Chapter 14
Digitalisation and Healthcare Workers: European Trends, Workforce Competencies

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14.1 Introduction

The advent of digitalisation in healthcare, driven by advances in artificial intelligence (AI), data science, and related technologies, offers transformative opportunities to enhance healthcare systems. Improved efficiency, sustainability, and social cohesion can result from such transformation, fostering both development and economic growth through integrated social responses. However, despite this potential, the application of digitalisation to improve population health remains largely unexplored or underutilised, leaving significant opportunities in public health untapped (World Health Organization, 2022). Recognising these possibilities, the World Health Organization (WHO) has outlined coordinated action in its *Global Strategy on Digital Health* (2020–2025) and the *Ethics and Governance of Artificial Intelligence for Health* (2021), calling for a coordinated effort to harness digital innovations to meet the Sustainable Development Goals (Regional Committee for Europe, 2022). The *Regional Digital Health Action Plan for the WHO European Region 2023–2030* emphasises the importance of investing in digital literacy and capacity-building, particularly for the healthcare workforce. Yet, the WHO/Europe

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2023 report, *Digital Health in the WHO European Region: the ongoing journey to commitment and transformation*, emphasised that large-scale investment and stronger integration are still urgently required. The report also indicated that just over half of the countries surveyed have adopted digital health literacy policies, and even fewer have implemented digital inclusion plans (World Health Organization, 2023).

Projections indicate a significant demand for investment in workforce digital capacity, particularly in the United Kingdom, where it is anticipated that 90% of all UK National Health Service (NHS) jobs will require some degree of digital and technological skills within the next two decades (NHS, 2019). Similar trends are visible across the European Union (EU). According to the Healthcare Information and Management Systems Society (HIMSS) Analytics (2019), healthcare providers across Europe face major obstacles in digital health implementation, including interoperability, shortages of sufficiently skilled workers, funding limitations, and, in some contexts, a lack of clear governmental leadership. Interoperability refers to *the ability of different information systems, devices, and applications to access, exchange, integrate, and cooperatively use data in a coordinated manner across organizational and regional boundaries* (HIMSS, n.d.). The primary objectives for the advancement of digital health encompass the thorough implementation of electronic medical records (EMRs), enhancement of patient access to health information, promotion of data sharing across systems, strengthening of Information Technology (IT) security, and improvement of system usability to foster efficient, patient-centred care. In response, studies have called for specific educational interventions to support healthcare professionals in developing digital competencies (Borges do Nascimento et al., 2023), especially given that psychological barriers, such as hesitancy and lack of confidence, remain common across the workforce.

One group that requires particular attention is older workers, notably in healthcare, which constitutes a substantial and growing segment of the workforce. Various studies indicate that age correlates with diminished self-rated digital competence, although this association is not always universally observed. For instance, while young professionals and recent graduates typically exhibit higher levels of digital health competence (Jarva et al., 2024; Reixach et al., 2022), other research indicates that older community health workers, when provided with adequate support, may demonstrate equal or even greater commitment to using digital technologies (Blondino et al., 2024). Additionally, research from Finland and international reviews support this age-related trend, necessitating policy responses that align with the broader framework of Digital Determinants of Health (DDoH) (Borges do Nascimento et al., 2023; Kaihlanen et al., 2021; Lawrence & Levine, 2024; Richardson et al., 2022).

The COVID-19 pandemic further amplified existing disparities in digital competence, mainly through the accelerated need of telemedicine and remote care platforms. Low digital literacy was identified as a key obstacle to the implementation of telemedicine (Bhaskar et al., 2020). Nevertheless, there is a growing consumer demand for personal health tools, including wearables, sensors, and digitally enabled gadgets that are connected to health innovation systems. Consequently, the

technology sector is developing new sensors that require active involvement from patients and health professionals (Milani et al., 2017).

This chapter analyses the digital transformation of healthcare systems in Europe, focusing on its implications for the healthcare workforce, particularly older workers who face unique challenges in adapting to rapidly evolving digital environments. The chapter examines digitalisation trends, the current state of digital health adoption, and the competencies required for healthcare professionals. The chapter also explores the intersection of age and digital readiness, with implications for professional training, health equity, and workforce sustainability.

Methodologically, the chapter draws on reviews of EU policy documents, empirical literature, and survey data. The chapter is organised into the following sections: an overview of digitalisation in Europe; an analysis of workforce challenges, particularly in related to ageing; a review of EU digitalisation policies; the concept of digital determinants of health (DDoH); and an assessment of digital competence frameworks and age-related findings. The discussion concludes with key findings and recommendations for building an inclusive, digitally capable health workforce.

Portugal is used as a case study to contextualise these broader developments. The country has achieved notable advances in digital prescriptions, telemedicine, and access to electronic health records; however, substantial structural barriers persist, such as interoperability gaps and uneven digital literacy. Analysing Portugal's experience provides the context relating to how national strategies align with European policy objectives, and how digital transformation intersects with workforce preparedness and age-related disparities.

14.2 Digitalisation in Europe: Trends, Challenges, and Equity Gaps

14.2.1 EU-Wide Digitalisation Policies

The EU has introduced various initiatives to promote digitalisation in healthcare. The Recovery and Resilience Plan (RRP) funds investments in digital transformation, including healthcare, while contributing to broader EU goals such as green transition, digitalisation, economic resilience, and social cohesion (European Commission, 2022a). The European Health Data Space (EHDS) aims to create standardised technical specifications and guidelines for the use of electronic health data throughout Europe, facilitating seamless cross-border healthcare services.

Progress in adopting electronic records across Europe is visible. According to the Organisation for Economic Co-operation and Development (OECD) working paper on the progress in implementing and using electronic health record systems has advanced significantly since 2013 (Slawomirski et al., 2023). In this context, in primary care, the number of countries using Electronic Medical Records (EMR) in over 90% of physician offices increased from 10 to 18 from 2016 to 2021. In

Medical Specialist Offices, EMR adoption increased from 6 to 17 countries in the same period, indicating a stronger push for digitalisation in outpatient specialist care. The adoption of Electronic Patient Records (EPR) in hospitals expanded from 12 countries in 2012 to 21 countries in 2021, while EPR use in Emergency Rooms rose from 8 to 20 countries (Slawomirski et al., 2023). Such rapid increase indicates a growing commitment to digital integration in healthcare settings, particularly between 2016 and 2021.

Despite these efforts, several challenges persist across the EU. Many countries still struggle with data interoperability legal barriers, and quality assurance of electronic health record (EHR) systems. In this context, the OECD has identified the following main challenges to the development of robust and reliable databases (Slawomirski et al., 2023):

- Legal obstacles to the development and/or examination of databases.
- Insufficient technical capacity and resources for data extraction and database creation.
- Concerns about data quality hindering effective database use.
- Limited technical capacity to anonymise data appropriately.

These challenges prevent the advancement of reliable and reusable health data systems across Europe. Data quality, interoperability, and legal accessibility are crucial success factors as digital health technologies become increasingly incorporated into clinical and administrative workflows.

To address these challenges, in 2022 the European Commission proposed the creation of the European Health Data Space (EHDS) with the aim of facilitating the secure, standardised, and interoperable use of health data across the EU. In force since 26 March 2025, the EHDS encompasses all EU member states, establishing a cohesive framework for both primary use (direct patient care) and secondary use (research, policymaking, and innovation) of health data, thus promoting a pan--European data ecosystem (European Commission, 2022b; European Parliament & Council of the European Union, 2025). The initiatives seek to facilitate individual access to health data and to encourage data-driven decision-making at the systemic level. The EHDS is enhanced by regulatory and legal frameworks such as the Artificial Intelligence Act (AI Act), which aims to ensure the ethical, safe, and reliable application of artificial intelligence in healthcare settings within the EU (European Parliament & Council of the European Union, 2024).

14.3 Overview of Digitalisation in Europe

The digitalisation of healthcare systems across the EU varies widely (European Commission, 2023;Majcherek et al., 2024; Olesch, 2022). This variation is largely shaped by each country's level of technological development, infrastructural capacity, and healthcare investment. Nordic countries, such as Denmark, Finland, and Sweden, are widely regarded as leaders in this field, with most healthcare services

integrated into digital platforms (Majcherek et al., 2024; Olesch, 2022). These countries have implemented extensive EHR systems, supported by interoperable infrastructures that allow seamless data sharing across different levels of healthcare (Olesch, 2022). Estonia has also achieved high digitalisation levels, with EHRs accessible to most of its population. Its eHealth system serves as a model, providing digital prescriptions, patient access to their own records, and extensive telemedicine services (Olesch, 2022).

Spain has also attained high levels of digitalisation of healthcare services. However, to be in a leading position in the EU, further efforts are needed to ensure full EHR coverage across all healthcare providers and to ensure that a comparable quality of service and completeness of electronic health data is provided at the regional level (European Commission, 2023). Germany and France have also made substantial progress, especially since the COVID-19 pandemic. While electronic records are used in many of their hospitals, full interoperability between regions and healthcare providers remains a challenge.

Italy has shown improvements in areas such as telemedicine and online health services. Nevertheless, its systems remain fragmented, particularly at the regional level, and they face ongoing issues regarding access to health records. These countries are working to improve the integration of patient data systems across their respective regions (European Commission, 2023; Olesch, 2022). In contrast, Romania and Bulgaria face greater difficulties due to a less developed digital infrastructure and lower investment in health technology solutions (European Commission, 2023; Majcherek et al., 2024; Olesch, 2022). Countries like Portugal, which are rapidly digitalising but still face interoperability and workforce challenges, will be discussed in greater detail later in this chapter.

14.3.1 The Healthcare Workforce in Europe

A key driver for digital transformation in European healthcare systems is the shortage of healthcare professionals, compounded by factors that increase their workload and risk of burnout (European Commission, 2021; World Health Organization, 2022). Some of these factors are related to changing health needs stemming from ageing populations, marked by increased multimorbidity and chronic conditions, and the growing need for home and community-based care (World Health Organization, 2022). These changes need a workforce that is highly adaptable and proficient in digital skills, and efforts to enhance productivity and decrease healthcare costs frequently result in increased administrative burdens for professionals, which detracts from the quality of patient care (AlQudah et al., 2021; Chidambaram et al., 2024).

The ageing of Europe's general population is reflected in the healthcare workforce. For instance, a considerable proportion of health professionals in European countries are aged 55 years and above, presenting substantial challenges for workforce sustainability. According to the WHO Regional Office for Europe, in 13 out of

44 reporting countries at least 40% of medical doctors are aged 55 years and above, with a median of 30% across the Region. For nurses, the median is 18%, with only four of 36 reporting countries having 40% or more aged 55 years or above (World Health Organization, 2022). This demographic imbalance presents countries with a dual challenge: replacing retiring professionals while at the same time expanding services to meet increasing demand for care. Notably, Northern and Western European countries, which maintain some of the highest healthcare worker ratios, are also among those with the lowest density of graduates and the highest proportion of older professionals. Such imbalance threatens long-term capacity if strategies are not implemented to attract, train, and retain a younger workforce (Jarva et al., 2024; Kaihlanen et al., 2021).

Age represents not only a demographic factor but also a matter of digital readiness. With the acceleration of the digital transformation, healthcare systems must ensure that both existing and new professionals possess the necessary digital competencies. Older professionals may encounter obstacles to digital engagement stemming from deficiencies in training or self-assurance; however, research indicates that with adequate support, many can successfully adopt and integrate digital tools into care delivery. The WHO Regional Office for Europe advocates for a series of immediate workforce measures, which include:

- Enhancing continuing professional development (CPD) to advance digital and clinical competencies.
- Enhancing the utilisation of digital tools that support healthcare workers without adding to their workload.
- Utilising data-driven planning to synchronise workforce training with actual population health and service delivery needs (World Health Organization, 2022).

According to the Standing Committee of European doctors (CPME), the patient-doctor relationship and medical practices are being reshaped by digitalisation. The CPME also stresses that current trainees and practicing healthcare professionals are inadequately prepared for a digitalised healthcare environment (CPME, 2020). In addition to critically evaluating the associated risks and limitations of these technologies, the CPME also argues that medical professionals must develop technical competencies and comprehend how digital solutions can enhance their functions. Additionally, the Joint Statement by EHMA and Health First Europe (2021) emphasises the significance of European healthcare systems that focus on the identification of effective practices in care integration and digitalised care.

Technical competencies, including the utilisation of health applications, telemedicine, and decision-support systems, alongside relational competencies, such as the development of trust and effective communication in digitally mediated care, should be systematically integrated into medical education, specialist training, and continuing professional development. This integration is essential to address the growing demand for digital skills within the healthcare workforce. Fostering an innovative culture and interdisciplinary learning are equally crucial to ensure that healthcare professionals of all ages are equipped to succeed in digital environments.

The next section examines the influence of digital determinants of health on patient outcomes, as well as capabilities and equity within the healthcare workforce.

14.4 The Digital Determinants of Health

The concept of digital determinants of health (DDoH) encompasses factors within the digital environment that influence health outcomes. Digital determinants range from access to technological tools, broadband internet, and digital literacy to the societal infrastructure that supports or hinders technology use and development in healthcare settings. These determinants can significantly affect how individuals and populations interact with healthcare technologies, influencing overall health outcomes, equity, and the efficiency of care delivery (Chidambaram et al., 2024; Slawomirski et al., 2023; TRIO, 2022).

These determinants are becoming increasingly critical as healthcare relies more on digital solutions such as telemedicine, remote monitoring, health applications, or AI prediction models. DDoH includes not only physical access to technology but also the skills and confidence to use these tools effectively.

Digital determinants are closely intertwined with social determinants of health (SDoH) (Fig. 14.1). For example, socioeconomic status, a social determinant, affects whether a person can afford access to digital health technologies. Conversely, inadequate digital access can exacerbate existing health inequalities driven by social determinants. Digital exclusion, such as the lack of broadband internet in rural areas, mirrors social inequalities such as limited access to healthcare facilities in underserved areas (Lawrence & Levine, 2024).

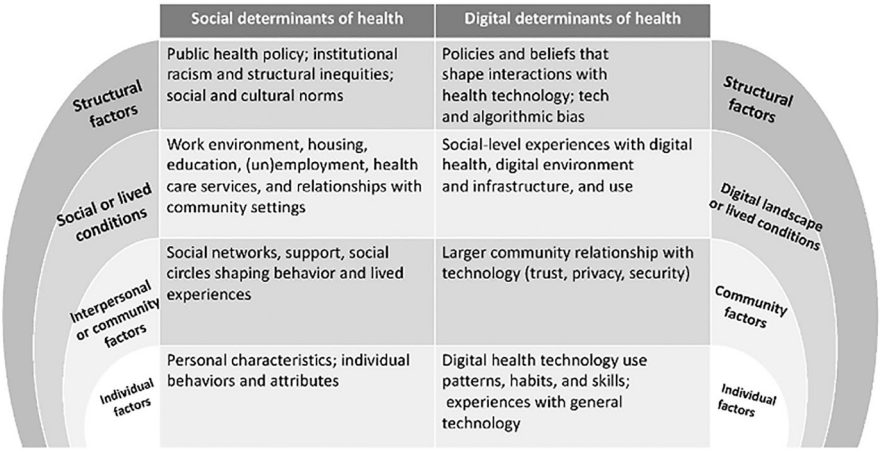

Fig. 14.1 Mapping digital determinants of health to social determinants of health [Source: Lawrence & Levine, 2024]

DDoH significantly influences the development and implementation of health technologies. Limited internet access or digital literacy can hinder patient engagement with digital health tools, reducing the effectiveness of technologies such as telemedicine or health applications. Furthermore, designing health technologies without considering DDoH could potentially widen health disparities. For example, AI-driven healthcare tools may not perform well for populations that are underrepresented in the data used to develop and validate these systems (Richardson et al., 2022; The Lancet Digital Health, 2021).

To ensure equitable access to digital health innovations and improve outcomes, healthcare systems must address these disparities. However, a key question is how governments, service providers, and the healthcare workforce are prepared to respond to these disparities. An analysis of the healthcare workforce reveals several issues directly related to these DDoH (Borges do Nascimento et al., 2023). Without a digitally motivated and informed healthcare workforce, the gap between healthcare providers and patients may widen.

Evidence on the role of age presents a mixed picture. Borges do Nascimento et al. (2023) identify age, in conjunction with education and professional experience, as a potential barrier to digital adoption, frequently associated with hesitancy or technophobia. However, other research indicates a more nuanced understanding of this issue. Blondino et al. (2024), for example, found that older community health workers were significantly more likely than their youngest peers to use digital devices when providing services to their communities, indicating that age alone is not a hindrance. In contrast, Nakagawa and Yellowlees (2020) emphasise that younger professionals are generally better prepared for digital environments and frame their recommendations around reducing burnout for this cohort. Taken together, these studies highlight the need for a balanced approach that addresses both younger and older generations. Table 14.1 presents the framework proposed by Nakagawa and Yellowlees (2020) in the first three columns. The fourth column incorporates evidence-based strategies by the authors of this chapter, tailored for older professionals.

The recommendations presented in Table 14.1 demonstrate that preparing for generational shifts in healthcare must extend beyond merely accommodating younger professionals. Nakagawa and Yellowlees (2020) focused their recommendations on burnout risks for younger cohorts, leaving older workers inadequately examined. The evidence presents a dichotomy: Borges do Nascimento et al. (2023) highlight age as a potential obstacle to digital adoption, whereas Blondino et al. (2024) demonstrate that older community health workers exhibit a significantly higher likelihood of utilising digital devices in their practice compared to their younger counterparts. The contradiction indicates that age is not a static determinant of digital readiness, but rather a variable influenced by training, support, and inclusion. By embedding strategies such as tailored continuing professional development (CPD), user-friendly design, intergenerational teams, and phased implementation, the extended framework reframes digitalisation as an intergenerational challenge to workforce wellbeing. Such strategies help to mitigate burnout, preserve

Table 14.1 Preparing for generational shifts in healthcare: original recommendations and adaptations for older professionals

Recommendation Nakagawa and Yellowlees (2020)	Examples Nakagawa and Yellowlees (2020)	Rationale Nakagawa and Yellowlees (2020)	Rationale adaptation for Older professionals
Incorporate technologies that make clinical workflows and patient experiences more efficient	Virtual scribes that automate all or parts of clinical documentation Self-service patient scheduling that allows patients to schedule/reschedule their appointments Asynchronous telemedicine that gives physicians more control over their schedules and when to see patients	Younger generations of physicians and patients expect more control over their schedule and lifestyle Physicians will want more control over their schedules, when and where they provide care, and increasing efficiency in their work. Patients will expect more "on demand" convenience and self-service options; less tolerant of waiting times	Implement digital tools in phases and offer practical support to mitigate workflow disruptions, thereby decreasing stress and burnout risks; customised assistance is essential for maintaining the engagement of older professionals during digital transitions (Blondino et al., 2024; Borges do Nascimento et al., 2023; WHO Europe, 2022)
Adapt clinical workflows to fit the cognitive processes of younger generations	Incorporate more opportunities to deliver care virtually Real-time, Wikipedia-like medical charts that physicians and patients can dynamically update	Younger generations (patients and physicians) are more comfortable communicating and interacting virtually. They also use more collaborative, synchronous documentation methods like cloud-based services like Google drive	Ensure user-friendly interfaces, paced training modules, and customisable dashboards to reduce cognitive overload and maintain confidence. Tailored workflow design helps prevent burnout and supports sustained engagement with digital tools (Jarva et al., 2024; Kaihlanen et al., 2021; WHO Europe, 2022)
Less hierarchical culture of medicine	Health systems include younger clinicians and staff in key meetings and decision--making processes	Including younger clinicians and staff will provide insights into newer technologies, emerging usage patterns, and behaviours that health systems can better anticipate and prepare for	Actively include older professionals in co-design and governance processes, recognising their experiential knowledge. Intergenerational teams enhance collaboration and provide older staff with a sense of agency and belonging, reducing risks of marginalisation and burnout (Blondino et al., 2024; Lawrence & Levine, 2024; WHO, 2020; WHO Europe, 2022)

(continued)

Table 14.1 (continued)

Recommendation Nakagawa and Yellowlees (2020)	Examples Nakagawa and Yellowlees (2020)	Rationale Nakagawa and Yellowlees (2020)	Rationale adaptation for Older professionals
Technology-based training throughout the year	EMR training offered multiple times throughout the year to accommodate software upgrades, teaching new features and reinforcing best practices Training should be encouraged for physicians with above average charting time and/or lower efficiency scores	EMR upgrades can be disruptive to physicians who have established workflows. Regular EMR upgrades can cause temporary but significant decreases in productivity and efficiency for some physicians	Deliver modular, recurring CPD tailored to older professionals, with opportunities for repetition and confidence-building. Implement peer-learning or buddy systems to foster intergenerational support, thereby mitigating anxiety associated with upgrades and decreasing the risk of burnout (Borges do Nascimento et al., 2023; Jarva et al., 2024; Kaihlanen et al., 2021; WHO Europe, 2022)

Source: adapted from Nakagawa and Yellowlees (2020) with critical extensions based on other studies

institutional knowledge, and strengthen resilience as health systems undergo rapid digital transformation.

Having strategies to approach better healthcare environments with healthcare workforce engagement is a priority. Achieving this goal requires that both executive and operational leaders possess digital-driven competencies and collaborate closely with healthcare professionals in the co-creation of technology. This leadership framework implies the acceptance of technology and it influences the success or failure of digital initiatives in promoting adoption and reducing burnout among healthcare professionals. This is dependent on the management of several factors associated with healthcare technology design, including anxiety, computer self-efficacy, innovativeness, and trust (AlQudah et al., 2021).

Several initiatives have already highlighted the critical role of training for both leadership and the healthcare workforce in managing and mitigating the DDoH. We delve deeper into the necessary competencies in the next section.

14.4.1 The Digital Competencies Needed for Healthcare Workers

The development of digital competencies is crucial for healthcare professionals to improve efficiency and quality of care, while ensuring equitable access to the benefits of digital health. This is closely associated with the digital determinants of

health (DDoH): insufficient digital readiness among professionals can perpetuate disparities in access, confidence, and use of technology within the workforce and in patient care. This challenge is especially acute given the ageing of the European healthcare workforce. In many countries, more than 30% of physicians are already aged 55 or above (WHO, 2022). Age interacts with other sociodemographic factors to shape digital readiness, so training strategies must be tailored to the realities faced by older healthcare workers.

Evidence shows that younger professionals and recent graduates tend to report higher digital competence levels (Jarva et al., 2024; Reixach et al., 2022), whereas older, more experienced staff often rate themselves lower (Shiferaw et al., 2020). Generational comparisons suggest that millennial physicians adapt more easily to new digital tools, while older physicians may face greater disruption when established workflows are altered by EMR upgrades and other platforms (Nakagawa & Yellowlees, 2020). The identified gaps may indicate a scarcity of structured training opportunities and diminished confidence among senior professionals (Jarva et al., 2024; Reixach et al., 2022). Studies show that, with proper support, older community health workers may demonstrate comparable or superior commitment to the integration of digital tools relative to younger workers (Blondino et al., 2024).

To align training strategies with actual digital requirements, it is important to identify sociodemographic factors that influence digital competence (Borges do Nascimento et al., 2023; European Commission, 2021; Milani et al., 2017; Reixach et al., 2022):

- Age: younger professionals tend to report higher competence (Jarva et al., 2024; Reixach et al., 2022).
- Gender: gender differences indicate that men tend to report higher levels of digital competence (Shiferaw et al., 2020).
- Educational status: professionals with higher education levels, and especially more recent graduates, report higher competence (Jarva et al., 2024; Kaihlanen et al., 2021; Shiferaw et al., 2020).
- Income and experience: higher income and longer professional experience are associated with lower digital competence (Shiferaw et al., 2020). While Shiferaw et al. do not explain this pattern, it may reflect missed opportunities for digital training among older, senior staff.
- Professional profile: competence levels are elevated in certain healthcare roles beyond those of physicians and nurses (Reixach et al., 2022).
- Work setting: nurses in specialised and elderly care demonstrate greater competence compared to their counterparts in emergency settings (Kaihlanen et al., 2021). Additionally, outpatient and home care environments are associated with increased competence levels (Jarva et al., 2024).

Referring to work settings, the WHO's *State of the World's Nursing* report emphasises that workplace policies must address nurse retention, including support for nurse-led care models, advanced practice roles, and adaptation to ageing workforce patterns (World Health Organization, 2020). Similarly, a scoping review by Cachata et al. (2024) emphasised the importance of digital technology in nursing

management and organisation. It highlighted the critical role of leadership in digitally mediated teams and identified key training needs, such as data analysis, digital identity management, and the operation of devices with digital interfaces. The study highlights the significance of institutional and structural contexts as determinants of health, affecting the equitable benefits of digital transitions for professionals and patients equally.

Healthcare institutions need to advocate for the continuous education of digital competencies as an integral component of professional development. Essential strategies encompass:

- Incorporation of digital education into initial and continuous training: requires mandatory modules and early exposure to digital technologies (Chidambaram et al., 2024; Lawrence & Levine, 2024). This is consistent with the CPME (2020) recommendation for the systematic incorporation of digital competencies into undergraduate curricula, specialist training, and continuing professional development (CPD).
- Simulations and practical experiences: include simulated telemedicine consultations and remote monitoring exercises aimed at improving confidence and preparedness (Lawrence & Levine, 2024; Richardson et al., 2022).
- Digital communication skills: involve training to interpret non-verbal cues in virtual care, communicate clearly online, and engage patients proactively (Chidambaram et al., 2024; Lawrence & Levine, 2024).
- Digital access: involves training professionals to recognise and address disparities in patients' access to devices, internet connectivity, and necessary skills (Chidambaram et al., 2024; Richardson et al., 2022).
- Digital literacy: is essential for enabling both providers and patients to be able to locate, assess, and utilise health information effectively (Chidambaram et al., 2024; Lawrence & Levine, 2024; Richardson et al., 2022).

Healthcare professionals require training that extends beyond technical skills to effectively identify and mitigate technological biases. Algorithmic bias may compromise care for minority or underserved populations when systems are developed using unrepresentative data. Consequently, institutions should (Chidambaram et al., 2024; Richardson et al., 2022):

- Establish algorithmic accountability policies in accordance with the AI Act (European Parliament & Council of the European Union, 2024), facilitating professional critique and oversight of AI applications.
- Promote a culture of digital inclusion alongside with technological empowerment.
- Investing in accessible infrastructures is essential for enhancing digital equity among professionals and patients.
- Encourage collaboration across healthcare, technology, government, and civil society to develop inclusive solutions.

Undergraduate curricula should incorporate national population health requirements, and continuous professional development should be readily available for older healthcare professionals. Digital health literacy must be integrated into both

initial training and ongoing education, enabling graduates and seasoned professionals to navigate effectively and influence healthcare in a digital age.

14.5 Portugal: A National Case Study

Portugal serves as a case study for how national health systems are navigating the opportunities and challenges of digitalisation in a broader European context. While the country has made significant progress in expanding digital health infrastructure, structural barriers continue to prevent the full implementation of its digital transformation.

Portugal has made steady progress in digital health, having achieved near-universal adoption of digital prescriptions and having expanded telemedicine services, especially during and after the COVID-19 pandemic. The *2024 Digital Decade eHealth Indicator Study* reports that Portugal achieved a composite eHealth maturity score of 76%, reflecting a substantial 23-percentage point increase from 2022, marking one of the most significant annual improvements within the EU (European Commission, 2024). This enhancement illustrates Portugal's efforts to enhance citizen access to electronic health records (EHRs), invest in online access platforms, and expand the availability of diverse health data types. Such advances reflect national initiatives to improve citizen access to EHRs, expand online access platforms, and broaden the range of available health data.

Portugal continues to fall short compared to leading EU countries in terms of comprehensive data availability, including medical images and discharge reports, as well as private sector data connectivity (European Commission, 2024). Interoperability remains a considerable challenge, with the European Commission highlighting the necessity for efficient data exchange among primary care, hospitals, pharmacies, and other healthcare providers in 2023 (European Commission, 2023). Furthermore, private healthcare providers exhibit a lower level of connectivity to the national EHR system compared to public providers (European Commission, 2024).

To tackle these ongoing challenges, the Portuguese government adopted a *National Digital Strategy* in 2024, aligned with the EU Digital Decade 2030 goals, which emphasises the development of sector-specific data spaces and cross-sectoral collaboration to strengthen integration and innovation (Republic of Portugal - Ministry of Education, 2024). Portugal aims to address existing gaps and utilise EU-level initiatives to create a more integrated, accessible, and technologically advanced healthcare system capable of effectively responding to future public health demands.

In line with broader European priorities, Portugal has integrated investments in digital health infrastructure with initiatives to assess and improve its workforce's digital readiness. The INCoDe.2030 public policy initiative, in collaboration with PwC Portugal and McKinsey & Company, mapped 49 professions and created a reference framework of 22 digital skills for employment. A mapping of the level of

digital proficiency across various professions showed that, among 24 professions in the healthcare and welfare sectors, ten professions needed urgent upskilling regarding the protection of personal data. All professionals required upskilling in data analysis and statistics, digital identity management, and the operation of devices with a digital interface. Medical specialists demonstrated advanced digital proficiency, whereas nurses and nurse specialists, with the exception of those in maternal and obstetric health, predominantly exhibited intermediate digital skills. The main areas recognised for upskilling encompassed information storage and retrieval, device security, and personal data protection (INCoDe.2030, 2022).

These findings align with broader European evidence in two respects. First, they reinforce the importance of role-based disparities, since differences between physicians and nurses are also observed in cross-national studies (Kaihlanen et al., 2021; Reixach et al., 2022). Second, they highlight the need for systematic, targeted upskilling in core digital domains, echoing broader calls for workforce-wide strategies to build confidence and competence in digital health (Borges do Nascimento et al., 2023). However, unlike several cross-country studies that explicitly examine age and career stage as predictors of digital readiness (Jarva et al., 2024; Shiferaw et al., 2020), the Portuguese mapping did not factor in generational dynamics. The absence of the age variable is notable and highlights a critical area for future national research and policy development, given the ageing of the European healthcare workforce, with a significant proportion of professionals already aged 55 years or above (World Health Organization, 2022).

Portugal demonstrates the dual reality observed throughout Europe: while rapid digitalisation improves access and efficiency, significant systemic challenges, particularly in interoperability and workforce preparedness, remain substantial obstacles. The Portuguese case demonstrates the significance of aligning national initiatives with EU frameworks, including the European Health Data Space, while also addressing workforce policies to support older professionals and reduce intra-professional digital divides.

14.6 Discussion and Conclusions

This chapter has analysed the complex relationships between digitalisation trends, workforce challenges, and the evolving demands of healthcare systems across Europe, with a particular focus on older workers.

14.6.1 General Knowledge and Wider Context

Existing research and policy reports show that, despite notable advances in the adoption of electronic health records, telemedicine, and various digital tools, disparities in their integration and utilisation persist across countries, healthcare

environments, and professional roles. Nordic countries and Estonia are widely recognised as leaders in digital innovation, while others showed uneven progress.

The chapter has addressed the dynamics between technological advancement and workforce preparedness, where healthcare systems in Europe encounter difficulties associated with ageing populations and an ageing workforce, which challenge the digital transformation process. In this context, the WHO Europe report indicates that many countries face the risk of insufficient replacements for retiring healthcare professionals. The challenge is exacerbated by older workers often reporting lower levels of digital competency (Jarva et al., 2024; Reixach et al., 2022; TRIO, 2022), which can be linked not to a lack of digital skills, but rather to deficiencies in training, exposure, and confidence.

Furthermore, age should not be considered a sole predictor of digital competence, as factors such as graduation year, educational background, and work environment interact with age to affect readiness in utilising digital tools. A recently graduated professional may exhibit a higher baseline digital literacy, while an older, more experienced healthcare worker may require targeted support to bridge the digital skills gap. Additionally, research suggests that the influence of age can be mitigated by institutions that offer structured and ongoing professional development (Kaihlanen et al., 2021). As a result, the neglect of the needs of older workers can result in a segmented workforce, in which digital transformation unintentionally contributes to intraprofessional disparities and undermines the essential institutional knowledge provided by experienced staff members.

14.6.2 Findings from This Chapter

This chapter presents four main findings that result from the analysis of digitalisation trends in Europe, workforce challenges, and the case study of Portugal. Firstly, despite overall advances, digitalisation in Europe continues to demonstrate significant disparities. The Nordic countries and Estonia demonstrate effective leadership in integrated systems, while Spain, Germany, France, and Italy, despite progress, face ongoing challenges associated with fragmentation and interoperability. Romania and Bulgaria, together with other member states, encounter persistent challenges associated with infrastructural and investment barriers. Furthermore, an individual's age alone does not adequately explain digital competence, as factors such as professional role, educational background, work environment, and graduation year play a crucial role in determining digital readiness. Third, older workers may exhibit underperformance not because of inherent limitations, but rather due to insufficient training and exposure opportunities earlier in their careers. As seen in this chapter, research shows that with appropriate institutional support, they can successfully adopt and advocate for digital tools. Third, the workforce is also subject to the DDoH. This chapter demonstrates that the DDoH debate is relevant not only to patients but also to the workforce. Disparities in infrastructure, limited access to training, and biases in technology design, such as algorithmic bias, may

lead to the digital exclusion of professionals, particularly among older individuals. Therefore, recognising the workforce as a population affected by DDoH improves the equity perspective in digital health.

Lastly, the case study shows how Portugal illustrates both progress and limitations. Significant advances, including widespread e-prescriptions, the growth of telemedicine, and a 23-point increase in eHealth maturity from 2022 to 2024, indicate the potential for rapid adoption. Conversely, interoperability, private sector connectivity, and disparities in workforce preparedness continue to pose significant challenges. Furthermore, the INCoDe.2030 mapping identified role-based disparities; however, it did not address generational dynamics, resulting in a significant discrepancy in workforce planning. The Portuguese case illustrates that national strategies can acknowledge role differences while still overlooking generational distinctions, particularly when evaluated along with recommendations such as those presented in Table 14.1 (Nakagawa & Yellowlees, 2020).

In conclusion, Europe's healthcare systems stand at a critical moment, where digital transformation offers unprecedented opportunities to improve efficiency, care quality, and equity—but also bringing risks of widening divides if such opportunities are not carefully managed. As healthcare becomes increasingly digitised, training healthcare professionals in digital competencies must be a priority not only to enhance system performance but also to ensure the equitable distribution of digital health benefits, therefore mitigating the digital DDoH.

Healthcare and educational institutions must continue to integrate the development of digital skills, as well as designing inclusive policies that address disparities in digital technology access and use. As discussed in this chapter, healthcare professionals and healthcare leaders do not need to be digital experts, but they should understand the basics of system design and AI integration to address effectively emerging challenges. Furthermore, training efforts should go beyond technical proficiency to prepare professionals to recognise and mitigate technological biases, such as algorithmic bias, which can exacerbate health inequalities.

Finally, policymakers, educators, and healthcare leaders must coordinate investments, implement empowering institutional policies, and cultivate a culture of digital inclusion. Investing in accessible digital infrastructures and collaborating across sectors are critical to ensuring that both healthcare professionals and patients benefit fully from technological advances. By addressing these issues, Europe can turn digitalisation into a driving force for a better, fairer, and more sustainable healthcare for all.

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