Образац **4.**

Факултет Фармацеутски

УНИВЕРЗИТЕТ У БЕОГРАДУ

01 број 1529/1-2
(Број захтева)

Већу научних области медицинских наука
(Назив већа научне области коме се захтев упућује)

18.06.2026.
(Датум)

З А Х Т Е В

за давање сагласности на одлук**е** о усвајању извештаја Комисије за оцену докторске дисертације и о именовању комисије за одбрану

Молимо да, сходно члану 47. ст. 5. тач. 4. Статута Универзитета у Београду ("Гласник Универзитет", број 186/15-пречишћени текст и 189/16), дате сагласност на одлуку о усвајању извештаја Комисије за оцену докторске дисертације:

КАНДИДАТ **ДУШАН (МИЛАН) ВУКМИРОВИЋ**
(име, име једног од родитеља и презиме)

студент докторских студија на студијском програму ДОКТОРСКЕ АКАДЕМСКЕ СТУДИЈЕ- ФАРМАЦЕУТСКЕ НАУКЕ
пријавио је докторску дисертацију под називом:

„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“

из научне области: ФАРМАЦЕУТСКЕ НАУКЕ

Универзитет је дана 21.10.2025.године својим актом под бр. 02-01 број 61206-3869/2-25 дао сагласност на предлог теме докторске дисертације која је гласила:

„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“

Име и презиме ментора :
1. Др сц. Душанке Крајновић, редовни професор, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)
2. Др сц. Марине Одаловић, редовни професор, Универзитет у Београду – Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)

Комисија за оцену докторске дисертације именована је на седници одржаној 09.04.2026.године одлуком факултета под бр. 01 бр.790/2 **,** у саставу:

Име и презиме члана комисије	звање	научна област	Установа у којој је запослен

1. Др. сц. Драгана Лакић, редовни професор, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)
2. Др. Др сц. Александра Јовић-Вранеш, редовни професор, Универзитет у Београду – Медицински факултет (Ужа научна област: Социјална медицина)
3. Др. сц. Андријана Милошевић Георгиев, доцент, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)

Напомена**:** уколико је члан Комисије у пензији навести датум пензионисања.

Датум стављања извештаја Комисије и докторске дисертације на увид јавности: 14.05.2026.године.

Наставно-научно веће факултета усвојило је извештај Комисије за оцену докторске дисертације наседници одржаној дана 18.06.2026.године.

Комисија за одбрану докторске дисертације именована је на седници одржаној 09.04.2026.године

одлуком факултета под бр. 01 број 790/2, у саставу:

Име и презиме члана комисије	звање	научна област	Установа у којој је запослен

1. Др. сц. Драгана Лакић, редовни професор, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)
2. Др. Др сц. Александра Јовић-Вранеш, редовни професор, Универзитет у Београду – Медицински факултет (Ужа научна област: Социјална медицина)
3. Др. сц. Андријана Милошевић Георгиев, доцент, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)

Напомена: уколико је члан Комисије у пензији навести датум пензионисања.

ДЕКАН ФАКУЛТЕТА

Прилози:
1. Одлука Наставно-научног већа о усвајању извештаја Комисије за оцену докторске дисертације и одлука о именовању Комисије за одбрану докторске дисертације
2. Извештај Комисије о оцени докторске дисертације
3. Примедбе на извештај Комисије о оцени докторске дисертације (уколико их је било) и мишљење Комисије о примедбама

Напомена: Факултет доставља Универзитету захтев са прилозима у електронској форми и у једном писаном примерку за архиву Универзитета

УНИВЕРЗИТЕТ У БЕОГРАДУ
ФАРМАЦЕУТСКИ ФАКУЛТЕТ
11000 - БЕОГРАД
Ул. Војводе Степе 450.
01. број 1529/1
18.06.2026. године

На основу члана 28. Статута и предлога Комисије за последипломске студије – докторске студије, Наставно-научно веће Универзитета у Београду – Фармацеутског факултета на седници одржаној 18.06.2026.године, донело је

О Д Л У К У

ПРИХВАТА СЕ позитиван извештај Комисије за оцену и одбрану завршене докторске дисертације**,** кандидата **маг. фарм. Душана Вукмировића** под насловом: **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“** и упућује Већу научних области медицинских наука на усвајање, а по добијеној писаној сагласности одобрава јавна одбрана пред Комисијом у саставу:

Комисија за оцену и одбрану завршене докторске дисертације у саставу:

1. Др. сц. Драгана Лакић, редовни професор, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)
2. Др. Др сц. Александра Јовић-Вранеш, редовни професор, Универзитет у Београду – Медицински факултет (Ужа научна област: Социјална медицина)
3. Др. сц. Андријана Милошевић Георгиев, доцент, Универзитет у Београду - Фармацеутски факултет (Ужа научна област: Социјална фармација и фармацеутска пракса)

Универзитет је дана 21.10.2025.године својим актом бр.: 02-01 бр: 61206-3869/2-25 дао сагласност на предлог теме докторске дисертације.

Кандидат маг. фарм. Душан Вукмировић, објавио је резултате из ове докторске дисертације у три рада категорије М22 у међународним часописима са СЦИ листе:

1. **Vukmirović D,** Krajnović D, Odalović M. Translation, adaptation and psychometric testing of the Digital Health Technology Literacy Assessment Questionnaire (DHTL-AQ) in the Serbian language. Int J Clin Pharm. 2025 Apr;47(2):365–72
   Категорија: Pharmacology & Pharmacy
   Импакт фактор 2 (2024) = 3,2(126/352)**; М22, Импакт фактор 5 (2024) = 2,7**(176/344); **М22**
2. **Vukmirović D**, Krajnović D, Odalović M. Evaluation of digital health technology literacy among community pharmacists in Serbia. J Am Pharm Assoc. 2026;66(1):102958
   Категорија: Pharmacology & Pharmacy

Импакт фактор 2 (2024) = 2,5 (181/352)**; M22, Импакт фактор 5 (2024) = 2,2** (220/344); **M22**

3. **Vukmirović D**, Krajnović D, Odalović M. Exploring Community Pharmacists' Awareness, Attitudes, and Experiences with Digital Health Technologies: A Focus on Mobile Applications for Diabetes Mellitus Self-Management. Pharmacy. 2026 Mar 2;14(2):39
   Категорија: Pharmacology & Pharmacy
   Импакт фактор 2 (2024) = 1.8 (244/352)**; M22, Импакт фактор 5 (2024) = 2,0** (231/344)**; M22**

Одлуку доставити: кандидату, Универзитету, члановима комисије, декану, секретару, продекану за последипломске студије, менторима (проф др. Душака Крајновић и проф.др. Марина Одаловић), Одсеку за наставу и студентска питања, Одсеку за правне и опште послове, пословном секретару, председнику Комисије за последипломске студије – докторске студије (Проф. др Биљана Антонијевић) и архиви.

ПРЕДСЕДНИК
НАСТАВНО-НАУЧНОГ ВЕЋА
ФАРМАЦЕУТСКОГ
ФАКУЛТЕТА

Проф. др Наташа Богавац Станојевић

НАСТАВНО-НАУЧНОМ ВЕЋУ УНИВЕРЗИТЕТА У БЕОГРАДУ – ФАРМАЦЕУТСКОГ ФАКУЛТЕТА

КОМИСИЈИ ЗА ПОСЛЕДИПЛОМСКУ НАСТАВУ – ДОКТОРСКЕ СТУДИЈЕ

На седници Наставно-научног већа Универзитета у Београду – Фармацеутског факултета, одржаној 09.04.2026. године, одлука број 790/2, именовани су чланови Комисије за оцену и одбрану завршене докторске дисертације кандидата магистра фармације Душана М. Вукмировића, под насловом: **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“**.

Ова докторска теза урађена је под менторством др. сц. Душанке Крајновић, редовни професор, Универзитет у Београду - Фармацеутски факултет (ужа научна област: Социјална фармација и фармацеутска пракса) и др сц. Марине Одаловић, редовни професор, Универзитета у Београду - Фармацеутског факултета (ужа научна област: Социјална фармација и фармацеутска пракса).

Чланови комисије за оцену и одбрану докторске дисертације у саставу:

1. Др. сц. Драгана Лакић, редовни професор, Универзитет у Београду - Фармацеутски факултет (ужа научна област: Социјална фармација и фармацеутска пракса)

2. Др. Др сц. Александра Јовић-Вранеш, редовни професор, Универзитет у Београду – Медицински факултет (ужа научна област: Социјална медицина)

3. Др. сц. Андријана Милошевић Георгиев, доцент, Универзитет у Београду - Фармацеутски факултет (ужа научна област: Социјална фармација и фармацеутска пракса)

Чланови Комисије су прегледали приложену дисертацију и подносе Наставно-научном већу Универзитета у Београду – Фармацеутског факултета следећи извештај:

ИЗВЕШТАЈ

1. ОСНОВНИ ПОДАЦИ О КАНДИДАТУ И ПРИКАЗ САДРЖАЈА ДОКТОРСКЕ ДИСЕРТАЦИЈЕ

Кандидат Душан М. Вукмировић, рођен у Београду 1988. године, дипломирао је на Фармацеутском факултету Универзитета у Београду 2012. године са просечном оценом 9,2. На истом факултету 2014. године завршио је специјалистичке академске студије - Индустријска фармација са просечном оценом 10. Након основних студија завршио је приправнички стаж и положио стручни испит за фармацеуте 2014. године.

Докторске академске студије на програму фармацеутских наука уписао је 2020. године, а научноистраживачки рад обављао је при Катедри за социјалну фармацију и фармацеутско законодавство Фармацеутског факултета Универзитета у Београду.

Докторска дисертација кандидата под насловом: **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“** садржи десет поглавља: 1. Увод, 2. Циљеви, 3. Материјали и методе, 4. Резултати, 5. Дискусија, 6. Закључак, 7. Литература, 8. Прилози, 9. Биографија аутора и 10. Изјаве. Докторска дисертација укључује сажетак на српском и енглеском језику и садржај докторског рада, као и потписане изјаве о ауторству, истоветности штампане и електронске верзије и коришћењу докторске дисертације. Дисертација је написана јасним и прегледним стилом и обухвата 129 страна са 9 слика, 16 табела и 114 литературних навода.

Увод докторске дисертације садржи преглед литературних података о дигитализацији и трансформацији улоге фармацеута у здравственом систему. У оквиру текста представљене су традиционалне и проширене улоге фармацеута, са акцентом на саветовање пацијената, управљање хроничним болестима и интерпрофесионалну сарадњу. Посебно је истакнута примена дигиталних здравствених технологија (ДЗТ), укључујући мобилно здравство, платформе за телефармацију и системе засноване на вештачкој интелигенцији, као и њихов значај током пандемије болести корона вируса 2019 (*COVID-19)*. У засебном делу дат је преглед законодавног оквира апотекарске делатности у Србији, са нагласком на могућности фармацеута да пружају додатне услуге и активно учествују у дигиталној трансформацији здравственог система. Наведен је Национални програм дигитализације здравственог система за период 2022–2026. године, који предвиђа интеграцију апотекарске делатности кроз електронске рецепте, здравствене картоне и централизоване базе података. Посебно поглавље посвећено је здравственој, дигиталној и дигиталној здравственој писмености, уз дефиниције и значај ових концепата за пацијенте и здравствене раднике. Истакнута је потреба за развојем компетенција фармацеута у области дигиталног здравља, као и важност професионалне здравствене писмености у комуникацији са пацијентима. У наставку је описано мерење дигиталне здравствене писмености, са приказом најчешће коришћених инструмената као што је *eHEALS (eHealth Literacy Scale)* скала, као и новијих алата попут *DHTL-AQ* (*Digital Health Technology Literacy Assessment Questionnaire*) упитника, који процењују функционалну и критичку дигиталну писменост. Завршни део увода усмерен је на хроничне незаразне болести, са посебним освртом на дијабетес као представника ове групе. Представљени су подаци Светске здравствене организације о учесталости и последицама дијабетеса, факторима ризика и јавноздравственом значају болести. Циљеви докторске дисертације постављени су у односу на претходно публиковане резултате и потенцијални допринос фармацеута у пружању фармацеутских услуга и саветовања подржаног дигиталним здравственим технологијама (хипотеза истраживања).

Циљеви истраживања су јасно дефинисани и подељени на четири целине:

1. Превод, културолошка валидација и психометријско тестирање српске верзије скале за процену писмености у области употребе дигиталних здравствених технологија (*DHTL-AQ*).

2. Процена писмености у области употребе дигиталних здравствених технологија - *Digital Health Technology Literacy* (*DHTL*) код фармацеута у јавним апотекама у Републици Србији, употребом валидираног упитника са задовољавајућим психометријским карактеристикама.

3. Испитивање ставова и искустава фармацеута у јавним апотекама у Републици Србији у вези са ДЗТ.

4. Испитивање ставова и искустава фармацеута у јавним апотекама у Републици Србији у вези са употребом мобилних апликација које могу користити пацијенти оболели од дијабетеса.

У поглављу **Материјали и методе** описане су фазе истраживања у складу са постављеним циљевима. Детаљно су приказани поступци превођења и културолошке адаптације инструмента, формирање узорка, дизајн и спровођење истраживања, као и статистичка и психометријска анализа добијених података.

Прво истраживање обухватило је превод и културолошку валидацију српске верзије скале *DHTL-AQ*. За коришћење оригиналне верзије упитника обезбеђена је сагласност аутора (*Yoon J.* и сар.). Описани су кораци превода, повратног превода и консензус истраживача, као и пилот-тестирање међу фармацеутима ради провере разумљивости питања. Дефинисана је величина узорка за психометријско тестирање, а спроведене су анализе поузданости и валидности инструмента, укључујући *Cronbach α*, *split-half* тест, тест-ретест и експлораторну факторску анализу. Наведене су и мере за очување анонимности учесника, као и етички аспекти добровољног учешћа.

Друго истраживање било је студија пресека усмерена на процену писмености фармацеута у области употребе дигиталних здравствених технологија. Примењена је валидирана српска верзија *DHTL-AQ* скале и додатни упитник, са секцијама које обухватају социо-демографске податке, перцепцију дигиталног здравља и општу дигиталну писменост испитаника. Описан је процес креирања упитника на основу литературе и консензуса истраживача, као и начин прикупљања података у онлајн и папирној форми.

Треће истраживање фокусирало се на ставове и искуства фармацеута у вези са дигиталним здравственим технологијама и употребом мобилних апликација код пацијената са дијабетесом. Упитник је садржао посебну секцију са 26 питања, усмерених на информисаност, ставове и праксу фармацеута у раду са овом популацијом пацијената.

Описан је поступак развоја питања, њихова прилагођеност циљној групи и начин анализе добијених одговора.

Истраживања су спроведена међу фармацеутима запосленим у јавним апотекама у Србији, уз примену онлајн и папирних верзија упитника.

Резултати докторске дисертације су прегледно груписани у три главне целине у односу на три научно-истраживачке студије, које прате претходно описане фазе. У овом поглављу су на свеобухватан и јасан начин текстуално и графички приказани оригинални резултати, док је у поглављу **Дискусија** обухваћена анализа и разматрање добијених резултата са критичким осврtом на резултате сличних истраживања. Истакнуте су предности и ограничења свих спроведених истраживања.

Закључак приложене докторске дисертације садржи наведене основне закључке у вези са резултатима истраживања, и у складу са претходно дефинисаним циљевима.

Литература обухвата списак референци (114) које су коришћене у оквиру приложене докторске дисертације.

Поглавље **Прилози** обухвата осам делова, Прилог 1: Листа скраћеница и ознака, Прилог 2: Скала коришћена у пилот фази истраживања, Прилог 3: Скала коришћена у фази психометријске валидације, Прилог 4: Коначна верзија упитника примењена у II и III фази истраживања, Прилог 5: ROC криве српске верзије упитника *DHTL-AQ* за различите перцентилне граничне вредности, Прилог 6: Списак табела, Прилог 7. Списак слика, Прилог 8. Објављени радови који чине саставни део докторске дисертације. **Биографија аутора** садржи кратку биографију кандидата. Поглавље **Изјаве** садржи изјаве о ауторству, истоветности штампане и електронске верзије и коришћењу докторске дисертације.

1.1. Одлуке Етичке Комисије Факултета и остале неопходне етичке одлуке

Истраживање је реализовано у складу са важећим етичким принципима и стандардима истраживања у области биомедицинских наука. Ниједна од истраживачких студија није укључивала пацијенте нити биолошки материјал пацијената (Изјава ментора од 16.03.2026).

Сва наведена истраживања су одобрена од стране Етичког комитета за биомедицинска истраживања Фармацеутског факултета Универзитета у Београду (одобрење број 355/1, од 07. фебруара 2023. године). Сви испитаници су добровољно дали пристанак да учествују у истраживању и да се прикупљени подаци могу користити у научно-истраживачке сврхе, за анализу и публиковање резултата.

2. ОПИС ПОСТИГНУТИХ РЕЗУЛТАТА

Први циљ

У првој фази истраживања спроведен је превод, културолошка адаптација и психометријско тестирање српске верзије скале *DHTL-AQ*. Превод је извршен уз очување изворног значења и јасноће формулација, а у процесу адаптације уведена је додатна опција одговора „немам искуства“, чиме је постигнута већа прецизност и функционалност инструмента. Пилот-тестирање на узорку од 22 фармацеута показало је да су питања углавном разумљива, уз потребу за мањим изменама у формулацији питања 3 и 4 ради јаснијег тумачења. Психометријска анализа спроведена на узорку од 162 испитаника показала је добру унутрашњу конзистентност и поузданост скале. Уочено је да потпитања у оквиру питања 2, која су се односила на ИКТ иконе, имају ниску корелацију са осталим ставкама и негативно утичу на поузданост инструмента, па су изостављена из финалне верзије. Редукцијом скале са 34 на 25 ставки вредност *Cronbach α* је повећана са 0,798 на 0,822, што је потврдило побољшање поузданости. Тест-ретест анализа показала је висок степен временске стабилности (*ICC* = 0,981), док су факторска анализа и ротација идентификовале три фактора који заједно објашњавају 52% варијабилности података. Први фактор односи се на употребу дигиталних здравствених апликација, други на проналажење поузданих здравствених информација на интернету, а трећи на техничку компетентност у подешавању апликација. Коначна српска верзија *DHTL-AQ* садржи 5 питања са 25 ставки и показала је задовољавајуће психометријске карактеристике, што је потврђено кроз све спроведене анализе.

Други циљ

У другој фази истраживања процењивана је дигитална писменост фармацеута у јавним апотекама у Србији применом валидиране српске верзије *DHTL-AQ* скале. Минимална величина узорка, одређена са нивоом поузданости од 95% и маргином грешке од 5% на основу укупног броја фармацеута запослених у јавним апотекама, износила је 365 учесника. Укупно је прикупљено 368 валидних одговора, при чему су испитаници имали просечно радно искуство од 13,9 година, а већину узорка чиниле су жене. Резултати су показали да је већина фармацеута припадала категорији средњег нивоа дигиталне писмености (68,8%), док је 15,2% имало низак, а 16,0% висок ниво. *ROC* анализе потврдиле су добру дискриминативну способност упитника, при чему је гранична вредност на 16. перцентилу показала најбољу равнотежу осетљивости и специфичности. Уочене су статистички значајне разлике између група са различитим нивоима дигиталне писмености. Испитаници са ниским нивоом имали су најдуже радно искуство и најчешће нису препознавали дефиницију е-Здравства, док су они са високим нивоом показали најбоље резултате у препознавању појмова и укупном резултату на скали. Додатна анализа указала је на различите обрасце коришћења друштвених мрежа. Већина фармацеута користила је друштвене мреже у приватном животу, док је професионална употреба била ограничена. Најчешће коришћена платформа у професионалном контексту био је *Viber*, док су *Facebook*, *Instagram* и *YouTube* били знатно ређе присутни. *LinkedIn* је имао ниску заступљеност, а *Twitter*/*X* и *TikTok* готово да нису коришћени. У погледу сврхе

професионалне употребе друштвених мрежа, најчешће је навођено повезивање са другим фармацеутима, праћење актуелних здравствених информација и континуирана медицинска едукација. Мањи део испитаника користио је мреже за комуникацију са пацијентима. Резултати *DHTL-AQ* упитника показали су јасне разлике између група: испитаници са ниским нивоом најчешће су наводили да немају искуства у коришћењу дигиталних здравствених технологија, док су они са високим нивоом показали висок степен компетентности и самосталности у свим доменима скале.

Трећи и четврти циљ

У трећој фази истраживања испитани су ставови и искуства фармацеута у јавним апотекама у Србији у вези са применом дигиталних здравствених технологија, као и специфично у вези са употребом мобилних апликација које могу користити пацијенти оболели од дијабетеса. Узорком је обухваћено 368 фармацеута, већином запослених у приватним апотекама (76,4%) и у урбаним срединама (63,3%). Резултати су показали да већина фармацеута није информисана о постојању мобилних апликација за подршку здравом начину живота (77,2%) нити о апликацијама за самоуправљање болешћу и терапијом (84,2%). Информисаност је била значајно повезана са нивоом дигиталне писмености: фармацеути са високим нивоом *DHTL* чешће су пријављивали да познају овакве апликације (70,1%), док су фармацеути са ниским нивоом *DHTL* најчешће били неинформисани (83,3%). У погледу ставова о пацијентима, већина фармацеута сматрала је да пацијенти са дијабетесом показују интересовање за коришћење мобилних апликација (89,4%), али да је оно углавном делимично (43,5%) или ретко (36,1%). Само мали број фармацеута (око 5%) навео је да активно пружа подршку пацијентима у употреби ових апликација, при чему су у тој групи доминирали фармацеути са високим нивоом *DHTL*. Фармацеути су у значајном проценту препознали корисност познавања мобилних апликација у раду са пацијентима – 58,4% је оценило да је то знање често или скоро увек корисно. Већина испитаника сматрала је да би фармацеути требало да имају активну улогу у саветовању и едукацији пацијената (70–78%), као и да је потребно додатно усавршавање у области дигиталних здравствених технологија (87,5% за опште алате; 89,7% за апликације за дијабетес). У погледу начина едукације, фармацеути са ниским нивоом *DHTL* чешће су преферирали едукацију уживо (49,7%), док су фармацеути са високим нивоом *DHTL* више бирали онлајн едукацију у реалном времену (50,7%) или самостално учење (52,8%). Као најчешћи начин информисања о новим технологијама навођена је електронска пошта (52,2%), уз уочене разлике у односу на ниво дигиталне писмености. Велика већина фармацеута (92,1%) сматрала је да би званичне препоруке у вези са мобилним апликацијама за дијабетес биле корисне у свакодневном раду.

3. УПОРЕДНА АНАЛИЗА РЕЗУЛТАТА ДИСЕРТАЦИЈЕ СА ПОДАЦИМА ИЗ ЛИТЕРАТУРЕ

Први циљ

Резултати прве фазе истраживања показали су да је српска верзија *DHTL-AQ* скале валидан и поуздан инструмент за процену дигиталне здравствене писмености међу фармацеутима у јавним апотекама. Процес превода и културолошке адаптације спроведен је у складу са међународним препорукама, уз очувану семантичку и концептуалну еквиваленцију са оригиналном верзијом, што је у складу са стандардима који се препоручују у литератури за адаптацију психометријских инструмената (1). Пилот-тестирање је потврдило разумљивост и прихватљивост упитника у циљној популацији, што указује да су спроведене измене допринеле функционалности и методолошкој робусности српске верзије упитника (2).

Психометријска анализа показала је добру унутрашњу поузданост и временску стабилност инструмента, уз висок степен сагласности између поновљених мерења. Ови налази су у складу са литературом која истиче значај тест-ретест анализе и интра-класа корелације као показатеља поузданости инструмената за процену дигиталних компетенција. Добијени резултати потврђују да је упитник погодан за примену у истраживањима која подразумевају поновљена мерења, као и у евалуацији ефеката образовних и професионалних интервенција усмерених на унапређење дигиталне здравствене писмености.

Факторска анализа је идентификовала три фактора, што представља одступање у односу на оригиналну верзију инструмента која је предвиђала четири фактора. Овај налаз је у складу са подацима из литературе који указују да адаптација инструмената у различитим културолошким контекстима често доводи до редукције или прегруписавања ставки, посебно када су основне дигиталне вештине већ широко усвојене (3). У литератури се истиче да брз развој мобилних апликација и дигиталних интерфејса доводи до смањења дискриминативне вредности основних ИКТ симбола, што је потврђено и у овом истраживању (4–6).

Посебан допринос дисертације огледа се у чињеници да је ово први покушај превода и психометријске валидације *DHTL-AQ* на српски језик и у популацији фармацеута. У литератури нису идентификоване сличне студије у региону, што резултате чини значајним за даљи развој и примену инструмента. Ови налази подржавају препоруке међународних организација да се развијају и валидирају локално прилагођени инструменти за процену дигиталних компетенција здравствених радника, како би се обезбедила њихова адекватна припрема за нове професионалне улоге у дигиталној ери (7).

Ограничења истраживања, као што су примена инструмента у ограниченом обиму и усмереност искључиво на фармацеуте у јавним апотекама, у складу су са налазима других студија које наглашавају потребу за ширим компаративним истраживањима и применом инструмента у различитим групама здравствених радника. У литератури се истиче да је перспектива здравствених радника у погледу употребе дигиталних здравствених

апликација још увек недовољно истражена, што додатно наглашава потребу за систематским испитивањем овог питања и развојем циљаних образовних интервенција усмерених на јачање дигиталних компетенција (8).

Други циљ

Резултати друге фазе истраживања показали су да примена валидираног упитника *DHTL-AQ* омогућава систематску процену дигиталне здравствене писмености фармацеута у јавним апотекама у Србији. Ово представља први покушај такве процене у домаћем контексту, заснован на психометријски провереном инструменту, што је у складу са препорукама из литературе о потреби развоја и примене валидних алата за процену дигиталних компетенција здравствених радника (9).

Класификација фармацеута према различитим *DHTL* профилима показала је да већина испитаника припада категоријама средњег или високог нивоа дигиталне писмености, што указује на релативно повољну спремност за примену дигиталних алата у фармацеутској пракси. Ови налази су у складу са резултатима истраживања спроведеног у Енглеској, где је такође утврђен висок ниво дигиталне писмености међу запосленима у апотекарској делатности (10). Ипак, удео фармацеута са ниским нивоом *DHTL* (35,9%) био је значајно већи у односу на уделе са ниским нивоом опште дигиталне писмености (19,6%), што потврђује да опште дигиталне компетенције не подразумевају нужно и специфична знања и вештине неопходне за примену ДЗТ. Овај налаз је у складу са подацима који указују да је дигитална компетентност уопштено изражења код млађих генерација, али да постоје ограничења у специфичним знањима потребним за професионалну примену (11).

Радно искуство се издвојило као значајан фактор повезан са нивоом *DHTL*: фармацеути са краћим стажом постизали су више резултате, што је у складу са претходним истраживањима која показују да млађи фармацеути постижу више нивое дигиталне писмености (10). Са друге стране, није утврђена статистички значајна повезаност са полом, типом апотеке, нивоом образовања или географском локацијом, што указује да ове карактеристике нису имале утицај на резултате у испитиваној популацији.

Један од значајних налаза односи се на професионалну употребу друштвених мрежа: 41,3% фармацеута навело је да их уопште не користи у професионалне сврхе. Међу онима који их користе, најчешће су навођене платформе *Facebook*, *YouTube* и *Instagram*, што је у складу са међународним истраживањима, док је *Viber* био посебно заступљен у Србији, што одражава локалне комуникационе навике. Ови резултати указују на потенцијал друштвених мрежа као допунског канала за професионалну комуникацију и континуирану едукацију фармацеута.

Добијени налази показали су да фармацеути добро познају основне дигиталне термине, али да постоји простор за унапређење у познавању новијих технологија као што су „гласовни помоћници“ и „носиви уређаји“. Ограничено познавање ових технологија има

посебан значај с обзиром на њихову све већу примену у здравству, што је у складу са подацима из литературе о растућој употреби носивих уређаја и алата заснованих на вештачкој интелигенцији (12–14).

Ограничења студије, као што су самопроцена испитаника и дистрибуција упитника у онлајн и папирној форми, у складу су са налазима других истраживања која указују на потребу за лонгитудиналним и интервенционим студијама ради бољег разумевања узрочно-последичних односа у развоју дигиталних компетенција (97–99). Упркос овим ограничењима, резултати пружају вредне информације о дигиталним компетенцијама фармацеута и представљају основу за дизајнирање циљаних програма обуке.

Трећи и четврти циљ

Резултати треће фазе истраживања, која је обухватила трећи и четврти циљ, показали су ставове и искуства фармацеута у јавним апотекама у Србији у вези са применом дигиталних здравствених технологија уопште, као и специфично у вези са употребом мобилних апликација које могу користити пацијенти оболели од дијабетеса.

У погледу општих дигиталних здравствених технологија (циљ 3), налази указују на ограничену информисаност фармацеута, што је у складу са подацима из литературе који показују да недовољан ниво дигиталне писмености може довести до смањене ефикасности интервенција и лошијих здравствених исхода (17–21). У извештају *FIP*-а из 2025. године наглашена је кључна улога фармацеута у усмеравању пацијената кроз употребу дигиталних алата, али и изражене разлике у степену спремности фармацеутске радне снаге на глобалном нивоу (22). Ови налази потврђују да ограничено познавање дигиталних технологија може представљати препреку пуној интеграцији у фармацеутску праксу.

Када је реч о мобилним апликацијама за пацијенте са дијабетесом (циљ 4), резултати показују да већина фармацеута није била упозната са њиховим постојањем, док је информисаност била нешто већа у односу на апликације за промоцију здравих стилова живота. Ови налази су у складу са студијом спроведеном у Саудијској Арабији, где је утврђен низак ниво информисаности о м-Здравство апликацијама, упркос позитивним ставовима према њиховој употреби (23). Систематски прегледи литературе потврђују да примена мобилних апликација у пракси остаје ограничена факторима као што су недовољна информисаност и нижи ниво дигиталне писмености (24,25).

Резултати студије показали су да интернет претрага представља најчешћи извор информисања међу фармацеутима са високим нивоом *DHTL*, док су програми континуиране медицинске едукације и размена искустава са колегама били доминантни канали информисања у целокупном узорку. Ови налази су у складу са претходним истраживањима која показују да су формализовани и стручно посредовани канали и даље главни извори информација за фармацеуте.

Већина фармацеута сматрала је да пацијенти са дијабетесом показују одређени степен интересовања за коришћење мобилних апликација, али да је оно углавном делимично. Ови ставови су у складу са налазима других студија које показују да фармацеути препознају потенцијал м-Здравство алата, али да је њихово практично искуство често ограничено (23). Истовремено, мали број фармацеута навео је да је имао формалну обуку у области дигиталних технологија, што је у складу са извештајем *FIP*-а који наглашава потребу за систематским јачањем дигиталних компетенција кроз образовање и КМЕ (22).

Висок проценат фармацеута изразио је потребу за додатном едукацијом, а већина је подржала развој званичних смерница за употребу мобилних апликација. Ови налази су у складу са међународним трендовима који указују на глобалну потребу за структуираном дигиталном едукацијом и интеграционим стратегијама у фармацеутској пракси (10,26–28). При томе, преференције у формату едукације варирале су у зависности од нивоа дигиталне писмености: фармацеути са нижим *DHTL* преферирали су обуке у присуству предавача, док су они са вишим нивоом *DHTL* показивали веће интересовање за самостално усвајање знања кроз модуларне програме и онлајн ресурсе. Ови налази одражавају утицај дигиталних компетенција на самопоуздање у технолошки посредованом учењу, што је у складу са претходним истраживањима у области здравствене едукације (26–28).

У целини, трећа фаза истраживања показала је да фармацеути препознају значај дигиталних здравствених технологија и мобилних апликација за дијабетес, али да је њихова информисаност и практично искуство ограничено. Ови налази потврђују потребу за систематским унапређењем дигиталне писмености кроз формално образовање, континуирану професионалну едукацију и развој смерница заснованих на доказима, како би фармацеути могли пружати безбедну и ефикасну подршку пацијентима у дигиталној ери.

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4. ОБЈАВЉЕНИ РЕЗУЛТАТИ КОЈИ ЧИНЕ САСТАВНИ ДЕО ДИСЕРТАЦИЈЕ

Радови објављени у међународним часописима категорије М22:

i. ***Vukmirović D,*** *Krajnović D, Odalović M. Translation, adaptation and psychometric testing of the Digital Health Technology Literacy Assessment Questionnaire (DHTL-AQ) in the Serbian language. Int J Clin Pharm. 2025 Apr;47(2):365–72*

Назив часописа: *International Journal of Clinical Pharmacy*
Категорија: *Pharmacology & Pharmacy*
Импакт фактор 2 (2024) = 3,2(126/352)**; М22, Импакт фактор 5 (2024) = 2,7**(176/344); **М22**

ii. ***Vukmirović D****, Krajnović D, Odalović M. Evaluation of digital health technology literacy among community pharmacists in Serbia. J Am Pharm Assoc. 2026;66(1):102958*

Назив часописа: *Journal of the American Pharmacists Association*
Категорија: *Pharmacology & Pharmacy*
Импакт фактор 2 (2024) = 2,5 (181/352)**; М22, Импакт фактор 5 (2024) = 2,2** (220/344); **М22**

iii. ***Vukmirović D****, Krajnović D, Odalović M. Exploring Community Pharmacists' Awareness, Attitudes, and Experiences with Digital Health Technologies: A Focus on Mobile Applications for Diabetes Mellitus Self-Management. Pharmacy. 2026 Mar 2;14(2):39*

Назив часописа: *Pharmacy*
Категорија: *Pharmacology & Pharmacy*
Импакт фактор 2 (2024) = 1.8 (244/352)**; М22,Импакт фактор 5 (2024) = 2,0** (231/344)**; М22**

5. ЗАКЉУЧАК - ОБРАЗЛОЖЕЊЕ НАУЧНОГ ДОПРИНОСА ДОКТОРСКЕ ДИСЕРТАЦИЈЕ

На основу спроведених истраживања и добијених резултата, чланови Комисије закључују да дисертација представља значајан научни допринос у области дигитализације фармацеутске праксе и процене дигиталне здравствене писмености фармацеута у јавним апотекама у Републици Србији. Резултати све три фазе истраживања пружају свеобухватан увид у дигиталне компетенције фармацеута, као и у њихова знања, ставове и искуства у вези са применом дигиталних здравствених технологија и мобилних апликација.

Преведена и културолошки адаптирана верзија *DHTL-AQ* скале показала је адекватне психометријске карактеристике, чиме је потврђена њена поузданост и валидност за процену писмености у области дигиталних здравствених технологија. Овај инструмент

омогућава систематско праћење нивоа дигиталних компетенција фармацеута и може служити као основа за планирање циљаних образовних и тренинг програма. Процена нивоа и домена дигиталне здравствене писмености показала је да фармацеути генерално поседују задовољавајући ниво опште дигиталне писмености, док је специфична писменост хетерогена и у одређеним доменима недовољна. Радно искуство и претходна изложеност дигиталним алатима издвојили су се као значајни фактори повезани са нивоом компетенција, а уочене слабости, посебно у доменима који захтевају практичну примену знања, указују на потребу за структурисаном и циљаном едукацијом.

Анализа ставова и искустава фармацеута истакла је да, иако постоји свест о потенцијалној вредности мобилних здравствених апликација у подршци пацијентима са дијабетесом, њихова употреба и обука остају ограничени. Фармацеути су исказали значајну потребу за додатним образовањем, смерницама и подршком у примени дигиталних технологија намењених пацијентима са хроничним болестима. Образовни програми би требало да буду прилагођени нивоу дигиталних компетенција фармацеута, уз комбинацију модула самосталног темпа учења и приступа информацијама путем е-поште, како би се обезбедила већа доступност и ефикасност усвајања знања.

Свеобухватно, дисертација доприноси развоју научних и практичних основа за унапређење дигиталних компетенција фармацеута, формулисање препорука за креирање професионалних стандарда и интеграцију дигиталних алата у свакодневну фармацеутску праксу. Ови резултати представљају темељ за даљи развој фармацеутских услуга и националних стратегија дигиталног здравља, што је од кључног значаја за одговарање на променљива очекивања здравствених система у дигиталној ери и за обезбеђивање квалитетне, безбедне и фармацеутске здравствене заштите усмерене на пацијента.

6. ПРОВЕРА ОРИГИНАЛНОСТИ ДОКТОРСКЕ ДИСЕРТАЦИЈЕ

На основу извештаја од 29.04.2026. године о провери оригиналности докторске дисертације Душана М. Вукмировића, под насловом: **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“,** коришћењем програма *iThenticate* регистровано **подударање текста износи 5%.** Овај степен подударности последица је претходно публикованих резултата истраживања докторанда, цитата, личних имена, општих места и података, што је у складу са чланом 9. Правилника о поступку провере оригиналности докторских дисертација које се бране на Универзитету у Београду.

На основу свега изнетог, а у складу са чланом 8. став 2. наведеног Правилника, **изјављујемо да извештај указује на оригиналност докторске дисертације, те се прописани поступак припреме за њену одбрану може наставити.**

7. ПРЕДЛОГ КОМИСИЈЕ ЗА ОЦЕНУ ЗАВРШЕНЕ ДОКТОРСКЕ ДИСЕРТАЦИЈЕ

На основу изложеног, Комисија закључује да докторска дисертација кандидата магистра фармације Душана М. Вукмировића чија је израда одобрена на седници Већа научних области медицинских наука Универзитет у Београду (Одлука бр 61206-3869/2-25 од 21.10.2025. године) урађена према одобреној пријави. Кандидат је успешно реализовао постављене циљеве истраживања, а резултати приказани у овој докторској дисертацији представљају оригинално и самостално научно дело са значајним научним доприносом у области социјалне фармације и фармацеутске праксе. Резултати докторске дисертације су публиковани у **три рада у међународним часописима категорије М22.**

Комисија у наведеном саставу позитивно оцењује докторску дисертацију магистра фармације Душана М. Вукмировића под насловом: **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом“** и предлаже Наставно-научном већу Фармацеутског факултета, Универзитета у Београду да прихвати овај Извештај о израђеној докторској дисертацији и упути га Већу научних области медицинских наука ради добијања сагласности за јавну одбрану докторске дисертације.

30.04. 2026**.**

Комисија за оцену и одбрану докторске дисертације:

_____

Др сц. Драгана Лакић, редовни професор
Универзитет у Београду - Фармацеутски факултет

_____

Др сц. Александра Јовић-Вранеш, редовни професор
Универзитет у Београду - Медицински факултет

_____

Др сц. Андријана Милошевић Георгиев, доцент
Универзитет у Београду - Фармацеутски факултет

УНИВЕРЗИТЕТ У БЕОГРАДУ – ФАРМАЦЕУТСКИ ФАКУЛТЕТ

ИЗЈАВА МЕНТОРА

Истраживање спроведене у оквиру докторске дисертације кандидата магистра фармација Душана М. Вукмировић под називом **„Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом “** није рађено у здравственој установи са пацијентима, нити са биолошким материјалом.

У Београду,
16.03.2026.

Студент докторских студија

_____
магистра фармације Душан Вукмировић

Ментори:

_____
Др сц. Марина Одаловић, редовни професор,

Универзитет у Београду - Фармацеутски факултет

_____
Др сц. Душанка Крајновић, редовни професор,

Универзитет у Београду - Фармацеутски факултет

ОЦЕНА ИЗВЕШТАЈА О ПРОВЕРИ ОРИГИНАЛНОСТИ ДОКТОРСКЕ ДИСЕРТАЦИЈЕ

На основу Правилника о поступку провере оригиналности докторских дисертација које се бране на Универзитету у Београду и налаза у извештају из програма iThenticate којим је извршена провера оригиналности докторске дисертације ,, **Ставови, искуства и писменост фармацеута у области употребе дигиталних здравствених технологија са фокусом на мобилне апликације за пацијенте са дијабетесом**", аутора магистра фармације Душана М. Вукмировића, констатујемо да утврђено подударање текста износи **5%**. Овај степен подударности последица је претходно публикованих резултата истраживања докторанда, цитата, личних имена, општих места и података, што је у складу са чланом 9. Правилника.

На основу свега изнетог, а у складу са чланом 8. став 2. Правилника о поступку провере оригиналности докторских дисертација које се бране на Универзитету у Београду, изјављујемо да извештај указује на оригиналност докторске дисертације, те се прописани поступак припреме за њену одбрану може наставити.

30. април 2026. године

Ментори:

_____

Проф. др Душанка Крајновић

_____

Проф. др Марина Одаловић

УНИВЕРЗИТЕТ У БЕОГРАДУ
ФАРМАЦЕУТСКИ ФАКУЛТЕТ
Војводе Степе 450
11000 Београд
Бр. 3551/1
Датум: 7.2.2023.

На основу члана 19. Правилника о раду Етичког комитета за биомедицинска истраживања Фармацеутског факултета у Београду, Етички комитет за биомедицинска истраживања Фармацеутског факултета у Београду на седници одржаној 3.2.2023. године, донео је

О Д Л У К У

ДАЈЕ СЕ САГЛАСНОСТ за спровођење истраживања магистра фармације Вукмировић Душана, под називом: "Истраживање знања, ставова и искустава фармацеута у апотекама о дигиталним здравственим технологијама са посебним фокусом на мобилне апликације за пацијенте са дијабетесом", у циљу израде докторске дисертације.
Молбу за давање сагласности поднеле су проф. др Душанка Крајновић и проф. др Марина Одаловић, са Катедре за социјалну фармацију и истраживање фармацеутске праксе са Универзитета у Београду - Фармацеутског факултета.

Одлуку доставити: подносиоцима захтева, именованом, председнику Комитета, секретару, шефу Одсека за правне и опште послове, Одсеку за наставу и студентска питања и Архиви.

ПРЕДСЕДНИК ЕТИЧКОГ КОМИТЕТА
ЗА БИОМЕДИЦИНСКА ИСТРАЖИВАЊА
Проф. др Иван Станковић

pharmacy

MDPI

Article

Exploring Community Pharmacists' Awareness, Attitudes, and Experiences with Digital Health Technologies: A Focus on Mobile Applications for Diabetes Mellitus Self-Management

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Abstract

Diabetes mellitus is a growing global health challenge, and digital health technologies offer new opportunities to support self-management. Mobile applications can benefit both patients and healthcare professionals; however, awareness and integration of these tools into community pharmacy practice remain limited. As accessible frontline providers, pharmacists are well positioned to promote digital health, yet their readiness and engagement require further investigation. A cross-sectional survey was conducted among community pharmacists in Serbia using a structured questionnaire. Developed through a consensus-based process, the instrument assessed pharmacists' awareness, attitudes, and experiences with digital health technologies, focusing on mobile applications for diabetes self-management. Only 15.8% of pharmacists were aware of such applications, and 2.4% reported receiving relevant training. Higher digital health technology literacy was associated with greater awareness, confidence, and preference for digital learning. Most participants supported expanding pharmacists' roles in advising patients on digital tools and expressed interest in structured education and official guidance. These findings indicate limited awareness and training in mobile health applications among community pharmacists. Enhancing digital competencies through targeted education and structured guidance may facilitate greater integration of digital tools into routine pharmacy practice and strengthen pharmacists' roles in chronic disease management.

Keywords: digital health technology literacy; mobile health applications; continuing professional development; chronic disease management; pharmaceutical care

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1. Introduction

Chronic non-communicable diseases (NCDs) remain the leading cause of mortality and morbidity globally. Among them, diabetes mellitus (DM) is a major public health concern, affecting over 500 million people worldwide, and contributing to more than 2 million deaths annually [1]. Its rising incidence has led many to label it a modern preventable pandemic due to its widespread and persistent nature [2].

The rapid advancement of digital technologies in recent years has opened new avenues for the prevention, monitoring, and management of NCDs. One notable area of growth is the development of mobile and software applications designed specifically to support self-management of diabetes by patients and aid healthcare professionals (HCPs) in clinical decision-making [3].

As pharmacy practice evolves, pharmacists are increasingly expected to become "digital pharmacists", capable of leveraging digital tools and technologies to enhance patient care. This transformation requires expanded digital literacy, updated education, and infrastructural support to fully realize the potential benefits of digital health [4,5]. This perspective aligns with the International Pharmaceutical Federation (FIP), which identifies digital health competence as a core requirement for the future pharmaceutical workforce and emphasizes the need for systematic integration of digital technologies into pharmacy education and practice [6,7].

In Serbia, continuing professional development (CPD) is a legal requirement for pharmacists employed in the healthcare sector (community and hospital pharmacies), regulated by national legislation and overseen by the Pharmaceutical Chamber of Serbia. The National Competency Framework for community pharmacists provides a professional reference for competency development and recognizes the use of information technologies and digital tools in pharmacy practice [8]. While digital health competencies are not explicitly mandated within CPD, elements of healthcare digitalization, such as electronic prescribing, electronic health records, and pharmacy information systems, are included in selected training programs. Structured training specifically focused on broader digital health solutions remains limited.

A consensus report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) classifies diabetes-related digital health applications into three broad categories: those designed for general health and wellness monitoring, those functioning as standalone medical devices, and those that interface with data from medical devices to support diabetes care [9].

These tools offer potential benefits in improving glycemic control, medication adherence, and lifestyle modification. The report also emphasizes that HCPs should be aware of both the benefits and limitations of such technologies and actively guide patients in their proper use [9]. Recent research reinforces this call, noting that as digital tools become more sophisticated and widely adopted, HCPs require clearer guidelines and training to effectively incorporate them into routine practice [10]. This is particularly important in community settings, where frontline providers can play a key role in bridging the digital divide. Global professional bodies, including FIP, similarly stress the responsibility of pharmacists to support patients in navigating digital health tools in a safe, effective, and patient-centered manner [11].

Community pharmacists, due to their high accessibility and frequent patient contact, are strategically positioned to promote digital health literacy and support the use of digital tools for diabetes care. Studies show that pharmacists recognize the potential of digital platforms, such as electronic health records, teleconsultations, and mobile applications, to enhance patient engagement and outcomes, especially in underserved areas [10,12]. However, they also face challenges, including inadequate digital infrastructure, data privacy concerns, and a lack of specialized training [12–14].

While pharmacist-led digital interventions have shown promise in improving diabetes outcomes, few studies have explored community pharmacists' awareness, attitudes, and practical experiences with mobile applications tailored for diabetes self-management. A recent systematic review of healthcare professionals' perceptions, including those of pharmacists, on marketed mobile applications for type 2 diabetes self-management, highlighted generally positive attitudes but also identified significant gaps in awareness and confidence, particularly among community pharmacists [15]. For instance, one of the studies included found that only 56% of community pharmacists were aware of health apps, and of those, 60% recommended them to patients.

Moreover, a separate systematic review of pharmacist-led digital health interventions, including mobile applications, confirmed measurable benefits in glycemic control and medication adherence, underlining the clinical value of these tools when effectively implemented [16].

Although much of the existing literature originates from high-income countries with well-established digital infrastructures, Serbia, like many low and middle-income nations, offers a valuable lens through which to explore both the opportunities and challenges faced by community pharmacists in engaging with digital health tools. Insights from this context not only address a national evidence gap but also contribute transferable lessons for other countries navigating similar digital transitions in primary care settings.

The aim of this study is to evaluate the awareness, attitudes, and experiences of community pharmacists in Serbia concerning digital health technologies, with a particular emphasis on the use of mobile applications for the self-management of DM.

2. Materials and Methods

The study employed a structured questionnaire developed following an extensive literature review and preliminary exploratory work [15,17].

The first section collected sociodemographic and professional characteristics of the participants (7 items). The second section included the Serbian version of the Digital Health Technology Literacy–Assessment Questionnaire (DHTL-AQ), comprising 5 items, which has previously undergone full psychometric validation for use among pharmacists [18]. In the present study, the DHTL-AQ was used to stratify respondents according to their level of digital health technology literacy. Analyses of DHTL group characteristics and cut-off value determination are reported in a separate publication [19], while the present study focuses on pharmacists' awareness, attitudes, and experiences with digital health technologies and diabetes-related mobile application use.

The third section, entitled "Mobile Applications for Patients with Diabetes," comprised 26 author-developed items and represented the primary focus of the present study. These items were generated based on a targeted literature review and refined through expert review and an iterative consensus process among the authors to ensure content relevance, clarity, and suitability for the target population. This section was designed to assess community pharmacists' awareness, attitudes, and experiences related to digital health technologies, with a particular emphasis on mobile applications for diabetes mellitus self-management.

2.1. Study Design and Setting

This study employed a cross-sectional design using both online and paper-based questionnaires to collect data from community pharmacists in Serbia. The entire population of community pharmacists was informed about the study and its objectives and invited to participate through an email notification facilitated by The Pharmaceutical Chamber of Serbia. The email included a link that provided access to the online version of the questionnaire.

To complement online data collection, identical paper questionnaires were distributed in parallel via direct fieldwork across community pharmacies. A representative sample was achieved by offering the paper-based survey to pharmacists working in both major pharmacy chains and independent pharmacies, spanning diverse geographic locations-from urban centers to rural areas across multiple regions of the country.

Data collection began on 19 December 2023 and continued until the targeted sample size was reached on 15 May 2024.

2.2. Participants and Data Collection

This study focused on community pharmacists employed in community pharmacies who voluntarily consented to participate without incentives and agreed to the use of their responses for scientific purposes. The selection process aimed to ensure broad representation across various pharmacy settings, aligning with the study's objective.

To determine the necessary sample size, calculations were based on the total population of community pharmacists in Serbia, as verified by the Pharmaceutical Chamber of Serbia (7207 pharmacists). A representative sample of at least 365 participants was required, following a standard calculation with a 95% confidence level and a 5% margin of error [20].

Data collection combined both digital and in-person methods. Online responses were gathered via Google Forms, ensuring accessibility for participants across different regions. Paper-based surveys were completed privately and retrieved at designated collection points within pharmacies, supporting engagement from pharmacists in various practice environments. To prevent duplicate participation, respondents were asked whether they had previously completed the questionnaire. In the digital version, participants who indicated they had already completed the survey were automatically redirected to the end of the questionnaire with a thank-you message. All submitted responses remained anonymous, with access restricted solely to the research team.

2.3. Data Analysis

Statistical analysis was conducted using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were applied to summarize sample characteristics: categorical variables (gender, education level, pharmacy type, pharmacy location, diabetes consultancy, perception of digital health, eHealth, and mHealth) were presented as frequencies, while continuous variables (duration of working experience) were described using means, standard deviations, medians, and interquartile ranges.

To assess statistical significance in the difference between categories, the chi-square (χ^2) test was employed for categorical variables, and the Kruskal–Wallis test was used for comparisons involving nonparametric data between groups.

3. Results

This study explored community pharmacists' awareness, attitudes, and experiences with digital health technologies, with a particular focus on mobile applications for diabetes mellitus self-management. The study sample comprised 368 community pharmacists from various regions of Serbia. Participants had a mean professional experience of 13.9 ± 9.8 years. The majority were female (89.1%), held a Master of Pharmacy degree (83.4%), and were employed in private pharmacy chains (76.4%). With respect to geographic distribution, most respondents worked in large urban areas with more than 150,000 inhabitants (63.3%), followed by medium-sized cities (19.3%), small towns (11.4%), and rural settings (6.0%). Additionally, 8.4% of participants reported working as certified diabetes consultants.

Further details regarding participants' sociodemographic and professional characteristics according to awareness of different categories of mobile applications are summarized in Table 1.

The majority of community pharmacists (Table 2) reported a lack of awareness with mobile applications designed to support a healthy lifestyle (77.2%) and those intended for disease self-management and therapy management (84.2%) (Supplementary Materials Table S1).

Table 1. Sociodemographic and professional characteristics of community pharmacists according to awareness of mobile applications for diabetes care.

Characteristic	Total N (%)	Awareness of Mobile Apps Supporting a Healthy Lifestyle		Awareness of Mobile Apps Supporting Disease Self-Management and Therapy	
		Yes N (%)	No N (%)	Yes N (%)	No N (%)
Gender					
Female	328 (89.1%)	68 (20.7%)	260 (79.3%)	58 (15.8%)	310 (84.2%)
Male	40 (10.9%)	16 (40.0%)	24 (60.0%)	10 (25.0%)	30 (75.0%)
Pharmacy type					
Pharmacies within Pharmacy Chains (state property)	39 (10.6%)	15 (38.5%)	24 (61.5%)	8 (20.5%)	31 (79.5%)
Pharmacies within Pharmacy Chains (private)	281 (76.4%)	63 (22.4%)	218 (77.6%)	43 (15.3%)	238 (84.7%)
Independent pharmacies	48 (13.0%)	6 (12.5%)	42 (87.5%)	7 (14.6%)	41 (85.4%)
Degree of education					
Master of Pharmacy	307 (83.4%)	72 (23.5%)	235 (76.5%)	47 (15.3%)	260 (84.7%)
Master of pharmacy—specialist	58 (15.8%)	12 (20.7%)	46 (79.3%)	11 (19.0%)	47 (81.0%)
Master of Pharmacy-Doctor of Science	3 (0.8%)	0 (0.0%)	3 (100%)	0 (0.0%)	3 (100%)
Pharmacy location					
Large city (>150,000 inhabitants)	233 (63.3%)	60 (25.8%)	173 (74.2%)	38 (16.3%)	195 (83.7%)
Medium-sized city (50,000–150,000 inhabitants)	71 (19.3%)	12 (16.9%)	59 (83.1%)	10 (14.1%)	61 (85.9%)
Small town (<50,000 inhabitants)	42 (11.4%)	8 (19.0%)	34 (81.0%)	6 (14.3%)	36 (85.7%)
Rural environment	22 (6.0%)	4 (18.2%)	18 (81.8%)	4 (18.2%)	18 (81.8%)
Works as diabetes consultant					
Yes	31 (8.4%)	8 (25.8%)	23 (74.2%)	7 (22.6%)	24 (77.4%)
No	337 (91.6%)	76 (22.6%)	261 (77.4%)	51 (15.1%)	286 (84.9%)
Working experience (years)	368 (100%)	13.4 ± 9.8, 11.0 [14.8] *	14.1 ± 9.9, 12.0 [13.0] *	15.5 ± 10.5, 13.0 [17.3] *	13.6 ± 9.7, 12.0 [14.0] *

* Mean ± standard deviation, median [interquartile range].

Results for mobile applications promoting a healthy lifestyle that were more widely recognized among pharmacists demonstrated a statistically significant difference ($\chi^2(2) = 8.40$, $p = 0.02$) across different levels of DHTL, indicating that pharmacists with higher DHTL scores were more likely to be aware of such applications. Post hoc analysis revealed that participants with high DHTL were significantly more likely than expected to report awareness ($Z = +2.9$, $p < 0.01$), while those with low DHTL were significantly more likely to report unawareness ($Z = +2.1$, $p < 0.05$). Conversely, high DHTL participants were significantly less likely to report unawareness ($Z = -2.9$, $p < 0.01$).

Table 2. Statistically significant associations between DHTL level and community pharmacists' awareness, attitudes, and experiences with digital health technologies ($p < 0.05$).

Characteristic		N = 368 (%)	Low DHTL (Score ≤ 32.5, n = 132)	Medium DHTL (32.5 < Score < 35.5, n = 72)	High DHTL (Score ≥ 35.5, n = 164)	*p* Value
Are you aware of the existence of mobile applications to support a healthy lifestyle?	Yes	84 (22.8%)	22 (26.2%)	13 (15.5%)	49 (58.3%)	0.02
	No	284 (77.2%)	110 (38.7%)	59 (20.8%)	115 (40.5%)	
How did you become aware of the existence of mobile applications that can benefit patients with diabetes? (Mobile applications to support a healthy lifestyle)?	I am not aware	284 (77.2%)	110 (38.7%)	59 (40.5%)	115 (20.8%)	0.01
	Internet search	49 (13.3%)	10 (20.4%)	6 (12.2%)	33 (67.4%)	
	Conversation with colleagues and other healthcare professionals	18 (4.9%)	5 (27.8%)	4 (22.2%)	9 (50.0%)	
	Talking to patients	3 (0.8%)	2 (66.7%)	1 (33.3%)	0 (0.0%)	
	Pharmaceutical companies, Wholesalers of medicines and medical devices	9 (2.4%)	5 (55.6%)	0 (0.0%)	4 (44.4%)	
	Professional and scientific magazines and other literature	5 (1.4%)	0 (0.0%)	2 (40.0%)	3 (60.0%)	
Can knowledge of mobile applications that can be used by patients with diabetes help you in working with these patients?	Yes, almost always	55 (14.9%)	13 (23.6%)	8 (14.6%)	34 (61.8%)	<0.001
	Yes, often	160 (43.5%)	51 (31.9%)	34 (21.2%)	75 (46.9%)	
	Partially	108 (29.3%)	43 (39.8%)	23 (21.3%)	42 (38.9%)	
	Rarely	27 (7.3%)	14 (51.8%)	5 (18.5%)	8 (29.7%)	
	No, not at all	18 (4.9%)	11 (61.1%)	2 (11.1%)	5 (27.8%)	
Which way of conducting education about digital technologies, including mobile applications that can be used by patients with diabetes, would be most useful to you?	Face-to-face education	155 (42.1%)	77 (49.7%)	25 (16.1%)	53 (34.2%)	<0.001
	Online education in real time	71 (19.3%)	21 (29.6%)	14 (19.7%)	36 (50.7%)	
	Online education for self-study	142 (38.6%)	34 (23.9%)	33 (23.2%)	75 (52.9%)	
How would you like to receive current information about existing and new digital technologies, including mobile applications, that can be used by patients with diabetes?	In person, via e-mail address	192 (52.2%)	55 (28.6%)	43 (22.4%)	94 (49.0%)	0.03
	Through professional publications	20 (5.4%)	7 (35.0%)	5 (25.0%)	8 (40.0%)	
	Continuing Professional Development (CPD) courses	156 (42.4%)	70 (44.9%)	24 (15.4%)	62 (39.7%)	

Note: Table 2 presents variables that showed statistically significant associations ($p < 0.05$) related to community pharmacists' awareness, attitudes, and experiences with digital health technologies. Non-significant findings are available in Supplementary Materials Table S1; DHTL—Digital Health Technology Literacy.

When asked how they became aware of mobile applications supporting a healthy lifestyle, most respondents reported internet searches (13.3%) or discussions with colleagues and other health professionals (4.9%), while a smaller proportion cited professional literature (1.4%). The most common response overall, however, was a lack of awareness (77.2%), which was particularly pronounced among respondents with low DHTL levels (83.3%; 110 out of 132), compared to medium (81.9%; 59 out of 72) and high (70.1%; 115 out of 164) DHTL groups (Fisher's Exact Test, $p = 0.008$).

The method of discovering mobile health applications varied significantly by DHTL level. Internet search was the most frequently cited source among those aware of such applications, particularly among high DHTL participants (20.1%; 33 out of 164), compared to medium (8.3%; 6 out of 72) and low (7.6%; 10 out of 132) groups. Post hoc analysis revealed that high DHTL participants were significantly more likely to report internet searches as their source of awareness ($Z = +3.4$, $p < 0.01$), whereas low DHTL participants were significantly more likely than expected to report no awareness ($Z = +2.1$, $p < 0.05$). Conversely, high DHTL participants were significantly less likely to report being unaware ($Z = -2.9$, $p < 0.01$). No significant group differences were observed for other information sources (all $|Z| < 1.96$).

When it comes to the developments in the field of diabetes, pharmacists reported that they stay informed primarily through CPD courses (92.93%) and conversations with colleagues and other healthcare professionals (79.35%). Other significant sources include pharmaceutical companies (63.32%), professional journals and literature (54.62%), and talking to patients (53.53%). Internet searches are used less frequently (41.30%), with no participants indicating that they do not keep up to date with diabetes news.

Among pharmacists who use internet searches to stay informed about diabetes, the most frequently accessed website category was unspecified (25.00%). This was followed by general medical education portals (22.37%) and websites of diabetes-related organizations (20.39%). Pharmacists also commonly accessed websites of pharmacists' organizations (19.74%) and regulatory or health institutions (19.74%). Less frequently used sources included medical literature databases (16.45%), drug information databases (9.21%), and search engines (5.26%). Websites of healthcare product manufacturers or wholesalers were accessed by 3.29% of pharmacists, while social media platforms were the least utilized source (0.66%).

Table 3 presents the different categories of mobile applications mentioned by community pharmacists, covering both those supporting a healthy lifestyle and those focused on diabetes self-management and therapy management.

Table 3. Categories of Mobile Applications and the Number (N) and Percentage (%) of Community Pharmacists Aware of Their Use.

Mobile Application Category	Healthy Lifestyle (N = 84, 22.8%)	Diabetes Self-Management and Therapy Management (N = 58, 15.8%)
General Health and Wellness Tracking	35 (41.67%)	4 (6.90%)
Physical Activity Tracking	14 (16.67%)	—
Weight Management, Nutrition, and Diet Tracking	11 (13.10%)	—
Diabetes Management	8 (9.52%)	9 (15.52%)
Blood Glucose Monitoring	—	23 (39.66%)
Multi-Functional Medical Software	—	2 (3.45%)
Medication and Drug Information	—	1 (1.72%)
Health Insurance Management	1 (1.19%)	—
Other	24 (28.57%)	24 (41.38%)

The most frequently mentioned applications are Samsung Health, Apple Health, and HUAWEI Health; they all belong to the category for monitoring general health and well-being, and they were mentioned by 30.95% of pharmacists who indicated that they were aware of the existence of this type of application.

Pharmacists generally believe that patients with diabetes are interested in using mobile applications for disease management (89.4%). However, the majority perceive this interest as partial (43.5%) or rare (36.1%).

Only a small proportion of pharmacists (4.9–5.2%) provided feedback on the support they provided as community pharmacists to patients regarding mobile applications for diabetes self-management. Among those who provided feedback, more than 50% fell into the high DHTL category. The areas of support provided to both patients who already use and those who do not use mobile applications are detailed in Table 4.

Table 4. Patient Support Questions Reported by Community Pharmacists: Users vs. Non-Users of Diabetes-Related Mobile Applications.

Category	Questions Reported by Pharmacists from App-Using Patients (N = 18, 4.9%)		Questions Reported by Pharmacists from Non-App-Using Patients (N = 19, 5.2%)
Most Frequently Asked Questions		Most Frequently Asked Questions	
General clarifications about use of the application	4 (22.2%)	Which application (evidence-based) should I install?	3 (15.8%)
How to set up the application and log in?	1 (5.6%)	How do diabetes management applications work?	1 (5.3%)
Can I use the application multiple times a day?	1 (5.6%)	Which application provides the simplest visual presentation of glucose levels?	1 (5.3%)
How to record blood glucose level and frequency?	1 (5.6%)	Which application is the most reliable?	1 (5.3%)
Not Specified	11 (61.1%)	Which mobile applications can help me?	1 (5.3%)
		How are applications connected with glucose meters?	1 (5.3%)
		Are there applications for diabetes management?	1 (5.3%)
		What is the name of an application?	1 (5.3%)
		Not Specified	9 (47.4%)
Type of Diabetes of Patients Seeking Support		Type of Diabetes of Patients Seeking Support	
Type 1	6 (33.3%)	Type 1	4 (21.1%)
Type 2	2 (11.1%)	Type 2	3 (15.8%)
Both Types	10 (55.6%)	Both Types	12 (63.2%)
Age of Patients Seeking Support		Age of Patients Seeking Support	
≤30 years	7 (38.9%)	≤30 years	7 (36.8%)
31–65 years	11 (61.1%)	31–65 years	11 (57.9%)
65+ years	0 (0.0%)	65+ years	2 (10.5%)

Note: Percentages are calculated based on the number of pharmacists reporting questions in each subgroup. Age groups reflect pharmacists' general impressions from routine interactions, not patient records, and no identifiable patient data were collected. Questions represent patient-initiated inquiries as reported by pharmacists.

Overall, a limited number of pharmacists reported receiving training on digital technologies. Specifically, only 2.4% had undergone training related to mobile applications for diabetes self-management, while 11.7% reported receiving training on other digital technologies. Detailed information is provided in Table 5.

Table 5. Characteristics of Training Received by Community Pharmacists on Mobile Applications for Diabetes Self-Management and Other Digital Technologies.

Category	Training on Mobile Applications (N = 9, 2.4%)		Training on Other Digital Technologies (N = 43, 11.7%)
Category of Technology for Which Pharmacists Received Training		Category of Technology for Which Pharmacists Received Training	
Blood Glucose Monitoring	55.6%	Health Monitoring and Diagnostics	18.4%
General Diabetes Management	11.1%	eHealth and Digital Records	27.9%
Not specified	33.3%	Pharmacy and Medical Software	27.9%
		Data Analysis and Research	4.6%
		General Computer Skills	2.3%
		Not specified	25.6%
Type of Training Received		Type of Training Received	
Continuing Professional Development (CPD) courses/Workshop	66.7%	Continuing Professional Development (CPD) courses/Workshop	67.4%
Symposium/Congress	22.2%	Symposium/Congress	11.6%
Do not remember	11.1%	Do not remember	20.9%
		Other	11.6%
Training Organizer		Training Organizer	
Health institution	22.2%	Health institution	37.2%
Pharmaceutical company	36.4%	Pharmaceutical company	23.3%
Wholesalers of medicines and medical devices	33.3%	Wholesalers of medicines and medical devices	4.7%
The Pharmaceutical Chamber of Serbia	11.1%	The Pharmaceutical Chamber of Serbia	20.9%
Pharmacists' associations	11.1%	Other organizations	2.3%
Health institution	22.2%	Do not remember	34.9%

Note: Participants could specify more than one mobile application/digital technology and select more than one option for both the type of training and the training organizer.

A majority of pharmacists (58.4%) indicated that knowledge of mobile applications for diabetes self-management would be helpful either "almost always" (14.9%) or "often" (43.5%). Additionally, 29.3% believed such knowledge was partially helpful, while 7.3% and 4.9% considered it "rarely" or "not at all" helpful, respectively. A linear-by-linear association test showed a significant trend between DHTL level and perceived usefulness of mobile application knowledge, with higher DHTL scores associated with greater perceived usefulness ($\chi^2(1) = 15.04$, $p < 0.001$). Post hoc adjusted residuals indicated that pharmacists with high DHTL scores were more likely to perceive such knowledge as "almost always" helpful ($Z = +2.8$, $p < 0.01$), whereas those with low DHTL scores were more likely to perceive it as "not at all" ($Z = +2.3$, $p < 0.05$) or "rarely" helpful ($Z = +1.8$, $p = 0.07$).

A significant proportion of pharmacists believe they should provide guidance and training to patients on the appropriate use of mobile applications designed to support a healthy lifestyle (70.7%), as well as those facilitating disease self-management and therapy management (78.3%).

Additionally, pharmacists recognize the need for further training, both in general digital technologies applicable to pharmaceutical healthcare (87.5%) and in specific mobile applications tailored to support patients with diabetes (89.7%).

Face-to-face education was the most commonly selected method overall (42.1%), and was significantly more preferred by respondents with low DHTL (49.7%) than by those with medium (16.1%) or high DHTL (34.2%) ($\chi^2(4) = 23.08$, $p < 0.001$). Post hoc analysis confirmed this pattern, with low DHTL participants more likely than expected to choose in-person education ($Z = +4.7$, $p < 0.001$), and high DHTL participants significantly less likely than expected to prefer this format ($Z = -3.4$, $p < 0.001$). Conversely, self-paced online education was most popular among high DHTL participants (52.8%), while only 23.9% of low DHTL and 23.2% of medium DHTL participants chose this option. Post hoc residuals supported this, showing high DHTL respondents were significantly more likely to choose this format ($Z = +2.5$, $p < 0.01$), and low DHTL respondents significantly less likely ($Z = -3.8$, $p < 0.001$). Although real-time online education was selected more often by those with high DHTL (50.7%) compared to medium (19.7%) and low (29.6%), this difference was not statistically significant based on adjusted residuals (all $Z < 1.96$).

When asked how they would like to receive updates about digital technologies, the most preferred method overall was via email (52.2%), especially among high DHTL participants (49.0%), compared to medium (22.4%) and low (28.6%) ($\chi^2(4) = 10.54$, $p = 0.03$). However, post hoc analysis showed only the low DHTL group had a significant deviation, being less likely than expected to prefer email ($Z = -3.0$, $p < 0.01$). The higher preference among high DHTL respondents was not statistically significant ($Z = +1.8$). Continuing Professional Development (CPD) courses were selected by 42.4% overall and were significantly more preferred by low DHTL participants ($Z = +3.1$, $p < 0.01$), indicating a preference for more structured learning formats in this group. Professional publications were the least chosen method (5.4%), and no significant differences across DHTL groups were found (all $Z < 1.96$).

The vast majority of pharmacists (92.1%) believe that official guidelines on mobile applications for diabetes management would be beneficial in their work with diabetic patients.

4. Discussion

A key finding of this study is the limited awareness among community pharmacists of mobile health applications, particularly those designed for disease self-management and therapy support. This aligns with the 2025 FIP report on Pharmacy's Role in the Digital Transformation of Health, which highlights the critical role of pharmacists in guiding patients through digital tools while noting global variability in workforce readiness [21]. Despite the growing availability of such tools, most respondents were not familiar with their existence. Awareness was higher for applications promoting a healthy lifestyle than for those supporting disease or therapy management, suggesting that wellness-focused apps may be more visible or better integrated into public health messaging. Importantly, awareness was associated with DHTL, indicating that pharmacists with higher DHTL were more likely to recognize these tools. This finding is consistent with our previous report, where the majority of community pharmacies (64.1%) exhibited medium or high levels of DHTL, and significant differences were observed across groups with varying lengths of professional experience [19]. Together, these results suggest that digital competence plays a significant role in whether healthcare professionals are equipped to identify and potentially recommend mobile health technologies to patients. These findings highlight the need for targeted interventions aimed at improving digital literacy and integrating digital health awareness into professional education and continuing development frameworks [22]. This

is consistent with FIP Development Goal 20, which calls for the development of a digitally competent pharmacy workforce capable of integrating digital tools into practice [7].

A substantial gap in awareness of mobile applications for promoting a healthy lifestyle among pharmacists was observed, with 77.2% of respondents indicating they were unaware of such tools. Even among pharmacists with higher DHTL, 70.1% still reported being unaware. Internet searches were the most commonly cited source of awareness among those familiar with mobile applications, particularly among high DHTL pharmacists, while those with lower DHTL levels were significantly more likely to report no awareness. These patterns suggest that limited digital navigation skills or reduced confidence in engaging with digital health technologies may contribute to lower discovery rates in less digitally literate groups.

These results are consistent with prior research. For instance, one study reported limited knowledge of mHealth apps among pharmacists and pharmacy students in Saudi Arabia, despite generally positive attitudes toward their use [23]. Similarly, systematic reviews indicate that while mHealth apps can effectively support diabetes adherence and monitoring, their real-world uptake is often constrained by barriers such as lack of awareness, low digital literacy, and limited user engagement [24,25]. The present study reinforces these findings within a new context and highlights the urgency of designing targeted education and awareness-raising interventions.

In addition to the primary findings, insights into how pharmacists stay informed about diabetes developments offer valuable context. Most pharmacists reported relying on Continuing Professional Development (CPD) courses and peer discussions, while internet searches and professional literature were less commonly used. Social media platforms were the least utilized source. General medical education portals and diabetes-specific organizational websites were the most frequently accessed online sources. These patterns suggest a need to optimize dissemination strategies by aligning educational outreach with pharmacists' preferred information channels.

The majority of pharmacists believe that patients with diabetes are at least somewhat interested in using mobile apps. Many also felt that pharmacists should play a role in supporting and advising patients on the use of these tools. Furthermore, most respondents agreed that knowledge of mobile applications for diabetes self-management is useful in their everyday work, particularly among those with higher DHTL scores. This aligns with other findings showing that pharmacists generally perceive mHealth tools as beneficial in theory, despite limited practical familiarity [23].

However, few pharmacists in this study reported receiving formal training on digital technologies. Only 2.4% indicated having training on mobile apps, and just 11.7% had received training on other digital technologies. This suggests a possible disconnect between pharmacists' professional development and the evolving digital landscape of healthcare. The low uptake may also reflect low retention, inadequate emphasis, or a lack of visibility of available digital training programs. This gap mirrors observations in the FIP report, which emphasizes the urgent need to equip pharmacists with digital competencies through formal education and continuing professional development [6].

Encouragingly, most respondents recognized the need for further education. Specifically, 87.5% expressed interest in additional training on general digital technologies relevant to pharmaceutical care, and 89.7% supported training on mobile apps for diabetes support. This demand highlights a significant gap between current exposure and perceived need.

Furthermore, a strong majority (92.1%) of participants supported the development of official guidelines for the use of mobile applications in diabetes care. This suggests that pharmacists would likely welcome standardized, evidence-based resources to support their integration of digital tools into everyday practice. The development of such guidelines

could be a critical step toward better equipping pharmacists to support patients with chronic conditions like diabetes.

Preferences for educational delivery also varied by digital literacy. Pharmacists with lower DHTL preferred in-person formats and structured continuing education, while those with higher DHTL favored self-paced online modules and email-based updates. These results reflect the influence of digital competence on comfort with independent, technology-mediated learning, consistent with earlier findings in healthcare education [26]. For example, structured approaches are often required to build confidence in digital health instruction among healthcare professionals [27]. Additionally, high interest in digital health has been observed among medical students, though digital readiness varies significantly depending on previous exposure and confidence [28]. Tailoring educational formats to pharmacists' digital competencies could enhance the uptake and effectiveness of mHealth technologies in practice.

These findings are also in line with broader international trends. A recent study conducted among community pharmacists in the UK found that although many acknowledged the increasing importance of digital health technologies, confidence in their use and recommendation within patient care remained limited [29]. This further highlights the global relevance of structured digital training and practice integration strategies.

This study has several methodological limitations. First, although both online and paper-based surveys were distributed to increase sample diversity, the sampling strategy was not random. This may have introduced selection bias, particularly if participants opting for the online survey were more digitally literate. To mitigate this, alternative formats were offered to accommodate a broader range of digital skill levels. Second, the reliance on self-reported data introduces potential for social desirability bias and recall inaccuracies. Third, the cross-sectional design limits causal interpretations and captures a single point in time, which may not reflect ongoing changes in technology adoption or literacy. Finally, pharmacists' age was not collected, as years of experience in community pharmacy were prioritized as a more practice-relevant indicator of exposure to digital technologies. Given the conceptual overlap and potential multicollinearity between age and professional experience, only the latter was retained in the analysis. As previously reported in our research [19], significant differences in DHTL levels were associated with years of community pharmacy experience, which further supports this choice. In Serbia, years of community pharmacy experience generally correlate with age, since pharmacists typically enter practice soon after graduation and often remain in this setting long term. Although this relationship is not absolute, excluding age may limit the ability to assess its independent influence on digital literacy and technology acceptance and should be considered in future research.

In addition, data collection spanned a five-month period, which allowed partial coverage of potential seasonal variations in pharmacy workload and patient demand. This extended timeframe may enhance the representativeness of responses by capturing practice conditions across different periods of the year. At the same time, recruitment overlapped with several public and religious holidays in Serbia, which may have influenced pharmacist availability and response rates. These contextual factors may be relevant for future researchers when planning recruitment strategies and timelines.

The observed gaps in awareness and training highlight important opportunities to better equip pharmacists for digital health integration. Tailored interventions should consider pharmacist demographics and digital literacy: for example, modular, time-efficient training, peer mentoring, or continuing education incentives may help engage those with lower digital confidence. FIP's Statement of Policy on Digital Health recommends structured

workforce development, guidance, and supportive infrastructure to enable pharmacists to deliver safe, effective, and patient-centered digital services [11].

In particular, the results suggest missed opportunities to expand pharmacists' roles in supporting patients with mobile health applications for chronic disease self-management. By embracing digital technologies, pharmacists can develop new patient-centered services that go beyond traditional functions. This evolution is critical to meeting the changing expectations of healthcare systems in the digital era and safeguarding the future relevance of the pharmacy profession.

Future research should evaluate structured education models matched to varying DHTL levels, test standardized search protocols and resource bundles to assist pharmacists in identifying credible digital tools, and explore how digital literacy influences pharmacist–patient communication and the uptake of mHealth in diabetes care. In addition, future studies could examine demographic factors influencing participation in training and investigate barriers among pharmacists who do not perceive training as helpful to better inform targeted educational strategies.

5. Conclusions

This study reveals that although many community pharmacists recognize the value of mobile health applications in diabetes care, their awareness and training remain limited, especially regarding disease-specific tools. Awareness and perceived usefulness were positively associated with digital health technology literacy. However, structured training on digital technologies is largely lacking, and pharmacists express a clear need for further education and official guidance. Enhancing digital competence and integrating mHealth tools into routine pharmacy practice will be essential to ensure pharmacists can effectively support patients with chronic conditions like diabetes. While these findings are context-specific and based on cross-sectional data, they highlight critical areas for professional development and future research.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/pharmacy14020039/s1, Table S1: Non-Significant Associations Between DHTL Level and Community Pharmacists' Awareness, Attitudes, and Experiences with Digital Health Technologies ($p \geq 0.05$); File S2: Questionnaire Used in the Study.

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RESEARCH ARTICLE

Translation, adaptation and psychometric testing of the Digital Health Technology Literacy Assessment Questionnaire (DHTL-AQ) in the Serbian language

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Abstract

Background The use of digital health technologies (DHTs), systems that use computing platforms, connectivity, software, and/or sensors for health care and related uses, is rapidly increasing. Assessing literacy in this area may be challenging given the absence of comprehensive instruments, especially those dedicated to health care professionals. The digital health technology literacy assessment questionnaire (DHTL-AQ) is a 34-item instrument that assesses an individual's ability to use DHTs, services, and data.

Aim To translate and culturally adapt the DHTL-AQ and to evaluate the psychometric properties of the Serbian version.

Method The DHTL-AQ English version was translated into Serbian, back-translated, and adapted via expert consensus discussion. Pilot testing was conducted among a population of community pharmacists. To gather evidence of initial validity, the culturally adapted version was tested in the same population as the pilot. Reliability was examined using Cronbach's alpha (Cα), and a test–retest methodology for temporary stability. Validity was explored through factor analysis.

Results A pilot study ($n=22$) included linguistic and cultural adjustments, confirming the item comprehensibility. The final Serbian DHTL-AQ consists of 5 questions and 25 items. The psychometric analysis ($n=162$) indicated, satisfactory internal consistency (Cα = 0.822) and temporal stability (ICC = 0.981). Factor analysis identified 3 factors that explained 52% of the total variance, reducing the number of factors to 3 compared with 4 into the original questionnaire.

Conclusion The culturally adapted DHTL-AQ Serbian version demonstrated strong psychometric properties. Practical application can support the development and implementation of customized education and training programs and new DHT-related services that pharmacists can offer patients.

Keywords Community pharmacist · Digital health literacy · Instrument adaptation · mHealth · Validation

Impact statements

- The DHTL-AQ Serbian version is a validated instrument to assess DHTL in a population of community pharmacists.
- A comprehensive understanding of DHTL among community pharmacists may provide valuable information for further tailoring the training and services that they provide.
- The DHTL-AQ Serbian version may serve as a reference for further research and validation of DHTL instruments for a wider group of HCPs.

Introduction

Digital health technologies (DHTs) are "systems that use computing platforms, connectivity, software, and/or sensors for health care and related uses" [1].

DHTs encompass various software and hardware products that are increasingly accessible to health care professionals

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(HCPs) and patients/other users. The World Health Organization (WHO) promotes the responsible utilization of digital technologies in health care, recognizing their potential to address key challenges in health care systems [2]. The WHO's regional digital health (DH) action plan aims to align strategic actions with health systems' needs, emphasizing health equity [3].

The evolving DHT environment has led to a rapid increase in available products, identifying barriers and challenges that hinder HCPs from fully adopting DHTs [4]. Community pharmacists (hereafter referred to as 'pharmacists') and other HCPs are undergoing digital transformation, adjusting their practices to industry trends [5, 6]. Therefore, they require a sufficient level of digital literacy (DL), defined as the "ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship" [7]. Assessing DL can be difficult due to the lack of comprehensive instruments available, along with the limited number of instruments specifically developed for HCPs.

Among the instruments mentioned in the literature on DL in health, the eHEALS–eHealth literacy assessment scale is frequently used [8–10]. eHealth literacy is the ability to search for, find, understand and evaluate health information from electronic sources and apply this knowledge to solve health problems [11]. This instrument was validated in Serbian for adolescents, but there are no data on its use among HCPs [12]. Published in 2006, eHEALS focuses on internet searches. Recent research suggests updating this scale to align with advances in DHTs [13].

The evolution of health technologies has led to new terminology. DH literacy now encompasses DL and health literacy, explaining the skills needed to access digitized health resources such as online information, electronic health records, electronic prescriptions, personal health and fitness tools, and online support communities [14].

In the absence of an instrument for assessing DH literacy while considering DHT advances, Yoon et al. developed the Digital Health Technology Literacy-Assessment Questionnaire (DHTL-AQ) to evaluate the ability of the general population to use DHTs, services and data [15].

The DHTL-AQ addresses the limitations of current instruments by evaluating both digital functional literacy (basic skills for using digital tools) and digital critical literacy (assessing the reliability and relevance of DH information). The instrument boasts high reliability and validity, with broader applicability.

The lack of an adequate instrument for assessing DHTL in HCPs, particularly in Serbian, highlights the need for such a tool to support WHO priorities related to DH and technologies. This instrument will enable the collection of valuable data to evaluate the existing situation and implement necessary measures for pharmacists to assist patients in the use of DHTs.

Only a subset of DHTs are classified as medical devices, requiring quality, safety, and efficacy approval. Many DHTs are not subject to such classification, and regulations vary worldwide [16]. Despite efforts towards global harmonization led by the International Medical Device Regulators Forum, harmonized criteria for DHT classification are lacking. Thus, the DH literacy of HCPs is crucial for the safe and effective use of these technologies. This aligns with the WHO's focus on capacity-building and skill strengthening among HCPs for the use of DHTs in disease prevention and management [3].

Aim

The aim was to translate and culturally adapt the DHTL-AQ and evaluate the psychometric properties of the Serbian version. The psychometric properties intended for analysis are reliability (internal consistency and test-retest reliability) and construct validity.

Ethics approval

Approval for this research was obtained from the Biomedical Research Ethics Committee – Faculty of Pharmacy, University of Belgrade (number 355/1 07 Feb 2023).

Method

The original DHTL-AQ consists of 4 questions (34 items) (1) ICT terms—11 items; (2) ICT icons—9 items; (3) use of an app—9 items; and (4) evaluation of the reliability and relevance of health information—5 items.

To ensure the representativeness of pharmacies in Serbia, pharmacists were included from major chains and independent pharmacies. This dual approach captured the diversity of practice settings and geographic distribution. Pharmacy locations ranged from large cities to rural areas across different regions of the country.

The cultural adaptation of the questionnaire was performed in stages, as shown in Fig. 1.

The Serbian translation of the English DHTL-AQ was completed by two native Serbian speakers proficient in English. All authors reviewed both translated versions, evaluating each question for accuracy. Any uncertainties were resolved through consensus.

An independent native English speaker fluent in Serbian conducted a blinded back-translation. This version was compared to the original English version, leading to the development of a prefinal Serbian version through researcher consensus. Like the original version, the translated Serbian

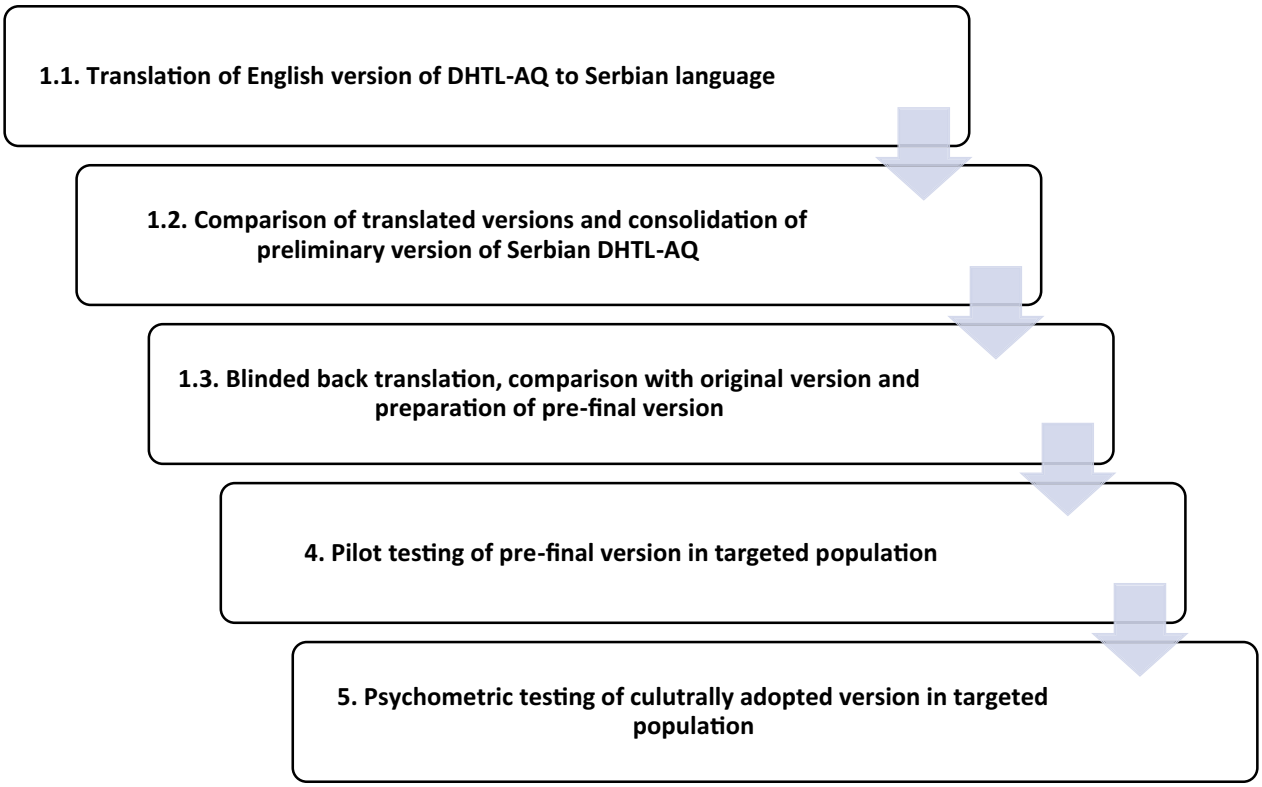

Fig. 1 Methodology flowchart for the Serbian DHTL-AQ: translation, adaptation, and psychometric testing

DHTL-AQ consists of 4 questions (34 items), with additional questions included to gather basic sociodemographic information from participants.

Pilot testing was conducted among 22 pharmacists to ensure the instrument's clarity. This number aligns with the recommended sample size of 10–40 participants for this phase of questionnaire adaptation [17].

Participants rated the understandability of each question on a four-point Likert scale (1—difficult to understand; 2—partially understandable; 3—understandable, additional clarification needed; 4—easy to understand) and provided comments as needed. Data were collected in paper form during face-to-face interviews.

Pharmacists employed in public pharmacies who willingly gave their consent for participation in the research and the use of collected data for scientific research (no incentives offered) were considered eligible for inclusion in the study. The sample size was determined by multiplying the number of items by 10, a common rule that aligns with the suggested sample size limits for psychometric testing in the relevant literature [18–20]. Questions 1 and 2 examined the knowledge about ICT terms and icons and were observed as two independent items. Questions 3 and 4 involved the assessment of independent statements, 9 and 5, respectively, about DHT usage and were observed as separate items, contributing to a total of 16 items. Accordingly, a minimum of 160 participants was defined for the study sample. For the stability reliability analysis (test−retest), 20% of the total sample was used, consistent with the literature, which recommends a minimum sample size of 30 participants for reliable estimates [21]. The questionnaire was completed twice for test−retest evaluation, with a 15-day interval between completions. To maintain anonymity, the respondents completed a paper version of the questionnaire privately, using a unique code for each form. Data from other participants were collected online via Google Forms, with the link shared through the pharmacy intranet. To ensure that the participants completed the questionnaire only once, they were asked, "Have you already completed this questionnaire?" Completed paper questionnaires and electronic data did not contain identifying information and were accessible only to the research team. The data were collected in May 2023.

Statistical analysis was conducted using IBM SPSS Statistics for Windows, version 26 (SPSS Inc. Chicago, Illinois, USA). Descriptive statistics were used to present the sample characteristics: frequencies for the categorical variables (gender, pharmacy type, education level, and pharmacy location) and means, standard deviations, medians, and interquartile ranges for the continuous variables (duration of work experience).

Reliability testing assesses the replicability of measurements. Cronbach's alpha (Cα) was used for internal

reliability, with values above 0.7 indicating good reliability [22], and it was calculated from the average interitem correlation. A split-half test, using the Spearman–Brown or Guttman method, randomly divided the questionnaire into two parts, with Cα calculated for each part and their correlation. A lack of significant differences in Cα values between the two parts and the entire questionnaire suggests overall reliability. The following assumptions for reliability analysis were tested: independence of observations, bivariate distribution of item pairs, and additivity of item values.

For temporal stability, a test−retest approach was used. Mean-level absolute stability was assessed via nonparametric Spearman correlation of total scores between the first and second measurements, as the normality assumption for parametric correlation was not met. Additionally, the intraclass correlation coefficient (ICC) was calculated for test−retest reliability of the total score using a two-way mixed-effects model, reflecting absolute agreement without considering interactions between individual questions. The ICC was derived from analysis of variance and mean squares.

Factor analysis was conducted with the Kaiser–Meyer–Olkin (KMO) test and Bartlett's sphericity test to assess the suitability of the data. The KMO measures sample adequacy, indicating the proportion of total variance explained by underlying factors; values closer to 1 suggest a more suitable sample. Bartlett's test determines whether the correlation matrix significantly differs from an identity matrix, indicating the feasibility of factor analysis [23].

Factor analysis explores the relationships between item scores to identify the smallest number of latent variables underlying the construct measured by the questionnaire. Common factor analysis separates total variance into common and unique components. Factors are estimated by revealing relationships between the measured items and factors, approximating the observed correlation matrix. Factors were extracted using the generalized least squares method, retaining those with eigenvalues above one and positioned above the "elbow" on the scree plot. Extraction followed orthogonal rotation with the Varimax method and Kaiser normalization, maximizing item loadings for each extracted factor. Post-rotation factor loadings represent the correlations between extracted factors and items.

Results

In the forwards translation to Serbian, all questions were translated. To align the question format, the option "I have no experience" was added to question 4, alongside the existing agree/disagree options (question 3 had three options: "yes", "no", and "do not know"). The options were further aligned to "I do not agree/I have no experience/I agree". This consistency ensured that the same concept was applied across the questions, improving clarity and allowing participants to express their agreement more effectively while reducing confusion.

Pilot testing ($n=22$) revealed that questions 1 and 2 are easy to understand. Questions 3 and 4 were adjusted on the basis of participant feedback to improve clarity. The original phrasing included "different functions" and "different difficulties", which were rephrased to "different statements" to clarify that participants should read the subsequent statements and indicate their level of agreement.

The study sample included 162 participants (females 89.5%), with a mean work experience of 12.1 years (Table 1).

Descriptive statistics (Supplement 1) for the DHTL-AQ revealed an asymmetric distribution of responses, with high frequencies at maximum values and a long left tail towards smaller values. The narrow distributions negatively impacted questionnaire reliability, partly due to the limited response options (only 2 or 3). The subquestions under question 2

Table 1 Validation study sample characteristics ($N=162$)

Characteristic		Value
Gender	Female	145 (89.5%)
	Male	17 (10.5%)
Pharmacy type	Pharmacies within Pharmacy Chains	145 (89.5%)
	Independent pharmacies	17 (10.5%)
Degree of education	Graduate pharmacist/Master of pharmacy	150 (92.6%)
	Graduate pharmacist/Master of pharmacy-specialist	11 (6.8%)
	Graduate pharmacist-Master or Doctor of Science	1 (0.6%)
Pharmacy location	A large city with more than 150,000 inhabitants	73 (45.1%)
	A medium-sized city with 50–150,000 inhabitants	44 (27.2%)
	A small town with less than 50,000 inhabitants	27 (16.7%)
	Rural environment	18 (11.1%)
Work experience (years)		12.1 ± 0.7, 10.0 [11.3]*

*Mean ± standard deviation, median [interquartile range]

(ICT icons) showed extremely high kurtosis (28 to 162) and significant negative skewness (–5.5 to − 12.7). The respondents consistently answered these questions similarly, resulting in poor correlation with other items and decreased overall reliability. Removing this question increased the Cα value and improved reliability.

Correlations between individual questions and the total questionnaire score without the correlated question (Supplement 2) confirmed that the question 2 items had a very low correlation with the rest of the questionnaire (corrected item–total correlation ranging from − 0.012 to 0.092 for the question 2 items).

Eliminating question 2 reduced the DHTL-AQ Serbian version to 25 items (question 1 had a maximum value of 11, while questions 2 and 3 had 9 and 5 subquestions/items, respectively). This removal increased Cα from 0.798 to 0.822, thereby improving the questionnaire reliability. Further analysis and validation were performed on the shortened questionnaire with 25 remaining items.

The split-half method showed that after the questionnaire was divided into two parts (with a similar number of questions randomly), the Cα for both parts exceeded 0.7, while the Cα for the entire questionnaire was closer to 0.8, indicating satisfactory reliability.

For the temporal stability, responses from 32 participants who completed the questionnaire twice were assessed. The correlation coefficient was very high (0.970), with a p value less than 0.001. The ICC was 0.981 (95% CI 0.961–0.991) for individual measurements ($F = 108.558$, $df = 31$, $p < 0.001$). The maximum ICC was 1.000, indicating high temporal stability of the questionnaire.

Prerequisite tests for factor analysis revealed KMO values between 0.70 and 0.79, and Bartlett's test indicated a significant difference between the questionnaire's correlation matrix and the identity matrix, confirming the feasibility of factor analysis.

The common variance values (Supplement 3) revealed that after factor extraction, most questions had a common variance greater than 0.5, indicating the appropriateness of the analysis.

After extraction and rotation (Table 2), we identified 3 factors that collectively accounted for approximately 52% of the variability.

Figure 2 shows that the first three factors above the "elbow" line represented the optimal solution. The "elbow" of the curve indicated the first point where it flattened, suggesting that only the factors before this point explained sufficient variability (more than one item). Factors beyond the "elbow"' had eigenvalues below one, accounting for such a small fraction of variability that they could not be considered valid factors.

The rotated factor matrix in Table 3 identified correlations between the questions and factors, grouping questions on the basis of their highest correlation value.

Factors were named and classified on the basis of the related question profiles within the Serbian DHTL-AQ:

Factor 1: Use of digital health applications (DHAs), question 1 (4 items) (Cα = 0.920): Reflects an individual's ability to use digital applications for personal health, indicating both the willingness and ability to record and interpret data from monitored physiological functions. This factor assesses interest in health and readiness for ongoing preventive measures, which pharmacists can extend to patients.

Factor 2: Use of the internet for health, questions 2 (11 items), 3 (2 items), and 4 (5 items) (Cα = 0.715): Indicates the ability to find reliable health information online, reflecting pharmacists' knowledge and skills in locating relevant data and assessing the quality of the information to determine its evidence-based validity.

Factor 3: Applications setup, question 5 (3 items) (Cα = 0.815): Indicates the ability to adjust digital application settings, revealing pharmacists' technical proficiency with various software tools beyond just health applications.

The final Serbian DTHL-AQ consisted of 5 questions (25 items).

Table 2 Extracted factors, initially and after rotation

Total variance explained						
Factor	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.243	28.3	28.3	3.097	20.6	20.6
2	1.191	7.9	36.2	2.715	18.1	38.7
3	2.391	15.9	52.2	2.013	13.4	52.2
Extraction Method: Generalized Least Squares						

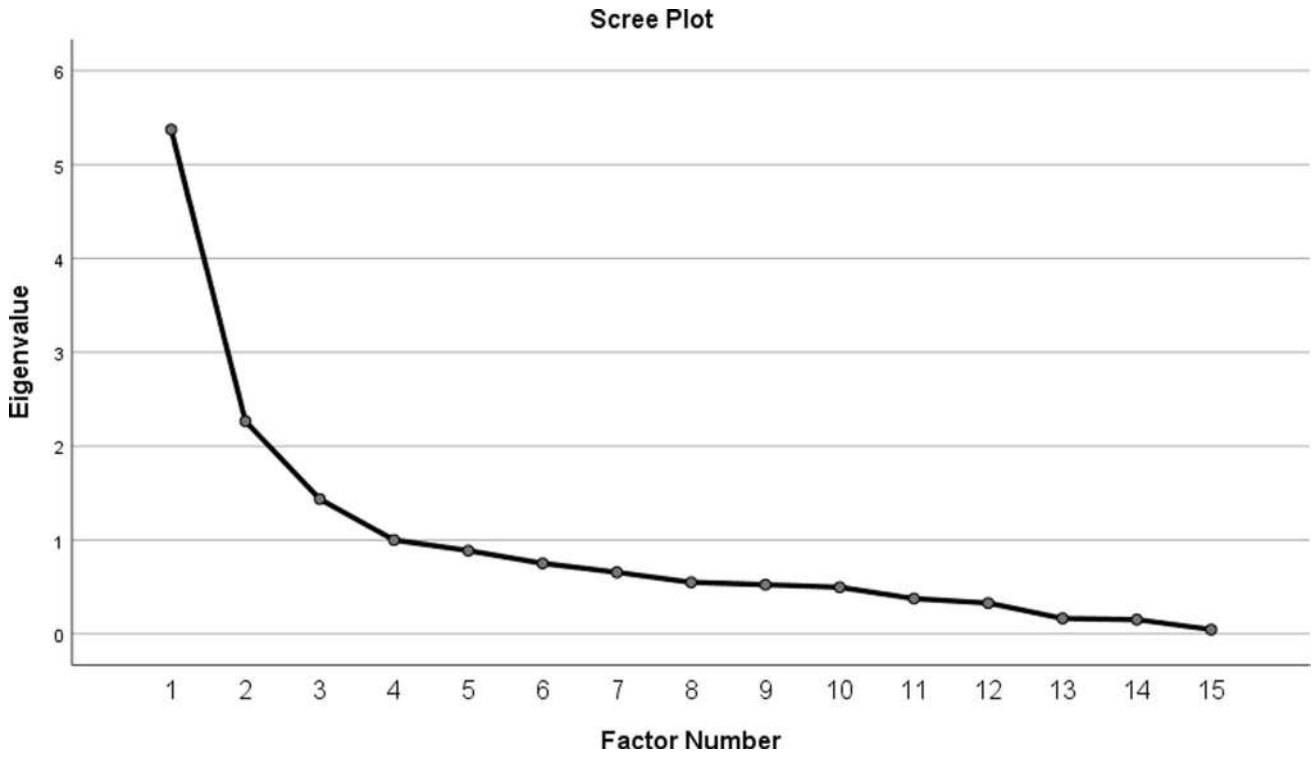

Fig. 2 Scree plot of rotated factors

Table 3 Rotated factor matrix

Rotated factor matrix	Factor*		
	1	2	3
1. Number of known terms related to use of computers or smartphones and the Internet.	0.105	**0.584**	0.129
3. Below are the various statements related to applications on smartphones, tablets, etc. Please read the statements provided and indicate whether you agree with the statements.	0.254	**0.528**	0.045
3.1 [I can easily find an application that will help my health]			
3.2[I can find more reliable applications by comparing different applications]	0.355	**0.534**	0.197
3.3 [I can log in to use the application (create an account, password, etc.)]	0.159	0.127	**0.630**
3.4 [I can update the application]	0.185	0.136	**0.973**
3.5 [I can record my health information through the application]	**0.708**	0.368	0.223
3.6 [I can use the health information recorded through the application for my health]	**0.559**	0.495	0.234
3.7 [I can record the volume of physical activity (e.g. number of steps), body mass and meals via the application]	**0.923**	0.094	0.186
3.8 [I can check the volume of physical activity (e.g. number of steps), body mass and meals recorded through the application]	**0.973**	0.056	0.221
3.9 [I can adjust the options in the application according to my wishes (sound, security, screen, notifications, etc.)]	0.400	0.016	**0.610**
4. Listed statements are related to difficulties when using health information from the Internet and digital health technologies or services. Please read the listed statements and indicate whether you agree with the statements.	0.098	**0.491**	0.030
4.1 [I can judge whether information on the Internet or within digital health technologies is reliable]			
4.2 [I can judge whether information on the Internet or within digital health technologies is used for commercial purposes]	0.127	**0.403**	0.081
4.3 [I can check if the same information is available on other websites or other sources on the Internet]	0.166	**0.438**	0.092
4.4 [I can judge whether the information I find on the Internet or within digital health technologies is adequate to use]	0.000	**0.687**	0.083
4.5 [I can use information I find on the Internet or within digital health technologies to make health-related decisions]	0.103	**0.559**	0.170
Extraction Method: Generalized Least Squares Rotation Method: Varimax with Kaiser Normalization.[a] a. Rotation converged in 5 iterations			

*Bold values indicate the corresponding factor for each question

Discussion

Statistical analysis confirmed the good reliability and validity of the Serbian DHTL-AQ for pharmacists. From a validity perspective, the 3-factor model showed the highest model fit and optimal solution for the targeted population.

To our knowledge, this study is the first to adapt and validate the DHTL-AQ in a language other than that originally developed, specifically for pharmacists in Serbia. This adaptation is significant as it addresses a critical gap in the literature, where no similar studies have involved HCPs.

The questionnaire assesses DHTL among pharmacists in Serbia and Serbian-speaking Balkan countries, providing essential insights into their role in the digital era. Its importance lies in evaluating DHTL levels, including the ability to set up and use DHAs, which are increasingly used by HCPs and patients.

The limited application of the DHTL-AQ restricted the discussion. Another limitation was the focus on pharmacists; however, the findings may still aid in developing validated tools for a wider range of HCPs.

This adaptation improved the questionnaire by ensuring proper formulation of the questions and answers in Serbian and standardizing the Likert scale to odd numbers as recommended [24]. Pretesting facilitated additional adjustments and confirmed the comprehensibility of the instrument in the targeted population [25].

Descriptive statistics indicate that the distributions are skewed towards one end of the response scale, suggesting that most individuals have higher DL. Statistical analysis revealed that removing nine items from the original questionnaire increased its reliability. These items demonstrated that pharmacists are already familiar with ICT icons, rendering them irrelevant for assessing DH literacy.

Factor analysis identified 3 factors and reorganized the questions into 3 new categories. The total number of factors was reduced from 4 to 3 with the complete removal of the original ICT icons. DHTs are advancing rapidly as evidenced by the significant rise in health-related apps [26]. The proliferation of digital technologies likely increases familiarity with ICT-related icons, reducing the need to retain these items in the questionnaire.

The new factor, "Use of DHAs", consists of 4 items from the original "Use of an app" factor, which had 9 items. The second factor, "Use of the Internet for Health", combines the original ICT terms and 2 items from the "Use of an app" factor. The "Application setup" factor includes 3 items from the original "Use of an app factor". This reorganization allows better differentiation of participants' ability to perform the technical setup of applications, use the internet for health-related actions, and utilize actual DHAs.

DHTs support various aspects of health care, particularly mobile applications designed for patients to self-manage diseases. While many applications are intended for patient use, HCPs' awareness and ability to guide patients are crucial for effective use of such applications. HCPs' perspective on DHAs used by patients requires further research, as limited data suggest a lack of awareness and experience among HCPs, particularly pharmacists [27].

Considering the importance of developing relevant instruments for measuring DHL, it is recommended to adapt this instrument for use in other languages, especially among HCPs, and to confirm its adequacy in different populations for further improvements and broader application.

Research on the DH competences of HCPs has increased [28–30]. The DHTL-AQ Serbian version assesses competencies among pharmacists and provides valuable insights into their readiness for DH engagement, allowing further actions aligned with achieving the International Pharmaceutical Federation DH development goals [31]. High DHTL scores can identify those prepared to offer specialized services, such as consulting on DHAs and enhancing patient care. Conversely, low scores may reveal vulnerable pharmacists who struggle with digital technologies, highlighting the need for targeted educational programs. Future research should focus on developing training initiatives to boost DHTL for these groups and creating guidelines for services that DHT-literate pharmacists can provide, ultimately fostering a more competent pharmacy workforce in the digital age.

Conclusion

The translated and culturally adapted Serbian version of the DHTL-AQ demonstrated statistical results confirming its reliability and validity for assessing DHTL among pharmacists. Further studies should utilize this validated instrument to explore DHTL among Serbian pharmacists. Assessing DHTL can support efforts to further customize education and training in this area and facilitate the introduction of new DHT-related services that pharmacists can offer to their patients or customers.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11096-024-01837-4.

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Conflicts of interest The authors declare they have no financial interests or non-financial interests to disclose.

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RESEARCH

Evaluation of digital health technology literacy among community pharmacists in Serbia

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ABSTRACT

Background: Community pharmacists' roles are expanding beyond traditional tasks to include digital health interventions. Despite the growing integration of digital health technologies, gaps remain in understanding pharmacists' digital health technology literacy (DHTL). Adequate DHTL is essential for supporting patients and ensuring the effective implementation of digital tools in pharmacy practice.

Objectives: To assess general digital literacy (gDL) and identify specific levels of DHTL among community pharmacists.

Methods: A version of the DHTL Assessment Questionnaire (DHTL-AQ), specifically validated for use by community pharmacists, was distributed via online and paper-based formats. In addition to the DHTL-AQ, the questionnaire also included supplementary items assessing gDL. The sample size was calculated on the basis of the targeted pharmacist population. The data were analysed via SPSS. Receiver operating characteristic curves were used to determine cut-off scores, whereas chi-square and Kruskal-Wallis tests were used to assess group differences and associations.

Results: A total of 368 valid responses were collected. Among the respondents, 15.2% had low, 68.8% had medium, and 16.0% had high gDL. On the basis of these findings, DHTL cut-off scores were defined as low (35.9%), medium (19.6%), and high (44.5%). Significant differences in DHTL levels were associated with years of working experience. While 41.3% did not use social media professionally, Facebook, YouTube, Instagram, and Viber were the most commonly used platforms among pharmacists.

Conclusion: This study provides the first comprehensive assessment of DHTL among Serbian community pharmacists, revealing high gDL but highlighting the need for targeted DHTL training. Future research should focus on expanding the sample size and addressing specific DHTL gaps. The approach used in this study offers a practical framework for assessing DHTL that can be applied internationally to inform the development of relevant, tailored training programs and support the expansion of pharmacist-led services in an increasingly digital health environment.

Background

In addition to their traditional roles in medication procurement, dispensing, and patient counselling, community pharmacists are increasingly recognized as frontline healthcare providers who deliver a growing range of clinical and public health services.[1-9]

These expanded roles—such as immunization, chronic disease management, and interprofessional collaboration—are well established in high-income countries like the United States, where pharmacists are integrated into multidisciplinary care teams. However, in many low- and middle-income countries, including Serbia, pharmacists remain an underutilized resource, largely due to limited infrastructure, workforce development, and system-level support.[10,11]

As highly accessible medication experts, community pharmacists are uniquely positioned to support the

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Key points

Background:

- Community pharmacists are increasingly recognized as essential providers of clinical and public health services, yet remain underutilized in some settings due to infrastructure, policy, or workforce limitations.
- The COVID-19 pandemic highlighted pharmacists' critical role in delivering digital health services, underscoring the need for strong digital health technology literacy (DHTL) in frontline pharmacy practice.
- Existing tools inadequately assess the full scope of digital competencies; the DHTL-Assessment Questionnaire provides a more comprehensive measure of pharmacists' readiness to engage with evolving digital health systems.

Findings:

- This study examines general digital literacy and specific levels of digital health technology literacy (DHTL) among community pharmacists, highlighting areas for targeted training and development.
- By identifying gaps in DHTL, this research informs educational strategies to enhance pharmacists' engagement with emerging health technologies.
- This study offers a practical framework for assessing DHTL, with potential for international application in pharmacist training and service development.

implementation of digital health technologies (DHTs) in clinical practice. This became especially apparent during the COVID-19 pandemic, when pharmacists worldwide played a pivotal role in sustaining care through digital tools, telehealth consultations, and remote patient monitoring.[12,13]

Digital health encompasses a broad array of technologies aimed at improving health outcomes, including electronic health (eHealth) systems and mobile health (mHealth) applications.[14] To use these technologies effectively, health care professionals (HCPs) must possess digital health technology literacy (DHTL)—defined as the ability to engage with DHTs, services, and data in a competent and confident manner.[15]

Serbia's national health care digitalization program (2022–2026) aims to fully integrate pharmacy and clinical services through electronic prescriptions, patient records, and centralized health data systems, marking a significant shift toward digital pharmaceutical care.[16]

In Serbia, the Law on Healthcare provides a legal foundation for pharmaceutical care, empowering community pharmacists to contribute to preventive services, health promotion, and proper use of both medications and medical devices.[17] However, despite growing interest in digital integration, there is a critical gap in the literature regarding the actual DHTL levels of pharmacists in this context.

Existing assessment tools—such as the eHealth Literacy Scale—often fail to capture the broader competencies required to navigate today's complex digital health landscape.[18] In contrast, the recently developed Digital Health Technology Literacy Assessment Questionnaire (DHTL-AQ) offers a more comprehensive evaluation, including functional digital skills and the ability to critically assess digital health information.[15]

Improving DHTL among pharmacists is essential for advancing patient-cantered care and optimizing the adoption of digital health innovations. This aligns with global priorities, including the World Health Organization's Digital Health Action Plan for 2023–2030, which emphasizes workforce training as a cornerstone for scaling digital health systems.[19]

This study addresses this gap by offering the first in-depth assessment of DHTL among Serbian community pharmacists, using the version of the DHTL-AQ specifically validated for the community pharmacist population. The results may offer insights that support future workforce development initiatives in comparable international contexts.

Objectives

Given the evolving role of pharmacists and the increasing reliance on DHTs, this study aims to provide a comprehensive assessment of general digital literacy (gDL) and determine the specific levels of DHTL among community pharmacists in Serbia.

Methods

Instrument

A questionnaire consisting of 47 questions divided into 5 sections was developed by the authors to facilitate comprehensive data collection from a single sample population. The instrument was designed to support broader research. An extensive review of the literature informed the development of the survey instrument, particularly in shaping items related to digital health perception and gDL.[20-40] Additionally, preliminary research conducted by the authors, including a systematic review and an analysis of relevant regulations, helped contextualize the instrument.[41,42] Sections relevant to this paper include sociodemographic data (7 questions), perceptions of digital health (3 questions), gDL (6 questions), and the DHTL-AQ - Serbian version (5 questions), which enables the estimation of gDL and DHTL among pharmacists. The reliability and validity of the DHTL-AQ Serbian version were demonstrated in prior research.[43] This segment assesses individuals' ability to perform technical setup of applications, use the internet for health-related actions, and navigate digital health applications.

The final section contains 26 distinct research questions exploring pharmacists' attitudes and experiences in working with a specific patient population. It was positioned at the end of the instrument and clearly delineated from the preceding sections.

Study design and setting

A cross-sectional study utilizing both online and paper-based questionnaires was conducted among community pharmacists in Serbia. Data collection commenced on December 19, 2023, when the entire population of community pharmacists (7,207) was informed about the study and its

objectives and invited to participate through an email distributed by the Pharmaceutical Chamber of Serbia. The email contained a link to the online version of the questionnaire. Identical paper questionnaires were distributed in parallel through direct fieldwork among community pharmacies. To achieve a representative sample, paper versions of the questionnaire were distributed to pharmacists from both major chains and independent pharmacies to cover different pharmacy types and across different geographic locations, ranging from large cities to rural areas in various regions of the country. Data collection continued until the targeted representative sample size was reached on May 15, 2024.

Participants and data collection

Pharmacists employed in public pharmacies who voluntarily provided consent for participation in the research and agreed to the use of collected data for scientific purposes were considered eligible for inclusion in the study. No incentives were offered for participation.

The required number of participants was calculated on the basis of the population of community pharmacists (the total number of community pharmacists, as confirmed by the Pharmaceutical Chamber of Serbia, was 7207). The minimum necessary sample size to ensure representativeness, which is based on a sample size calculation with a 95% confidence level and a 5% margin of error, was 365.[44]

Data from online participants were collected via Google Forms. Paper questionnaires were completed privately and collected at a predetermined time. To prevent duplicate responses, participants were asked, “Have you already completed this questionnaire?” Completed paper questionnaires, and electronic data did not contain identifying information and were accessible only to the research team.

Ethics approval for this research was obtained from the Biomedical Research Ethics Committee – Faculty of Pharmacy, University of Belgrade (Approval number 355/1, dated February 7, 2023).

Data analysis

Statistical analysis was performed via IBM SPSS Statistics for Windows, version 26 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were used to present the sample characteristics: frequencies for categorical variables (gender, education level, pharmacy type, pharmacy location, perception of digital health, eHealth, and mHealth) and means, standard deviations, medians, and interquartile ranges for the continuous variable (duration of working experience).

Receiver operating characteristic (ROC) curves were used to determine optimal cut-off values for the DHTL-AQ Serbia version. ROC curves plot sensitivity against 1-specificity at various thresholds. The area under the ROC curve (AUC) measures the test's ability to discriminate between positive and negative cases. An AUC of 0.5 indicates no discrimination, 0.7 – 0.8 is acceptable, 0.8 – 0.9 is excellent, and >0.9 is outstanding.[45] The cut-off values were determined by the point on the ROC curve that maximizes the Youden index (sensitivity + specificity - 1), providing the best balance between sensitivity and specificity.[46]

To determine cut-off values for different levels of DHTL, a nonparametric numerical method was applied to percentile values from a gDL section of the questionnaire. Four threshold values (below the 2.5th, 10th, 16th, and 25th percentiles) were used to identify the lower cut-off, distinguishing individuals with low versus medium DHTL.

A ROC curve was generated for the Serbian version of the DHTL-AQ for each threshold. The best-matching value from the low side was then selected. The corresponding value on the high side was used to establish a medium-to-high cut-off, ensuring a structured classification of individuals into low-, medium-, and high-literacy groups.

To test the significance of associations, the chi-square test was used for categorical data, and the Kruskal-Wallis test was employed for comparing nonparametric data between groups.

Results

A total of 368 eligible responses were obtained from community pharmacists. The collection of responses was halted once the calculated reliable sample size was reached.

The average working experience of the participants was 13.9 ± 9.8 years, and 89.1% were females (Table 1).

Most pharmacists who completed their specialization (81.0%) received additional training in pharmaceutical care (31.0%), pharmaceutical management and marketing (25.9%), and pharmacotherapy in pharmaceutical practice (24.1%).

The majority of participants (73.1%) recognized the definition of digital health, while the definitions of eHealth and mHealth were not known to most (85.1% and 57.3%, respectively).

Predictive value of the DHTL-AQ Serbian version for detecting individuals with different literacy levels

The level of gDL was determined on the basis of the gDL section of the questionnaire (questions 11–16), with an average score of 59.5 (maximum 84), a standard deviation of 12.5, a median of 62.0, and an interquartile range of 16.8. Among the study participants, 56 (15.2%) exhibited low gDL, 253 (68.8%) demonstrated medium proficiency, and 59 (16.0%) were classified as having high gDL.

The ROC curve for the 16th percentile was chosen as the best option since it aligns with one standard deviation below the mean and statistically represents the most relevant option.

The AUC was 0.861 (Figure 1), indicating a high level of discrimination, and was significantly greater than chance ($P < 0.001$). The cut-off value for the DHTL-AQ Serbian version is 32.5 (maximum 40), meaning that individuals with a score below this value are considered to have low DHTL (132 participants, 35.9%). With this cut-off value, the scale's sensitivity was 73.1%, and its specificity was 85.7%.

To identify the most digitally literate individuals, we selected values above the 84th percentile, corresponding to the 16th percentile for the least literate individuals.

The AUC was 0.802 (Figure 2), indicating a high level of discrimination, and was significantly greater than chance ($P < 0.001$). The cut-off value for the DHTL-AQ Serbian version is 35.5, meaning that individuals with a score above this value

Table 1
Sociodemographic characteristics of the study sample (N = 368) and perceptions of digital health

Characteristic	Value
Gender	
Female	328 (89.1%)
Male	40 (10.9%)
Pharmacy type	
Pharmacies within pharmacy chains (state property)	39 (10.6%)
Pharmacies within pharmacy chains (private)	281 (76.4%)
Independent pharmacies	48 (13.0%)
Degree of education	
Master of pharmacy	307 (83.4%)
Master of pharmacy - Specialist	58 (15.8%)
Master of pharmacy - Doctor of Science	3 (0.8%)
Pharmacy location	
A large city with more than 150,000 inhabitants	233 (63.3%)
A medium-sized city with 50–150,000 inhabitants	71 (19.3%)
A small town with less than 50,000 inhabitants	42 (11.4%)
Rural environment	22 (6.0%)
Working experience (years)	13.9 ± 9.8, 12.0 [14.0][a]
Digital health definition	
Recognize the correct definition	269 (73.1%)
Does not recognize the correct definition	99 (26.9%)
eHealth definition	
Recognize the correct definition	55 (14.9%)
Does not recognize the correct definition	313 (85.1%)
mHealth definition	
Recognize the correct definition	157 (42.7%)
Does not recognize the correct definition	211 (57.3%)

Abbreviations used: eHealth, electronic health; mHealth, mobile health.
[a] Mean ± standard deviation, median [interquartile range].

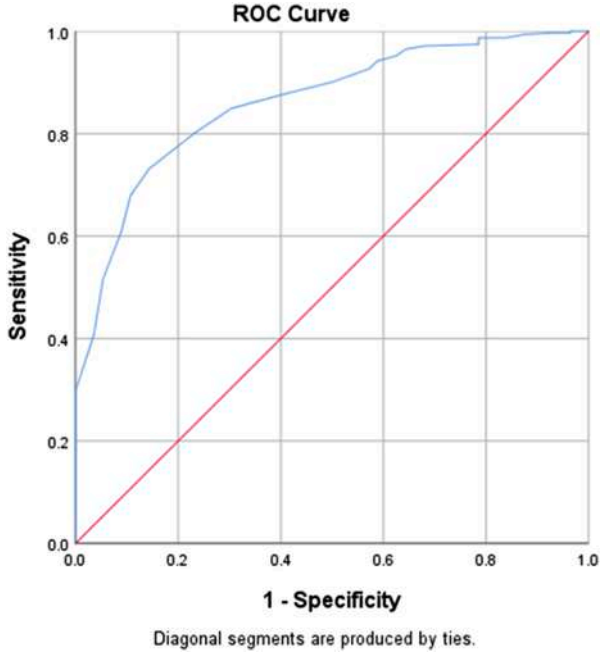

Figure 1. Receiver operating characteristic (ROC) curve for detecting individuals below the 16th percentile (low literacy individuals).

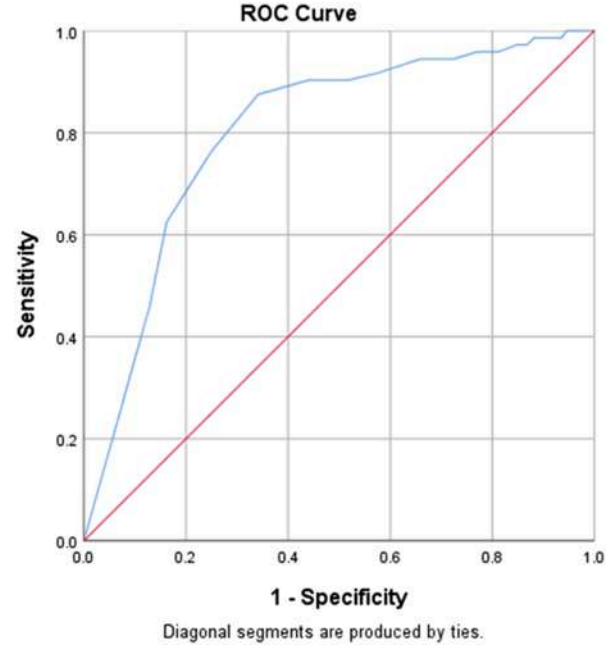

Figure 2. Receiver operating characteristic (ROC) curve for detecting individuals above the 84th percentile (high literacy individuals).

are considered to have high DHTL (164 participants, 44.5%). With this cut-off value, the scale's sensitivity was 87.5%, and its specificity was 65.9%.

The number of individuals between the 16th and 84th percentiles represent individuals with medium DHTL (72 participants, 19.6%).

Cut-off values based on the gDL questionnaire were used to assess the results of the Serbian version of the DHTL-AQ and differentiate levels of DHTL. Low-medium-high profiles were examined, as shown in Table 2.

Significant differences in several key characteristics were observed across the 3 groups with varying levels of DHTL (low, medium, and high). Working experience differed significantly among the groups ($P < 0.001$), with the low-DHTL group having the most experience on average, followed by the medium- and high-DHTL groups. A significant difference was also found in participants' ability to correctly recognize the definition of eHealth ($P = 0.039$), where higher DHTL levels were associated with a greater likelihood of correctly identifying the definition. Furthermore, gDL scores varied significantly across the groups ($P < 0.001$), with the high-DHTL group achieving the highest mean score. Lastly, DHTL questionnaire scores themselves showed significant differences between groups, with the high-DHTL group scoring the highest ($P < 0.001$).

Other gDL results

With respect to social media usage, the results reveal a significant difference between the distributions of social media usage in private and professional environments (Table 3). Only 6.25% of the participants indicated that they do not use social media in their private lives, whereas 41.3% reported that they do not use social media for professional purposes (<0.001).

The most common purpose of using social media in professional environments among community pharmacists was to connect with other pharmacists, of the 368 participants reported by 48.91% of respondents (n = 180). A notable proportion (41.30%, n = 152) indicated that they do not use social media for professional purposes. Other commonly cited reasons included staying updated with current health information (38.32%, n = 141), connecting with other HCPs (32.88%, n = 121), and continuing professional development (32.88%, n = 121). Additionally, 21.74% of respondents (n = 80) reported using social media for the purpose of connecting with patients.

Among the participants, there was a high level of awareness of terms associated with the use of computers and smartphones. More than 90% are familiar with terms such as "Play Store (application store)", “Bluetooth”, “Application (App)”, “Web Browser”, and “Update (synchronization)”.

Other commonly known terms include "Search Bar" (89.95%) and "QR Code" (86.41%). However, awareness begins to decline with terms such as "Cloud" (70.92%), "Domain (URL)" (64.67%), "Voice Assistant (Chatbot)" (53.26%), and "Wearable Device" (47.83%). Notably, only a small fraction of participants (0.82%) indicated that they were unfamiliar with any of these terms.

Discussion

This is the first study to present results on DHTL among community pharmacists in Serbia using a validated questionnaire. To our knowledge, this is the first study to evaluate levels of DHTL among HCPs through this particular approach.

On the basis of the obtained results, recommendations are provided for cut-off values to assess different DHTL profiles: low (≤32.5; 35.9%), medium (32.5 < score <35.5; 19.6%), and high (≥35.5; 44.5%). These findings indicate that the majority of community pharmacies (64.1%) exhibit medium or high levels of DHTL.

Higher values were observed for gDL, with medium and high scores combined accounting for nearly 85% of the participants. This trend aligns with findings from a study conducted in England, which reported high levels of digital literacy among community pharmacy staff.[47]

Conversely, the results indicate that DHTL scores are lower than gDL scores are, with the proportion of participants classified as having low DHTL (35.9%) being notably higher than those with low gDL scores (19.6%). The main statistically significant differentiator is working experience, indicating that participants with less working experience achieved better scores. The group of participants with the highest DHTL scores had a median of 10 years of experience.

The statistically significant difference between groups of participants with different DHTL scores in terms of working experience duration suggests that pharmacists with fewer years in practice may be more adaptable to new technologies. This trend may not solely be a function of shorter tenure but could also reflect greater exposure to digital tools during their continuing professional development, as well as broader generational differences in digital engagement. This aligns with previous research showing that younger members of the pharmacy workforce report higher digital literacy levels[47], and that digital proficiency tends to be greater among younger generations more broadly.[48]

No significant differences in DHTL levels were found across gender, pharmacy type, education, or location ($P > 0.05$), suggesting that these factors do not influence DHTL scores.

An important finding related to gDL is the professional use of social media among pharmacists. Notably, 41.3% of the pharmacists reported that they did not use social media for professional purposes. Among those who do, the primary use was communication with other HCPs, whereas patient interaction was the least frequently selected option. Similar to findings from a study conducted in England[47], Facebook, YouTube, and Instagram remain the most widely used social media platforms among pharmacists. Additionally, our research identifies Viber as another highly utilized platform. The use of social media for professional purposes, although not widespread, underscores its potential as a valuable tool for communication, information dissemination, and continuous education among pharmacists.

The most common terms associated with the use of computers and smartphones are well known to pharmacists. However, there is room for improvement in understanding less frequently used terms, such as 'Voice Assistant' and 'Wearable Device', which are known to only approximately half of the participants. This knowledge gap is particularly important considering the rapid growth in AI-driven tools and

Table 2
Comparison of low-, medium-, and high-literacy individuals according to the results of the digital health technology literacy assessment questionnaire serbian version

Characteristics	N = 368	Low DHTL (score ≤ 32.5, n = 132 [35.9%])	Medium DHTL (32.5 > score <35.5, n = 72 [19.6%])	High DHTL (score => 35.5, n = 164 [44.5%])	Test statistic (df), *P* value
Working experience (y)	368 (100.0%)	16.8 ± 11.0, 15.0 [16.8][a]	13.5 ± 9.6, 13.0 [13.8][a]	11.7 ± 8.3, 10.0 [11.8][a]	H (2) = 15.70, $P < 0.001$
Gender					χ^2 (2) = 0.86, $P = 0.650$
Male	40 (10.9%)	13 (32.5%)	10 (25.0%)	17 (42.5%)	
Female	328 (89.1%)	119 (36.3%)	62 (18.9%)	147 (44.8%)	
Pharmacy type					χ^2 (4) = 3.66, $P = 0.454$
Pharmacy chain (state property)	39 (10.6%)	19 (48.7%)	7 (18.0%)	13 (33.3%)	
Pharmacy chain (private)	281 (76.4%)	97 (34.5%)	54 (19.2%)	130 (46.3%)	
Independent pharmacies	48 (13.0%)	16 (33.3%)	11 (22.9%)	21 (43.8%)	
Degree of education					Fisher's exact test, $P = 0.521$
Master of pharmacy	307 (83.4%)	113 (36.8%)	62 (20.2%)	132 (43.0%)	
Master of pharmacy - Specialist	58 (15.8%)	17 (29.3%)	10 (17.2%)	31 (53.5%)	
Master of pharmacy -Doctor of Science	3 (0.8%)	2 (66.7%)	0 (0.0%)	1 (33.3%)	
Pharmacy location					Fisher's exact test, 0.372
A large city with more than 150,000 inhabitants	233 (63.3%)	77 (33.0%)	50 (21.5%)	106 (45.5%)	
A medium-sized city with 50–150,000 inhabitants	71 (19.3%)	29 (40.8%)	11 (15.5%)	31 (43.7%)	
A small town with less than 50,000 inhabitants	42 (11.4%)	16 (38.1%)	10 (23.8%)	16 (38.1%)	
Rural environment	22 (6.0%)	10 (45.5%)	1 (4.5%)	11 (50.0%)	
Digital health definition					χ^2 (4) = 4.66, $P = 0.324$
Recognize the correct definition	269 (73.1%)	93 (34.6%)	49 (18.2%)	127 (47.2%)	
Does not recognize the correct definition	99 (26.9%)	39 (39.4%)	23 (23.2%)	37 (37.4%)	
eHealth definition					χ^2 (4) = 10.08, $P =$ **0.039**
Recognize the correct definition	55 (14.9%)	21 (38.2%)	5 (9.1%)	29 (52.7%)	
Does not recognize the correct definition	313 (85.1%)	111 (35.5%)	67 (21.4%)	135 (43.1%)	
mHealth definition					χ^2 (4) = 6.54, $P = 0.162$
Recognize the correct definition	157 (42.7%)	47 (29.9%)	32 (20.4%)	78 (49.7%)	
Does not recognize the correct definition	211 (57.3%)	85 (40.3%)	40 (18.9%)	86 (40.8%)	
General digital literacy questionnaire total score	368 (100.0%)	51.2 ± 13.4, 52.0 [19.0][a]	58.4 ± 9.3, 59.0 [13.0][a]	66.7 ± 7.9, 68.0 [12.0][a]	**H(2) = 318.28, *P* < 0.001**
Digital health technology literacy questionnaire total score	368 (100.0%)	27.4 ± 5.3, 29.0 [6.0][a]	34.2 ± 0.8, 34.0 [1.7][a]	37.8 ± 1.2, 38.0 [2.0][a]	**H(2) = 113.82, *P* < 0.001**

[a] Mean ± standard deviation, median [interquartile range].
Abbreviations used: DHTL, Digital Health Technology Literacy; eHealth, electronic health; mHealth, mobile health.

Table 3
Usage of different social media platforms by community pharmacists in private and professional environments

Social media platform	Usage for private purposes (n = 368)	Usage for professional purposes (n = 368)
Facebook	233 (63.32%)	48 (13.04%)
Instagram	261 (70.92%)	86 (23.37%)
Twitter/X	30 (8.15%)	3 (0.82%)
LinkedIn	122 (33.15%)	38 (10.33%)
YouTube	291 (79.18%)	49 (13.32%)
WhatsApp	215 (58.42%)	45 (12.23%)
Viber	325 (88.32%)	172 (46.74%)
TikTok	48 (13.04%)	2 (0.54%)
I don't use social media	23 (6.25%)	152 (41.30%)

wearable health technologies. Wearable devices, such as smartwatches or fitness trackers, can facilitate continuous health monitoring, support chronic disease management, and improve patient engagement through real-time feedback.[49] Similarly, voice assistants powered by AI are increasingly being integrated into medication adherence tools, health information delivery, and even remote patient monitoring.[50,51] Limited familiarity with these technologies among pharmacists could hinder their ability to effectively recommend, implement into care plans, or counsel patients on digital health solutions.

This study has several limitations. First, while efforts were made to ensure a broad and diverse sample through a combined distribution strategy (online and field-distributed paper surveys), the sampling approach was not purely random and may introduce selection bias. We acknowledge the potential concern that individuals who completed the online version of the questionnaire may inherently possess higher digital health literacy. To mitigate this, we used both online and paper-based formats to encourage participation from individuals with varying levels of digital proficiency. Second, the reliance on self-reported data may be subject to response biases, such as social desirability or inaccurate recall. Third, the cross-sectional nature of the study limits the ability to draw causal conclusions or observe changes in DHTL over time.

The findings of this study indicate that community pharmacists in Serbia possess a relatively high level of DHTL, which is crucial for the effective implementation of DHTs in pharmacy practice. The strong outcomes in gDL and DHTL suggest that the majority of pharmacists are well prepared to integrate digital tools into their professional activities. However, the lower scores observed in a subset of participants highlight the need for targeted educational interventions to increase DHTL among all pharmacists.

Our results are complementary to findings from other studies that have assessed DL among HCPs. For instance, a study conducted by the World Health Organization[52] highlighted the importance of digital health literacy in overcoming barriers for health workers. Similarly, Turnbull et al.[53] identified both barriers to and facilitators of the use of digital health tools by health care practitioners. These studies emphasize the need for ongoing training and support to enhance DL among HCPs.

By specifically assessing the levels of DHTL among Serbian pharmacists, our work contributes to identifying areas for improvement and aids in designing targeted training programs. While the general use of various digital technologies is well established, greater emphasis should be placed on training that enables the full integration of DHTs in community pharmacies. This will not only streamline pharmacists' workflow but also enhance their ability to support patients effectively. Special attention should be given to tailoring support on the basis of the needs of different age groups to ensure effective adoption. This approach ensures that training efforts are well focused and address the specific needs of pharmacists, ultimately enhancing their digital competencies.[54]

Future research should consider expanding the sample size and participant diversity to enhance the generalizability of findings across various health care settings and populations. Validation of the DHTL-AQ in other countries and cultural contexts is also recommended to establish cross-national relevance. Longitudinal studies would be valuable to examine temporal trends and potential causal relationships in DHTL development. Additionally, intervention-based research targeting identified DHTL deficiencies could inform the design of scalable training programs applicable in Serbia and other low-resource or digitally transitioning health systems. Finally, qualitative or mixed-methods studies could help uncover barriers to DHT use, particularly among participants with low DHTL, providing deeper insights into user behavior, motivations, and contextual challenges.

The methodology employed in this study provides a practical and adaptable framework for evaluating DHTL among pharmacists. Given its straightforward application and relevance to evolving pharmacy practice, this framework may be used in other countries to guide the identification of specific training needs and to support the development of pharmacist-led digital health services tailored to diverse health care settings.

Conclusion

This study provides the first comprehensive assessment of DHTL among community pharmacists in Serbia. These findings indicate that while Serbian pharmacists generally possess strong gDL skills, there is a need for targeted educational interventions in specific areas and across different subgroups of the pharmacist population.

The significant impact of working experience on DHTL scores and the use of social media for professional purposes highlight important areas for further improvement and training. Our research highlights the importance of tailored interventions in enhancing DHTL and the applicability of DHT in the routine practice of community pharmacists.

Disclosure

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Supplementary data

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