

An exploratory survey of the digital technology readiness of the health care workforce across nine EU member states

Badanie eksploracyjne gotowości pracowników opieki zdrowotnej do korzystania z technologii cyfrowych w dziewięciu państwach członkowskich UE

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STRESZCZENIE

BADANIE EKSPLOKACYJNE GOTOWOŚCI PRACOWNIKÓW OPIEKI ZDROWOTNEJ DO KORZYSTANIA Z TECHNOLOGII CYFROWYCH W DZIEWIĘCIU PAŃSTWACH CZŁONKOWSKICH UE

Wprowadzenie. Niedawne kryzysy, takie jak COVID-19, cyberataki na infrastrukturę cyfrową opieki zdrowotnej, masowa migracja i wojna, podkreślają kluczową rolę technologii cyfrowej w świadczeniu usług. Ustanowienie Programu UE dla zdrowia 4 w 2021 r. podkreśliło potrzebę kompleksowego podniesienia umiejętności cyfrowych pracowników w całej UE, z naciskiem na odporność na kryzysy. Obecnie nie ma prawie żadnych badań porównawczych pracowników w całej UE w tej dziedzinie, które mogłyby pomóc w skutecznym wdrażaniu polityki.

Cel pracy. Zbadanie wykorzystania technologii cyfrowych, wyrażonych potrzeb szkoleniowych, dobrego samopoczucia i postrzegania zdolności organizacyjnych związanych z technologią cyfrową wśród pracowników opieki zdrowotnej w dziewięciu krajach Unii Europejskiej.

Metody. Opracowano 36-punktową ankietę koncentrującą się na kompetencjach cyfrowych, wykorzystaniu technologii cyfrowych, świadomości cyberbezpieczeństwa, potrzebach szkoleniowych, poczuciu dobrostanu i postrzeganiu gotowości organizacyjnej do wdrożenia zmian cyfrowych, wykorzystując wygodny dobór próby. Do celów analizy respondenci zostali podzieleni na personel kliniczny i niekliniczny. Dane zostały przeanalizowane przy użyciu SPSS zgodnie z wcześniej zarejestrowanym planem analizy.

Wyniki. Po oczyszczeniu danych przeanalizowano odpowiedzi 2 028 respondentów. Personel niekliniczny wykazał się wyższą biegłością i wskaźnikami wykorzystania technologii cyfrowych. Znaczące różnice między personelem nieklinicznym i klinicznym odnotowano w zakresie świadomości bezpieczeństwa, przy czym personel kliniczny miał znacznie mniejszą wiedzę/świadomość. Wszyscy respondenci postrzegali swoje organizacje jako tylko umiarkowanie gotowe do wdrożenia cyfrowych zmian w opiece zdrowotnej.

Wnioski. Te wstępne wyniki podkreślają potrzebę opracowania polityki i działań, które zwiększą kompetencje cyfrowe pracowników opieki zdrowotnej w całej UE. Wyniki sugerują również, że trzeba zająć się zdolnościami organizacyjnymi, żeby wspierać zarówno szkolenia pracowników, jak i efektywne wykorzystanie ich umiejętności cyfrowych po ich zdobyciu.

Słowa kluczowe:

cyfrowa infrastruktura zdrowotna, polityka zdrowotna UE, pracownicy opieki zdrowotnej, ankieta, gotowość cyfrowa, cyberbezpieczeństwo

ABSTRACT

AN EXPLORATORY SURVEY OF THE DIGITAL TECHNOLOGY READINESS OF THE HEALTH CARE WORKFORCE ACROSS NINE EU MEMBER STATES

Introduction. Recent crises such as COVID-19, cyber-attacks on health care digital infrastructure, mass migration and war, highlight the crucial role of digital technology in service delivery. The establishment of the EU4 Health Programme in 2021, emphasized the need for an EU wide comprehensive enhancement of workforce digital skills with an emphasis on crisis resilience. At present there is almost no comparative EU wide workforce survey research in this area to inform effective policy implementation.

Aim. To explore the use of digital technologies, the expressed training needs, the wellbeing and perception of organisational capacities referenced to digital technology across health care workforce in nine European Union states.

Methods. A 36-item survey was developed focused on digital competencies, digital use, cybersecurity awareness, training needs, sense of wellbeing and perception of organisational readiness to implement digital change, utilising convenience sampling. For purposes of analysis workforce respondents were divided between clinical and non-clinical staff. Data was analysed using SPSS according to a pre-registered analysis plan.

Results. After data cleaning, 2,028 respondents' answers were analysed. Non-clinical staff demonstrated higher proficiency and usage rates in digital technologies. Significant differences between non-clinical and clinical staff were noted in security awareness, with clinical staff having significantly less knowledge/ awareness. All respondents perceived their organisations as only moderately ready to implement digital health care change.

Conclusions. These exploratory results highlight need for policy development and interventions that enhance digital competencies across the EU health workforce. The results also suggest there is a need to address organisational capacities to support both training of the workforce and effective use of the workforce's digital skills once these are acquired.

Key words:

digital health infrastructure, EU health policy, health care workforce, survey, digital readiness, cybersecurity

INTRODUCTION

In 2024, the European Union (EU) Parliament approved an agreement to establish a European Health Data Space [1] to enable transfer patients' health data to health professionals in other EU countries (with the patient's permission). This legislation is a significant step towards the digital integration of health systems across the EU. Online digital health records integrated digital health care systems and increased use of mobile devices are an essential part of health care operations and delivery in many EU member states and beyond. At the same time, sudden 'surge' events such as the recent COVID-19 pandemic have emphasised both the increased importance of digital technology as a

key response component to a sudden health emergency and how unprepared health services can be for such events.

In an increasingly unstable international environment consequent of climate change, population movement, faltering multilateralism and international conflict, health care services are now in the top tier of deliberate Information Technology (IT) attack [2] because of the significant social, political and economic impacts that can result. Common cyber-attacks on networked health services include distributed denial of service attacks, stealing large data sets, interference with digital system operations, and, in some very rare cases, targeting of a specific patient [3,4]. As systems become more digital network integrated

so their vulnerability to incompetent operation or exposure to deliberate attack can lead to significant and, potentially, catastrophic delivery failure [5]. (Reuters, 2024).

The United States (US) based website Techtarget Health IT Security, which specialises in reporting on cyber security in health services states that 540 US organizations reported data breaches impacting upwards of 112 million individuals in 2023 alone [6]. The European Union Agency for Cybersecurity reports that 54% of cybersecurity threats to EU health services involve ransomware attacks. Hospitals are subject to such attacks accounting for 42% of reported incidents [7]. Vulnerability to cyberattacks or the accidental release of data are, in most cases, the result of human error from within health care organisations [7]. This suggests that the digital competencies and awareness of cyber security of many working within health services are less than optimal for the challenges currently posed.

In 2021, the EU Parliament established the EU4Health programme to improve the crisis preparedness and resilience of Europe's health systems [6]. Within digital health technology implementation there tends to be an emphasis on the technical aspects of its employment and protection (for example, firewalls) with little focus on the skilling of the diverse individuals in the health workforce who use it [4]. The World Health Organization (WHO) Global Strategy on Digital Health 2020 - 2025 also notes "many countries still require institutional support for the development and consolidation of national eHealth and/or digital health strategies and the implementation of their action plans, which usually requires more resources and capabilities"[9].

Because of the dynamic of change that digital technologies induce, the health care workforce can find it difficult to keep constantly updated and competent in its use. This negatively affects both organisational and individual competency and health care workers sense of wellbeing [10]. As COVID-19 demonstrated health care workers' psychological wellbeing can have serious impacts on the delivery of health services in times of crisis [11,12].

The Organisation for Economic Co-operative Development (2021) identified professional resistance to and acceptance of the value of digital technologies combined with a lack of a clear management vision and understanding in their deployment as barriers to the take up of digital training amongst health care workers [13]. The Committee on Digital Skills for Health Professionals of the European Health Parliament (2016) reported that part of the problem with overcoming professional resistance to use and training is that the health workforce is rarely consulted about what digital skills they need and how they should be delivered [14]. It stated that there was a failure to develop and make available Continuous Professional Development (CPD) programmes to support and reinforce digital skills acquisition. It is possible that this resistance reflects health professionals feeling overworked and lacking the personal, psychological and physical resources to keep up to date on top of their duties and obligations [15].

Several recent systematic reviews investigating health care workers' digital competencies and skills have reported that available surveys are either national, highly local (for example one clinical service in a particular location) or focused on one discipline (nurses or radiographers for example) [15,16]. Moreover, a few studies exceed sample sizes of 400 while other studies examined the degree to which digital health technologies improve health care workforce performance [17].

Whilst such surveys have utility within the context of digitization health policy and upskilling of specific disciplines they have some limitations. Health care is a multi-disciplinary endeavour and this implies that there needs to be a shared understanding in the use of digital technologies, with a concomitant need for comparative workforce analysis in terms of understanding, use and training needs. As health care systems become more integrated across the EU – for example through the establishment of the European Health Union and the EU Health Data Space- digital competencies and skills will need to be standardised across the EU health workforce. This is even more so relevant/critical when referenced to the EU principle of the free movement of labour, in which the health workforce is one of the most mobile across Europe [18,19].

Reports such as that of Fahy and Williams (2021) and a European Observatory on Health Systems and Policies sponsored webinar 'European health workforce and the digital skills gap: what is the EU's role in closing the divide?' (<https://www.youtube.com/watch?v=zReCjXyldoo>) held in 2022, indicates that the pace of training of the European health care workforce is not keeping up with the rapid and extensive adoption of digital technologies [20]. The European Commission emphasises the key need to combat threats to the digital infrastructure of the European health care system means that a clear and comprehensive understanding of the European health care workforce in terms of cybersecurity awareness training and resilience needs is warranted [21,22]. The establishment and implementation of this exploratory survey is referenced, therefore, to these needs. The aim was to explore the digital skills, use of digital technologies and training needs of the health care workforce across nine EU countries, referenced to the need to build workforce resilience and crisis responsiveness in support of an integrated EU health care infrastructure. Specific aims were to explore differences in use, knowledge, skills, training, wellbeing and organizational readiness regarding digital technology between clinical and non-clinical staff.

METHODS

Design

This pan European survey was designed an initial 'mapping' exercise and across EU comparative analysis of health care workers. Therefore, the study was classified as exploratory in nature and reflected by an 'open design' approach to the survey instrument [23].

Survey Instrument development and validity

Through a review of the literature and consultation with healthcare professionals, experts in the field of digital technologies within health care (including cybersecurity) and multi-disciplinary health care professional educators drawn from across the EU initial question domains were developed. Survey construction was then informed further by a review of several established validated instruments as following: (1) the European DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes [24]; (2) the Organizational readiness for implementing change (ORIC) instrument [25] and (3) the World Health Organisation 5 (WHO 5) Wellbeing Index [26]. The survey construction was also informed by the All-Ireland Digital Capability Framework [27] and the OECD Skills for the Digital Transition [13]. Subject matter experts within the extensive project team drawn from the nine participating countries within the EU reviewed the survey instrument in its English format to ensure content validity.

The survey instrument developed was translated into the following languages: Croatian, English, German, Italian, Latvian, Lithuanian, Polish, Slovenian and Spanish. The English text was translated using an artificial intelligence translation tool (DeepL). Each jurisdictional team was then asked to engage in a backtranslation exercise compared to the original English version.

The final Survey consisted of 36 questions to measure reported frequency of use, knowledge, skill, training and wellbeing as these related to digital and electronic associated instruments and cybersecurity issues used within health care settings (closed questions and Likert scale-based questions). The survey in word and Qualtrics® format was then published on the Open Science Framework (<https://osf.io/sf5xr/>).

The reliability of the questions adopted from the European DigComp 2.2: The Digital Competence Framework for Citizens (=12 items relating to knowledge, skills and attitude), was determined by calculating the Cronbach's alpha coefficient, which was 0.92. The 5-Item World Health Organisation (WHO-5) Wellbeing Index Instrument was incorporated into the survey and the Cronbach's alpha coefficient was 0.90. The Organisational Readiness to Implement Change (ORIC) instrument was integrated within the survey to measure organisational readiness to implement digital health resulting in a Cronbach's alpha coefficient of 0.96 for the 12 items of the ORIC scale, 0.92 for Change Commitment, and 0.93 for Change efficacy [25]. Additional items generated by the research team to measure frequency of use, training received, elements relating to cybersecurity and concerns when using patient information systems, were also included. The overall Cronbach's alpha coefficient was found to be to 0.66, which is below the commonly accepted threshold of 0.70. Post-hoc reliability analysis indicated that items relating to confidence in accessing digital data and using digital tools were negatively affecting the internal consistency of the Survey. Following established psychometric guidelines [28], these two items were removed. The refined version, consisting of 34 items achieved a Cronbach's alpha

of 0.75. All subsequent analyses were conducted using the revised scale. In addition, three questions relating to training were incorporated into the survey and were ranked or allowed for multiple answers, therefore this data is nominal or binary in nature and was not included in the analysis for Cronbach's alpha coefficient. These questions allowed the reporting of frequency of training and training needs across various relevant topics and were therefore included in the final analysis.

Setting(s)

Utilising a convenience sampling approach and reflecting the nationalities of the institutions involved in this research, the survey was promoted extensively at all levels of health care services in nine countries – Croatia, Ireland, Germany, Italy, Latvia, Lithuania, Poland, Slovenia and Spain.

Ethics

The Helsinki Declaration was followed, and all participants were informed about the study aim and the possibility to withdraw from the survey at any time. This information was included as an introduction to the survey. To gain access to the survey, a participant had to click a button stating that “I agree and confirm that I consent to participate in this survey”. Ethical approval was granted in accordance with the requirements of the appropriate jurisdictional research ethics committees in each of the nine countries involved from the following organisations: South East Technological University, University College Dublin, University of Maribor, Medical University of Lublin, University of Udine, Azienda Unita Sanitaria Locale Di Teramo, University of Osijek, Ostfalia University of Applied Sciences, Klaipėdos University, the Red Cross Medical College of Rīga Stradiņš University between August and October 2023.

Data collection and analysis

The survey was implemented on the Qualtrics® platform based at Southeast Technological University (SETU), Ireland before data was imported into the IBM Statistical Package for Social Sciences (SPSS) 29 for analysis. Data collection took place between November 2023 and January 2024. The survey was promoted by teams based in each participating country through their established professional networks, conferences, social media and a survey project newsletter issued to doctors, nurses, professions allied to medicine and non-clinical staff working in health care settings in the respective jurisdictions.

The participants were divided into clinical (nurses, other healthcare professionals and medical doctors) and non-clinical (managers, senior managers, support staff and administrators) respondents for the purpose of analysis.

Frequencies and percentages were calculated for categorical measures, and measures of central tendency and distribution were calculated for Digcomp 2.2 items relating to knowledge and skills, WHO-5 and ORIC scores. Pearson's Chi-Square test was used to test associations between categorical measures. The non-parametric

Mann-Whitney U-test was used to test bivariate associations between Digicomp 2.2 scale items, WHO-5 scores and ORIC scores with the dichotomous measure of clinical or non-clinical participants. Age was identified as a possible contributing factor in scale analysis, with Spearman's rank correlation used to assess the strength and direction of the relationship between age and Digicomp 2.2 items, WHO-5 scores and ORIC scores. To control for the increased risk of Type I errors associated with multiple comparisons, a Bonferroni correction was applied with each conceptual domain of frequencies, knowledge, skills, training, organisational readiness to implement change and age. The corrected alpha level was calculated by dividing the conventional significance threshold ($\alpha = 0.05$) by the number of comparisons within each domain. Corrections were applied across domains based on the number of items tested.

RESULTS

Two Thousand and Twenty-Eight survey responses were recorded. After 'cleaning' data, remaining responses (n=2023) were analysed according to the pre-registered data analysis plan. The mean age of participants was 43.3 (SD: 11.8). One thousand five hundred and ten respondents identified as female (74.7%); 494 as male (24.4%); seven as non-binary/third gender (0.3%) and 11 as prefer not to say (0.5%).

Respondents were from Italy (n=530; 26.1%), Slovenia (n=335; 16.5%), Poland (n=298; 14.7%), Germany (n=249; 12.3%), Croatia (n=211; 10.4%), Spain (n=152; 7.5%), Ireland (n=143; 7.1%), Latvia (n=53; 2.6%) and Lithuania (n=46; 2.3%). Places of work were hospitals (n=1309; 65.3%), primary care (n=428; 21.3%) and community service (n=268; 13.4%). Professional/occupational iden-

ties of respondents were nurses (n=894; 44.1%); other healthcare professionals (n=386; 19 %); medical doctors (n=354; 17.5%); managers (n=143; 7.1%); senior managers (n=85; 4.2%); support staff (n=81; 4%) and administrators (n=80; 3.9%).

Clinical respondents were 1634 (80.8%) and non-clinical 389 (19.2%).

Frequencies

As reported in Tab. 1, non-clinical staff reported a higher percentage of using digital tools "very often" in the last two weeks when compared to their clinical peers such as video conferencing software (21.7%; n=77 versus 8.8%; n=130), data analysis software (19%; n=63 versus 6.5%; n=91), desktop/laptop (95.1%; n=366 versus 86.2%; n=1366), smartphone (78.2%; n=287 versus 57.6%; n=865), mobile tablet (25.2%; n=78 versus 14.9%; n=204) and robotics (3.2%; n=7 versus 1.9%; n=23). Non clinical staff also reported lower percentages of using video conferencing software (19.2%; n= 68 versus 39.3%; n=580), data analysis software (27.7%; n=92 versus 48.5%; n=679), desktop/laptop (0.5%; n=2; 1.4%; n=22), smartphone (5.4%; n=20 versus 14%; n=210), mobile tablet (42.7%; n=132 versus 57.4%; n=787) or robotics (79.6%; n=176 versus 86.4%; n=1038) "never" in the last two weeks when compared to clinical staff.

In contrast, a higher percentage of clinical staff reported using electronic health records (44.1%; n=650 versus 30.2%; n=89), sensors (24.4%; n=330 versus 14.8%; n=34) and automated medical dispensers (3.8%; n=44 versus 3.5%; n=7) "very often" in the last two weeks compared to non-clinical staff. Clinical staff also reported lower percentages of using electronic health records (21.7%; n=320 versus 30.2%; n=89), sensors (41.1%; n=555 versus 53.9%; n=124) and automated medical dispensers (83.9%; n=972 n= versus 87.1%; n=175) "never" in the last two weeks compared to non-clinical staff.

■ Tab. 1. Differences in frequency survey responses between clinical and non clinical staff (Statistically significant responses only)

	Very often	Often	Sometimes	Rarely	Never	χ^2 (df)	p Value
Video conferencing*							
Clinical	130 (8.8%)	187 (12.7%)	303 (20.5%)	277 (18.8%)	580 (39.3%)	112.73 (4)	< 0.001*
Non clinical	77 (21.7%)	93 (26.2%)	66 (18.6%)	51 (14.4%)	68 (19.2%)		
Data analysis software							
Clinical	91 (6.5%)	142 (10.2%)	225 (16.1%)	262 (18.7%)	679 (48.5%)	104.26 (4)	< 0.001*
Non clinical	63 (19%)	73 (22%)	48 (14.5%)	56 (16.9%)	92 (27.7%)		
Electronic health records							
Clinical	650 (44.1%)	245 (16.6%)	147 (10%)	112 (7.6%)	320 (21.7%)	21.85 (4)	< 0.001*
Non clinical	89 (30.2%)	59 (20%)	36 (12.2%)	22 (7.5%)	89 (30.2%)		
Smartphone							
Clinical	865 (57.6%)	209 (13.9%)	134 (8.9%)	85 (5.7%)	210 (14%)	55.46 (4)	< 0.001*
Non clinical	287 (78.2%)	32 (8.7%)	20 (5.4%)	8 (2.2%)	20 (5.4%)		
Mobile tablet							
Clinical	204 (14.9%)	83 (6.1%)	135 (9.9%)	161 (11.8%)	787 (57.4%)	28.81 (4)	< 0.001*
Non clinical	78 (25.2%)	25 (8.1%)	37 (12%)	37 (12%)	132 (42.7%)		
Sensors							
Clinical	330 (24.4%)	182 (13.5%)	160 (11.8%)	125 (9.2%)	555 (41.1%)	22.29 (4)	< 0.001*
Non clinical	34 (14.8%)	19 (8.3%)	24 (10.4%)	29 (12.6%)	124 (53.9%)		

χ^2 = Pearson Chi Square; df = degrees of freedom; Some percentages calculated using denominator less than stated total due to missing data; * Significance at the 0.005 level (2-tailed; Bonferroni correction applied)

By applying a Bonferroni correction to control for the increased risk of Type I error, the adjusted significance threshold was set at $p < 0.005$ ($0.05/11$). Non clinical staff reported a significant higher frequency of use in several areas, with chi square analysis revealing associations for video conferencing ($p < 0.001$), data analysis software ($p < 0.001$), smart phone ($p < 0.001$) and mobile tablet ($p < 0.001$). Clinical staff reported a statistically significant higher use of electronic health records ($p < 0.001$), and sensors and wearable devices ($p < 0.001$). No associations were found for desktop/laptop, digital prescription software, automated medicine dispensers, robotics and clinical decision support systems.

Knowledge

The data identifies distinct trends in the reported knowledge between clinical and non-clinical respondents (Tab. 2). Bonferroni correction for multiple comparisons within the knowledge domain was applied (adjusted $\alpha = 0.017$). Nonclinical staff reported higher knowledge scores in all responses than clinical staff. The associations were significant for the following statements: ‘I understand the benefits and also the safety risks when using Internet-connected devices or systems’ ($p < 0.001$), ‘I understand the importance of keeping the operating system, antivirus and other software up to date in order to prevent security issues’ ($p < 0.001$) and ‘I know which personal data I should not share and display online’ ($p = 0.004$).

Clinical staff respondents reported higher percentages of having no understanding of the benefits and the safety risks of internet-connected devices or systems (4.7% versus 2.2%) or only having a limited understanding of this and needing more explanation (34.1% versus 27.2%) when compared to non-clinical staff. The percentage of clinical staff reporting no understanding of the importance of keeping the operating system, antivirus and other software up to date to protect security issues was higher compared to non-clinical staff (1.1% versus 0.5%) with 22.8% of clinical staff reporting a limited understanding compared to 15% of non-clinical staff. None of the non-clinical respondents (0.0%) reported having no understanding of which personal data they should not share and display online compared to 0.9% of clinical staff. In relation to having a limited understanding a higher percentage of clinical staff was reported compared to non-clinical (10.8% versus 9.6%).

The analysis of age in relation to knowledge scale items revealed significant, small and negative correlations. Specifically, Spearman’s correlations coefficients ranged from $\rho = -0.13$ to $\rho = -0.20$, all of which were significant at $p < 0.01$ following Bonferroni correction. There are weak negative correlations between age and knowledge items, with age accounting for at maximum 4% of the variance in knowledge scale scores.

Skills

The distribution of responses for each item that indicated statistically significant differences are summarised in Tab. 3. Before applying Bonferroni correction, the statements were statistically significant between clinical and

non-clinical respondents in 4 out of 8 areas, such as ‘I know how to check that the website where I am asked to provide personal data is secure’ ($p < 0.01$); ‘I know how to protect myself from unwanted and malicious online encounters and materials’ ($p < 0.05$); ‘I know how to select the right tool, device or service to perform a given task’ ($p < 0.01$); and ‘I can use data tools’ ($p < 0.001$). After applying Bonferroni correction (adjusted $\alpha = 0.006$) only the last statement reached statistical significance. Other areas that did not indicate statistically significant differences included knowing how to configure the settings of a firewall on different devices; how to recover digital information and other content from a backup; use of data tools that manage and organize complex information to make decisions and solve problems; and use of online learning tools to improve digital skills. However, the data does suggest trends in the reported skills with nonclinical staff reporting higher skill scores in all responses when compared to clinical staff.

Clinical staff reported higher percentages of not knowing how to check a website is secure (18.8% versus 15.1%) compared to non-clinical staff. Clinical staff also reported a higher percentage of knowing how to do it with help (31.9% versus 25.8%) compared to non-clinical staff. The percentage of clinical staff reporting not knowing how to protect themselves from unwanted and malicious online encounters reported higher compared to non-clinical staff (14.9% versus 13.4%). Conversely, when given help, a higher percentage of clinical staff reported that they could protect themselves from these compared to non-clinical staff (31.5% versus 26.3%). Clinical staff reported higher percentages of not knowing how to select the right tool, device or service (9.0% versus 6.8%), however a higher percentage of clinical staff indicated they would know how to do it with help (28.3% versus 22.7%) compared to non-clinical respondents. The percentage of

■ Tab. 2. Differences in knowledge survey item responses between clinical and non clinical staff

	I fully understand this and could explain it to others n (%)	Mean (SD)	U	P value
I understand the benefits and also the safety risks when using Internet-connected devices or systems (e.g. smart watches, smart home devices).				
Clinical	225 (14.9%)	2.71 (0.77)	246344	< 0.001*
Non clinical	71 (19.3%)	2.88 (0.74)		
I understand the importance of keeping the operating system, antivirus and other software up-to-date in order to prevent security issues.				
Clinical	346 (22.9%)	2.98 (0.71)	245637	< 0.001*
Non clinical	107 (29.2%)	3.13 (0.67)		
I know which personal data I should not share and display online (e.g. on social media).				
Clinical	536 (35.5%)	3.23 (0.67)	251133	0.004*
Non clinical	160 (43.8%)	3.34 (0.65)		

U = Mann Whitney U test; Some percentages calculated using denominator less than stated total due to missing data; * Significance at the 0.017 level (2-tailed: Bonferroni correction applied)

clinical respondents reporting not knowing how to use data tools was highest of all compared to non-clinical staff (32.7% versus 22.3%) with 42.1% of clinical staff reporting they would know how to do it with help compared to 39.6% of non-clinical staff.

■ Tab. 3. Differences in skill survey item responses between clinical and non clinical staff (Statistically significant responses only, before Bonferroni correction)

	I know how to do it with confidence and, if needed, I can support/guide others	Mean (SD)	U	P value
I know how to check that the website where I am asked to provide personal data is secure (e.g. https sites, safety logo or certificate)				
Clinical	203 (13.5%)	1.44 (0.95)	248455	0.003
Non clinical	56 (15.3%)	1.59 (0.92)		
I know how to protect myself from unwanted and malicious online encounters and materials (e.g. spam messages, identity theft emails)				
Clinical	215 (14.3%)	1.53 (0.91)	256537	0.035
Non clinical	61 (16.7%)	1.64 (0.92)		
I know how to select the right tool, device or service to perform a given task (e.g. select a smartphone for my needs, choose a tool for a professional videocall).				
Clinical	258 (17.2%)	1.71 (0.86)	248073	0.002
Non clinical	82 (22.4%)	1.86 (0.84)		
I can use data tools (e.g. databases, data mining and analysis software) that manage and organise complex information to make decisions and solve problems)				
Clinical	80 (5.4%)	0.98 (0.86)	224021	< 0.001*
Non clinical	44 (12.1%)	1.28 (0.94)		

U = Mann Whitney U test; Some percentages calculated using denominator less than stated total due to missing data; * Significance at the 0.006 level (2-tailed; Bonferroni correction applied)

Spearman's correlations coefficients for age and skill items ranged from $\rho = -0.14$ to $\rho = -0.28$, all of which were not statistically significant following Bonferroni correction. The analysis indicated that age has a small effect on scores on the skill items, with variables sharing at maximum 8% of the variance.

Training

Respondents were asked to indicate if they had received training in particular topics in the last 12 months. Five hundred and twenty-six (26%) reported cybersecurity, 420 (21%) reported electronic health records, 298 (15%) reported computer skills, 245 (12%) reported use of digital and mobile communication devices and 238 (12%) identified digital data management and analysis as training they had received. Regarding whether an employer provided stress management training in the last 12 months, there was a significant association between role and provision of training with 28% (n=94) of non-clinical staff indicating they had received training compared with only 14% (n=194) of clinical staff ($p < 0.001$).

When asked to rank in order of preference areas where they would like training, 430 (21%) ranked cybersecurity, followed by emergency preparedness (n=336; 17%), using electronic health records (n=283; 14%), personal wellbeing (n=231; 11%), telehealth and mobile health in patient care (n=179; 9%), organisational resilience (n=99; 5%) and management of health and climate change (n=58; 3%). Initial analysis indicated there was a significant association between role and a preference for training in emergency preparedness ($p < 0.001$) with 22% (n=290) of clinical staff ranking emergency preparedness as number 1 compared with 14% (n=46) of non-clinical staff. A higher proportion of clinical participants (4%; n=50) also ranked management of health impacts of climate change as number 1 compared with non-clinical participants (2.5%, n=8), ($p = 0.023$). In contrast, 12 % (n=38) of non-clinical participants ranked organisational resilience as number 1 compared with 4.7% (n=61) of clinical participants ($p < 0.001$). However, following Bonferroni correction (adjusted $\alpha = 0.004$), only training in emergency preparedness and organisational resilience remained statistically significant.

Respondents were asked to rank areas they would personally like to improve. Five hundred and eighty one (29%) respondents ranked digital tools and databases as number 1. 'Understanding how a device or software works that I use at work' was ranked as number 1 by 348 (17%) participants, this was followed by 'how to deal with digital device malfunctions' (n=221; 11%), 'How to use digital processing skills correctly' (n=219; 11%) and 'How to recognise cyberthreats and deal with them' (n=199; 10%). No statistically significant associations were reported between role and any of the above statements following Bonferroni correction.

Wellbeing

The overall mean score (SD) for the WHO-5 Wellbeing scale was 56.52 (20.77) indicating above average levels of wellbeing. However, there was a broad range of well-being levels ranging from 0 to 100. Nonclinical respondents had a WHO-5 mean score (SD) of 56.96 (21.31) slightly above clinical respondents mean score (SD) of 56.64 (20.66). A Mann-Whitney U test showed no significant score difference in well-being between the clinical and non-clinical participants ($p = 0.638$).

Organisational readiness to implement change (ORIC)

The ORIC scale had a total median score of 38 (IQR=16), reflecting a moderate level of readiness to implement digital health. The change commitment subscale had a total median score of 16 (IQR = 8), indicating moderate dedication to an associated change process with Change Efficacy having a median score of 22 (IQR = 10), showing moderate confidence in carrying out change.

The median ORIC score was 37 (IQR=16) among clinical participants compared to 40 (IQR=15) among non-clinical participants ($p < 0.001$). For change commitment, the median score was 16 (IQR=7) among clinical participants and 17 (IQR=7) among non-clinical participants ($p < 0.001$). Meanwhile, the median change efficacy score was 22 (IQR=10) among clinical participants and 23 (IQR=9) among non-clinical participants ($p < 0.001$).

■ Tab. 4. Differences in Organisational Readiness to Implement Change (ORIC) between clinical and non clinical staff

	Clinical		Non clinical		U	P value
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)		
ORIC (n=1675)	37.10 (11.38)	37 (16)	40.13 (11.35)	40 (15)	188480	< 0.001*
Change Commitment (n=1706)	15.57 (5.05)	16 (7)	16.84 (4.95)	17 (7)	196628	< 0.001*
Change Efficacy (n=1700)	21.54 (6.66)	22 (10)	23.29 (6.68)	23 (9)	195232	< 0.001*

U = Mann Whitney U test; SD = Standard Deviation; IQR = Interquartile Range; * Significance at the 0.017 level (2-tailed; Bonferroni correction applied)

Senior management were assessed in relation to the ORIC score as they may have an influence on readiness to implement change. The median ORIC score for senior managers was 40 (IQR=17) and for change commitment, the score was 18 (IQR=8). The median change efficacy score for senior management was 24 (IQR=10).

DISCUSSION

Multidisciplinary and cross-sectoral collaboration and partnerships are key to building a holistic and integrated healthcare system. This is identified as a key element to the development of a pan European Union health strategy if impending public health threats are to be effectively addressed [29]. The World Health Organization [30] recently highlighted that to enhance the digital skills of the health care workforce across Europe an integrated approach between continuous professional development needs to be related to the expansion of the digital health care infrastructure. Aligned with these WHO recommendations a recent policy document published by the EU All Policies for a Healthy Europe Group [19] emphasises the importance of an EU wide workplan on the development of digital upskilling of the EU workforce.

If this integrated pan European strategy in terms of infrastructures and training is to be achieved is to understand the common and differentiating knowledge, skills, and frequency in the use of different digital technologies between the diverse workforce groups who deliver health care services across the EU. The results of this survey identified several challenges if these recommendations are to be achieved. An important finding was that survey results highlight significant differences between clinical and non-clinical staff in terms of frequency of digital tool use. For example, clinical staff tended to report higher use of electronic health records compared to their non-clinical colleagues. In turn non-clinical staff reported greater use of data analysis software. It is likely that in both cases the same data is involved but this result calls into question the degree to which an integrated use of the data across organisations and between the workforce can be effectively achieved.

A general finding overall is that the clinical workforce tended have less knowledge, skills and use of digital related technology compared to non-clinical colleagues. Non-clinical staff reported higher knowledge scores in all responses. Worryingly, there was a significant statistical

difference between clinical and non-clinical staff relating to security related knowledge (safety risks when using Internet-connected devices or systems, the importance of keeping the operating system, antivirus and other software up to date and not sharing personal data) with non-clinical staff more aware of the importance of these issues compared to their clinical colleagues. These results suggest that clinical staff are not as familiar with or as exposed to several digital technologies and are less conscious of them than one might assume in relation to standard security protocols and their importance. This maybe because they feature less in their day-to-day practice compared to their non-clinical colleagues and therefore in terms of a work priority means less to them. Either way this digital divide will need to address, taking account of different roles in relation to use and perceptions of relevance [31].

In the face of significant climate related and geopolitical challenges to the health of the European population [8,20,32] rapid organisational adoption and adaptation of digitalisation to build and reinforce the resilience of the EU health care infrastructure is a key and pressing strategic priority [33]. A concerning result of this survey is the widely reported perception of respondents was that there was only a moderate readiness on the part of their health organisations to implement digital changes. Senior management also demonstrated moderate readiness which may impact resources allocated to training and improvements in cybersecurity. Whilst much of the focus has been on the needs of the workforce in terms of digital skills/upskilling, a comprehensive EU Policy needs to also give prominence to the iterative relationship between organisational capacity to adopt digital technologies and the workforce's ability and willingness to adapt to digital technologies. There is little point on the part of the workforce acquiring skills if there is a poor or moderate organisational appetite or capacity to effectively deploy and use such skills. This in turn is likely to lead to a less effective organisation in meeting health care challenges in the future.

Since the COVID-19 pandemic emergency, as previously highlighted, there have been a significant number of cyberattacks on the healthcare system within the European Union (for example, the CONTI attack in Ireland in 2020 and attacks in Belgium, Netherlands and Spain in 2023). As we have discussed the results of this survey seem to indicate that non-clinical staff have a greater sense of awareness of security related issues compared to their clinical colleagues. Previously published research [3] indicates that awareness itself does not necessarily translate into regular practice.

To improve both awareness and practice access to regular training to reinforce both would seem to be obvious. However, the survey results indicate a worryingly small number of all respondents reported receiving cybersecurity training in the last 12 months prior to their completion of the survey. Perhaps in recognition of this gap, the highest indicated priority in terms of training needs was cyber security, though even this at 21% of all respondents, suggests a certain lack of awareness and professionally perceived relevance. One might conclude, therefore, that a key element in building digital resilience within the European Union health care ecosystem will be a policy emphasis

on requirements for ongoing regular and mandated training of the health care workforce that also emphasises personal and professional self-interest in maintaining and practising cyber security skills.

One of the positive findings of the survey was that only a small minority reported anxiety in relation to their use of digital technology. This result would seem to confirm the recent findings of the WHO systematic review that digital technology use generally does not impact wellbeing [17]. There was no significant difference between clinical and non-clinical staff in terms of their reported sense of wellbeing. This is an interesting finding bearing in mind that twice as many non-clinical staff reported receiving stress management training compared to their clinical colleagues in the last 12 months prior to their completion of the survey. This disparity in training provision is an area that is often emphasised as important in relation to the retention of clinical staff [34] and needs to be further investigated in terms of access and perception of relevance to role.

Limitations

Whilst this survey is one of the first to be comparatively explore digital health care issues across the European health care workforce there are several limitations that need to be considered. The first of these is the exploratory nature of the survey design itself. Whilst the survey incorporated elements from validated and well-established instruments, new question items were developed and subjected to a face validation by experts in the field. Secondly, age was included in the analysis to explore its potential effect and was demonstrated to have limited influence on scores. However, other variables such as work environment and placement may also influence, suggesting that these should be considered in future surveys. Work environment is a problematic concept when engaging with a pan European survey because of the different constructs of what are considered health working environments between member states; moreover no differences between public and privately funded health services were investigated.

The survey respondents are not necessarily representative of all health care workers across the EU, but only drawn from nine EU member states and, in some case countries, response rates were much lower than others. This might lead to distortions in results reflective of local conditions which a broader sample drawn from all EU member states might correct. The survey sample is also relatively small which has obvious impacts on the robustness of data and limits the potential to infer generalisations of the total European health care workforce and disaggregate data. The survey data is, however, relatively large when compared to current research of healthcare workers. Moreover, limited socioeconomic data around education and employment (for example, educational attainment, institution type, employed/self-employed) were not collected which may be explanatory variables for some results. Future research should consider introducing a structured sample to reduce typical bias.

CONCLUSIONS

The results highlight need for policy development and interventions that not only enhance digital competencies across the EU health workforce but also address organisational capacities to support both training of the workforce and effective use of the workforce's digital skills once these are acquired. From the perspective of the underlying goals of the EU4Health the results can be used to inform further policy and operational development in relation to the mandating of regular, role-specific training while simultaneously boosting organisational readiness for digital adoption. Therefore, EU4Health needs not only to focus on workforce upskilling but also on approaches that strengthen structural capacities that promote a resilient, integrated European health system that promotes a pan European system of training, perhaps through micro credentialing [35].

This survey highlights the significant disparities in digital competencies, knowledge, skills and frequency of use between clinical and non-clinical staff. The differences between clinical and non-clinical staff in relation to cyber security are clearly concerning and greater thought needs to be given as to how cybersecurity and practice reinforcement needs to be addressed within training and continuous professional development.

Acknowledgement

This research was conducted as part of the Dynamic Digital Skills for Medical and Allied Professionals (DDS-MAP) project co-funded by the European Health and Digital Executive Agency. Funded by the European Union. The views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or HaDEA. Neither the European Union nor the granting authority can be held responsible.

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An exploratory survey of the digital technology readiness of the health care workforce across nine EU member states

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Manuscript received: 23.08.2025

Manuscript accepted: 14.09.2025