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UPOTREBA MOBILNE APLIKACIJE ZA POBOLJŠANJE ORALNOG ZDRAVLJA DECE SA AUTIZMOM

Aleksandra Stamatović[1], Bobana Mitrašinović[2], Anđela Pavlović[3], Dejan Marković[4], Olja Jovanović[5], Jelena Vranješević[5], Julijana Jovanović[6], Dejan Ostojic[7], Jugoslav Ilic[7], Ana Vuković[4]

[1] Dom zdravlja Požega, Republika Srbija
[2] Dom zdravlja Vršac, Republika Srbija
[3] Stomatološki fakultet, Univerzitet u Beogradu, Republika Srbija
[4] Klinika za dečju i preventivnu stomatologiju, Stomatološki fakultet, Univerzitet u Beogradu, Republika Srbija
[5] Filozofski fakultet, Univerzitet u Beogradu, Republika Srbija
[6] Stomatološki fakultet, Univerzitet u Beogradu, Republika Srbija
[7] Klinika za restaurativnu odontologiju i endodonciju, Stomatološki fakultet, Univerzitet u Beogradu, Republika Srbija

[*] Korespondencija: dr Aleksandra Stamatović, doktor stomatologije, Dom zdravlja Požega, Republika Srbija; DMD, student postdiplomskih studija dečije stomatologije, Jug Bogdanova 1, Požega, Republika Srbija; e-mail: stamatoviceva@gmail.com; telefon: 0641534700

SAŽETAK

Uvod/Cilj: Osobe iz autističnog spektra (ASD) često se susreću sa značajnim izazovima kada posećuju stomatologa. Mobilne tehnologije pokazale su se obećavajućim kao efikasna pomoćna sredstva u promovisanju zadataka vezanih za oralno zdravlje. Ova studija imala je za cilj da u prvoj fazi ispita dostupnost mobilnih aplikacija za oralno zdravlje na srpskom jeziku i ćiriličnom pismu, a u drugoj da proceni efikasnost aplikacije dizajnirane posebno za posete stomatologu, razvijene na srpskom jeziku i koja koristi ćirilično pismo.
Metod: Ova sudija preseka je sprovedena od novembra 2021. do februara 2022. godine na Klinici za dečju i preventivnu stomatologiju Stomatološkog fakulteta u Beogradu, Republika Srbija. Početna faza podrazumevala je pretragu onlajn aplikacija, kako na srpskom tako i na engleskom jeziku, koristeći specifične ključne reči: „mobilne aplikacije“, „autizam“, „stomatologija“ i „oralno zdravlje“. U sledećoj fazi, uključeno je deset porodica koje imaju dete sa ASD-om koje su koristile mobilnu aplikaciju na srpskom jeziku i ćiriličnom pismu koja je posebno razvijena za njihove posete stomatologu. Napredak u saradnji sa stomatologom kod korisnika ove aplikacije je procenjen pomoću strukturisanog protokola posmatranja zasnovanog na TEACCH metodi.
Rezultati: Analiza sadržaja mobilnih aplikacija otkriva da je od ukupnog broja aplikacija 64 (70,3%) funkcionalno. Više od polovine (59,4%) ovih aplikacija je dizajnirano za rešavanje poteškoća u razvoju, učenju i govoru. Što se tiče jezika, samo jedna aplikacija za podršku razvoju, učenju i govoru je bila dostupna na srpskom, a tri su bile na hrvatskom jeziku i napisane latiničnim pismom. Međutim, među ovim mobilnim aplikacijama, identifikovana je samo jedna aplikacija za oralno zdravlje, i to na engleskom jeziku. Ovo ukazuje na jasnu potrebu za razvojem aplikacija za oralno zdravlje na srpskom jeziku. Pilot test je pokazao da testirana mobilna aplikacija efikasno podržava decu sa ASD-om u njihovim posetama stomatologu.
Zaključak: Istraživanje je potvrdilo da su mobilne aplikacije koje podržavaju decu sa ASD-om tokom posete stomatologu obećavajuće sredstvo. Zbog toga treba uložiti napore da se ove vrste mobilnih aplikacija razviju i testiraju na srpskom jeziku.

Ključne reči: autizam, studija preseka, online aplikacije za očuvanje i unapređenje oralnog zdravlja, stomatologija, deca

Uvod

Autizam ili poremećaji iz spektra autizma (engl. *Autism Spectrum Disorder*, ASD) obuhvataju spektar stanja koja karakterišu teškoće u socijalnoj interakciji i komunikaciji, kao i prisustvo ponavljanih i stereotipnih ponašanja (1). Za osobe sa autizmom posete stomatologu mogu predstavljati izazov jer

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THE USE OF A MOBILE APPLICATION TO IMPROVE THE ORAL HEALTH OF CHILDREN WITH AUTISM

Aleksandra Stamatović[1], Bobana Mitrašinović[2], Anđela Pavlović[3], Dejan Marković[4], Olja Jovanović[5], Jelena Vranješević[5], Julijana Jovanović[6], Dejan Ostojic[7], Jugoslav Ilic[7], Ana Vuković[4]

[1] Health Center Požega, Republic of Serbia
[2] Health Center Vršac, Republic of Serbia
[3] School of Dental Medicine, University of Belgrade, Belgrade, Republic of Serbia
[4] Clinic for Pediatric and Preventive Dentistry, School of Dental Medicine, University of Belgrade, Belgrade, Republic of Serbia
[5] Faculty of Philosophy, University of Belgrade, Belgrade, Republic of Serbia
[6] School of Dental Medicine, University of Belgrade, Belgrade, Republic of Serbia
[7] Department of Restorative Odontology and Endodontics, School of Dental Medicine, University of Belgrade, Belgrade, Republic of Serbia

[*] Correspondence: Aleksandra Stamatović, Doctor of Dental Medicine, Požega Health Center, Republic of Serbia; DMD, student of postgraduate studies in children's dentistry, 1 Jug Bogdanova street, Požega, Republic of Serbia;
e-mail: stamatoviceva@gmail.com; phone: 0641534700

SUMMARY

Introduction: Individuals with autism spectrum disorder (ASD) often encounter significant challenges when visiting a dentist. Mobile supportive technologies have shown promise as effective assisting tools in promoting oral health-related tasks. This study aimed, in its first stage, to investigate the availability of oral health mobile applications in the Serbian language and Cyrillic script. In the second stage, our goal was to evaluate the effectiveness of an application designed specifically for dentist visits, developed in the Serbian language and using the Cyrillic alphabet.
Method: The cross-sectional study was conducted from November 2021 to February 2022 at the Clinic for Pediatric and Preventive Dentistry at the School of Dental Medicine in Belgrade, Republic of Serbia. The initial stage involved conducting a search of online apps, both in Serbian and English, using specific keywords: "mobile applications," "autism," "dentistry," and "oral health." In the subsequent stage, a sample of 10 families of children with ASD utilized a mobile app in Serbian and using Cyrillic script specifically developed for their dental visits. Progress in cooperation with the dentist among users of this application was assessed using a structured observation protocol based on the TEACCH method.
Results: The content analysis of mobile apps reveals that out of the total number of applications, 64 (70.3%) were deemed functional. More than half of these applications (59.4%) were designed to address developmental, learning, and speech difficulties. In terms of language, only one application aimed at supporting development, learning, and speech was available in Serbian, while three apps were in Croatian, utilizing the Latin script. However, among these mobile apps, only one application was identified for oral health, and it was in English. This indicates a clear need for the development of oral health apps in Serbian. A pilot test suggested that the tested mobile app effectively supports children with ASD in their visits to the dentist.
Conclusion: The research suggests that mobile apps supporting children with ASD during dentist visits are a promising tool. Therefore, efforts should be made to develop and test these types of mobile apps in the Serbian language.

Key words: autism, cross-sectional study, online applications for maintaining and improving oral health, dentistry, children

Introduction

Autism or autism spectrum disorder (ASD) includes a spectrum of conditions that are characterized by difficulties in social interaction and communication, as well as the presence of repeated and stereotyped behaviors (1). Persons with autism might find dental visits challenging

imaju poteškoća da sarađuju tokom stomatoloških intervencija, posebno ako imaju izražene senzorne smetnje. Jednostavni zadaci oralne higijene kod kuće za njih takođe mogu biti zbunjujući. Stoga, sve navedeno može uticati na njihovo oralno zdravlje i veći rizik od oralnih bolesti i oralnih samopovreda (2).

Poteškoće u društvenim interakcijama i komunikacijskim veštinama koje karakterišu ASD izazivaju prepreke u razumevanju neverbalnih obrazaca ponašanja, uspostavljanju i održavanju kontakata, nedostatak potrebe za deljenjem osećanja sa drugima, odsustvo socijalno-emocionalnog reciprociteta, smanjenu sposobnost imitacije i razumevanja drugih ljudi i njihovih psihičkih stanja, želja i ponašanja (3). Ove karakteristike čine proces socijalizacije izazovnim, kao i proces komunikacije i ponašanja tokom poseta stomatologu. Pored toga, može se desiti da se uobičajene nefarmakološke bihejvioralne metode u stomatološkoj ordinaciji, za koje su stomatolozi obučeni na osnovnim studijama, nije moguće primeniti. S obzirom da uobičajeno stomatološko lečenje nije uvek moguće izvesti, osobama sa ASD-om je često potrebna dodatna podrška kako bi prevazišli teškoće u obavljanju svakodnevnih aktivnosti. Multidisciplinarni pristup koji podrazumeva saradnju roditelja (ili staratelja), stomatologa, psihologa ili psihijatra u održavanju, unapređenju oralnog zdravlja i kontroli ponašanja pacijenta u stomatološkoj ordinaciji, izuzetno je važan za postizanje punog potencijala oralnog zdravlja (4). Zbog toga su neophodne prilagođene i specifične strategije kako bi se prevazišle barijere i obezbedila adekvatna stomatološka nega (5). Prvi i najvažniji korak bilo bi prevazilaženje poteškoća u komunikaciji i uspostavljanje odnosa poverenja, čime se smanjuje anksioznost i unapređuje saradnja u stomatološkoj ordinaciji.

Ubrzani razvoj novih tehnologija koje se sve više koriste u savremenom svetu doneo je novu potencijalnu strategiju u stomatološkoj ordinaciji – korišćenje mobilnih aplikacija za poboljšanje komunikacije sa osobama sa ASD-om (5). Mobilne aplikacije su specijalizovani softveri koji pružaju dodatnu podršku pri uspostavljanju saradnje i komunikacije između članova porodice, terapeuta i defektologa sa osobama sa ASD-om u svakodnevnim aktivnostima. One su dizajnirane i namenjene za dnevne aktivnosti i navigaciju u okruženju da bi se pomoglo deci da budu što je moguće nezavisnija i da uspostave pozitivan odnos sa okolinom. Uglavnom se koriste za komunikaciju, učenje, praćenje dnevnih aktivnosti, zabavu i vežbanje. Korišćenje mobilne aplikacije kao savremenog edukativnog alata omogućava ne samo unapređenje saradnje sa stomatologom, već i uspostavljanje odnosa poverenja, upoznavanje sa prostorom stomatološke ordinacije pre posete stomatologu kao i sa budućim stomatološkim procedurama.

Studija je imala dva cilja. Prvi cilj je bio ispitivanje dostupnosti mobilnih aplikacija za oralno zdravlje na srpskom jeziku i ćiriličnom pismu. Drugi cilj bio je procena efikasnost aplikacije posebno dizajnirane za posete stomatologu, razvijene na srpskom jeziku i ćiriličnom pismu.

Metode

Dizajn studije preseka

Prva faza studije bila je struktuisana kao pregled onlajn prodavnica aplikacija: *Google Play* aplikacija za *Android* i *App Store* aplikacija na *Apple* platformi. To je urađeno unošenjem ključnih reči na srpskom i engleskom jeziku: „mobilne aplikacije“, „autizam“, „stomatologija“, „oralno zdravlje“ i „zubi“.

Kriterijumi za uključivanje u analizu bili su sledeći: 1) aplikacija je namenjena osobama sa ASD-om; 2) aplikacija je dostupna za besplatno preuzimanje preko *Android* i *Apple* operativnih sistema; 3) aplikacija je funkcionalna i upotrebljiva u Srbiji.

Analiza sadržaja je sprovedena radi klasifikacije aplikacija na osnovu njihove funkcionalnosti (funkcionalne/nefunkcionalne), jezika (srpski_hrvatski_bosanski_ crnogorski/ engleski), platformi za korišćenje (aplikacije dizajnirane za *Android* platformu/aplikacije dizajnirane za *Apple* platformu/aplikacije kompatibilne sa obe platforme), i obima podrške funkcionisanju pojedinca (podrška teškoćama u razvoju, učenju i govoru/ podrška u praćenju svakodnevnih zadataka i rutina/ podrška u identifikaciji i razumevanju emocija/ podrška u korišćenju prevoza i aktivnosti na otvorenom/ podrška u roditeljstvu dece sa ASD/ podrška u aktivnostima vezanim za oralno zdravlje).

Dizajn pilot testiranja

Druga faza studije je obuhvatila pilot testiranje mobilne aplikacije na srpskom jeziku i ćiriličnom pismu, koja za cilj ima podršku deci sa ASD-om tokom poseta stomatologu. Pilot testiranje je osmišljeno kao deo studentskog naučnog rada

since they have difficulties cooperating during dental interventions particularly if they have pronounced sensory disturbances. Simple oral hygiene tasks at home might be puzzling too. Therefore, these features might affect their oral health and favor higher risk for oral diseases and oral self-injuries (2).

Difficulties in social interactions and communication skills that characterizes ASD causes obstacles in understanding non-verbal patterns of behavior, establishing and maintaining contacts, lack of the need to share feelings with others, absence of social-emotional reciprocity, reduced ability to imitate and understand other people and their mental states, desires and behavior (3). These characteristics make the process of socialization challenging, as well as the process of managing behavior during dental visits. Moreover, the typical non-pharmacological behavioral methods in a dental office, for which undergraduate dentists are trained, might be impossible to apply. Since the usual dental treatment is not always possible to perform, persons with ASD often need additional support to overcome difficulties in performing daily activities. The multidisciplinary approach involving cooperation between parent (or guardian), dentist, psychologist or psychiatrist in maintaining, improving oral health, and behavioral management in dental office is extremely important in order to achieve the full potential of oral health (4). Therefore, it is necessary adapted and specific strategies in order to overcome barriers and provide adequate dental care (5). First and most important step would be overcoming difficulties in communication and establishing a relationship of trust, which reduces anxiety and improves cooperation in the dental office.

Rapid development of new technologies that are increasingly used in the modern world brought new potential strategy in dental office – using mobile applications to improve communication with ASD persons (5). Mobile applications are specialized software that provide additional support when establishing cooperation and communication between family members, therapists and special education teachers with ASD persons in everyday activities. Mobile applications are designated and intended for daily activities and navigating the environment in order to help children to be as independent as possible and to achieve a positive relationship with the environment. They were mostly used for communication, learning, monitoring daily activities, entertainment and exercise. The use of mobile application as a modern educational tool enables not only the improvement of cooperation with the dentist, but also establishing a relationship of trust, making familiar with the space of the dental office before dental visit and for future dental procedures.

The study had two aims. Firstly, to investigate the availability of oral health mobile applications in the Serbian language and Cyrillic script. Secondly, to evaluate the effectiveness of an application specifically designed for dentist visits, developed in the Serbian language and utilizing the Cyrillic alphabet.

Method

Review design

The first stage of the study was structured as a review of the online app stores: the Google Play application for Android and the App Store application on the Apple platform. This was done by inputting keywords in both Serbian and English: "mobile applications," "autism," "dentistry," "oral health," and "teeth."

The criteria for inclusion in the analysis were as follows: 1) the application is intended for individuals with ASD; 2) the application is available for free download through Android and Apple operating systems; 3) the application is functional and usable in Serbia.

The content analysis was conducted to classify applications based on their functionality (functional/non-functional), language (Serbian_Croatian_Bosnian_Montenegrin/English), platforms for usage (applications designed for the Android platform/applications designed for the Apple platform/applications compatible with both platforms), and the scope of support for an individual's functioning (support for developmental, learning, and speech difficulties/support in monitoring daily tasks and routines/support in identifying and understanding emotions/support in using transportation and outdoor activities/support in parenting children with ASD/support in activities related to oral health).

Pilot test design

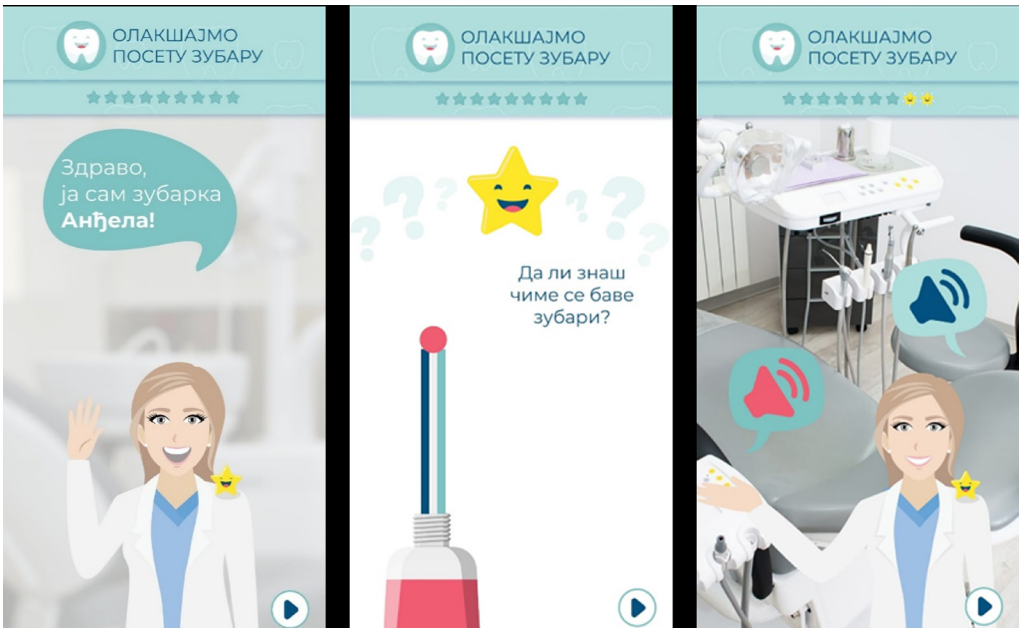
The second stage of the study included pilot testing the mobile application in the Serbian

u okviru projekta koji je podržalo Ministarstvo zdravlja Republike Srbije. Projektni tim činila je multidisciplinarna grupa, uključujući nastavnike i studente osnovnih studija Stomatološkog fakulteta Univerziteta u Beogradu, kao i Filozofskog fakulteta Univerziteta u Beogradu. Pored toga, tim je uključivao programera, veb dizajnera, fotografa, decu sa posebnim potrebama koja su se suočavala sa izazovima u saradnji u stomatološkim ustanovama i njihove roditelje ili staratelje.

Ova aplikacija (Slika 1) uključuje virtuelni obilazak stomatološke ordinacije, upoznavanje sa zvucima u ordinaciji, upoznavanje sa stomatološkim instrumentima, igre za strpljenje, koncentraciju i pažnju i upoznavanje sa postupkom pri pregledu zuba i uklanjanju plaka, kao i igre koje imaju za cilj da podrže kontrolu impulsa.

Pigodni uzorak za pilot test uključivao je desetoro dece sa ASD-om i njihove roditelje koji su dobrovoljno prihvatili učešće u istraživanju, tražeći stomatološko lečenje na Klinici za dečju i preventivnu stomatologiju Stomatološkog fakulteta u Beogradu. Posete stomatologu su bile zakazane jednom nedeljno, uvek istog dana i u isto vreme, tokom perioda praćenja od 3 meseca. Roditelji su dobili instrukcije da dozvole deci da koriste aplikaciju najmanje 15 minuta dnevno tokom perioda igre. Pogodan uzorak se sastojao od 8 dečaka i 2 devojčice, prosečne starosti od 10,3 godine. U ovoj fazi istraživanja pacijentima je, uz pomoć roditelja i/ili staratelja, data prilika da testiraju aplikaciju. Nakon korišćenja, dali su povratne informacije o svom iskustvu i predložili poboljšanje njene efikasnosti u cilju pomaganja deci sa ASD-om tokom poseta stomatološkoj ordinaciji.

Dizajn pilot testa uključivao je upotrebu metode TEACCH (eng. T*reatment and Education of Autistic and Related Communication Handicapped Children*) koja je razvijena kao pedagoška strategija namenjena osobama sa autizmom (6). Protokol je obuhvatao 10 sukcesivnih koraka, koji imaju prethodno utvrđeno trajanje, uz primenu komunikacionih strategija i bihejvioralnih tehnika (Tabela 1). Koraci su se izvodili jednom nedeljno, najmanje u 5 sesija. Svi koraci za istog pacijenta su se uvek izvodili u istoj prostoriji, istog dana u nedelji, u isto doba dana. Svaki korak je podrazumevao uspešno obavljanje određenih aktivnosti. Moguće je podeliti bilo koji od navedenih koraka na dve sesije, ako je u skladu sa individualnom procenom. Tokom prvog koraka, nakon uspešnog ulaska u ordinaciju, neophodno je da pacijent ostane u toj prostoriji i da se u njoj oseća prijatno i opušteno. Prvi susret sa pacijentom je u većini slučajeva razgovor sa roditeljima, tokom kojeg se stomatolog i pacijent upoznaju i stomatolog prikuplja sve potrebne podatke za dalji tok lečenja. Pacijenti bi uvek trebalo da imaju vremensku orijentaciju koliko će svaki korak trajati, tako da odbrojavanje uvek treba da bude najavljeno. Osoba koja izvodi intervenciju treba uvek da broji naglas, jasnim, prijatnim i opuštenim tonom.



Slika 1. Prezentacija aplikacije na srpskom jeziku.

language and Cyrillic script, with the aim at supporting children with ASD during their dental visits . It was designed as part of an undergraduate student's scientific work supported by the Ministry of Health of the Republic of Serbia. The project team comprised a multidisciplinary group, including teachers and undergraduate students from the School of Dental Medicine at the University of Belgrade, as well as from the Faculty of Philosophy at the University of Belgrade. Additionally, the team included a programmer, web designer, photographer, children with special needs who faced challenges cooperating in dental settings, and their parents or guardians.

Within this application (Figure 1), features included a virtual tour of the dental office, familiarization with the sounds commonly heard in the office environment, getting acquainted with dental instruments, understanding the procedure during dental examinations and plaque removal, and games aimed at supporting impulse control.

The study utilized a convenient sample consisting of 10 children with ASD and their parents who volunteered to participate, seeking dental treatment at the Clinic for Pediatric and Preventive Dentistry at the School of Dental Medicine in Belgrade. Dental visits were scheduled once a week, consistently on the same day and time, throughout a follow-up period of 3 months. Parents were instructed to allow their children to use the application daily for at least 15 minutes during their playtime.

A convenient sample comprised 8 male and 2 female participants, with an average age of 10.3 years. In this phase of the research, patients, with the aid of their parents and/or guardians, were given the chance to test the application. After using it, they provided feedback regarding their experience and offered suggestions to improve its effectiveness in assisting children with ASD during visits to the dental office.

The pilot test design included the use of TEACCH (Treatment and Education of Autistic and Related Communication Handicapped Children) method developed as a pedagogical strategy intended for people with autism (6). The protocol includes 10 subsequent steps, which have previously specified duration, with the application of communication strategies and behavioral techniques (Table 1). The steps should be carried out once a week, through at least five sessions. All steps for the same patient should always be performed in the same room, on the same day of the week, at the same time of day. Each step implies the successful performance of certain activities. It is possible to divide any of the mentioned steps into two sessions if it is in accordance with the individual assessment. During the first step after successfully entering the office, it is necessary for the patient to stay in that room and to feel comfortable and relaxed in it. The first meeting with the patient in most cases is a conversation with parents, during which the dentist and patient get to know each

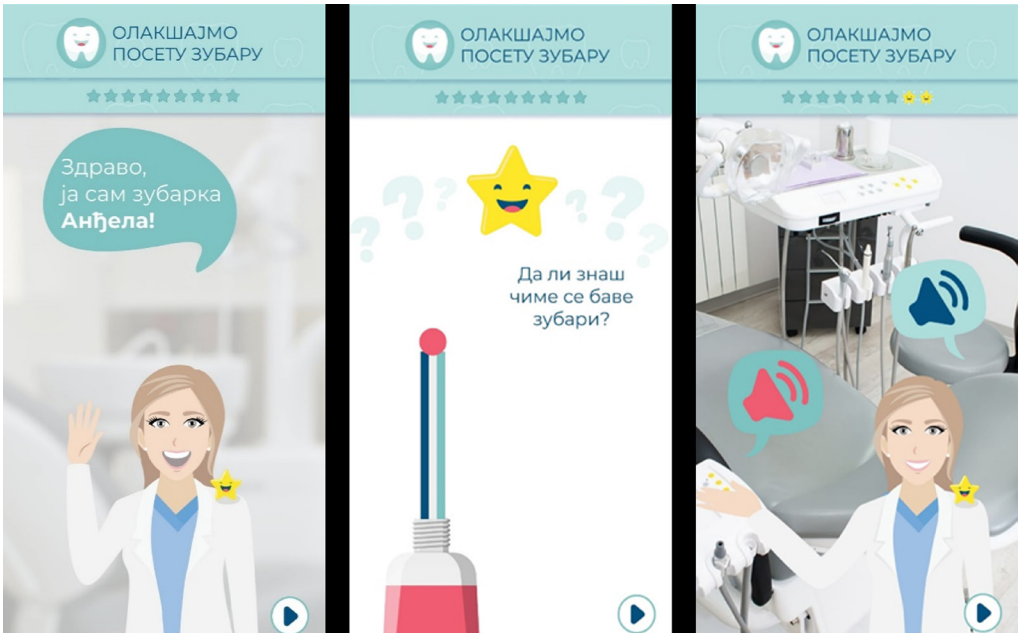


Figure 1. Presentation of the application in the Serbian language

Tabela 1. Opis korakaTEACCH metoda koji se koriste u stomatološkoj ordinaciji

Korak 1	Ulazak u stomatološku ordinaciju (koliko god je pacijentu potrebno)
Korak 2	Sesti na stomatološku stolicu i potom sedeti na stomatološkoj stolici 10s
Korak 3	Nasloniti leđa i glavu na stomatološku stolicu i zatim ostati u toj poziciji 10s
Korak 4	Usmeriti svetlo prema licu dok pacijent sedi naslonjen na stomatološkoj stolici, zatim držati tako usmereno svetlo prema ustima pacijenta 10 s
Korak 5	Otvoriti širom usta i tako ostati 10s
Korak 6	Stomatolog stavlja ruku u usta pacijenta i drži ruku u ustima pacijenta 5s
Korak 7	Uvesti stomatološko ogledalce, zatim sprovesti stomatološki pregled korišćenjem samo ogledalca 5s
Korak 8	Uvesti stomatološku sondu, a zatim uraditi pregled korišćenjem samo sonde tokom 5s
Korak 9	Stomatološki pregled sa ogledalcem i sondom u trajanju od 5s
Korak 10	Pregled okluzije, što podrazumeva da pacijent drži zube tokom perioda centralne okluzije u trajanju od 5 do 10s

*ako pacijent nije mogao da uđe u stomatološku ordinaciju što je računato kao rezultat 0 za potrebe ovog istraživanja.

Za statističku analizu podataka korišćene su metode deskriptivne statistike u SPSS verziji 26 (*SPSS Inc, Chicago, IL)*. Jedan stomatolog je bio angažovan u nadgledanju kliničkog stomatološkog (AV) tretmana pacijenata u pilot programu, a procena rezultata urađena je pomoću TEACCH skora. Svaki uspešan korak ima rezultat koji odgovara redosledu koraka (na primer, ako je korak 1 uspešan, skor=1; ako je korak 2 uspešan, skor=2, itd.). Na ovaj način, minimalni skor koji pacijent može postići je skor 0 (ako pacijent nije mogao da uđe u stomatološku ordinaciju), a maksimalni skor 10.

Rezultati

Pregledom aplikacija putem onlajn prodavnica identifikovana je 91 mobilna aplikacija koja ima za cilj podršku funkcionisanju osoba sa ASD-om u različitim aspektima života, od kojih su se 64 (70,3%) smatrale funkcionalnim. Među funkcionalnim aplikacijama, više od polovine (59,4%) je dizajnirano da podrži osobe sa ASD-om sa poteškoćama u učenju i govoru. Distribucija učestalosti dostupnih aplikacija u zavisnosti od kategorije aplikacije prikazana je na slici 2.

Od ukupnog broja funkcionalnih aplikacija, samo jedna aplikacija (6,3%) je bila na srpskom jeziku i spadala je u kategoriju aplikacija za smetnje u razvoju, učenju i govoru. Tri aplikacije su bile na hrvatskom jeziku i na latiničnom pismu.

Od ukupnog broja aplikacija, samo jedna aplikacija je bila dostupna za poboljšanje oralnog zdravlja i ova aplikacija je bila na engleskom jeziku. Rezultati su pokazali odsustvo aplikacija koje se odnose na oralno zdravlje na srpskom jeziku, na ćiriličnom pismu.

Nakon pilot testiranja nove aplikacije na srpskom jeziku i ćiriličnom pismu obavljeni su intervjui sa roditeljima. Prilikom provere razumevanja sadržaja, date su sledeće sugestije: dodati glas stomatologa, dodati tajmer za odbrojavanje aktivnosti na aplikaciji, naglasiti izgled stomatološke ordinacije i stomatološke stolice, poboljšati zvukove žamora u stomatološkoj ordinaciji i zvuk stomatoloških instrumenata.

Svi roditelji su primetili smanjenu napetost kod svoje dece tokom poseta stomatologu nakon svakodnevne upotrebe aplikacije. Analiza TEACCH rezultata dece koja učestvuju u pilot studiji ukazuje na značajno poboljšanje TEACCH rezultata nakon upotrebe aplikacije (9,7±0,5) u poređenju sa TEACCH ocenama pre korišćenja aplikacije (2,1±2,3) (srednji rezultat ± standardna devijacija) (Slika 3).

Diskusija

Rezultati ovog istraživanja pokazali su da ne postoji aplikacija na srpskom jeziku i ćiriličnom pismu namenjena pacijentima sa ASD-om u

Table 1. Description of TEACCH method steps applied in dental office

Step 1	Entering the dental office (as much as the patient needs)
Step 2	Sitting in the dental chair and then sitting in the dental chair for 10s
Step 3	Leaning on the back and headrest in the dental chair, then holding the reclining position for 10s
Step 4	Directing the spotlight to the face while the patient is reclining in the dental chair, and then keeping the spotlight on the patient's mouth for 10s
Step 5	Opening the mouth wide and then holding it for 10s
Step 6	Inserting the dentist's hands into the patient's mouth and then keeping the dentist's hand in the patient's mouth for 5s
Step 7	Dental mirror introduction, followed by dental examination using only mirror during 5s
Step 8	Dental probe introduction, followed by dental examination using only probe during 5s
Step 9	Dental examination with the mirror and probe during 5s
Step 10	Occlusion examination, which implies that the patient keeps the teeth during the period of central occlusion during 5 to 10s

*if patient could not enter the dental office that was for the purposes of this research counted as score 0.

other and the dentist gathers all the necessary data for the further treatment plan. Patients should always have time orientation how much each step will last therefore the counting should always be announced. The person performing the intervention should always count out loud, in a clear, pleasant and relaxed tone.

Descriptive statistics methods in SPSS version 26 (SPSS Inc, Chicago, IL) were used for the statistical analysis of the data. One dentist was engaged in supervising clinical dental (AV) treatment of patients in the pilot, and assessments were made using TEACCH scores. Each successful step was assigned the same score; for example, if step 1 was successful, the score was 1, and if step 2 was successful, the score was 2, and so on. In this way, the minimal score that a patient could achieve was 0 (if patient could not enter in dental office), and the maximal score was 10.

Results

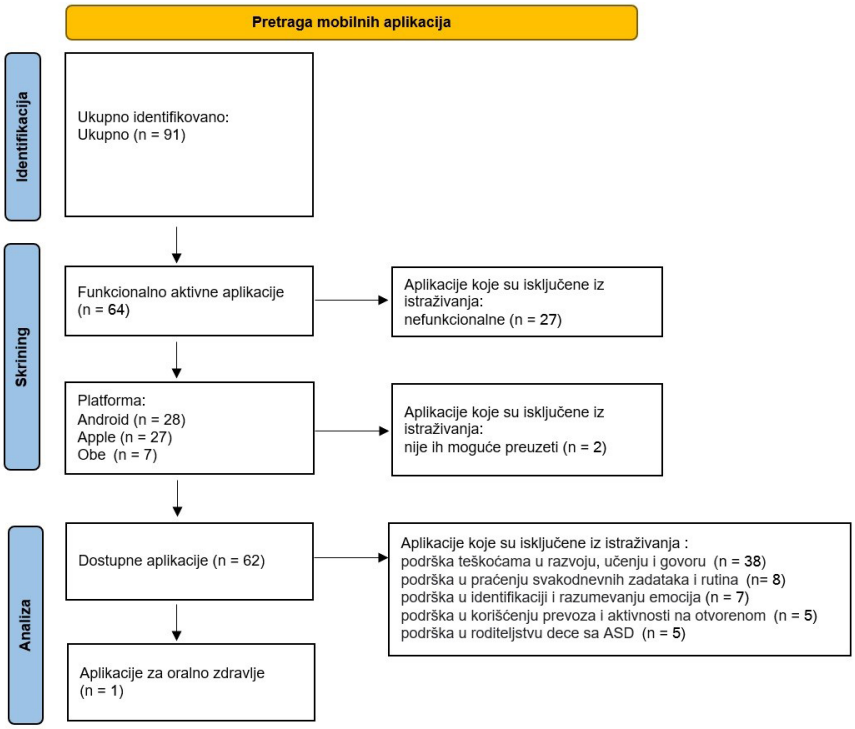
The review of the online app stores, resulted in the identification of 91 mobile applications aimed at supporting functioning of individuals with ASD in various aspects of life, with 64 (70.3%) deemed functional. Among the functional applications, more than half (59.4%) were designed to support ASD individuals with learning and speech difficulties. Frequency distribution of available applications depending on the application category is presented in the Figure 2.

Out of the total number of functional applications, only one (6.3%) was in the Serbian language, falling into the category of applications for developmental, learning, and speech difficulties. Three applications were in Croatian, all utilising the Latin script.

Among the overall number of applications, only one was available for enhancing oral health, and it was in English. These findings indicated the absence of applications related to oral health in the Serbian language using Cyrillic script.

After pilot test of the new application in the Serbian language and Cyrillic script interwiews with the parents were carried out. Regarding the comprehension of the content, several suggestions were put forward: including the voice of the dentist, integrating a timer for activity countdowns within the application, giving more prominence to images of the dental office and the dental chair, and enhancing the sounds of murmurs in the dental office along with the sound of dental instruments.

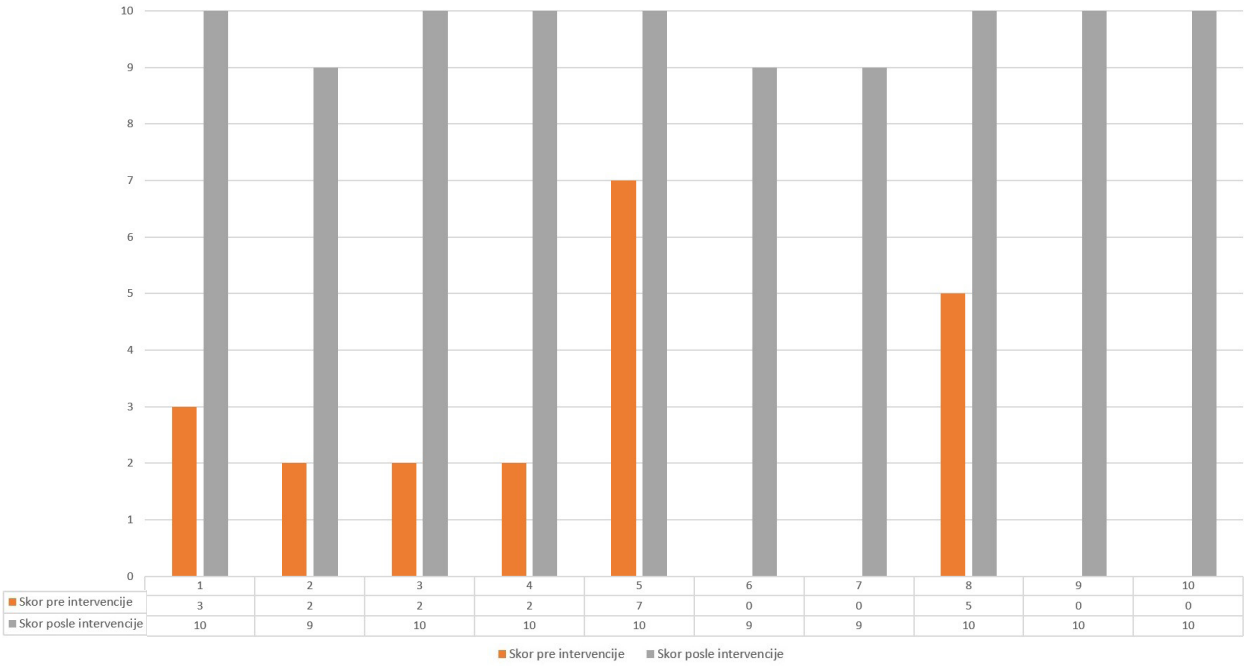
All parents observed reduced tension in their children during dental visits after the daily use of the application. An analysis of the TEACCH scores of participating children in the pilot study indicates an improvement in TEACCH scores after the application's use (9.7 ± 0.5) compared to TEACCH scores before using the application (2.1 ± 2.3) (mean score ± standard deviation) (Figure 3).



Slika 2. Dijagram toka koji predstavlja identifikaciju aplikacija za pomoć osobama sa ASD.

stomatološkoj ordinaciji. Pregledom literature nije pronađena nijedna studija koja procenjuje upotrebu i efikasnost mobilnih aplikacija za pripremu i prilagođavanje pacijenata prvenstveno prilikom posete stomatologu i stomatoloških intervencija.

Utvrđeno je da su anksioznost/strah od stomatologa prisutni kod 6,3% dece uzrasta od 5 do 10 godina (7). U populaciji dece sa autizmom, učestalost otežane saradnje sa stomatologom se višestruko povećava – utvrđeno je da više od polovine dece sa poremećajem autističnog spektra (50-72%) pokazuje znake anksioznosti, straha ili odbija da sarađuje sa stomatologom (3). Ovo se može pripisati strahu od nepoznatog, teškoćama u komunikaciji i pojačanoj reakciji na senzorne stimuluse. Takođe, autistični spektar ponašanja



Slika 3. Vizuelizacija TEACCH skorova pre i nakon pilot testiranja.

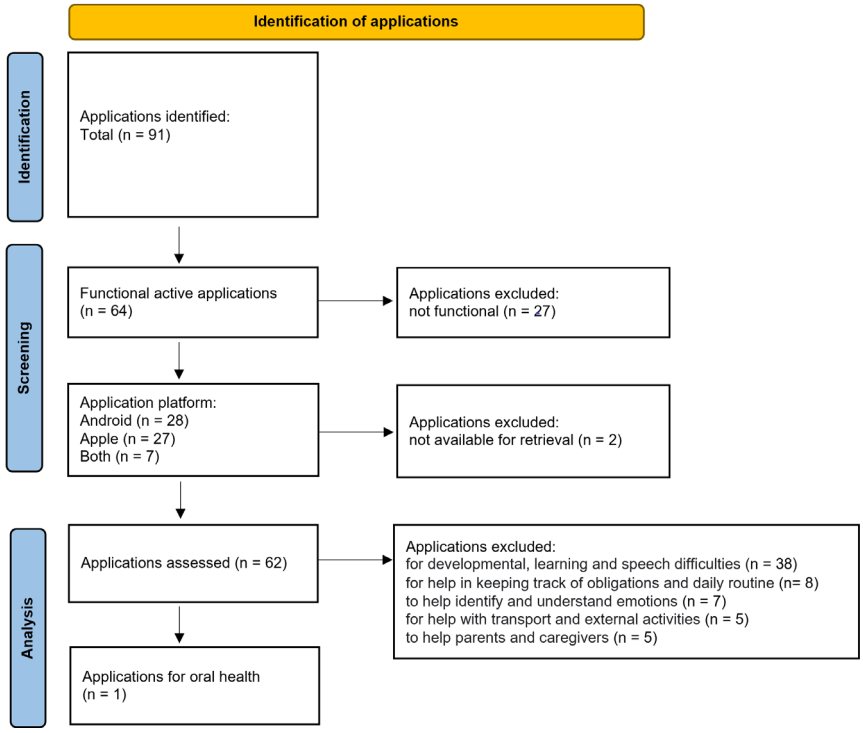


Figure 2. Flow diagram related to the identification of applications used to support ASD persons

However, due to the small sample size, we cannot assert statistical significance.

Diskusija

The results of the study showed that there were no application in the Serbian language and Cyrillic script intended for ASD patients in dental office. The literature review did not find any studies evaluating the use and effectiveness of mobile applications for patient preparation and adaptation primarily for dental visits and dental interventions.

It was found that fear/anxiety related to the dentist is present in 6.3% of children of age 5 to 10 years (7). In the population of children with autism, the frequency of difficult cooperation

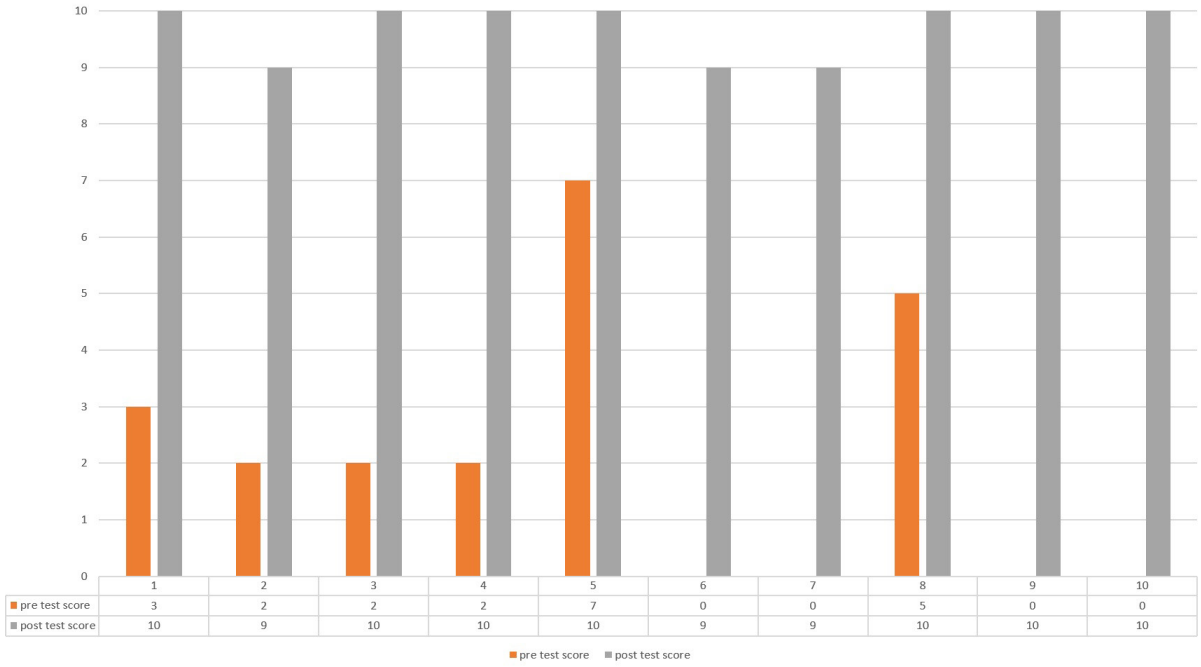


Figure 3. Visualization of pre and post pilot test TEACCH scores

obuhvata različite stepene poremećaja socijalne interakcije i komunikacije (1), što se često ogleda u otežanoj saradnji u stomatološkoj ordinaciji. Takođe, promene u ustaljenoj dnevnoj rutini mogu izazvati poteškoće u ponašanju i izlive besa. Napadi besa su kratkotrajne i iznenadne epizode besa i agresije u vidu neprijatnog ponašanja ili emocionalnih izliva. Često nastaju kao odgovor na nezadovoljene potrebe ili želje. Napadi besa se češće javljaju kod mlađe dece ili kod drugih osoba koje ne mogu da izraze svoje potrebe ili kontrolišu svoje emocije kada su frustrirani. Manifestuju se vikanjem, plačem, bacanjem na pod i udaranjem predmeta. Takođe, promene u ustaljenoj dnevnoj rutini mogu izazvati poteškoće u ponašanju i napade besa (8).

Osobe sa autizmom pokazuju poteškoće kada je u pitanju recipročna komunikacija/ interakcija, kao što je neočekivano reagovanje u razgovorima, pogrešno razumevanje neverbalnih poruka ili poteškoće u izgradnji prijateljstava koja su adekvatna uzrastu. Pored toga, mogu biti previše zavisni od rutine, veoma osetljivi na promene u svom okruženju ili intenzivno fokusirani na određene teme. Potrebno je da kliničari uzmu u obzir razlike u simptomima i ponašanju koji mogu varirati od osobe do osobe prilikom plana terapije. Prema kriterijumima DSM-5, osobe sa ASD moraju da ispoljavaju simptome od ranog detinjstva, čak i ako se ovi simptomi prepoznaju tek kasnije. Prema podacima iz savremene literature, dijagnoza iz spektra autizma postavlja se nakon četvrte godine života (9). Smatra se da rano započinjanje lečenja ima pozitivan uticaj na ishod autističnog spektra (10). Iz istog razloga, rana poseta stomatologu i blagovremena primena bihejvioralnih mera, preventivnih i profilaktičkih postupaka omogućila bi značajno unapređenje saradnje i unapređenje zdravlja.

Kliničko iskustvo je da je kod dece sa autizmom najteže ostvariti komunikaciju i saradnju tokom pregleda, a intervencije u ambulantnim uslovima često su teško izvodljive s obzirom na nedovoljnu obučenost stomatologa za rad sa ovom grupom pacijenata. Konvencionalne bihejvioralne tehnike za smanjenje straha od stomatološke intervencije uključuju: „reci-pokaži-uradi“, desenzitizaciju, kontrolu glasa/hipnozu, pozitivnu stimulaciju, skretanje pažnje i prisustvo ili odsustvo roditelja. Međutim, nedostatak socijalnih i komunikacijskih veština koji karakteriše ponašanje iz spektra autizma, nedostatak potrebe za deljenjem osećanja sa drugima, odsustvo socijalno-emocionalnog reciprociteta, smanjena sposobnost imitacije i razumevanja drugih ljudi i njihovih mentalnih stanja, želja i ponašanja otežavaju korišćenje i razumevanje neverbalnih obrazaca ponašanja (10). Ove karakteristike ne samo da otežavaju proces socijalizacije i prilagođavanja stomatološkom lečenju, već često znatno otežavaju i onemogućavaju primenu uobičajenih bihejvioralnih metoda za koje su stomatolozi obučeni.

Bihejvioralna teorija nalaže da što je osoba više izložena stimulansu koga se plaši, na bezbedan, nežan i postepen način, to se više gradi tolerancija na anksioznost, što će na kraju smanjiti intenzitet reakcije straha. Za decu sa poremećajem iz spektra autizma i decu sa smetnjama u učenju, ovo treba da bude praktično, vizuelno i što je moguće realnije, jer deca sa neurorazvojnim poremećajima imaju poteškoća da razumeju apstraktne pojmove (11). Farmakološke metode koje se za sada mogu primeniti u našoj zemlji su *per os* davanje sedativa, intravensko i inhalaciono davanje sedativa, ili opšta endotrahealna anestezija, pri čemu je za poslednje dve procedure potrebno prisustvo anesteziologa.

Savremeni svet, a sa njim i pandemija virusa kovid-19 doveli su do toga da se nove tehnologije koje se brzo razvijaju sve više koriste u svakodnevnom životu. Rukovodeći se ovim, a takođe i na osnovu istraživanja došlo se do zaključka da nove tehnologije mogu značajno olakšati svakodnevni život dece sa autizmom. Tehnološke metode se uglavnom zasnivaju na odvlačenju pažnje korišćenjem slušalica za slušanje muzike, igranjem igrica i gledanjem crtanih filmova na telefonu i tabletu kako bi se smanjilo senzorno opterećenje. Odvlačenje pažnje se godinama uspešno koristi u stomatologiji i zasniva se na hipotezi da percepcija bola ima jaku psihološku komponentu, što znači da ako se manje pažnje usmeri direktno na stresor ili okidač anksioznosti, percepcija bola je slabija. Stoga bi se optimalno odvraćanje pažnje moglo postići korišćenjem multisenzornog iskustva putem mobilnih aplikacija. Mobilne aplikacije i igrice angažuju ruke i prste prilikom korišćenja telefona ili tableta, a s obzirom na to da ove radnje nisu prikladne prilikom stomatološke intervencije jer je neophodna saradnja deteta, bilo bi važno razmisliti o programiranju mobilnih aplikacija tako da se zasnivaju na tehnici „razotkrivanja“ iskustava koja su nepoznata detetu i sa kojima treba da se susretne i suoči. Tera-

with the dentist increases significantly; it was determined that more than half of the children with autism spectrum disorder (50-72%) show signs of anxiety, fear, or refuse to cooperate with the dentist (3). This can be attributed to the fear of the unknown, difficulty in communication, and heightened reaction to sensory stimuli. Also, the autistic spectrum of behavior includes varying degrees of social interaction and communication disorders (1), which is often reflected in difficult cooperation in the dental office. Also, changes in the established daily routine can cause behavioral difficulties and temper tantrums. Temper tantrums are short-lived and sudden episodes of anger and aggression in the form of unpleasant behavior or emotional outbursts. They often arise in response to unsatisfied needs or desires. Tantrums are more likely to occur in younger children or others who cannot express their needs or control their emotions when frustrated. They manifest themselves by shouting, crying, throwing on the floor and hitting objects. Also, changes in the established daily routine can cause behavioral difficulties and temper tantrums (8).

Individuals with autism exhibit deficits in reciprocal communication/interaction, such as responding inappropriately in conversations, misreading nonverbal interactions, or having difficulties in building age-appropriate friendships. In addition, they may be too dependent on routine, very sensitive to changes in their environment, or intensely focused on certain subjects. Clinicians need to consider differences in symptoms and behavior that may vary from person to person when planning treatment. According to DSM-5 criteria, individuals with ASD must exhibit symptoms from early childhood, even if these symptoms are not recognized until later. According to data from contemporary literature, in the majority of cases, the diagnosis from the autism spectrum is made after the fourth year of life (9). It is believed that early initiation of treatment has a positive impact on the outcome of the autism spectrum (10). For the same reason, an early visit to the dentist and the timely application of behavioral measures, preventive and prophylactic procedures would enable a significant improvement in cooperation and improvement of health.

Clinical experience shows that in children with autism, it is most difficult to achieve communication and cooperation during the examination, and interventions in ambulatory conditions are often difficult to implement given the insufficient training of dentists to work with this group of patients. Conventional behavioral techniques for reducing dental phobia include: "Say-Show-Do", desensitization, voice control/hypnosis, positive stimulation, distraction and the presence or absence of parents. However, the deficit of social and communication skills that characterizes the autistic spectrum of behavior, the lack of need to share feelings with others, the absence of social-emotional reciprocity, the reduced ability to imitate and understand other people and their mental states, desires and behaviors make it difficult to use and understand non-verbal behavior patterns (10). These characteristics not only make the process of socialization and adaptation to dental treatment difficult, but often make it much more difficult and impossible to apply the usual behavioral methods that dentists are trained for.

Behavioral theory dictates that the more a person is exposed to the feared stimulus, in a safe, gentle and gradual way, the more tolerance to anxiety is built, which will eventually reduce the intensity of the fear reaction. For children with autism spectrum disorder and children with learning disabilities, this should be practical, visual and as realistic as possible, because children with neurodevelopmental disorders have difficulty understanding abstract concepts (11). Pharmacological methods that can be used in our country for now include per os administration of sedatives, intravenous and inhalation administration of sedatives or general endotracheal anesthesia, with the last two procedures requiring the presence of an anesthesiologist.

The modern world, and together with it the COVID-19 virus pandemic, have led to the fact that new rapidly developing technologies are increasingly used in everyday life. Guided by this, and also based on research, the conclusion was reached that new technologies can significantly facilitate the daily life of children with autism. Technological methods are mainly based on distraction using headphones to listen to music, play games and watch cartoons on the phone and tablet to reduce the sensory load. Distraction has been successfully used in dentistry for years and is based on the hypothesis that pain perception has a strong psychological component, which means that if less attention is focused directly on

pija izlaganjem se smatra prvim izborom za mnoge fobije (12). Zasniva se na ublažavanju negativnog dejstva stresora kroz ponovljeno i pojačano izlaganje pacijenta situacijama koje kod njega izazivaju anksioznost (13). Terapija izlaganjem je prilagođena za upotrebu u virtuelnom svetu (eng. *Virtual Reality Exposure Therapy*, VRET), tako što pacijentu daje osećaj prisustva u virtuelnom prostoru, što je posebno pogodno za decu sa autizmom koja obično provode veći deo dana sa tehnološkim pomagalima. Korišćenje virtuelnih aplikacija aktivira više čula (vida, sluha, dodira) i tako odvlači pažnju od spoljašnjih pokretača čula. Psihološki osećaj koji proizilazi iz ovoga je osećaj prisustva (14).

Pregledom literature potvrđeno je da preoperativna priprema pacijenata korišćenjem tehnoloških pomagala značajno smanjuje anksioznost kod dece (15). Povećana preoperativna anksioznost je povezana sa neprijatnim postoperativnim ishodom: pojačan bol, duži oporavak, postoperativna anksioznost. Takođe je povezana sa pojavom noćnog mokrenja i problemom sa spavanjem. Deca koja su bila izložena virtuelnom obilasku stomatološke ordinacije pokazala su niže nivoe preoperativne anksioznosti u poređenju sa kontrolnom grupom. Takođe, kod dece koja su za stomatološke intervencije pripremana putem interaktivnih kompjuterskih igrica ili animiranih filmova, preoperativna anksioznost je značajno smanjena u poređenju sa kontrolnom grupom koja je pripremana samo verbalno. Deca su preoperativno pripremana pre svega za opštu anesteziju uz pomoć virtuelnih slika aparata za opštu anesteziju i samog postupka opšte anestezije (16).

Mobilne aplikacije kao tehnološka pomagala su veoma primenjive u zdravstvu jer pomažu pacijentima da se informišu o zdravlju uopšte i simptomima bolesti, kao i da se kod kuće pripreme za predstojeći pregled i intervenciju. Ovo je posebno pogodno za mlađu populaciju, a pogotovo za decu sa autizmom i teškoćama u učenju i govoru, koja inače provode dosta vremena u virtuelnom svetu koristeći savremena tehnološka pomagala. Sama priprema bi započela osnovnim korišćenjem aplikacija koje se tiču oralnog zdravlja kako bi se deca sa autizmom najpre upoznala sa proizvodima za oralnu higijenu, okruženjem u stomatološkoj ordinaciji i konceptom stomatološkog pregleda. Uz korišćenje mobilnih aplikacija kod kuće, pre posete stomatologu, pacijent se „transportuje“ u virtuelni prostor koji pacijentu daje osećaj da se nalazi u imaginarnoj stomatološkoj čekaonici i ordinaciji. Na ovaj način se stimulišu auditorne i vizuelne senzacije – kod određenog broja pacijenata sa ASD-om vizuelna iskustva se doživljavaju kao prijatna, dok se, sa druge strane, zvuci poput šištanja pumpe, i zujanja kolenjaka i turbine doživljavaju kao uznemirujući. Upoznavanje sa njima putem aplikacije bilo bi značajno u pripremi za predstojeće stomatološke procedure. Takođe, aplikacija praktično prikazuje put od kuće kroz grad do čekaonice i stomatološke ordinacije. To bi pomoglo da se pažnja pacijenta skrene sa osećaja straha od nepoznatog, tako što bi se dete kroz imaginarni sadržaj upoznalo sa tim kako izgledaju stomatološka čekaonica i ordinacija, stomatološka stolica i instrumenti. Na ovaj način se detetu pomaže da se psihički pripremi za nepoznate situacije i da prevaziđe stresne faktore koji su pokretači jakih emocionalnih reakcija i napada besa u ordinaciji. Time bi se poboljšala dostupnost standardne stomatološke nege ovih pacijenata i ostvario njihov puni zdravstveni potencijal, čime se smanjuje verovatnoća da će intervencija biti obavljena u opštoj anesteziji.

Dodatne kliničke studije su potrebne da bi se procenio značaj korišćenja mobilnih aplikacija u pripremi za posete stomatologu i za uspostavljanje direktne komunikacije sa stomatologom. Praktično, to još nije potvrđeno, ali se teoretski može istaći da se mobilne aplikacije mogu koristiti kao alat za prilagođavanje i navikavanje na stomatološke intervencije, kao i za smanjenje anksioznosti i straha od nepoznatog pre i tokom posete stomatologu. Konačno, ovo bi moglo pomoći da se smanji broj poseta, da se savlada tehnika pranja zuba ili da se stomatološka intervencija završi efikasnije.

Zaključak

Mobilne aplikacije su alati koji bi olakšali saradnju dece sa autizmom u ordinaciji, kao i upoznavanje sa intervencijom pre prve posete stomatologu, čime bi se olakšala komunikacija između deteta i roditelja sa stomatologom. Nepostojanje bilo kakve mobilne aplikacije na srpskom jeziku ide u prilog neophodnosti razvoja aplikacije za mlađu decu i decu sa smetnjama u razvoju koja ne koriste engleski jezik.

Mogućnost korišćenja mobilnih aplikacija mogla bi značajno da doprinese saradnji tokom poseta stomatologu osoba sa ASD, poboljšanju rutine oralne higijene i smanjenju straha od

the stressor or anxiety trigger, the pain perception is weaker. Therefore, the optimal distraction of attention could be achieved using a multisensory experience through mobile applications. Mobile applications and games employ hands and fingers during the use of a phone or tablet, and considering that these actions are not appropriate during a dental intervention because the cooperation of the child is necessary, it would be important to consider programming mobile applications so that they are based on the technique of "exposing" the child unknown experiences that he needs to meet and face. Exposure therapy is considered the first choice for many phobias (12). It is based on mitigating the negative effect of stressors through repeated and increased exposure of the patient to situations that cause him anxiety (13). Exposure therapy is adapted for use in the virtual world (known as VRET-Virtual Reality Exposure Therapy) by giving the patient a sense of presence in a virtual space, which is especially suitable for children with autism who normally spend most of the day with technological aids. Using virtual applications activates more senses (sight, hearing, tactile) and thus distracts attention from external sensory triggers. The psychological feeling that results from this is a sense of presence (14).

A review of the literature confirmed that preoperative preparation of patients using technological aids significantly reduces anxiety in children (15). Increased preoperative anxiety is associated with an unpleasant postoperative outcome: increased pain, longer recovery, postoperative anxiety. It is also associated with the occurrence of nocturnal urination and sleep problems. Children exposed to the virtual tour of dental study showed lower levels of preoperative anxiety than the control group. Also, in children who were prepared for dental interventions through interactive computer games or animated films, preoperative anxiety was significantly reduced compared to the control group that was only prepared verbally. Children were pre-operatively prepared primarily for general anesthesia using virtual images of the general anesthesia apparatus and the general anesthesia procedure itself (16).

Mobile applications as a technological aid are very applicable in healthcare since they help patients to be informed about health in general and symptoms of diseases as well to prepare themselves at home for the upcoming examination and intervention. This is particularly suitable for the younger population and especially children with autism and learning and speech difficulties, who normally spend a lot of time in the virtual world using modern technological aids. The preparation itself would begin with the basic use of applications related to oral health so that children with autism would first become familiar with oral hygiene products, the environment in the dental office and the concept of a dental examination. With the use of mobile applications at home, before visiting the dentist, the patient is "transported" to a virtual space that gives the patient feeling of being in an imaginary dental waiting room and office. In this way, auditory and visual sensations are stimulated - For a certain number of patients with ASD, visual experiences are perceived as pleasant while, on the other hand, sounds as the rustling of the pump, the hum of the crank and the turbine are disturbing. Getting familiar with these through the application would be of importance in preparation for oncoming dental procedures. Also, the application shows virtually the path from home through the city to the waiting room and the dental office. This would help to divert the patient's attention from the feeling of fear of the unknown, by introducing the child to the dental waiting room and office, dental chair and instruments through the imaginary content. In this way, the child is helped to be mentally prepared for unknown situations and to overcome stressful factors that are the triggers of strong emotional reactions and temper tantrums in the doctor's office. This would improve the availability of standard dental care of these patients and achieve their full health potential, thus reducing the likelihood that the intervention would be performed under general anesthesia.

Practically, it has not yet been confirmed, but theoretically it can be pointed out that mobile applications can be used as a tool to adapt and get used to dental interventions, as well as to reduce anxiety and fear of the unknown before and during the visit to the dentist. Finally, this could help to reduce the number of visits, to master the technique of teeth brushing or to complete the dental intervention more efficiently. Although confirming that use of applications in dentistry might be helpful, result of the present study should be interpreted carefully. It should be highlighted that subjects had several (at least five) visits to the

nepoznatog tokom stomatoloških tretmana – kako preventivnih, tako i terapijskih.

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dental office which might influence cooperativity since being in an already familiar setting and previous positive experience are confirmed to be supportive for patients with behavioral difficulties. More clinical studies are needed to assess the importance of using mobile apps in preparation for dental visits and for establishing direct communication with dentist.

Conclusion

Mobile applications are the tools that would make easier cooperation of children with ASD in dental office, as well as familiarization with the intervention before their first visit to the dentist, thus facilitating mutual communication between the child and parents with the dentist. The absence of any mobile application in the Serbian language underscores the need for the development of an application tailored for younger children and those with disabilities who do not use the English language. The possibility of using mobile applications could significantly contribute the cooperation during visits to the dentist for persons with ASD, improve their oral hygiene routine, and reduce fear of the unknown during dental treatments - both preventive and therapeutic.

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Competing interests

The authors declared no competing interests.

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