclusions can be drawn about the exact time of the changes in the morningness-eveningness dimension. Furthermore, the external factors that are crucial for a better understanding of the relationship between the examined variables were not taken into account. For example, in studies in this area it is essential to include information on late-night use of various entertainment media and social networks on the Internet in order to control their impact on the psychological arousal and quality of sleep. In addition, the study of fatigue in adolescence can be a difficult assignment because it is a process that is influenced by various factors specific for that age group: physical (hormonal and puber-

funkcioniranju), emocionalnih (npr. pojačan osjećaj neovisnosti) i socijalnih faktora (utjecaj vršnjaka, obiteljske interakcije, školski raspored i sl.) (46).

## ZAKLJUČAK

Može se zaključiti da su prva i druga hipoteza u ovom istraživanju potvrđene: pubertalno zreliji adolescenti pokazuju veću sklonost večernjosti i izvještavaju o više simptoma umora. Adolescentice su pubertalno zrelije, pa u skladu s prethodno rečenim, pokazuju veću sklonost večernjosti i izraženiji umor u odnosu na muške vršnjake. Neočekivan nalaz u ovom istraživanju odnosio se na treći cilj istraživanja. Kronološka dob i pubertalni status su visoko međusobno korelirani, no razlikuju se s obzirom na njihov doprinos objašnjenju jutarnjosti-večernjosti i umora. Pokazalo se da pubertalna zrelost nije značajan prediktor jutarnjosti-večernjosti i umora već su u ovom uzorku te varijable povezane s pubertalnim statusom preko varijable kronološke dobi. Taj nalaz upućuje da je oba pokazatelja potrebno uzeti u obzir kako bi se dobio bolji uvid u promjene tijekom adolescencije.

Naposljetku treba napomenuti da istraživanje spavanja i umora u adolescenciji ima veliku važnost jer može izravno pridonijeti znanjima o unutarnjim utjecajima na obrasce spavanja i doživljavanje umora tijekom razvoja, a također bi se u budućim istraživanjima pažnja trebala usmjeriti na sveobuhvatnu interakciju kako unutarnjih tako i vanjskih utjecaja na spavanje u ovom razdoblju života (45).

tal changes in physical appearance and functioning), emotional (for example an increased feeling of independence), and social (influence of peers, family interactions, school schedule, etc.) (46).

## CONCLUSION

It can be concluded that the first and second hypothesis of this study were confirmed: adolescents with a higher pubertal maturity show a greater tendency toward eveningness and report more symptoms of fatigue. Adolescent girls have a higher pubertal maturity, and in accordance with abovementioned data, show a greater tendency toward eveningness and report more symptoms of fatigue than their male peers. An unexpected finding in this study was related to the third objective. The chronological age and pubertal status were significantly correlated but differed in their contribution to the explanation of morningness-eveningness and fatigue. It has been shown that pubertal maturity is not a significant predictor of morningness-eveningness and fatigue, but in this sample these variables were related to the pubertal status through the variable of chronological age. This finding suggests that both indicators need to be taken into account in order to gain a better insight into the changes during adolescence. Finally, it should be noted that the study of sleep and fatigue in adolescence is of great importance and can directly contribute to the knowledge about internal factors on sleep patterns and experience of fatigue during development, and future studies should focus their attention on the comprehensive interaction of internal and external factors on sleep in this period of life (45).

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