PREVALENCIJA I SOCIODEMOGRAFSKE NEJEDNAKOSTI U OBOLEVANJU OD DIJABETES TIP 2 MULTIMORBIDITETA U SRBIJI

ORIGINALNI RAD

ORIGINAL ARTICLE

PREVALENCE AND SOCIODEMOGRAPHIC INEQUALITIES IN DEVELOPING TYPE 2 DIABETES MULTIMORBIDITIES IN SERBIA

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SAŽETAK

Uvod: Broj ljudi sa dijabetesom raste širom sveta, pri čemu većina obolelih živi u zemljama sa niskim i srednjim prihodima. Dijabetes melitus tip 2 (T2DM) često je povezan sa istovremenom pojavom jednog ili više dugotrajnih zdravstvenih stanja (komorbiditeti i multimorbiditeti), na koje mogu uticati socijalno-ekonomske prilike pacijenata, ali nije poznato u kojoj meri je to prisutno u Srbiji. Stoga je cilj ovog istraživanja da ispita prevalenciju i uticaj socijalno-demografskih faktora na T2DM komorbiditet i multimorbiditet u Srbiji.

Materijali i metode: Sprovedena je sekundarna analiza podataka Istraživanja zdravlja stanovništva Republike Srbije iz 2013. i 2019. godine, u populaciji starijoj od 45 godina. Korišćene su multivarijantne analize za istraživanje odnosa između sociodemografskih determinanti učesnika u različitim grupama bolesti (sa/bez T2DM-a i jednim ili više komorbiditeta). Rezultati su prikazani kao odnos relativnog rizika sa 95%-im intervalima poverenja i predviđenim verovatnoćama.

Rezultati: Prevalencija T2DM komorbiditeta iznosila je 8,8%, a multimorbiditeta 29,5%. T2DM je najčešće udružen sa moždanim udarom, infarktom miokarda i cirozom jetre. Multimorbiditet se češće javljao kod starijih osoba, žena, osoba sa nižim nivoom obrazovanja i nižim prihodima. Najveći rodni jaz identifikovan je u predviđenim verovatnoćama za T2DM i multimorbiditete među najmanje obrazovanim ispitanicima (žene: $p = 0,333$ naspram muškaraca: $p = 0,208$) i u najnižem kvintilu prihoda (žene: $p = 0,366$ naspram muškaraca: $p = 0,236$), dok rodna razlika nije identifikovana među onima koji imaju završene barem osnovne fakultetske studije (žene: $p = 0,258$ naspram muškaraca: $p = 0,260$).

Zaključak: Sveobuhvatni pristup identifikaciji i razvrstavanju populacije u podgrupe na osnovu njihovog rizika za dugotrajna zdravstvena stanja pruža dragocene uvide koji mogu poboljšati rano otkrivanje i kontrolisanje bolesti.

Ključne reči: diabetes melitus tip 2, dugotrajna stanja, komorbiditet, multimorbiditet, prevalencija, sociodemografski faktori, rod, zdravstvene nejednakosti

ABSTRACT

Introduction: The number of people living with diabetes is increasing worldwide, with the majority of those affected residing in low- and middle-income countries. Type 2 diabetes mellitus (T2DM) is often associated with the co-occurrence of one or more long-term conditions (LTCs), which might be affected by patients' socioeconomic characteristics, however, to what extent, it is as yet unknown in Serbia. Therefore, we have aimed to examine the prevalence and impact of sociodemographic factors on T2DM multimorbidity in Serbia.

Materials and methods: Secondary data analysis of the Serbian National Health Surveys 2013 and 2019 was conducted in a population older than 45 years. Multivariate analyses were used to investigate relative risk ratios with 95% confidence intervals and corresponding predicted probabilities between the sociodemographic profiles of participants in different disease groups (with/without T2DM and one or more LTCs).

Results: The prevalence of T2DM comorbidity and multimorbidity was 8.8% and 29.5%, respectively. Most often, T2DM co-occurred with stroke, myocardial infarction, and liver cirrhosis. Multimorbidity was associated with older age, the female gender, lower level of education, and lower income. The biggest gender gap was identified in the predicted probabilities for having T2DM and two or more LTCs among the subjects with the lowest level of education (women: $p = 0.333$ vs. men: $p = 0.208$) and in the lowest income quintile (women: $p = 0.366$ vs. men: $p = 0.236$), while the gender gap was not identified among those with at least a bachelor's degree (women: $p = 0.258$ vs. men: $p = 0.260$).

Conclusion: A comprehensive approach to identifying and subgrouping populations based on their risk of LTCs yields valuable insights that can facilitate early detection and disease management.

Keywords: diabetes mellitus type 2, long-term conditions, comorbidity, multimorbidity, prevalence, sociodemographic factors, gender, health inequalities

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UVOD

Broj ljudi koji živi sa dijabetesom je u porastu širom sveta i predviđa se da će dostići 745 miliona u naredne dve decenije [1], od kojih većina živi u zemljama sa niskim i srednjim prihodima (engl. *low- and middle-income countries - LMICs*) [2]. Inovacije u lečenju dijabetesa dovele su do značajnog porasta stope preživljavanja pacijenata. Međutim, one su takođe imale za posledicu veću prevalenciju višestrukih hroničnih stanja, često povezanih sa dijabetesom, fenomenom koji se obično naziva multimorbiditet [1].

Multimorbiditet se definiše kao istovremena pojava najmanje dva hronična stanja kod jednog pacijenta [3]. Ovaj rastući trend multimorbiditeta predstavlja značajan izazov za pružaoce zdravstvenih usluga i kreatore politike jer može dovesti do složenih zdravstvenih problema i veće potražnje za zdravstvenim uslugama. U literaturi su opisani efekti multimorbiditeta kod pacijenata sa dijabetesom na kvalitet života, upotrebu lekova, ukupan pristup zdravstvenim uslugama i troškove zdravstvene zaštite. Stoga je od ključnog značaja da se ovaj fenomen istraži primenom integrisanog i koordinisanog pristupa, kako bi se obezbedili optimalni ishodi za pacijente i efikasno upravljanje resursima zdravstvene zaštite. Međutim, sadašnji zdravstveni sistemi su više prilagođeni da se bave pojedinačnim bolestima [3,4].

Dobro poznate komplikacije dijabetesa su bubrežna oboljenja, koronarna bolest srca, periferna vaskularna bolest, te cerebrovaskularne bolesti. Međutim, i druge bolesti koje nisu obično povezane sa ovim oboljenjem mogu se javiti kao komorbiditeti kod dijabetesa. Ove bolesti uključuju stanja mentalnog zdravlja, kao što su šizofrenija i depresija, kao i tuberkulozu, bolest masne jetre, opstruktivnu apneju u snu, demenciju i osteoartritis [1,5,6].

U mnogim zemljama sa niskim i srednjim prihodima dešava se epidemiološka tranzicija, uz porast nezaraznih bolesti, kao što su dijabetes melitus tip 2 (T2DM), hipertenzija, kardiovaskularne bolesti i rak, u relativno mlađoj populaciji nego u zemljama sa visokim prihodima. Procenjuje se da postoji veći teret depresije i tuberkuloze sa dijabetesom u zemljama sa niskim i srednjim prihodima, u poređenju sa zemljama sa visokim prihodima, što odslikava manju dostupnost resursa i finansijskih sredstava, posebno za mentalno zdravlje [5]. Pored toga, faktori životne sredine, siromaštvo i ograničena socijalna infrastruktura, među ostalim skrivenim faktorima (engl. *confounding factors*), takođe utiču na razvoj multimorbiditeta u zemljama sa niskim i srednjim prihodima [3]. Korišćenje zdravstvene zaštite je takođe komplikovanije u zemljama sa niskim i srednjim prihodima, jer razlike u pristupu zdravstvenoj zaštiti utiču na cele porodice [3].

INTRODUCTION

The number of people living with diabetes is increasing worldwide and is predicted to reach 745 million in the next two decades [1], of whom the majority reside in low- and middle-income countries (LMICs) [2]. The breakthroughs in diabetes management have led to a significant rise in patient survival rates. However, they have also resulted in a higher prevalence of multiple long-term conditions often associated with diabetes, a phenomenon commonly referred to as multimorbidity [1].

Multimorbidity is defined as the co-occurrence of at least two chronic conditions in one patient [3]. This growing trend of multimorbidity poses a considerable challenge for healthcare providers and policymakers as it can lead to complex health issues and greater demands for healthcare services. The effects of multimorbidity among patients with diabetes on the quality of life, the use of medication, overall access to health services, and healthcare costs have been described in literature. Therefore, it is crucial to address this phenomenon with an integrated and coordinated approach, to ensure optimal patient outcomes and effective management of healthcare resources. However, current healthcare systems are better equipped to deal with a single disease [3,4].

Well-known complications of diabetes are kidney disease, coronary heart disease, peripheral vascular disease, and cerebrovascular disease, but other illnesses not commonly associated with this disease can occur as comorbidities in diabetes. These illnesses include mental health conditions like schizophrenia and depression, as well as tuberculosis, fatty liver disease, obstructive sleep apnea, dementia, and osteoarthritis [1,5,6].

Many LMICs are experiencing an epidemiological transition, with a rise in non-communicable diseases such as type 2 diabetes mellitus (T2DM), hypertension, cardiovascular disease, and cancer in a relatively younger population than in high-income countries (HICs). It is estimated that there is a higher burden of depression and tuberculosis with diabetes in LMICs, as compared to HICs, reflecting lower availability of resources and funding, especially for mental health [5]. Additionally, environmental factors, poverty, and limited social infrastructure, among other confounding factors, also influence the development of multimorbidity in LMICs [3]. Healthcare utilization is also more complicated in LMICs as the differences in access to healthcare influence entire families [3].

The prevalence of chronic non-communicable diseases has been increasing in Serbia since the beginning of the 21st century, and these illnesses account for almost two-thirds of the burden of diseas-

Prevalencija hroničnih nezaraznih bolesti u Srbiji je u porastu od početka 21. veka i ove bolesti čine skoro dve trećine tereta bolesti u zemlji [6]. Prevalencija dijabetesa je porasla sa 5,3%, 2006. godine, na 8,3%, 2019. godine [7,8]. Prevalencija multimorbiditeta u opštoj populacionoj studiji u Srbiji sprovedenoj 2006. godine, iznosila je 30,2% [6]. Nijedna studija do danas nije ispitivala multimorbiditet povezan sa dijabetesom u Srbiji.

Trenutne smernice dobre kliničke prakse u zemlji su usmerene na lečenje pojedinačnih bolesti, kao što je to slučaj u mnogim zemljama [6]. Ovo je ozbiljna prepreka za zdravstvene radnike koji leče pacijente sa multimorbiditetom. Shodno tome, postoji potreba za unapređenjem sadašnjih znanja kako bi se omogućilo adekvatno lečenje pacijenata sa multimorbiditetom u Srbiji.

Ova studija ima za cilj da ispita prevalenciju i uticaj sociodemografskih faktora T2DM multimorbiditeta u Srbiji.

MATERIJALI I METODE

Dizajn studije i ispitivani uzorak

Sprovedena je studija preseka kako bi se ispitao T2DM multimorbiditet u Srbiji. U ovoj studiji, primenili smo sekundarnu analizu podataka iz dva najnovija Istraživanje zdravlja stanovništva Republike Srbije (u daljem tekstu: Nacionalna istraživanja), na nacionalno reprezentativnom uzorku. Ova istraživanja su sprovedena 2013. i 2019. godine, na zahtev Ministarstva zdravlja Republike Srbije. Anonimizovani elektronski skupovi podataka iz Nacionalnih istraživanja dobijeni su na osnovu etičkog odobrenju Instituta za javno zdravlje Srbije, koji je i sproveo Nacionalno istraživanje 2013. godine [9], dok je 2019. godine ovo istraživanje sproveo Republički zavod za statistiku u saradnji sa Institutom za javno zdravlje Srbije [8].

Skupovi podataka sadrže podatke iz stratifikovanog dvoetapnog reprezentativnog uzorka stanovništva Srbije, prema metodologiji Nacionalnog istraživanja [8,9]. Oba uzorka daju statistički pouzdane procene na nacionalnom nivou i nivoima četiri geografska regiona Srbije (Vojvodina, Beograd, Šumadija i Zapadna Srbija i Južna i Istočna Srbija). Popisni krugovi (grupe domaćinstava) su odabrani nasumično na osnovu verovatnoće proporcionalne veličini i definisani kao primarne uzoračke jedinice. U domaćinstvima (6.500 domaćinstava u 2013. [9] i 5.114 domaćinstava u 2019. godini [9]), kao sekundarnim uzoračkim jedinicama, anketirano je 15.999 ispitanika, u 2013. godini, i 15.621 ispitanika, u 2019. godini.

Populaciju od značaja za našu studiju činile su odrasle osobe starosti 45 godina i više (n = 8.749, 2013. godine, i n = 8.081, 2019. godine) obolele od dijabetes melitusa tipa 2 (n = 1.144, 2013. godine, i n = 1.075, 2019. godine). Detalji o metodama uzorkovanja objavljeni su na drugom mestu [8,9].

es in the country [6]. The prevalence of diabetes has increased from 5.3%, in 2006, to 8.3%, in 2019 [7,8]. The prevalence of multimorbidity in a general population-based study in Serbia was 30.2% [6]. No studies, to date, have examined diabetes-associated multimorbidity in Serbia.

The current good clinical practice guidelines within the country are single-disease-centered, as is common in many countries [6]. This presents a significant obstacle for healthcare practitioners treating patients with multimorbidity. Consequently, there is a need to improve current knowledge to accommodate the management of patients with multimorbidity in Serbia.

This study aims to examine the prevalence and impact of sociodemographic factors of T2DM multimorbidity in Serbia.

MATERIALS AND METHODS

Study design and sample

A cross-sectional study was conducted to investigate the multimorbidity of T2DM in Serbia. In this study, we applied secondary analysis of data from the two most recent National Health Surveys (NHS), on a nationally representative sample. The surveys were conducted in 2013 and 2019, at the request of the Ministry of Health of the Republic of Serbia. Anonymized NHS electronic datasets were obtained upon ethical approval from the Institute of Public Health of Serbia, which carried out the 2013 NHS [9], while in 2019, the NHS was conducted by the Statistical Office of the Republic of Serbia in cooperation with the Institute of Public Health of Serbia [8].

Datasets contain data from a stratified two-stage representative sample of the population of Serbia, as per NHS methodology [8,9]. Both samples provide statistically reliable estimates at the national level and the levels of four geographical regions of Serbia (Vojvodina, Belgrade, Šumadija and Western Serbia, and Southern and Eastern Serbia). Census enumeration areas (groups of households) were selected randomly with probability proportional to size and defined as primary sample units. In the households (6,500 in 2013 [9] and 5,114 in 2019 [9]), defined as second-stage sample units, 15,999 respondents in 2013 and 15,621 respondents in 2019 were interviewed.

The population of interest in our study included adults aged 45 years and older (n = 8,749, in 2013, and n = 8,081, in 2019) suffering from diabetes mellitus type 2 (n = 1,144, in 2013, and n = 1,075, in 2019). Details on the sampling methods were published elsewhere [8,9].

Instrumenti primenjeni u Nacionalnom istraživanju

U nacionalnim istraživanjima je korišćena metodologija Evropske ankete o zdravlju (engl. *European Health Interview Survey – EHIS*) za kreiranje istraživačkih instrumenata i varijabilnih skupova podataka [8,9]. Stoga, skupovi podataka iz Nacionalnih istraživanja pružaju informacije o sociodemografskim karakteristikama i zdravstvenim merama, koje su dobijene iz iskaza samih ispitanika tokom intervjua licem u lice, uz primenu standardizovanog upitnika za odrasle osobe (15+ godina), dok su informacije o indeksu telesne mase (visina, težina) i krvnom pritisku prikupljene antropometrijskim metodama i merenjem krvnog pritiska. Sve intervjue i merenja su obavili terenski istraživači u kući ispitanika.

Od svih učesnika je dobijena pismena informisana saglasnost a studija je odobrena od strane Etičkog odbora Instituta za javno zdravlje Srbije (Odluka broj 5996/1, od 01.10.2013. godine, za Nacionalno istraživanje iz 2013. godine, i Odluka broj 7703/1, od 8. 12. 2021. godine, za Nacionalno istraživanje iz 2019. godine).

Varijable studije

Studija je imala dve vrste varijabli: nezavisne (ulazne varijable) i zavisne varijable (koje su ishod varijabli od interesa). Ulazne varijable su bile sociodemografske varijable i ograničenja u obavljanju svakodnevnih aktivnosti usled zdravstvenih problema. Varijable ishoda studije bili su T2DM i druge hronične bolesti ili dugotrajna stanja.

Sociodemografske varijable uključivale su starost ispitanika (kategorisanu u sledeće tri starosne grupe: 45-54, 55-64, 65+ godina), pol (muški i ženski), bračni status (četiri kategorije: u braku ili vanbračnoj zajednici, nikada nisu stupili u brak ili vanbračnu zajednicu, udovice i udovci i rastavljeni/razvedeni), obrazovanje (kategorisano na sledeći način: bez osnovnog obrazovanja ili sa nepotpunim osnovnim obrazovanjem, osnovno ili trogodišnje srednje stručno obrazovanje, srednje obrazovanje i više ili visoko obrazovanje), i indeks blagostanja, kao posredna mera životnog standarda domaćinstva (ispitanici su razvrstani u pet socioekonomskih grupa ili kvintila: prvi kvintil – gornjih 20%, odnosno najbogatija kategorija ispitanika, druga kvintil – kategorija dobrostojećih ispitanika, treći kvintil – ispitanici koji pripadaju srednjoj klasi, četvrti kvintil – ispitanici koji pripadaju siromašnijoj klasi, te peti kvintil – najsiromašnija kategorija ispitanika). Varijable uključene u izračunavanje indeksa blagostanja odnosile su se na imovinu ispitanika (broj spavaćih soba po članu domaćinstva, osnovni podni materijal, osnovni materijal korišćen za izgradnju krova i zidova kuće, tip glavnog izvora vode za piće, vrsta sanitacije, izvor energije koji se koristi za grejanje, posedovanje

NHS instruments

The National Health Surveys utilized the European Health Interview Survey (EHIS) methodology for creating survey instruments and variable datasets [8,9]. Therefore, the NHS datasets provide information on self-reported sociodemographic characteristics and health measures, obtained from face-to-face interviews using a standardized questionnaire for adults 15+, while information on BMI (height, weight) and blood pressure was gathered with anthropometric and blood pressure measurements, respectively. All interviews and measurements were carried out at the respondent's home by field researchers.

Written informed consent was obtained from all participants and the study was approved by the Ethics Review Board of the Institute of Public Health of Serbia (Decision number 5996/1, October 1, 2013, for the 2013 NHS, and 7703/1, December 8, 2021, for the 2019 NHS).

Study variables

The study had two types of variables: independent (input variables) and dependent variables (which are the outcome of variables of interest). Input variables were sociodemographic variables and limitations in practicing daily activities due to health problems. The study outcome variables were self-reported T2DM and other chronic diseases or long-term conditions.

Sociodemographic variables included the age of the respondent (categorized into the following three age groups: 45-54, 55-64, 65+ years), gender (male and female), marital status (four categories: married or living with a partner, never married or cohabited, widowed, and separated), education (categorized in the following way: no or incomplete elementary education, elementary education or vocational training, secondary education, and bachelor's degree or higher), and the wealth index as a proxy measure of the standard of living of the household (the respondents were classified into five socioeconomic groups or quintiles: the first quintile – top 20%, i.e., the richest category of respondents, the second quintile – the category of respondents that are well-off, the third quintile – respondents belonging to the middle class, the fourth quintile – respondents belonging to the poorer class, and the fifth quintile – the poorest category of respondents). Variables included in the wealth index calculation were related to the respondents' assets (number of bedrooms per household member, the predominantly used flooring material, the main material used in constructing the roof and walls of the house, the type of main drinking water source, type of sanitation, the energy source used for heating, possessing a color

televizora u boji, mobilnog telefona, frižidera, računara, veš mašine, mašine za pranje sudova, klima uređaja, centralnog grejanja, automobila, te pristup internetu). Izračunavanje indeksa blagostanja za svakog ispitanika detaljno je opisano na drugom mestu [10].

Ograničenja u obavljanju svakodnevnih aktivnosti usled zdravstvenih problema su svrstana u sledeće kategorije: bez ograničenja, umerena ograničenja i ozbiljna ograničenja.

Varijabla ishoda studije je samoprocenjen T2DM sa ili bez komorbiditeta/multimorbiditeta kod pojedinca, gde je prisustvo T2DM-a plus još jedne hronične bolesti ili dugotrajnog stanja (engl. *long-term condition – LTC*) kategorizovano kao komorbiditet dijabetesa, dok je istovremena pojava T2DM-a sa dve ili više drugih hroničnih bolesti ili *LTC*-a kategorisana kao multimorbiditet dijabetesa.

Podaci o prisutnosti hroničnih bolesti/stanja dobijeni su na osnovu iskaza ispitanika koji su odgovarali na sledeće da/ne pitanje: „Da li ste imali neku od sledećih bolesti ili stanja u prethodnih 12 meseci?". Navedenih 16 hroničnih bolesti/stanja jesu: dijabetes melitus, bronhijalnu astmu (uključujući alergijsku astmu), hronični bronhitis, hroničnu opstruktivnu bolest pluća, emfizem, infarkt miokarda (IM) ili dugoročne posledice infarkta miokarda, koronarnu bolest srca ili anginu pektoris, hipertenziju, moždani udar ili dugoročne posledice moždanog udara, artrozu (isključujući artritis), cirozu jetre, bolest bubrega, depresiju, rak, hiperlipidemiju (visok nivo holesterola), bol (preformulisan u jednoj varijabli kao bol u donjem delu leđa ili bol u vratu), alergije i urinarnu inkontinenciju.

Za potrebe ove analize, izraz „bilo koja *LTC*" odnosio se na bilo koju drugu hroničnu bolest ili dugotrajno stanje, a varijabla ishoda je kategorizovana u sledeće tri grupe: Grupa 1 – „Nema T2DM ili bilo koju *LTC*", Grupa 2 – „T2DM + 1 *LTC*", i Grupa 3 – „T2DM + ≥ 2 *LTC*".

Statistička analiza

Podaci su analizirani korišćenjem modela deskriptivne statistike i multivarijantne analize. Uzorak je stratifikovan u odnosu na prijavljeni T2DM i druga dugotrajna stanja u sledeće tri grupe: „Nema T2DM ili bilo koju *LTC*", „T2DM + 1 LTC" i „T2DM + ≥ 2 *LTC*". Učestalost i procentualna distribucija sociodemografskih faktora i prijavljenih ograničenja predstavljeni su po definisanim grupama.

Mutivarijantna analiza je korišćena za istraživanje povezanosti između sociodemografskih profila/profila ograničenja učesnika u Grupi 1 („Nema T2DM ili bilo koju *LTC*"), Grupi 2 („T2DM + 1 *LTC*") i Grupi 3 („T2DM + ≥ 2 *LTC*"), i prisustva T2DM-a sa ili bez drugih *LTC*. Model je uporedio rizik svakog ishoda (T2DM + 1 *LTC* ili T2DM + ≥ 2 *LTC*) sa rizikom učesnika bez T2DM-a ili bilo koje

TV, mobile phone, refrigerator, PC, washing machine, dishwasher, air conditioning, central heating, a car and having Internet access). The calculation of the wealth index for each respondent was described in detail elsewhere [10].

Limitations in carrying out daily activities due to health problems were categorized as: no limitations, moderate limitations, and serious limitations.

The study outcome variable was self-reported T2DM with or without comorbidity/multimorbidity in an individual, where the presence of T2DM plus one other chronic disease or long-term condition (LTC) was categorized as diabetes comorbidity, while the co-occurrence of T2DM with two or more other chronic diseases or LTCs was categorized as diabetes multimorbidity.

Self-reported data on the presence of chronic diseases/conditions were obtained with the following yes/no question: "Have you had any of the following diseases or conditions in the previous 12 months?". The 16 chronic diseases/conditions listed include diabetes mellitus, bronchial asthma (including allergic asthma), chronic bronchitis, chronic obstructive pulmonary disease, emphysema, myocardial infarction (MI) or long-term consequences of myocardial infarction, coronary heart disease or angina pectoris, hypertension, stroke or long-term consequences of stroke, arthrosis (excluding arthritis), liver cirrhosis, kidney disease, depression, cancer, hyperlipidemia (high cholesterol level), pain (reformulated in one variable as lower back pain or cervical back pain), allergies, and urinary incontinence.

For the purposes of this analysis, the acronym 'any LTC' applied to any other chronic disease and LTC, and the outcome variable was categorized into the following three groups: Group 1 – 'No T2DM or any LTC', Group 2 – 'T2DM + 1 LTC', and Group 3 – 'T2DM + ≥ 2 LTCs'.

Statistical analysis

Data were analyzed using descriptive statistics and multivariate analysis. The sample was stratified by reported T2DM and other long-term conditions into the following three groups: 'No T2DM or any LTC', 'T2DM + 1 LTC', and 'T2DM + ≥ 2 LTCs'. The frequency and percentage distributions of sociodemographic factors and reported limitations were presented across these groups.

The multivariate analysis was used to investigate associations between the sociodemographic/limitations profiles of participants in Group 1 ('No T2DM or any LTC'), Group 2 ('T2DM + 1 LTC'), and Group 3 ('T2DM + ≥ 2 LTCs'), and the presence of T2DM with or without other LTCs. The model compared the risk of each outcome (T2DM + 1 LTC or T2DM + ≥ 2 LTCs) with that of

LTC, u odnosu na sociodemografske/fizičke varijable ograničenja. Nadalje, ispitali smo kako su dve varijable – sociodemografske/ograničenja usled zdravstvenih problema, uticale na ishod od interesa (interakcije između starosti i pola, starosti i obrazovanja, starosti i prihoda, starosti i bračnog statusa, starosti i ograničenja, pola i obrazovanja, pola i prihoda, pola i bračnog statusa, pola i ograničenja). Relativni rizici (RR) su predstavljeni sa donjim i gornjim nivoima 95%-og intervala poverenja. Izračunate su predviđene verovatnoće za tri grupe ishoda: „Nema T2DM ili bilo koju *LTC*", „T2DM + 1 *LTC*" i „T2DM + ≥ 2 *LTC*", prema polu i starosti, polu i nivou obrazovanja, i polu i kvintilima prihoda, uz pomoć multivarijantnog regresionog modela.

Prikazujemo relativni rizik (RR) i interval poverenja (engl. *confidence interval – CI*) od 95%. Model je rađen pomoću *Stata* statističkog softvera (verzija 18.0).

REZULTATI

Ukupna prevalencija T2DM komorbiditeta je iznosila 8,8% (512/5.788), dok je prevalencija T2DM multimorbiditeta bila 29,5% (1.707/5.788). Tabela 1 prikazuje profil učesnika starosti ≥ 45 godina, iz dva nacionalna istraživanja, 2013. i 2019. godine, stratifikovan prema prijavljenom T2DM-u i bilo kojoj drugoj *LTC*, u sledeće tri grupe: „Nema T2DM ili bilo koju *LTC*", „T2DM + 1 *LTC*", i „T2DM + ≥ 2 *LTC*".

Raspodele učestalosti i procenata prema sociodemografskim faktorima i prijavljenim ograničenjima prikazane su u Tabeli 1. Procentualne raspodele T2DM + 1 *LTC* ili T2DM + ≥ 2*LTC*, u poređenju sa učesnicima bez bilo koje *LTC*, odražavaju disparitete po sociodemografskim faktorima. Procenat muškaraca je bio veći u grupi T2DM + 1 *LTC*, dok je bilo više žena u grupi T2DM + ≥ 2 *LTC*. I u T2DM + 1 *LTC* grupi i u T2DM + ≥ 2 *LTC* grupi, većina učesnika je bila starosti 65+ godina, sa 0-7 godina obrazovanja, sa osnovnim obrazovanjem ili trogodišnjim srednje stručnim obrazovanjem, udovci/udovice (posebno u T2DM + ≥ 2 *LTC* grupi), dok je najmanje bilo onih iz kvintila najbogatijih. U poređenju sa učesnicima bez T2DM-a ili bilo koje *LTC*, učesnici u grupama T2DM + 1 *LTC* i T2DM + ≥ 2 *LTC* su u većoj meri prijavili umerena ili ozbiljna ograničenja u svakodnevnim aktivnostima usled zdravstvenih problema.

Stubičasti grafikon (Slika 1) pokazuje procenat učesnika sa i bez T2DM-a među učesnicima sa drugim *LTC*. Sivi stupci pokazuju da je visok procenat ljudi sa nekom od navedenih *LTC* takođe imao T2DM. Najveća prevalencija T2DM-a je zabeležena među učesnicima sa cirozom jetre – 36,5% njih je imalo T2DM. Druga najveća prevalencija T2DM-a je registrovana kod pacijenata sa infarktom miokarda – 26% učesnika sa IM je takođe imalo T2DM.

participants with no T2DM or any LTC across sociodemographic/physical limitation variables. Furthermore, we examined how two variables – sociodemographic/limitations due to health problems, interacted to impact the outcome of interest (interactions of age and gender, age and education, age and income, age and civil status, age and limitations, gender and education, gender and income, gender and civil status, gender and limitations). Relative risk (RRs) were presented with the lower and upper levels of 95% confidence intervals. Predicted probabilities of the three outcome groups: 'No T2DM or any LTC', 'T2DM + 1 LTC', and 'T2DM + ≥ 2 LTCs', by gender and age, gender and education level, and gender and income quintiles, were calculated using multivariate regression model.

We report risk ratios (RRs) and a 95% confidence interval (CI). The model was fitted using Stata (Version 18.0).

RESULTS

The total prevalence of T2DM comorbidity was 8.8% (512/5,788), while the prevalence of T2DM multimorbidity was 29.5% (1,707/5,788). Table 1 shows the profile of participants aged ≥ 45 years, from two national surveys, 2013 and 2019, stratified by reported T2DM and any other LTC into the following three groups: 'No T2DM or any LTC', 'T2DM + 1 LTC', and 'T2DM + ≥ 2 LTCs'.

The frequency and percentage distributions by sociodemographic factors and reported limitations are presented in Table 1. The percentage distributions of T2DM + 1 LTC or T2DM + ≥ 2LTCs, as compared to subjects without any LTC, reflected disparities by sociodemographic factors. The percentage of male participants was higher in the T2DM + 1 LTC group, while there were more female participants in the T2DM + ≥ 2 LTCs group. In both the T2DM + 1 LTC group and the T2DM + ≥ 2 LTCs group, the majority of participants were aged 65+ years, with 0-7 years of education, with elementary education or vocational training, widowed (especially for the T2DM + ≥ 2 LTCs group), while the minority were from the most affluent income quintile. Compared to participants without T2DM or any LTC, people in the T2DM + 1 LTC and T2DM + ≥ 2 LTCs groups reported more moderate or serious limitations in daily activities due to health problems.

A bar graph (Figure 1) shows the percentage of participants with and without T2DM among those with other LTCs. The grey bars show that a high percentage of people with any of the LTCs listed also had T2DM. The highest prevalence of T2DM was noted among participants with liver cirrhosis – 36.5% of them had T2DM. The second highest prevalence of T2DM was registered in MI patients – 26% of participants with MI also had T2DM.

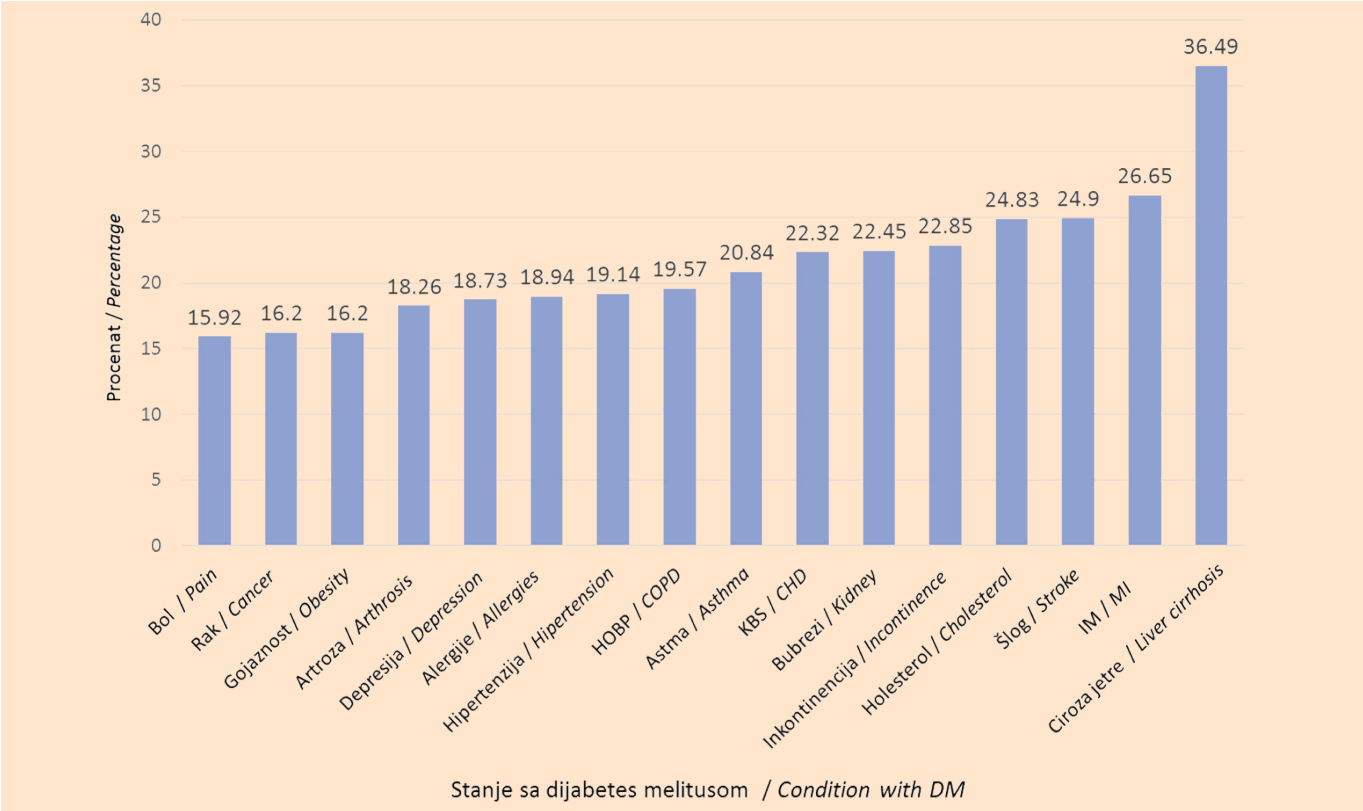
Tabela 1. Profil uzorka prema T2DM statusu i prisutnosti drugih dugotrajnih oboljenja/stanja

Table 1. Sample profile by T2DM status and presence of other long-term conditions

Varijable / *Variables*	No T2DM or any LTC (N = 3,569)		T2DM + one LTC (N = 512)		T2DM + two or more LTCs (N = 1,707)	
	n	%	*n*	%	*n*	%
Godina istraživanja / *Survey year*						
Nacionalno istraživanje 2013. / *National Survey 2013*	1,607	45.03	232	45.31	912	53.43
Nacionalno istraživanje 2019. / *National Survey 2019*	1,962	54.97	280	54.69	795	46.57
Pol / *Gender*						
Ženski / *Female*	1,599	44.8	213	41.6	997	58.41
Muški / *Male*	1,970	55.2	299	58.4	710	41.59
Starosna grupa / *Age group*						
45-54 godine / *45-54 years*	1,639	45.92	89	17.38	165	9.67
55-64 godine / *55-64 years*	1,144	32.05	134	26.17	497	29.12
65+ godina / *65+ years*	786	22.02	289	56.45	1,045	61.22
Kvintili prihoda / *Income quintiles*						
Prvi kvintil (gornjih 20%) / *First quintile (top 20%)*	749	20.99	97	18.95	210	12.3
Drugi kvintil / *Second quintile*	710	19.89	106	20.7	284	16.64
Treći kvintil / *Third quintile*	704	19.73	104	20.31	367	21.5
Četvrti kvintil / *Fourth quintile*	690	19.33	91	17.77	388	22.73
Peti kvintil (najnižih 20%) / *Fifth quintile (lowest 20%)*	716	20.06	114	22.27	458	26.83
Nivo obrazovanja / *Education*						
Viša ili visoka stručna sprema / *Bachelor's degree or higher*	422	11.82	50	9.77	94	5.51
Srednja stručna sprema / *Secondary education*	290	8.13	48	9.38	130	7.62
Osnovna škola ili trogodišnja srednja stručna škola / *Elementary education or vocational training*	2,618	73.35	359	70.12	1,135	66.49
Bez obrazovanja – 7 godina školovanja / *No education – 7 years of schooling*	221	6.19	47	9.18	309	18.1
Nedostaje / *Missing*	18	0.5	8	1.56	39	2.28
Bračni status / *Civil status*						
Bračna ili vanbračna zajednica / *Marriage or cohabitation*	2,680	75.09	347	67.77	1,131	66.26
Nikada nije bio-la u bračnoj ili vanbračnoj zajednici / *Never married or cohabited*	241	6.75	18	3.52	34	1.99
Udovac/Udovica / *Widowed*	376	10.54	129	25.2	460	26.95
Rastavljen-a/Razveden-a / *Separated*	261	7.31	18	3.52	82	4.8
Nedostaje / *Missing*	11	0.31				
Ograničenja / *Limitations*						
Bez ograničenja / *No limitations*	3,202	89.72	275	53.71	468	27.42
Umerena ograničenja / *Moderate limitations*	260	7.28	186	36.33	732	42.88
Ozbiljna ograničenja / *Serious limitations*	105	2.94	51	9.96	505	29.58
Nedostaje / *Missing*	2	0.06			2	0.12

Legenda: T2DM – Dijabetes melitus tip 2; LTC – dugotrajne bolesti/stanja (engl. *long-term conditions*)

Legend: T2DM – Type 2 diabetes mellitus; LTCs – long-term conditions



Legenda: HOBP – hronični bronhitis, hronična opstruktivna bolest pluća, emfizem; IM – infarkt miokarda ili dugoročne posledice IM-a; KBS – koronarna bolest srca ili angina pektoris; Artroza (isključujući artritis); Bol – bol u donjem delu leđa ili u vratu; Alergije - bilo koja alergija; Ciroza - ciroza jetre; Inkontinencija - urinarna inkontinencija; Bubrezi - bolest bubrega; Holesterol - visok nivo holesterola; Rak - bilo koja vrsta raka

Legend: COPD – chronic bronchitis, chronic obstructive pulmonary disease, emphysema; MI – myocardial infarction or long-term consequences of MI; CHD – coronary heart disease or angina pectoris; Arthrosis (excluding arthritis); Pain – lower back pain or cervical back pain; Allergies – any allergy; Cirrhosis – liver cirrhosis; Incontinence – urinary incontinence; Kidney – kidney disease; Cholesterol – high cholesterol level; Cancer – any type of cancer

Slika 1. Ukupna prevalencija T2DM-a kod osoba sa drugim dugotrajnim bolestima/stanjima u Srbiji, Nacionalna istraživanja 2013. i 2019

Figure 1. The total prevalence of T2DM in people with other long-term conditions in Serbia, NHS 2013 and 2019

Tabela 2 prikazuje odnos rizika (OR), upoređujući rizik od T2DM +1 *LTC* ili T2DM + ≥2 *LTC* sa subjektima bez T2DM-a i bez *LTC*, po kategorijama sociodemografskih faktora i ograničenjima usled zdravstvenih problema. Prijavljeni rizici od T2DM + 1 *LTC* gotovo se nisu promenili u 2019. godini, u poređenju sa istraživanjem iz 2013. godine, ali je rizik od T2DM + ≥ 2 *LTC* bio 29% manji u istraživanju iz 2019. godine, u poređenju sa grupom bez T2DM-a ili bilo koje *LTC*. Univarijabilna analiza je pokazala da postoji značajan relativni rizik (RR) od T2DM-a i 1 *LTC* u grupama ispitanika starijim od 55 godina (RR = 2,16, 95% *CI*: 1,63 – 2,85; i 6,77, 95% *CI*: 5,26 – 8,72), kod ispitanika sa 0-7 godina obrazovanja (RR = 1,80, 95% *CI*: 1,17 – 2,76), kod udovaca/udovica (RR = 2,65, 95% *CI*: 2,11 – 3,33) i kod onih koji imaju umerena ili ozbiljna ograničenja (RR = 8,33, 95% *CI*: 6,65 – 10,4 i 5,66, 95% *CI*: 3,96 – 8,08).

Multivarijantna analiza je pokazala povezanost T2DM +1 *LTC* sa starosnom grupom 55-64 godine (RR = 1,85, 95% *CI*: 1,39 – 2,46), starošću od 65+ godina (RR = 4,62, 95% *CI*: 3,50 – 6.11), stepenom obrazovanja od 0-7 godina (RR = 0,59, 95% *CI*: 0,36 – 0,96), statusom udovca/udovice (RR = 1,46, 95% *CI*: 1,12 – 1,91), te

Table 2 presents the risk ratio (RR), comparing the risk of T2DM +1 LTC or T2DM + ≥2 LTCs with subjects without T2DM and no LTCs, across the categories of sociodemographic factors and limitations due to health. Reported risks of T2DM + 1 LTC almost did not change in 2019, as compared to the 2013 survey, but the risk of T2DM + ≥ 2LTCs was 29% lower in the 2019 survey, compared to the group with no T2DM or any LTC. The univariable analysis showed that there was a significant relative risk of having T2DM and 1 LTC in age groups older than 55 years (RR = 2.16, 95% CI: 1.63 – 2,85; and 6.77, 95% CI: 5.26 – 8.72, respectively), in subjects with 0-7 years of education (RR = 1.80, 95% CI: 1.17 – 2.76), in people who are widowed (RR = 2.65, 95% CI: 2.11 – 3.33), and in those who have moderate or serious limitations (RR = 8.33, 95% CI: 6.65 – 10.4 and 5.66, 95% CI: 3.96 – 8.08, respectively).

The multivariable analysis showed the association between the T2DM +1 LTC and the 55-64 years age group (RR = 1.85, 95% CI: 1.39 – 2.46), the age 65+ years (RR = 4.62, 95% CI: 3.50 – 6.11), having 0-7 years of education (RR = 0.59, 95% CI: 0.36 – 0.96), being widowed (RR = 1.46, 95% CI: 1.12 – 1.91), and having

Tabela 2. Poređenje profila tri grupe ljudi: Grupa 1 ("Nema T2DM ili bilo koju LTC"), Grupa 2 ("T2DM i jedna LTC") i Grupa 3 ("T2DM i ≥ 2 LTC"), zasnovana na multivarijantnom modelu, sa Grupom 1 kao referentnom grupom

Table 2. Comparison of the profiles of three groups of people: Group 1 ('No T2DM or any LTC'), Group 2 ('T2DM and one LTC'), and Group 3 ('T2DM and ≥ 2 LTCs'), based on a multivariate model, with Group 1 as the reference group

	Univariable analysis				Multivariable analysis			
T2DM + 1 LTC / *T2DM + 1 LTC*	RR	LCI	UCI	*p*-value	RR	LCI	UCI	*p*-value
Godina istraživanja / *Survey year*								
Nacionalno istraživanje 2013. / *National Survey 2013*	1.00				1.00			
Nacionalno istraživanje 2019. / *National Survey 2019*	0.99	0.82	1.19	0.903	1.04	0.85	1.28	0.682
Pol / *Gender*								
Ženski / *Female*	1.00							
Muški / *Male*	1.14	0.94	1.38	0.173	1.23	1.00	1.52	0.051
Starosna grupa / *Age groups*								
45-54 godine / *45-54 years*	1.00				1.00			
55-64 godine / *55-64 years*	2.16	1.63	2.85	<0.001	1.85	1.39	2.46	<0.001
65+ godina / *65+ years*	6.77	5.26	8.72	<0.001	4.62	3.50	6.11	<0.001
Kvintili prihoda / *Income quintiles*								
Prvi kvintil (gornjih 20%) / *First quintile*	1.00				1.00			
Drugi kvintil / *Second quintile*	1.15	0.86	1.55	0.343	1.10	0.80	1.52	0.546
Treći kvintil / *Third quintile*	1.14	0.85	1.53	0.382	0.95	0.68	1.31	0.732
Četvrti kvintil / *Fourth quintile*	1.02	0.75	1.38	0.907	0.86	0.61	1.20	0.372
Peti kvintil (najnižih 20%) / *Fifth quintile*	1.23	0.92	1.64	0.162	0.97	0.70	1.35	0.847
Nivo obrazovanja / *Education*								
Viša ili visoka stručna sprema / *Bachelor's degree or higher*	1.00				1.00			
Srednja stručna sprema / *Secondary education*	1.40	0.92	2.13	0.122	1.17	0.74	1.84	0.505
Osnovna škola ili trogodišnja srednja stručna škola / *Elementary education or vocational training*	1.16	0.85	1.58	0.360	1.05	0.74	1.49	0.791
Bez obrazovanja – 7 godina školovanja / *0-7 years of schooling*	1.80	1.17	2.76	0.008	0.59	0.36	0.96	0.035
Nedostaje / *Missing*	3.75	1.55	9.07	0.003	0.93	0.35	2.51	0.892
Bračni status / *Civil status*								
Bračna ili vanbračna zajednica / *Marriage or cohabitation*	1.00				1.00			
Nikada nije bio-la u bračnoj ili vanbračnoj zajednici / *Single/never married*	0.58	0.35	0.94	0.028	0.74	0.44	1.23	0.243
Udovac/Udovica / *Widowed*	2.65	2.11	3.33	<0.001	1.46	1.12	1.91	0.005
Rastavljen-a/Razveden-a / *Separated*	0.53	0.33	0.87	0.012	0.65	0.39	1.08	0.097
Nedostaje / *Missing*	0.00	0.00	0.00	0.991	0.00	0.00	0.00	0.989
Ograničenja usled zdravstvenih problema / *Limitations due to health*								
Bez ograničenja / *No limitations*	1.00				1.00			
Umerena ograničenja / *Moderate limitations*	8.33	6.65	10.43	<0.001	6.86	5.42	8.69	<0.001
Ozbiljna ograničenja / *Serious limitations*	5.66	3.96	8.08	<0.001	4.15	2.86	6.03	<0.001
Nedostaje / *Missing*	0.00	0.00	0.00	0.985	0.00	0.00	0.00	0.993
T2DM + ≥ 2 *LTC* / *T2DM + ≥ 2 LTCs*								
Godina istraživanja / *Survey year*								
Nacionalno istraživanje 2013. / *National Survey 2013*	1.00				1.00			
Nacionalno istraživanje 2019. / *National Survey 2019*	0.71	0.64	0.80	<0.001	0.81	0.69	0.94	0.006
Pol / *Gender*								
Ženski / *Female*	1.00							
Muški / *Male*	0.58	0.51	0.65	<0.001	0.61	0.52	0.71	<0.001
Starosna grupa / *Age groups*								
45 - 54 godine / *45-54 years*	1.00				1.00			
55 - 64 godine / *55-64 years*	4.32	3.56	5.23	<0.001	3.40	2.73	4.23	<0.001
65+ godina / *65+ years*	13.21	10.98	15.89	<0.001	7.14	5.69	8.94	<0.001
Kvintili prihoda / *Income quintiles*								
Prvi kvintil (gornjih 20%) / *First quintile*	1.00				1.00			
Drugi kvintil / *Second quintile*	1.43	1.16	1.75	0.001	1.31	1.01	1.71	0.045
Treći kvintil / *Third quintile*	1.86	1.53	2.27	<0.001	1.33	1.03	1.73	0.030
Četvrti kvintil / *Fourth quintile*	2.01	1.65	2.44	<0.001	1.39	1.07	1.81	0.015
Peti kvintil (najnižih 20%) / *Fifth quintile*	2.28	1.88	2.77	<0.001	1.34	1.03	1.74	0.032
Nivo obrazovanja / *Education*								
Viša ili visoka stručna sprema / *Bachelor's degree or higher*	1.00				1.00			
Srednja stručna sprema / *Secondary education*	2.01	1.48	2.73	<0.001	1.51	1.03	2.21	0.033
Osnovna škola ili trogodišnja srednja stručna škola / *Elementary education or vocational training*	1.95	1.54	2.46	<0.001	1.26	0.94	1.71	0.128
Bez obrazovanja – 7 godina školovanja / *0 - 7 years of schooling*	6.28	4.73	8.33	<0.001	0.99	0.67	1.44	0.938
Nedostaje / *Missing*	9.73	5.33	17.75	<0.001	0.85	0.39	1.82	0.668

Legenda: *LTC* – dugotrajna bolest ili stanje (engl. *long-term condition*); *LCI* – donji 95%-ni interval poverenja (engl. *lower 95% confidence interval*); *UCI* – gornji 95%-ni interval poverenja (engl. *upper 95% confidence interval*); OR – odnos rizika

Legend: LTC – long-term condition; LCI – lower 95% confidence interval; UCI – upper 95% confidence interval; RR – risk ratio

umerenim (RR = 6,86, 95 % *CI*: 5,42 – 8 69) ili ozbiljnim ograničenjima (RR = 4,15, 95% *CI*: 2,86 – 6,03) usled zdravstvenih problema. Multivarijantna analiza je pokazala povezanost između T2DM + ≥ 2 *LTC*-a i istraživanja iz 2019. godine (RR = 0,81, 95% *CI*: 0,69 – 0,94), muškog pola (RR = 0,61, 95% *CI*: 0,52 – 0,71), starošću 55-64 godine (RR = 3,40, 95% *CI*: 2,73 – 4,23), ili 65+ godina (RR = 7,14, 95% *CI*: 5,69 – 8,94), pripadnosti drugom (RR = 1,31, 95% *CI*: 1,01 – 1,71), trećem (RR = 1,33, 95% *CI*: 1,03 – 1,73), četvrtom (RR = 1,39, 95% *CI*: 1,07 – 1,81) ili petom kvintilu prihoda (RR = 1,34, 95% *CI*: 1,03 – 1,03 74), srednjeg obrazovanja (RR = 1,51, 95% *CI*: 1,03 – 2,21), statusa samca-ice ili nekoga ko nikada nije bio u braku (RR = 0,47, 95% *CI*: 0,30 – 0,73), te umerenih (RR = 14,0, 95) % *CI*: 11,6 – 16,8) ili ozbiljnih ograničenja usled zdravstvenih problema (RR = 22,0, 95% *CI*: 17,2 – 28,3). Rezultati univarijantne i multivarijantne analize su prikazani u Tabeli 2.

DISKUSIJA

Najvažniji nalazi

U ovoj studiji smo istraživali prevalenciju i sociodemografske karakteristike T2DM-a i komorbiditeta i multimorbiditeta u populacijskim podacima Republike Srbije, prikupljenim u dva perioda: 2013. i 2019. godine. Prema našim saznanjima, ovo je prva studija koja je temeljno istražila prevalenciju i razlike u sociodemografskim karakteristikama pacijenata sa T2DM-om i još jednom ili još dve ili više dugotrajnih bolesti ili stanja. Vizuelna prezentacija predviđenih verovatnoća, izvedena iz multivarijantne analize, pružila je uvid u odnose između T2DM-a, komorbiditeta i multimorbiditeta, stratifikovano po sociodemografskim karakteristikama.

Ustanovili smo da je prevalencija T2DM komorbiditeta iznosila 8,8%, a prevalencija T2DM multimorbiditeta 29,5%. Ovaj nalaz je u skladu sa već utvrđenim shvatanjem da pacijenti sa T2DM-om imaju visok rizik od pojave pratećih zdravstvenih stanja, najčešće hipertenzije, poremećaja lipida, koronarne bolesti srca, mikrovaskularnih stanja i poremećaja mentalnog zdravlja, posebno depresije [11]. U našoj studiji, prevalencija T2DM-a među pacijentima sa drugim zdravstvenim stanjima bila je najveća kod pacijenata sa cirozom jetre (36%), zatim kod pacijenata sa infarktom miokarda, moždanim udarom i visokim holesterolom, pri čemu je oko jedne četvrtine ovih pacijenata imalo T2DM. Udruživanje ovih bolesti i T2DM-a može značajno da poveća rizike povezane sa ovim stanjima, ali i da poveća potrebu za korišćenjem zdravstvene zaštite [12].

Poznato je da su sociodemografski faktori koji su najjače povezani sa multimorbiditetom starost i socioekonomski status, a ovaj nalaz je prisutan u nekoliko

moderate limitations (RR = 6.86, 95% CI: 5.42 – 8 69) or serious limitations (RR = 4.15, 95% CI: 2.86 – 6.03) due to health. The multivariable analysis showed the association between T2DM + ≥ 2 LTCs and the 2019 survey (RR = 0.81, 95% CI: 0.69 – 0.94), male participants (RR = 0.61, 95% CI: 0.52 – 0.71), being 55-64 years old (RR = 3.40, 95% CI: 2.73 – 4.23), or 65+ years old (RR = 7.14, 95% CI: 5.69 – 8.94), being in the second (RR = 1.31, 95% CI: 1.01 – 1.71), third (RR = 1.33, 95% CI: 1.03 – 1.73), fourth (RR = 1.39, 95% CI: 1.07 – 1.81), or fifth income quintile (RR = 1.34, 95% CI: 1.03 – 1.74), having secondary level education (RR = 1.51, 95% CI: 1.03 – 2.21), being single or having never married (RR = 0.47, 95% CI: 0.30 – 0.73), and having moderate (RR = 14.0, 95% CI: 11.6 – 16.8) or serious limitations due to health (RR = 22.0, 95% CI: 17.2 – 28.3). The results of the univariable and multivariable analyses are presented in Table 2.

DISCUSSION

Main findings

In this study, we investigated the prevalence and sociodemographic characteristics of T2DM and comorbidities and multimorbidities in the Republic of Serbia population-based data, collected in two periods: year 2013 and year 2019. To the best of our knowledge, this is the first study to thoroughly explore the prevalence and the differences in sociodemographic characteristics of patients with T2DM with one or two or more long-term conditions The visual presentation of predicted probabilities, derived from multivariate analyses provided some insight into the relationships between T2DM, comorbidities and multimorbidities, stratified by sociodemographic characteristics.

We found that the prevalence of T2DM comorbidity was 8.8%, and the prevalence of T2DM multimorbidity was 29.5%. This finding is in line with the well-established understanding that T2DM patients have a high risk of co-occurring health conditions, most commonly hypertension, lipid disorders, coronary heart disease, microvascular conditions, and mental health disorders, especially depression [11]. In our study, the prevalence of T2DM among patients with other health conditions was the highest in patients with liver cirrhosis (36%), followed by those with myocardial infarction, stroke, and high cholesterol, with around one-quarter of these patients having T2DM. The clustering of these illnesses and T2DM can significantly increase the risks associated with these conditions and increase the need for healthcare utilization [12].

It is known that sociodemographic factors which have the strongest association with multimorbidity are age and socioeconomic status and this finding is

studija sprovedenih u zemljama sa niskim i srednjim prihodima [13,14]. Prevalencija multimorbiditeta je u porastu širom sveta u populaciji od 65+ godina, a posebno kod osoba starijih od 75 godina [11]. Među pacijentima sa T2DM-om, starijim od 65 godina, koji boluju duže od deset godina, veća je prevalencija multimorbiditeta i komplikacija u vidu sistemskih oštećenja organa, kao što su infarkt miokarda i terminalna bubrežna insuficijencija [11]. Na isti način, u našoj studiji, starosna grupa od 55 do 64 godine je bila povezana sa povećanim rizikom od T2DM komorbiditeta i T2DM multimorbiditeta. U multivarijantnoj analizi, učesnici ove starosne grupe su imali povećani rizik od komorbiditeta za 85% i povećani rizik od T2DM multimorbiditeta za 340%. Verovatnoća u starijoj starosnoj grupi (iznad 65 godina starosti) bila je još izraženija, sa povećanim rizikom od T2DM komorbiditeta za 462% i povećanim rizikom od T2DM multimorbiditeta za 714%.

Neke studije su pokazale povezanost između ženskog pola i multimorbiditeta [15,16], ali to nije bilo evidentno među kanadskim starijim licima, posebno u populacijskoj grupi sa najvećom prevalencijom multimorbiditeta (iznad 65 godina starosti) [17]. Nismo pronašli vezu između pola i T2DM komorbiditeta. Međutim, postojao je veći rizik od T2DM multimorbiditeta među ispitanicima ženskog pola. Naime, može se reći da je za žene veća verovatnoća da će otići kod svog lekara opšte prakse i stoga se češće kod njih uspostavljaju dijagnoze hroničnih bolesti i stanja [15], ali izgleda da postoji takođe i veća verovatnoća da će žene imati mentalni poremećaj kao komorbiditet [15].

Što se tiče socioekonomskog statusa, naši rezultati su pokazali da su ljudi u nižim kvintilima prihoda imali veći OR za razvoj multimorbiditeta, što je u skladu sa velikom kohortnom studijom sprovedenom u Engleskoj, u kojoj je grupacija sa najnepovoljnijim socioekonomskim statusom bila linearno povezana sa povećanom verovatnoćom multimorbiditeta [15]. Takođe, u studiji sprovedenoj u Španiji, rastući nivo siromaštva je bio snažno povezan sa rastućim procentom pacijenata sa T2DM-om i većim brojem istovremeno prisutnih bolesti [18].

U našoj studiji, ispitanici sa srednjim obrazovanjem su imali za 51% veći rizik od T2DM multimorbiditeta (p = 0,033), u poređenju sa onima sa višom ili visokom stručnom spremom, ali nije bilo značajnih razlika u OR-u između multimorbiditeta i nižeg nivoa obrazovanja. Međutim, nepostojanje ove povezanosti može proizilaziti iz razlika u veličini uzorka između obrazovnih kategorija. Ovi rezultati su u skladu sa onima iz studije nedavno sprovedene u Srbiji [19] koja ukazuje da su osobe sa nižim nivoom obrazovanja sklonije razvoju multimorbiditeta. U studiji Bendera i saradnika [20],

consistent across several studies conducted in LMICs [13,14]. Multimorbidity prevalence increases worldwide in the population aged 65+ years, and especially in those over the age of 75 [11]. Among patients with T2DM, older than 65 years, who have had their illness for more than ten years, there is a higher prevalence of multimorbidity and end-organ complications, such as myocardial infarction and end-stage renal disease [11]. Similarly, in our study, the age group 55-64 years was associated with an increased risk of both T2DM comorbidity and T2DM multimorbidity. In the multivariable analysis, participants in this age group had an 85% increase in the risk of comorbidity and a 340% increase in the risk of T2DM multimorbidity. The likelihood in the older age group (above the age of 65 years) was even more pronounced, with a 462% increase in the risk of T2DM comorbidity and a 714% increase in the risk of T2DM multimorbidity.

Some studies have shown the association between the female gender and multimorbidity [15,16], but this was not evident among Canadian seniors, particularly in the population group with the highest prevalence of multimorbidity (above the age of 65 years) [17]. We did not find an association between gender and T2DM comorbidity; however, there was a higher risk of T2DM multimorbidity among the female participants. Arguably, women do tend to have a higher likelihood of visiting their general practitioner and, therefore, more frequently establish diagnoses of chronic health conditions [15], but there seems to be a higher likelihood of women having a comorbid mental health disorder, as well [15].

As to socioeconomic status, our results indicate that people in the lower income quintiles had a higher RR for developing multimorbidity which is in line with a large English cohort study where the most disadvantaged socioeconomic class was linearly associated with an increased likelihood of multimorbidity [15]. Additionally, in a study conducted in Spain, an increasing deprivation level was strongly associated with an increasing percentage of patients with T2DM and a higher number of concurrent illnesses [18].

In our study, subjects with secondary education had a 51% increase in the risk of T2DM multimorbidity (p = 0.033), as compared to those with a bachelor's degree education level or higher, but there were no significant differences in RR between multimorbidity and lower educational levels. However, this lack of association may stem from the differences in sample sizes across education categories. These results are congruent with those from a recently conducted study in Serbia [19] indicating that individuals with a lower level of education are more prone to develop multimorbid-

utvrđena je povezanost između nižeg nivoa obrazovanja i rizika od razvoja komplikacija i komorbiditeta, kod pacijenata sa T2DM-om.

Povezanost između umerenih i ozbiljnih ograničenja u svakodnevnim aktivnostima i T2DM komorbiditeta i multimorbiditeta takođe je potvrđena u našoj studiji, što je u skladu sa studijom koju su sproveli Đija i saradnici [21] a koja je identifikovala T2DM kao faktor povezan sa ograničenjima u svakodnevnom životu, posebno među onima starijim od 65 godina.

Ograničenja studije

Ograničenja ove studije uključuju i činjenicu da su podaci o hroničnim stanjima dobijeni na osnovu iskaza ispitanika, a ne na osnovu zvaničnih dijagnoza, i da nisu uzimali u obzir važne faktore kao što su opterećenje i težina bolesti. Zbog ove metodologije nismo ispitivali populaciju koja živi u domovima i drugim ustanovama kolektivnog smeštaja ili bolnicama, što je doprinelo „potcenjivanju" naših podataka (engl. *underestimation*). Zbog toga što je u pitanju studija preseka, nisu bili mogući kauzalni zaključci o različitim etiološkim putevima komorbiditeta ili multimorbiditeta povezanog sa T2DM-om, što može biti od značaja za kliničku primenu.

Implikacije

Ova studija omogućava deskriptivnu karakterizaciju T2DM komorbiditeta i multimorbiditeta u Srbiji, obuhvatajući širok spektar stanja koja mogu opteretiti sisteme zdravstvene zaštite. Iako ovaj analitički pristup nudi dragocene uvide za identifikovanje grupa ljudi za koje postoji veća verovatnoća da su oboleli od jednog ili više dugoročnih stanja, unapređenje kliničkih i javnozdravstvenih praksi zahteva posebne smernice koje bi pomogle da se ovi pacijenti identifikuju i leče na vreme.

Nadalje, potrebno je dodatno istraživanje kako bi se ispitali drugi metabolički, bihejvioralni i faktori rizika životne sredine povezani sa komorbiditetom i multimorbiditetom kod T2DM-a, kao i analiza vremenskih trendova na nivou populacije. Takva istraživanja su od vitalnog značaja za olakšavanje pružanja kliničkih usluga i planiranja javnog zdravlja. Rasvetljavanjem etiologije bolesti, ovo istraživanje može da pruži informacije potrebne za razvoj delotvornih preventivnih i terapijskih intervencija. Stoga sprovođenje sveobuhvatnih studija kako bi se istražili ovi faktori predstavlja imperativ za unapređenje našeg razumevanja epidemiologije T2DM-a i njenih implikacija po pitanju zdravlja stanovništva.

ity. In a study by Bender et al. [20], an association was found between a lower level of education and the risk of developing both complications and comorbidities, in patients with T2DM.

The association between moderate and severe limitations in daily activities and T2DM comorbidities and multimorbidities was also confirmed in our study, which is in keeping with a study by Jie et al. [21] that showed T2DM as a factor associated with limitations in daily living, especially among those above the age of 65 years.

Study limitations

The limitations of this study include the fact that the data on chronic conditions were self-reported rather than diagnosed, and did not consider important factors like disease burden and severity. Due to this methodology, we have not examined the population living in care homes and other residential facilities or hospitals, which has contributed to the underestimation of our data. Due to the cross-sectional design, no causal inferences to the diverse etiologic pathways of T2DM-related comorbidity or multimorbidity were possible, which can be meaningful for clinical applications.

Implications

This study allows for the descriptive characterization of T2DM comorbidity and multimorbidity in Serbia, encompassing a wide spectrum of conditions that may strain healthcare systems. While this analytical approach offers valuable insights in identifying population groups with higher probabilities of having one or more long-term conditions, enhancing clinical and public health practices requires specific guidelines that would help to identify and treat these patients in a timely fashion.

Furthermore, additional research is needed to explore other metabolic, behavioral, and environmental risk factors linked to comorbidity and multimorbidity in T2DM, along with an analysis of population-level temporal trends. Such investigations are vital for facilitating clinical service delivery and public health planning. By shedding light on the etiology of the disease, this research can inform the development of effective preventive and therapeutic interventions. Hence, conducting comprehensive studies to explore these factors is imperative for advancing our understanding of T2DM epidemiology and its implications for population health.

CONCLUSION

ZAKLJUČAK

Identifikovanje i podela populacija u podgrupe prema njihovom riziku od dugotrajnih bolesti, korišćenjem sveobuhvatnog pristupa koji uzima u obzir sociodemografske determinante zdravlja, moglo bi da pruži značajne informacije za poboljšanje trenutne prakse ranog otkrivanja i lečenja bolesti. Ova studija ima značajan potencijal da omogući pravovremeno sprovođenje odgovarajućeg lečenja i redovnih kontrolnih pregleda, što doprinosi boljim zdravstvenim ishodima i, dugoročno gledano, povećanom kvalitetu života.

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Sukob interesa: Nije prijavljen.

Identifying and subgrouping populations according to their risk of LTCs, using a comprehensive approach that considers sociodemographic determinants of health, could be highly informative for improving current practices in early detection and management of disease. This study has significant potential to facilitate the timely delivery of appropriate treatment and regular check-ups, ultimately contributing to better health outcomes and an increased quality of life in the long run.

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LITERATURA / *REFERENCES*

1. Key global findings 2021. [Internet]. 2021. [pristupljeno: 20 June 2024]. Dostupno na: https://diabetesatlas.org/
2. Seewoodhary J, Benavides RV, Silveira A. Tropical medicine and diabetes: an integrative paradigm. Practical Diabetes. 2022; 39(5): 40–43. https://doi.org/10.1002/pdi.2420.
3. Skou ST, Mair FS, Fortin M, Guthrie B, Nunes BP, Miranda JJ, et al. Multimorbidity. Nat Rev Dis Primers. 2022 Jul; 8(1). https://doi.org/10.1038/s41572-022-00376-4.
4. Guthrie B, Payne K, Alderson P, McMurdo MET, Mercer SW. Adapting clinical guidelines to take account of multimorbidity. BMJ. 2012 Oct; 345: e6341. https://doi.org/10.1136/bmj.e6341.
5. Lam AA, Lepe A, Wild SH, Jackson C. Diabetes comorbidities in low-and middle-income countries: An umbrella review. Journal of Global Health. 2021 Jul;11:04040. https://doi.org/10.7189/jogh.11.04040.
6. Jovic D, Vukovic D, Marinkovic J. Prevalence and patterns of multi-morbidity in Serbian adults: A cross-sectional study. PLoS ONE. 2016 Feb; 11(2):1–14. https://doi.org/10.1371/journal.pone.0148646.
7. Institut za javno zdravlje Srbije. Istraživanje zdravlja stanovnika Republike Srbije 2006. Beograd: Institut za javno zdravlje Srbije "Dr Milan Jovanovic Batut" 2007. [Internet]. Dostupno na: https://www.batut.org.rs/download/publikacije/Finalni%20izvestaj%202006.pdf
8. Republički zavod za statistiku Republike Srbije. Istraživanje zdravlja stanovništva Srbije 2019. Beograd: Republički zavod za statistiku Republike Srbije, 2021. [Internet]. Dostupno na: https://publikacije.stat.gov.rs/G2021/pdf/G20216003.pdf
9. Ministarstvo zdravlja Republike Srbije. Rezultati istraživanja zdravlja stanovništva Srbije 2013. Beograd: Ministarstvo zdravlja Republike Srbije, 2014. [Internet]. Dostupno na: https://batut.org.rs/download/publikacije/IstrazivanjeZdravljaStanovnistvaRS2013.pdf
10. Janković J, Simić S, Marinković J. Inequalities that hurt: demographic, socio-economic and health status inequalities in the utilization of health services in Serbia. Eur J Public Health. 2010 Aug;20(4):389-96. doi: 10.1093/eurpub/ckp189.
11. Cicek M, Buckley J, Pearson-Stuttard J, Gregg EW. Characterizing Multimorbidity from Type 2 Diabetes: Insights from Clustering Approaches. Endocrinol Metab Clin North Am. 2021 Sep;50(3):531-558. doi: 10.1016/j.ecl.2021.05.012.
12. Khan A, Uddin S, Srinivasan U. Comorbidity network for chronic disease: A novel approach to understand type 2 diabetes progression. Int J Med Inform. 2018 Jul;115:1-9. doi: 10.1016/j.ijmedinf.2018.04.001.
13. Singh K, Patel SA, Biswas S, Shivashankar R, Kondal D, Ajay VS, et al. Multimorbidity in South Asian adults: prevalence, risk factors and mortality. J Public Health (Oxf). 2019 Mar 1;41(1):80-89. doi: 10.1093/pubmed/fdy017.
14. Afshar S, Roderick PJ, Kowal P, Dimitrov BD, Hill AG. Global Patterns of Multimorbidity: A Comparison of 28 Countries Using the World Health Surveys In: Springer, Cham; 2017:381–402.
15. Nowakowska M, Zghebi SS, Ashcroft DM, Buchan I, Chew-Graham C, Holt T, et al. The comorbidity burden of type 2 diabetes mellitus: patterns, clusters and predictions from a large English primary care cohort. BMC Med. 2019 Jul 25;17(1):145. doi: 10.1186/s12916-019-1373-y.
16. Seng JJB, Kwan YH, Lee VSY, Tan CS, Zainudin SB, Thumboo J, et al. Differential Health Care Use, Diabetes-Related Complications, and Mortality Among Five Unique Classes of Patients With Type 2 Diabetes in Singapore: A Latent Class Analysis of 71,125 Patients. Diabetes Care. 2020 May;43(5):1048-1056. doi: 10.2337/dc19-2519.
17. Gruneir A, Markle-Reid M, Fisher K, Reimer H, Ma X, Ploeg J. Comorbidity Burden and Health Services Use in Community-Living Older Adults with Diabetes Mellitus: A Retrospective Cohort Study. Can J Diabetes. 2016 Feb;40(1):35-42. doi: 10.1016/j.jcjd.2015.09.002.
18. Alonso-Morán E, Orueta JF, Esteban JI, Axpe JM, González ML, Polanco NT, et al. Multimorbidity in people with type 2 diabetes in the Basque Country (Spain): Prevalence, comorbidity clusters and comparison with other chronic patients. Eur J Intern Med. 2015 Apr;26(3):197-202. doi: 10.1016/j.ejim.2015.02.005.

19. Jankovic J, Mirkovic M, Jovic-Vranes A, Santric-Milicevic M, Terzic-Supic Z. Association between non-communicable disease multimorbidity and health care utilization in a middle-income country: population-based study. Public Health. 2018 Feb;155:35-42. doi: 10.1016/j.puhe.2017.11.014.
20. Bender AM, Vrangbæk K, Lange T, Brønnum-Hansen H, Andersen I. Joint effects of educational attainment, type 2 diabetes and coexisting morbidity on disability pension: results from a longitudinal, nationwide, register-based study. Diabetologia. 2021 Dec;64(12):2762-2772. doi: 10.1007/s00125-021-05559-4.
21. Jie JH, Li D, Jia LN, Chen Y, Yang Y, Zheng B, et al. Activities of daily living and its influencing factors for older people with type 2 diabetes mellitus in urban communities of Fuzhou, China. Front Public Health. 2022 Sep 26;10:948533. doi: 10.3389/fpubh.2022.948533.

PRILOG

Interakcije

Starost i pol

Nije registrovana značajna interakcija za ishod „T2DM + 1 *LTC*" u odnosu na ishod "Nema *LTC*". Uvođenje interakcije ukazuje na povećani RR kod muškaraca starosti 45-54 godine sa T2DM + 1 *LTC*, u poređenju sa onima bez *LTC*.

Postojala je značajna interakcija za ishod "T2DM + ≥ 2 *LTC*" naspram ishoda "Nema *LTC*". Sve u svemu, rizik za muškarce sa T2DM + ≥ 2 *LTC* u odnosu na one bez bilo koje *LTC*, nije se razlikovao od rizika kod žena u starosnoj grupi 45-54 godine (RR = 0,95 (0,67, 1,37); *p*-vrednost = 0,816), dok su muškarci imali manji rizik u starosnom dobu od 5-64 i 65+ godina. Rizik za žene je bio značajno veći u starijem dobu.

Prikazani obrasci za glavne efekte starosti ostali su isti, što ukazuje na povećan rizik od T2DM + 1 *LTC* i T2DM + ≥ 2 *LTC*, sa većom starošću.

Starost i prihodi

Iako interakcija nije bila značajna, glavni efekti govore u prilog značajnom povećanju rizika od T2DM + 1 *LTC* i T2DM + ≥ 2 *LTC* sa rastom starosti među bogatim pojedincima (kvintil gornjih 20% po prihodima).

Starost i stepen obrazovanja

Iako interakcija nije bila značajna, glavni efekti govore u prilog značajnom povećanju rizika od T2DM + 1 *LTC* u odnosu na ishod "Nema *LTC*", među ispitanicima starijim od 65 godina, sa višom ili visokom stručnom spremom (RR = 6,33 (2,82, 14,22)), u poređenju za osobama starosti 45-54 godine; kao i povećanom riziku od T2DM + ≥ 2 *LTC* u odnosu na ishod bez *LTC*, u starosnoj kategoriji 54-64 godine i 65+ godina (RR = 4,53 (1,92, 10,65) i 12,94 (5,74, 29,16)) u poređenju sa onima starosti 45-54 godine.

APPENDIX

Interactions

Age and gender

No significant interaction was registered for the outcome 'T2DM + 1 LTC' vs. the outcome 'No LTC'. The introduction of the interaction indicates an increased RR among men aged 45-54 years with T2DM + 1 LTC, as compared to those with no LTC.

There was a significant interaction for the outcome 'T2DM + ≥ 2 LTCs' vs. the outcome 'No LTCs'. In summary, the risk of T2DM + ≥ 2 LTCs over 'No LTCs' for men, was no different from that of the women in the age group 45-54 years (RR = 0.95 (0.67, 1.37); *p*-value = 0.816), while men had a lower risk at the age of 55-64 and 65+ years. The risk for women was significantly higher at an older age.

The patterns shown for the main effects of age remained the same, indicating an increased risk of T2DM + 1 LTC and T2DM + ≥ 2 LTCs, with an increase in age.

Age and income

While the interaction was not significant, the main effects support a significantly increased risk of T2DM + 1 LTC and T2DM + ≥ 2 LTCs with an increase in age among the affluent individuals (top 20% income quintile).

Age and education

While the interaction was not significant, the main effects support a significantly increased risk of T2DM + 1 LTC over 'No LTCs', among those aged 65+ years, with a bachelor's degree or higher (RR = 6.33 (2.82, 14.22)), as compared to those aged 45-54 years, as well as an increased risk of T2DM + ≥ 2 LTCs over 'No LTCs', among those aged 54-64 years and 65+ years (RR = 4.53 (1.92, 10.65) and 12.94 (5.74, 29.16) respectively), as compared to those aged 45-54 years.

Age and civil status

Overall, the interaction was not significant, and no differences in the risk of T2DM + 1 LTC across civil status groups were found. However, the introduction of the interaction revealed that the risk of T2DM + 1 LTC over 'No LTCs', among the subjects aged 55-64 years and 65+, was higher, as compared to those aged 45-54 years, in the married or cohabiting group. The RRs were 1.87 (1.35, 2.58) and 5.13 (3.75, 7.01), with a *p*-value < 0.001 for both. Similar patterns were noted for T2DM + ≥ 2 LTCs over 'No LTCs', indicating a slightly reduced risk of T2DM + 1 LTC and T2DM + ≥ 2 LTCs, for the married or cohabiting group.

Starost i bračno stanje

Sveukupno gledano, interakcija nije bila značajna i nisu pronađene razlike po pitanju rizika od T2DM + 1 *LTC* po grupama definisanim bračnim stanjem. Međutim, uvođenje interakcije otkrilo je da je rizik od T2DM + 1 *LTC* u odnosu na ishod „Nema *LTC*", među ispitanicima starosti 55-64 godine i 65+ godina, bio veći, u poređenju sa ispitanicima starosti 45-54 godine, u grupi onih koji su u braku ili vanbračnoj zajednici. Vrednosti RR su bile 1,87 (1,35, 2,58) i 5,13 (3,75, 7,01), sa p-vrednošću < 0,001 za svaku od RR vrednosti. Slični obrasci su zabeleženi za T2DM + ≥ 2 *LTC* u odnosu na „Nema *LTC*", što ukazuje na blago smanjeni rizik od T2DM + 1 *LTC* i T2DM + ≥ 2 *LTC*, za grupu onih koji su u braku ili vanbračnoj zajednici.

Starost i ograničenja usled zdravstvenih problema

Interakcija starosti sa zdravstvenim ograničenjima nije bila značajna. Uvođenje interakcije sugeriše značajno povećan rizik od T2DM + 1 *LTC* u odnosu na „Nema „*LTC*", sa povećanjem starosti, za podgrupu sa blagim ograničenjima ili bez ograničenja. U grupi starosti 45-54 godine, veći rizik je zabeležen kod onih sa umerenim i ozbiljnim zdravstvenim ograničenjima, u poređenju sa onima koji nisu imali ili su imali blaga ograničenja, što je u proseku slično onome što je nađeno u punom uzorku, bez uzimanja interakcije u obzir. Slični obrasci su zabeleženi za rizik od T2DM + ≥ 2 *LTC* u odnosu na „Nema *LTC*".

Pol i prihodi

Postojala je interakcija između pola i kvintila prihoda, ali ne na svim nivoima prihoda. Kad sumiramo glavne karakteristike ove interakcije, postojao je veći rizik od T2DM + 1 *LTC* u odnosu na „Nema *LTC*" kod žena u drugom (20% – 40%) i petom (najniži, 80% – 100%) kvintilu prihoda, u poređenju sa onima u prvom (gornjih 20%) kvintilu; vrednosti RR su bile 1,73 (1,04, 2,88), sa p-vrednošću = 0,035, i 1,83 (1,09, 3,07), sa p-vrednošću = 0,022. U prvom kvintilu prihoda, muškarci su bili pod većim rizikom od žena; RR je bio 2,43 (1,50, 3,94).

Za rizik od T2DM + ≥ 2 *LTC* u odnosu na „Nema *LTC*", nisu pronađene razlike između muškaraca i žena među onima u najvišem kvintilu prihoda (gornjih 20%). Postojao je značajno veći rizik za žene između drugog i petog kvintila, u poređenju sa ženama u prvom kvintilu; vrednosti RR su bile: 1,64 (1,13, 2,40), 1,81 (1,25, 2,61), 1,89 (1,31, 2,75) i 2,40 (1,66, 3,46), dok je *p*-vrednost bila < 0,01 za svaku vrednost RR.

Age and health limitations

The interaction of age with health limitations was not significant. The introduction of the interaction suggests a significantly increased risk of T2DM + 1 LTC over 'No LTCs', with increased age, for the subgroup with mild or no limitations. In the group aged 45-54 years, higher risks were noted among those with moderate and serious health limitations, as compared to those who had no or mild limitations, which is similar to what was found in the full sample, on average, without considering interactions. Similar patterns were noted for the risk of T2DM + ≥ 2 LTCs over 'No LTCs'.

Gender and income

There was an interaction between gender and income quintiles, but not at all the income levels. To summarize the main features of this interaction, there was a higher risk of T2DM + 1 LTC over 'No LTCs' in women in the second (20% – 40%) and the fifth (lowest, 80% – 100%) income quintiles, as compared to those in the first (top 20%) quintile; the RRs were 1.73 (1.04, 2.88), with a *p*-value = 0.035, and 1.83 (1.09, 3.07), with the *p*-value = 0.022, respectively. In the first income quintile, men were at higher risk than women; the RR was 2.43 (1.50, 3.94).

For the risk of T2DM + ≥ 2 LTCs over 'No LTCs', no differences between men and women were found among those in the top income quintile (top 20%). There was a significantly higher risk for women in the second to fifth quintiles, as compared to those in the first quintile; the RRs were 1.64 (1.13, 2.40), 1.81 (1.25, 2.61), 1.89 (1.31, 2.75), and 2.40 (1.66, 3.46), respectively, and the *p*-value was < 0.01, for each.

Gender and education

There was no significant interaction, but the introduction of the interaction indicates a higher risk of T2DM + 1 LTC in men, as compared to women, among the subjects with a bachelor's degree or higher level of education (RR = 2.54 (1.23, 5.27); *p*-value = 0.012). A higher degree of risk was noted for women of all other education levels, but this was not significant.

For the risk of T2DM + ≥ 2 LTCs, no differences between men and women were found. However, a significantly higher risk for women at all education levels, as compared to those with a bachelor's degree and higher, was registered. The RRs were, as follows: secondary education, 2.03 (1.10, 3.74), *p*-value = 0.023; elementary education or vocational training, 1.99 (1.24, 3.19), *p*-value = 0.005; and 0-7 years of education, 1.85 (1.07, 3.20), *p*-value = 0.027.

Pol i stepen obrazovanja

Nije bilo značajne interakcije, ali samo uvođenje interakcije ukazuje na veći rizik od T2DM + 1 *LTC* kod muškaraca, u poređenju sa ženama, među ispitanicima sa višom ili visokom stručnom spremom (RR = 2,54 (1,23, 5,27) *p*-vrednost = 0,012). Veći stepen rizika je zabeležen kod žena svih ostalih nivoa obrazovanja, ali to nije bilo značajno.

Za rizik od T2DM + ≥ 2 *LTC*, nisu pronađene razlike između muškaraca i žena. Međutim, registrovan je značajno veći rizik za žene na svim nivoima obrazovanja u odnosu na one sa višim i visokim stepenom obrazovanja. Vrednosti RR su bile sledeće: srednje obrazovanje, 2,03 (1,10, 3,74), *p*-vrednost = 0,023; osnovno obrazovanje ili trogodišnje srednje stručno obrazovanje, 1,99 (1,24, 3,19), *p*-vrednost = 0,005; i 0-7 godina obrazovanja, 1,85 (1,07, 3,20), *p*-vrednost = 0,027.

Pol i bračno stanje

Interakcije otkrivaju nešto veći rizik od T2DM + 1 *LTC* u odnosu na „Nema *LTC*", za muškarce, u poređenju sa ženama u bračnoj i/ili vanbračnoj grupi (RR = 1,36 (1,05, 1,75), *p*-vrednost = 0,018). Rizik od T2DM + ≥ 2 *LTC*, u poređenju sa „Nema *LTC*", bio je manji kod muškaraca u poređenju sa ženama koje pripadaju ovoj grupi po osnovu bračnog statusa (RR = 0,65 (0,54, 1,49), *p*-vrednost < 0,01).

Pol i ograničenja usled zdravstvenih problema

Nisu primećene nikakve interakcije između pola i ograničenja usled zdravstvenih problema u pogledu rizika od T2DM + 1 *LTC* u odnosu na „Nema *LTC*", kao ni razlike između muškaraca i žena. Za T2DM + ≥ 2 *LTC*, sa druge strane, muškarci su imali manji rizik u poređenju sa ženama u grupi bez ograničenja ili sa blagim ograničenjima (RR = 0,70 (0,57, 0,86), *p*-vrednost = 0,001. Žene sa umerenim ili ozbiljnim ograničenjima imale su značajno veći rizik od T2DM + ≥ 2 *LTC*, u poređenju sa onima bez ograničenja ili sa blagim ograničenjima 17,15 (13,22, 22,23) i 25,94 (17,72, 37,99); < 0,001, za dve grupe visokog rizika.

Gender and civil status

The interactions reveal a slightly higher risk of T2DM + 1 LTC over 'No LTCs', for men, as compared to women in the married and/or cohabiting group (RR = 1.36 (1.05, 1.75), *p*-value = 0.018). The risk of T2DM + ≥ 2 LTCs, as compared to 'No LTCs', was lower in men in comparison with women belonging to this civil status group (RR = 0.65 (0.54, 1.49), *p*-value < 0.01).

Gender and health limitations

No interactions between gender and health limitations regarding the risk of T2DM + 1 LTC over 'No LTCs', and no differences between men and women were noted. For T2DM + ≥ 2 LTCs, on the other hand, men had a lower risk, as compared to women in the group with no or with mild limitations (RR = 0.70 (0.57, 0.86), *p*-value = 0.001. Women with moderate or serious limitations had a significantly higher risk of T2DM + ≥ 2 LTCs, compared to those with no or mild limitations; RRs were 17.15 (13.22, 22.23); *p*-value <0.001, and 25.94 (17.72, 37.99); *p*-value < 0.001, for the two high-risk groups, respectively.