Title: Healthcare professionals' competence in digitalization: a systematic review

Running title: Competence in digitalization

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Healthcare professionals' attitudes and experiences influenced their willingness and motivation to use technology. Psychosocial and organizational predictors significantly impacted healthcare professionals' competence in digitalization. Therefore, the organizational support is needed during the implementation of new technology. We argue that appropriate and successful technology usage requires regular education that takes into account individual competence. Team climate should be taken into consideration when introducing new technology to healthcare staff.

Abstract

Aims and objectives: To identify key areas of competence for digitalization in healthcare settings, describe healthcare professionals' competencies in these areas, and identify factors related to their competence.

Background: Digitalization requires changes in healthcare practices, policies and actions to revise job expectations and workflows. The aspects of patient safety and integration of digitalization into the professional context necessitate an assessment of healthcare professionals' competencies in digitalization.

Design: Systematic review.

Methods: A systematic review was conducted following Center of Reviews and Dissemination guidelines, including application of a PRISMA statement. Four databases—CINAHL (EBSCO), Medline (Ovid), Web of Science, and Academic Search Premiere (EBSCO)—were searched for relevant original peer-reviewed studies published between 2012 and 2017. Twelve were chosen for final analysis: five quantitative studies and seven qualitative studies, which were respectively subjected to narrative and thematic synthesis.

Results: Key competence areas regarding digitalization from a healthcare perspective identified encompass knowledge of digital technology and the digital skills required to provide good patient care, including associated social and communication skills, and ethical considerations of digitalization in patient care. Healthcare professionals need the motivation and willingness to acquire experience of digitalization in their professional context. Collegial and organizational support appear to be essential factors for building positive experiences of digitalization for healthcare professionals.

Conclusion: Healthcare organizations should both pay attention to the social environment of a workplace and create a positive atmosphere if they want to improve the response to digitalization. The successful implementation of new technology requires organizational and collegial support.

Relevance to clinical practice: Recommendations for clinical practice include: development of competence in digitalization by healthcare professionals when using technological equipment to minimize errors; provision of sufficient resources, equipment and room for technology usage; and provision of regular education that considers the participants' competencies.

Keywords: competence, digitalization, healthcare professional, manager, midwife, nurse, primary healthcare, public healthcare specialist, specialized healthcare

What does this paper contribute to the wider global community?

- Heatlthcare staff need profound knowledge and skills to integrate digitalization into clinical practice in efforts to provide the best possible patient care.
- Healthcare professionals' attitudes and experiences influence their willingness and motivation to use technology.
- Appropriate and successful technology usage requires regular education that considers individuals' competence.
- Psychosocial and organizational factors are significant predictors of healthcare professionals' competence in digitalization.
- Organizational and collegial support is required for effective adoption and use of new technology.

1. Introduction

Digitalization is a global phenomenon (Sensmeier, 2009; Serbanati et al., 2011) involving the rapid integration of digital technology into increasingly diverse aspects of professional and personal life (Reis et al., 2018). *Inter alia*, rapidly developing digital information and communication technologies are becoming increasingly prevalent in healthcare (Dowding, 2013; Murphy, 2010; Nohl-Deryk et al., 2018; Sensmeier, 2011). Elements of this trend include the digitalization of numerous healthcare services (Wu et al., 2009) and practices (Sensmeier, 2011) enabling (for example) the development and provision of mobile health (mHealth), health information technology (IT), wearable devices, telehealth and telemedicine, health portals and personalized medicine (European Commission, 2012; Sensmeier, 2009). Digitalization can also reportedly enhance hospital performance by improving the quality of patient care (Murphy, 2009), reducing costs (Gastaldi & Corso, 2012), or increasing cost-effectiveness, and enabling personalized patient care (Tresp et al., 2016).

More than a decade ago, the European Commission (2004) adopted an action plan (called eHealth) to improve access to healthcare and increase the quality and effectiveness of healthcare services among member states by increasing access to digital technologies and the competence to exploit them. This action plan also aimed to increase socio-economic inclusion and equality, quality of life, and patient empowerment (European Commission, 2012). Digital competence was defined as "the confident and critical use of Information Society Technology (IST) for work, leisure and communication…underpinned by basic skills in information technology to retrieve, assess, store, produce, present and exchange information, to communicate and participate in collaborative networks via the Internet" (European Commission, 2016). The WHO (2016) considers competence in digitalization as part of human capital which requires perpetual education to keep existing skills in line with technological development and new knowledge. An associated concept, digital health, can be defined as the application of theoretical, technological and methodological competence to solve health preventative, diagnostic and treatment problems through integrating digital technology into healthcare (Aakhus et al., 2018; Zhang et al., 2018). A problem is that competence is a controversial concept and there is little consensus about its nature, but here it is regarded as a holistic combination of the knowledge, performance, skills, values and/or attitudes (Cowan et al., 2005) required for effective performance of specified tasks or activities.

Previous investigations of the inclusion of digitalization in patient care (Sewerin et al., 2018) and medicine (Kuhn et al., 2018; Zhang et al., 2018) have strongly focused on aspects related to medical science. However, identified obstacles to effective digitalization in healthcare include incompatible or obstructive stakeholder-specific interests and organizational structures (Nohl-Deryk et al., 2018). Another potential problem that has received less attention is that healthcare professionals must have the competence to incorporate new technological solutions into clinical practice, and the competencies required for successful digitalization in healthcare settings have not been clearly identified (Sensmeier, 2009). Thus, in accordance with the above definition of competence, this study focuses on the digitalization-related knowledge, skills and attitudes healthcare professionals need to integrate digital technology in the professional context of patient care. Following the WHO (2013), healthcare professionals are regarded as including physical therapists, nursing staff, medical technology specialists, clinical laboratory staff, dental technicians, occupational therapists and others (see Figure 1).

In the healthcare sector, it is important to recognize the impacts of competence in digitalization, as insufficient competence of healthcare professionals can harm patient safety and increase the incidence of errors (Salahuddin & Ismail, 2015). Moreover, insufficient competence can lead to negative experiences of technology usage, which will influence attitudes towards the adaptation of other technologies (de Veer & Francke, 2010). Digitalization in healthcare raises questions concerning the ethical needs to protect patients' data (Wadmann & Hoeyer, 2018), self-efficacy and autonomy (Gross & Schmidt, 2018), and competent integration of digitalization in morally correct decision-making (Capurro, 2017) by healthcare staff (Sharma et al., 2018). Achieving appropriate competence in digitalization requires regular evaluation, training and education of healthcare professionals, all of which are the healthcare organization's responsibility (Ingebritsen et al., 2014; Salahuddin & Ismail, 2015). Successful implementation of technology also requires appropriate willingness (in addition to competence) to use it (Ingebritsen et al., 2014; Wu et al., 2009).

Several contextual factors related to healthcare professionals' competence in digitalization have been identified. For instance, digitalization is reportedly accepted by healthcare professionals when it is perceived to help patients and support workflow processes, while negative attitudes and experiences, along with a lack of competence, cause frustration and unwillingness to adopt new technologies (Murphy, 2009). For example, de Veer and Francke (2010) found that attitudes of healthcare staff towards electronic patient records (EPRs) were influenced by the type of healthcare organization they work in, previous experiences of EPRs, number of working hours per week and perceived usefulness

related to the quality of care. Similarly, Buntin et al. (2011) found a connection between experiences of dissatisfaction and negative outcomes for technological implementation. However, broader knowledge of healthcare professionals' competence areas and experience in digitalization is needed to identify the educational and organizational requirements to enhance the effectiveness of digitalization. The systematic review presented here addresses this gap in knowledge.

2. The review

2.1 Aims

The aim of this systematic review is to address the knowledge gap described above by identifying key areas of competence for digitalization in healthcare settings, describing healthcare professionals' competencies in these areas, and identifying factors related to their competence.

Three specific research questions were addressed:

1. What are the key areas of competence regarding digitalization in a healthcare settings?
2. What factors are related to healthcare professionals' competence in digitalization?
3. What kind of experiences do healthcare professionals have regarding digitalization?

2.2 Design

A systematic review of quantitative and qualitative original studies was conducted according to Center of Reviews and Dissemination guidelines (CRD, 2009). The search and selection procedures applied are illustrated in the PRISMA flow diagram shown in Figure 1 and described in the following sections.

2.3 Search methods

Four databases—CINAHL (EBSCO); Medline (Ovid); Web of Science; and Academic Search Premiere (EBSCO)—were searched for relevant literature. Inclusion criteria based on participants (P=participants), outcomes or phenomena of interest (O=outcomes / I=phenomena of interest), context (C=context) and type of studies (S=type of studies) were set according to the PICOS review protocol (CRD, 2009; JBI, 2014). The inclusion criteria were used to assess the eligibility of studies (Aromataris & Pearson, 2014). The participants had to be healthcare professionals, excluding medical professionals. Outcomes or phenomena of interest included areas of competence in digitalization. The context was healthcare settings, including primary and specialized healthcare sectors. The types of studies chosen for the review were quantitative and/or qualitative original peer-reviewed studies published between 2012 and 2017. The language limit was set to English, Finnish and Japanese. The

search terms were organized into four specified groups of keywords according to the PICOS inclusion criteria which were combined with Boolean operators (Aromataris & Riitano, 2014) (Figure 1).

A total of 10,365 original studies were identified from the four databases. All of the original studies were screened by title (n=10,365), abstract (n=498) and full-text (n=123). A total of 13 original studies, five quantitative and seven qualitative, were included in the quality appraisal. The study selection process was conducted separately by two researchers, after which they came to a consensus. There was no disagreement between the two researchers during the selection process.

2.4 Quality appraisal

The quality appraisal was conducted, according to guidelines of the Joanna Briggs Institute (JBI, 2014), separately by two researchers, after which they came to an agreement. Each article had to receive positive scores for at least half of the evaluation criteria to be included in the review. Six of the original quantitative studies were assessed using the MAStARI critical appraisal for descriptive studies, which includes nine assessment criteria (JBI 2014). One of the quantitative studies (Mäkelä et al., 2010) received positive scores for less than half of the assessment criteria and was therefore excluded from the review. Seven of the original qualitative studies were examined using the Qualitative Assessment Research Instrument (QARI) for quality appraisal, which includes 10 assessment criteria (JBI, 2014). Twelve studies were included in the data synthesis (Table 1). The methodological quality of this systematic review was satisfactory according to all 11 assessment criteria included in the Assessment of Multiple Systematic Reviews (AMSTAR) instrument (Shea et al., 2007). PRISMA (Moher et al., 2009) checklist outcomes are available in Supplementary file 1.

2.5 Data extraction

Data regarding author, year, country of origin, study purpose, participants, methodology of data collection and analysis and main findings were extracted from the original articles and are presented in Table 1. Data extraction is meant to help other researchers easily obtain the necessary information about study characteristics and findings (CRD, 2009).

2.6 Data analysis and synthesis

2.6.1 Analysis of quantitative data

Information in the selected articles was analyzed by narrative analysis: transforming the data into common measures, tabulating the relevance of results and reporting textual descriptions of study

conclusions (CRD, 2009). Quantitative findings were analyzed by organizing data according to categories of competence in digitalization (see Table 2). Factors with statistically significant reported effects on competence in digitalization were identified and are presented in Table 3. Studies included in the analysis varied in terms of foci, design, methods, samples, data analysis procedures and results. None of the identified factors were linked to the same outcome in all of the included studies, prohibiting meta-analyses in this systematic review. Competence was measured in various ways in the quantitative studies. Hence, the presented values in each original study were changed into percentages by calculations (Kijsanayotin et al., 2009; Koivunen et al., 2014; Secginli et al., 2014; Wilson et al., 2013). Mean percentages were calculated when the original findings were observational and reported as frequencies and/or percentages (Sands et al., 2012).

Four of the quantitative studies (Kijsanayotin et al., 2009; Koivunen et al., 2014; Secginli et al., 2014; Wilson et al., 2013) used instruments that employed Likert-scales, whereas Sands et al. (2012) used a percentage scale. Kijsanayotin et al. (2009), Secginli et al. (2014) and Sands et al. (2012) developed the instruments used in their respective studies. Sands et al. (2012) used the Mental Health Telephone Triage Competencies Observation Tool (MHTTCOT) to collect observational data, while Kijsanayotin et al. (2009) and Secginli et al. (2014) did not name their instruments, but discussed the processes used to validate them. Koivunen et al. (2014) and Wilson et al. (2013) used pre-existing instruments. Koivunen et al. (2014) used both the Finnish version of the Team Climate Inventory and Burke´s ICT attitude questionnaire to collect data, while Wilson et al. (2013) used the Theory of Planned Behaviour (TPB) questionnaire.

2.6.2 Synthesis of qualitative data

Thematic synthesis was applied to analyze qualitative data in the selected articles, interpret the results (Thomas & Harden, 2008), and address the research questions (Aromataris & Pearson, 2014). The analytical process followed the three stages of thematic analysis recommended by Thomas & Harden (2008) and was conducted using an inductive qualitative approach (Elo & Kyngäs, 2008). The analysis began with compilation of statements regarding all results that included qualitative data relevant to the questions. The process continued with line-by-line coding (n=183), during which different codes were collected under descriptive themes (n=33) linked to relevant topics. The descriptive themes were then combined into analytical themes (n=9). To improve the clarity of the results, the analytical themes were combined under main themes (n=3) (see Table 4).

3. Results

The five original quantitative studies were conducted in Thailand (Kijsanayotin et al., 2009), Finland (Koivunen et al., 2014), Australia (Sands et al., 2012), Turkey (Secginli et al., 2014) and the USA (Wilson et al., 2013). The seven original qualitative studies were conducted in Finland (Anttila et al., 2008), Sweden (Holmström & Höglund, 2007; Munck et al., 2011), the Netherlands (van Houwelingen et al., 2016), Australia (O'Connell et al., 2007), USA (Zuzelo et al., 2013) and the UK (Snooks et al., 2008). The forms of digitalization covered in these studies were tele-health (n=2), telephone triage (n=1), telenursing (n=2), electronic health records (n=1), wireless communication devices (n=1), medical technology (n=2), computerized equipment (n=1), information technology-based patient education (n=1) and health information technology (n=1). Participants in the original studies represented a wide range of healthcare professionals, including registered and practical nurses, midwives, healthcare workers, public healthcare specialists, and nurse managers.

Key areas of competence, identified from quantitative and qualitative studies, include knowledge of digital technology (Sands et al., 2012) and digital skills needed to provide good patient care (Kijsanayotin et al., 2009), including social and communication skills (Munck et al., 2011), and the ability to take ethical decisions regarding use of digital technology in patient care (Holmström & Höglund, 2007; van Houvelingen et al., 2016; Wilson et al., 2013). Healthcare professionals also reportedly need the motivation (Koivunen et al., 2014; O'Connell et al., 2007) and willingness to accumulate experiences with digitalization in their professional context (Anttila et al., 2008; Snooks et al., 2008; Zuzelo et al., 2008). In addition, collegial and organizational support are reportedly essential factors for building positive experiences for healthcare professionals (Munck et al., 2008; Secginli et al., 2014; van Houwelingen et al., 2016; Zuzelo et al., 2008).

3.1 Areas of competence in digitalization and related factors

The areas of competence in digitalization were defined in terms of knowledge on telephone triage and telenursing; skills in the use of health information technology; attitudes regarding intention to use health information technology, beliefs concerning the benefits or barriers of technology, and motivation (Table 2). Factors related to competence in digitalization of healthcare professionals included job position, working place, team climate, and attitudes towards wireless communication devices (Table 3).

Healthcare professionals' competence in digitalization was reported in terms of level of competence (Sands et al., 2012), skills (Kijsanayotin et al., 2009) and attitudes (Koivunen et al., 2014; Secginli et al., 2014; Wilson et al., 2013). A study covering the core competence of mental health telephone triage (MHTT) found that specific competence was needed in both telenursing and mental health telephone triage (Sands et al., 2012), and competence in digitalization was closely connected with competence in a clinical expertise area. Kijsanayotin et al. (2009) reported that healthcare professionals need to be skilled in the use of health information technology (IT) in their everyday work. Attitudes towards digitalization in healthcare were described in terms of performance and effort expectancy regarding technology and voluntariness (Kijsanayotin et al., 2009), beliefs of healthcare professionals concerning the benefits or barriers to technology (Secginli et al., 2014), and motivation to use health information technology (Koivunen et al., 2014).

Three studies discussed related factors (Koivunen et al., 2014; Secginli et al., 2014; Wilson et al., 2013). The statistically significant factors reported in these studies were job position (Koivunen et al., 2014; Secginli et al., 2014), employment at a hospital (Secginli et al., 2014), team climate (Koivunen et al., 2014), perceived behavioral control (Wilson et al., 2013), and attitude towards using wireless communication devices (Wilson et al., 2013). Koivunen et al. (2014) found that higher frequencies of nurse managers (89%) showed strong motivation to use information and communication technology than both registered nurses (85%) and practical nurses (80%) ($p=0.05$). Secginli et al. (2014) found that job position also influences healthcare professionals' perceptions of benefits of EHRs, as 89% of participating physicians believed that EHRs decrease paper-based documentation, compared with 77% of participating nurses and midwives ($p=0.05$).

Koivunen et al. (2014) found that the motivation to use information and communication technology was related to experiences of a team climate and safe participation as well as perceived support for innovation and task orientation. Safe participation was rated as the most important factor (72%, $p=0.02$) by respondents, consisting of perceived safety at work, influence in decision-making, information sharing and interaction frequency. The second most important factor influencing motivation to use information and communication technology was task orientation (67%, $p=0.04$), which describes the interaction of team members to promote excellence in team-work. Support for innovation, which comprises time, co-operation, practical support and resources for the implementation of new ideas and proposals, was also highly ranked (65%, $p=0.04$) (Koivunen et al. 2014).

3.2 Healthcare professionals' experiences regarding digitalization

Healthcare professionals' experiences of digitalization were described under the heading of three main themes: professional knowledge and skills; healthcare professionals' attitudes; and psychosocial and organizational factors (Table 4).

3.2.1 Competence in digitalization requires strong professional knowledge and skills

According to statements in the selected articles regarding the first theme (competence in digitalization requires strong professional knowledge and skills), healthcare professionals must recognize ethical issues and make autonomous decisions, have knowledge of clinical practice, and possess a wide variety of professional skills. Technology usage can cause ethical problems and healthcare professionals must react with autonomous and intuitive decisions. Certain authors highlighted the ethical dilemmas related to telenursing (Holmström & Höglund, 2007; van Houvelingen et al., 2016) because patients' independence, integrity, and autonomy, along with identity verification, were seen as problematic (Holmstöm & Höglund, 2007). Competence in digitalization also requires healthcare professionals to have knowledge of clinical practice. For example, telenurses must have good analytical skills (van Houwelingen et al., 2016) as well as knowledge of clinical procedures and pharmacology (Sands et al., 2012).

A healthcare professional's competence in digitalization encompasses a wide array of professional skills. Social interaction and communication skills are required for using tele-technology. Social interaction skills are also important for communicating with different stakeholders and patients' relatives (Munck et al., 2011; Sands et al., 2012). Healthcare professionals also need a range of practical skills. For example, telenurses must have skills that enable them to manage different kinds of therapeutic interventions and de-escalation techniques, assess drug and alcohol problems (Sands et al., 2012), support patients' self-management and empowerment (van Houwelingen et al., 2016) and handle time management (Sands et al., 2012). Telenurses must also document and report calls, as well as aggregate information (Sands et al., 2012). Moreover, technology usage in healthcare settings generally requires users to be proficient at advanced planning, handling various situations and recognizing needs of patients and their families (Munck et al., 2011).

3.2.2 Healthcare professionals' competence in digitalization is influenced by attitudes that are based on experiences

A major finding related to the second theme (healthcare professionals' competence in digitalization is influenced by their specific attitudes, which are created through experiences) is that many healthcare professionals have negative attitudes towards technology education. For example, Anttila et al. (2008) found that information technology education was experienced as pointless (providing poorly understood benefits), time-consuming and inadequately resourced. They also found that a lack of motivation, along with prejudices, inhibited technology usage, and (interestingly) that lack of motivation increased when a patient had more advanced information technology skills and when the technology either demanded extra work or was not seen as part of the principal work (Anttila et al., 2008). Fears of being overheard and a lack of privacy (Wilson et al., 2013), a misunderstanding of the technology's purpose and feelings of difficulties and/or being uncomfortable (Anttila et al., 2008) are prejudices that may reportedly impede technology usage. Healthcare professionals' experiences also reportedly influence their ability and confidence to use technology, with continuous technology usage increasing self-reliance (Munck et al., 2011; O'Connell et al., 2007). In contrast, a lack of experience decreases familiarity with technology according to O'Connell et al. (2007). Experiences of technology usage may also influence the ability to learn to use technology safely (Zuzelo et al., 2008), while resistance to change (Wilson et al., 2013; Zuzelo et al., 2008) and age (Snooks et al., 2008; Zuzelo et al., 2008) negatively influence the degree of technology usage.

Technologies have varying reported effects on quality of care and care relationships. Technology usage can add value to the patient-nurse relationship according to Anttila et al. (2008), but may harm it by shifting the focus from the patient towards technology (Munck et al., 2011; O'Connell et al., 2007). Technology can also fragment care (Zuzelo et al., 2008). Munck et al. (2011) found that secure use of technology positively affected the care relationship, but technology can make healthcare professionals feel uncertain (Munck et al., 2011; O'Connell et al., 2007; Zuzelo et al., 2008), and using technology may cause stress (Munck et al., 2008; Snooks et al., 2008) and frustration (O'Connell et al., 2007; Zuzelo et al., 2008). Certain healthcare professionals may fear losing practical skills and clinical judgement (Zuzelo et al., 2008) while others may benefit from technology by gaining motivation (Snooks et al., 2008; Wilson et al. 2013; Zuzelo et al., 2008). Some healthcare professionals have reported negative emotions of anxiety and concern while using technology (Snooks et al., 2008).

3.2.3 Psychosocial and organizational factors are significant predictors of healthcare professionals' competence in digitalization

The third identified theme is that healthcare professionals' competence in digitalization is influenced by several psychosocial and organizational factors, including changing healthcare practices, organizational and collegial support, regular education, and technology usage. Technologies influence team work because they change team members' responsibilities and team dynamics, moreover healthcare professionals' competence in digitalization is promoted by organizational and collegial support (Zuzelo et al., 2008). Organizational and managerial support also influence technology usage. For example, a supportive manager can reduce subordinates' uncertainty (Munck et al., 2008). Managers are tasked with managing change (Kijsanayotin et al., 2009), yet increased technology usage is not always considered at the staffing level of organizations (Zuzelo et al., 2008). Furthermore, the personnel's beliefs about existing organizational and technical support influence health information technology usage (Kijsanayotin et al., 2009). There is a degree of social influence in the adoption of a new technology (Kijsanayotin et al., 2009; O'Connell et al., 2007), as the decision to use an implemented technology can be affected by the opinions of colleagues (Munck et al., 2008; Sands et al., 2012; Zuzelo et al., 2008).

Healthcare professionals need regular education and support for technology use (Munck et al., 2008; Secginli et al., 2014; van Houwelingen et al., 2016; Zuzelo et al., 2008), potentially including individual support through appropriate auditing and monitoring practices (Kijsanayotin et al., 2009; O'Connell et al., 2007). Information technology education can enhance healthcare professionals' skills, by adding a new dimension to their competence development (Anttila et al., 2008). Other studies have described information technology education as innovative, inspiring and motivating (Anttila et al., 2008), with education helping certain individuals overcome fears associated with new technology (O'Connell et al., 2007) and uncertainty (Munck et al., 2008). However, healthcare professionals may experience certain practical problems when using new technology, such as the lack of suitable rooms or technical equipment (Anttila et al., 2008) and failing support systems (Zuzelo et al., 2008). Moreover, a lack of knowledge may cause incorrect use of equipment (Zuzelo et al., 2008).

Several studies indicate that technological skills influence the frequency of technology usage. For example, skill level (O'Connell et al., 2007) and past experiences (Kijsanayotin et al., 2009) have been found to influence employees' reactions to computerized equipment and the use of technology in healthcare settings, with paucity of technological skills preventing professionals from deriving maximum benefits (Anttila et al., 2008). However, competence in using computerized equipment

does not necessarily depend on the level of computer literacy (O'Connell et al., 2007). In addition, technological skills are reportedly crucial for: effective use of tele-technology (Sands et al., 2012; Snooks et al., 2008), integration of technology is eased by the degree of technology usage (Kijsanayotin et al., 2009; Wilson et al., 2013) and hands-on education (Zuzelo et al., 2008), and technology usage supports development of new digitalization skills (Anttila et al., 2008; Munck et al., 2008; O'Connell et al., 2007; Snooks et al., 2008).

4. Discussion

The aims of this systematic review were to identify key areas of competence for digitalization in healthcare settings, describe healthcare professionals' competencies in these areas, and identify factors relating to their competence. The key areas of competence included sufficient knowledge and skills in the use of digital technology needed to provide high quality ethical patient care, social and communication skills by healthcare professionals in having the competence to apply digital technology into health prevention, diagnoses and treatment, motivation and willingness of healthcare professionals to integrate digitalization in their professional context, and collegial and organizational support for building positive experiences in digitalization. Results of this review indicate that healthcare professionals' competence in digitalization is closely related to their clinical knowledge and skills, and is an integrational tool that can enhance clinical practices, patient care and workflow efficiency (Sands et al., 2012; Munck et al., 2011). However, appropriate management and communication of digitalization in healthcare is clearly required. The results also show that employees' attitudes towards new technologies and perceptions of their ease of use strongly influence the implementation process (Koivunen et al., 2014; Secginli et al., 2014; Wilson et al., 2013). Ingebritsen et al. (2014) noted that successful implementation of technology is related to healthcare professionals' willingness to use it. Hence, it is important to give healthcare professionals sufficient time and resources to adapt to new technologies. Moreover, learning to use new devices should be integrated into their daily work, and managers should emphasize how the technologies can improve daily clinical practices. Further research on implementation of health information technology, and its meaningful use, is also required (Agarwal et al., 2010).

The review also identified job position as a significant factor influencing healthcare professionals' competence in digitalization (Koivunen et al., 2014; Secginli et al., 2014). For example, clinical leaders' technological competence influences the adoption of information technology by other healthcare professionals (Ingebritsen et al., 2014). This review also revealed that team climate

influences healthcare professionals' motivation to use information and communication technologies (Koivunen et al., 2014; Zuzelo et al., 2008). Mescó et al. (2017) argued that cultural differences and challenges, as well as patient needs, must be considered when planning implementation of technology to optimize health outcomes, and that digital health makes patients the focus of point-of care, thereby changing the status and roles of both patients and healthcare professionals.

A further finding is that psychosocial and organizational factors significantly influence healthcare professionals' competence in digitalization (Anttila et al., 2008; Munck et al., 2008; O'Connell et al., 2007; Snooks et al., 2008). Rippen et al. (2012) argued that it is important to enable technology usage in organizations by providing sufficient resources and equipment as well as a supportive environment. Moreover, organizations should ensure that their employees have enough time and opportunities to learn how to use new technology (Salahuddin & Ismail, 2015). Successful technology usage requires a supportive organizational culture along with shared goals and purposes (Cresswell & Sheikn, 2013). Collegial support is crucial because teamwork climate and values influence the adoption of new technology (Rippen et al., 2013). In addition, both teamwork and education increase the safe use of technology (Salahuddin & Ismail, 2015), but organizations should carefully consider the competency levels and developmental needs of employees when planning education in its use (Wu et al., 2009).

Previous studies have also noted that organizational support is needed during implementation of technology because it is a complex process that requires the commitment and readiness of both the organization and personnel (Cresswell & Sheikh, 2013). To elaborate, successful implementation requires organizational support, explicit policies and appropriate resources (Rippen et al., 2013). Factors related to the work environment are crucial to successful implementation because they can have either positive or negative effects on the outcome (Rippen et al., 2013). During the implementation process managers should also be aware that no approach may be suitable for every situation, but different procedures can be blended, modified and/or exploited to enhance the adoption of new technologies (Abbott et al., 2014). However, it is important to recognize that healthcare professionals' attitudes and experiences will influence their willingness and motivation to use technology, with negative attitudes and experiences contributing to a lack of motivation among staff to use technology (Buntin et al., 2011).

It is also important to note that appropriate and successful technology usage requires regular educational updates, which must take into account variations in competencies in digitalization among healthcare professionals (Cresswell & Sheikh, 2013; Murphy, 2010) to maximize the benefit for each

individual (Abbot et al., 2014; de Veer & Francke, 2010). Finally, further elucidation of the diverse competencies required for successful digitalization, and associated factors, is required to meet needs, exploit opportunities and adapt to shifts in the constantly changing healthcare environment, as digitalization modifies professionals' roles (Mesco et al., 2017), healthcare services (Wu et al., 2009) and clinical practices (Sensmeier, 2011).

5. Limitations of the review

This review has several limitations. First, the results show that healthcare professionals' competence in digitalization is strongly influenced by psychosocial and organizational factors. This raises doubts about the validity of direct comparisons of the reviewed studies (although it may strengthen general conclusions), as the reviewed studies were conducted in various countries, so the participants had diverse socioeconomic backgrounds. Moreover, the level of digitalization differs between these countries, raising further doubt about the validity of such comparison. In addition, the reviewed studies presented heterogeneous datasets, which raises challenges in data analysis (Aromataris & Pearson, 2014).

6. Conclusion

In today's rapidly changing world, healthcare professionals require competence in digitalization when providing technology-based services or using technological equipment to avoid misuse of technology and minimize errors. According to the results of this review, knowledge and skills in digital technology can serve to enhance better patient care, but healthcare professionals need to find benefits in the using of technology. Also, ethical decision making regarding the use of digital technology in patient care should be openly discussed to remove any possible hindrances for the building of a caring relationship between healthcare professionals and patients. Healthcare professionals need to amass positive experiences of digital technology usage because positive experiences will positively influence their attitudes and motivation to adapt and use technology in their work assignments. Attention should also be paid to the social environment at workplaces because there is a degree of social influence in technology usage, with a positive atmosphere improving reactions to digitalization. The demand for digital technology usage in healthcare is constantly increasing, and healthcare professionals need organizational as well as collegial support when adopting and using new technologies. Organizations are responsible for arranging sufficient resources, equipment and room for technology usage as well as affording employees time and opportunities to learn to use new

technology. Appropriate and successful technology usage requires regular education that considers the participants' competencies.

7. Relevance to clinical practice

Based on the results of the systematic review we provide the following recommendations for clinical practice:

- Competence in digitalization can enhance healthcare professionals' clinical practice. We recommend integrating digitalization into clinical practice by including it in the development of healthcare professionals' clinical competence to improve patient care and workflow efficiency.
- We recommend the formulation of policies tailored to smooth the process, and the provision of both organizational support and appropriate educational resources to healthcare professionals, in order to maximize prospects of successful implementation of digitalization.
- The results also show that the team climate influences healthcare professionals' motivation in using information and communication technologies. We recommend clinical management to integrate digitalization into clinical practice by providing education to inter-professional healthcare teams and sufficient time provided for professionals to learn and explore new ways of working in clinical practice. Learning to use new devices should be integrated into the professionals' daily work, while managers should emphasize how the technological devices can improve daily clinical practices.

Conflict of interest:

The authors declare no conflict of interest

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Table 1. Data extraction

Authors, year, and country	Purpose	Participants	Methodology, Data collection, and Data analysis	Key findings / Results	Quality assessment
Kijsanayotin, B., Pannarunothai, S., Speedie, S.M., 2009, Thailand	To understand factors that influence health informational technology (IT) acceptance and use in community health centers in Thailand, as well as to validate the tested IT adoption model in the context of healthcare in a developing country. To identify factors that predict survey respondents´ intention to use health IT and how they use this technology in Thai community health centers in Thailand.	Health workers, nurses and public health specialists (n=1607).	An observational research design; A cross-sectional national survey by self-administered questionnaire; Statistical analysis;	Response rate 82%. Intention to use health IT is a function of the perception of health IT's utility (performance expectancy), ease of use (effort expectancy), as well as how important it is to others that an employee uses health IT (social influence) and whether one has a choice in the use of IT (voluntariness). The predictive power of these four factors was substantial, accounting for more than half of the variance in the intention to use IT. Among these four influencing factors, performance expectancy was by far the strongest predicting factor.	MAStARI 5/9
Koivunen, M., Anttila, M., Kuosmanen, L., Katajisto, J., Välimäki, M., 2014, Finland	To describe team climate and attitudes toward ICT among nursing staff in acute psychiatric wards, as well as present how these factors are associated with each other.	Nursing staff, registered nurses, practical nurses and nurse managers (n= 146)	Quantitative study design, descriptive survey; Questionnaires (TCI, Burkes' ICT attitude); Statistical analysis (SPSS);	Response rate 81%. Nurses' motivation to use ICT is positively correlated with experienced team climate, in particular, participative safety (r=0.335, p=0.021), support for innovation (r=0.251, p=0.042) and task orientation (r=0.267, p=0.042). Nurse managers' motivation to use ICT was significantly higher than that of practical nurses and registered nurses (p=0.006).	MAStARI 6/9
Sands, N., Elsom, S., Gerdtz, M., Henderson, K., Keppich-Arnold, S., Droste, N., Prematunga, R.K., Wereta, Z.W., 2012, Australia	To identify the core competencies of mental health telephone triage, including the key roles, tasks, skills, knowledge and responsibilities necessary to perform safe and effective triage. To produce findings that may contribute to the evidence base for mental health triage practice, which is currently underdeveloped.	Mental health triage healthcare workers (n=18)	Quantitative study design, observational design; MHTS instrument with 42-items; MHTTCOT instrument with 58- item instrument; Statistical analysis;	Over a three-year period, 197 occasions of mental health telephone triage (MHTT) were observed. Clinicians participating in mental health telephone triage must be competent in: opening the call; mental status examination; risk assessment; planning and action; call termination; referral and reporting; and documentation. In addition, healthcare workers require specific skills (crisis assessment/intervention, therapeutic approaches/interventions, negotiating, time management, resource management communication/information transfer) and knowledge (community resources, psychopharmacology, co-morbidity and complexity, youth- and age-specific, drug and alcohol, legal) relevant to effective MHTT.	MAStARI 5/9
Secginli S., Erdogan S., Monsen K.A., 2014, Turkey	To understand healthcare professionals' attitudes towards, and satisfaction with, electronic health	Healthcare professionals from 129 Family Health Centers (FHCs): (n=325)	A cross-sectional, descriptive study design; Questionnaires;	Response rate 43%. The majority of respondents agreed with benefit items, but physicians were more likely to agree that EHRs decrease paper-based documentation (p=0.007).	MAStARI 6/9

	records (EHRs) in primary health care settings.		Statistical analysis;	The majority of respondents disagreed with most of the barrier items, with physicians and nurses/midwives providing significantly different responses regarding data security and cost (p=0.01). Physicians were more likely to agree that EHR costs are barriers to use.	
Wilson, R., Duhn, L., Gonzales, P., Hall, S., Chan, Y.E., VanDenKerkhof, E.G., 2013, USA	To document the perceptions and attitudes of nurses in an ICU (intensive care unit) before and after the implementation of WCDs (wireless communication devices).	Nurses in the ICU before (n=40) and after implementation (n=36)	Cross-sectional study design; Structured questionnaires; Statistical analysis;	Forty (32%) and 36 (29%) registered nurses (RNs) completed the questionnaire before and after WCD implementation, respectively. There were significant differences in both attitudes toward using the WCD ($p<0.01$) and perceived behavioral control ($p<0.01$) pre- and post-implementation.	MAStARI 5/9
Anttila M., Koivunen M., Välimäki M., 2008, Finland	To describe nurses´ experiences of the IT-based standardized patient education program in inpatient psychiatric care from both the nursing and patient perspectives.	Nurses (n=56) working in acute wards in two psychiatric hospitals (n=9) that participated in the IT-based patient education program.	Qualitative research; Questionnaire with open-ended items; Qualitative content analysis;	IT added value to the patient-nurse relationship. IT education was a motivating method, as well as innovative and inspiring for nurses. The method could modernize nursing and was shown to be a promising new tool. Participants were also able to add a new dimension to their professional skills, to receive new information about diseases and their treatment options and to develop their technology skills. The portal was a supportive, fast and thorough information source which was pleasant for nurses to use. A lack of IT skills was found to prevent healthcare workers from deriving the maximum benefit from computers and the Internet.	QARI 7/10
Holmström I., Höglund A.T., 2007, Sweden	To describe the ethical dilemmas, in the form of conflicting values, norms and interests, which telenurses experience in their work.	Female telenurses (n=12)	Qualitative approach Open-ended interviews, two rounds; Thematic analysis;	The study identified five themes of ethical dilemmas that are present in telenursing: talking through a third party; discussing personal and sensitive problems over the phone; insufficient resources and the organization of health care; balancing callers´ information needs with professional responsibility; and differences in judging the caller´s credibility. Questions of autonomy, integrity and prioritization were highlighted by the participating nurses. The study argues that telenursing is particularly sensitive to ethical demands and suggests that opportunities for ethical competence building should be provided so that telenurses can decrease moral uncertainty and distress.	QARI 9/10
van Houwelingen, C.T.M., Moerman, A.H., Ettema, R.G.A., Kort, H.S.M., ten Cate, O., 2016, Netherlands	To identify the competencies that nurses need to possess before they can be trusted to perform specific telenursing.	Phase II Delphi-study: round I: experts n=51 round II: experts n=32 round III: experts n=25 round IV: experts n=3, authors n=3	Qualitative research method, Delphi-study; Qualitative analysis;	All telenursing activities, except for providing psychosocial support and encouraging patients to undertake health promotion activities, require multiple knowledge sources, including clinical and procedural knowledge. Communication skills, coaching skills, the ability to combine clinical experience with telehealth, clinical knowledge, ethical awareness and a supportive attitude were seen as the most important competencies telenurses should possess.	QARI 7/10
Munck, B., Fridlund, B., Mårtensson, J., 2011, Sweden	To describe district nurses' perceptions of medical technology in palliative homecare.	District nurses working with palliative homecare (n=16)	A descriptive design with a phenomenographic approach; Semi-structured interviews; Data analyses were performed in a seven-step process according to Dahlgren and Fallsberg (1991) approach;	Five distinct categories emerged: 1) medical technology led to vulnerability in district nurses' work situations because of increasing demands and changing tasks; 2) medical technology demanded collaboration between all involved actors; 3) medical technology demanded self-reliance; 4) awareness of managing medical technology in a patient-safe way; 5) medical technology provided freedom for the palliative patients. Lack of time and continuity, in combination with increased workload, created uncertainty that could potentially jeopardize patient safety. District nurses need regular training on medical devices, must be more specialized in this kind of care and must not fragment their working time with other specialties.	QARI 9/10
O'Connell, M., Reid, B.,	To explore the education and training experiences of	Nursing staff (n=6): nurses from fully computerized ICU	Qualitative research method, phenomenological approach;	Participants identified a range of formal and informal education and training sources available within the ICU setting, articulating both positive and negative experiences	QARI 8/10

O'Loughlin, K., 2007, Australia	intensive care unit (ICU) registered nurses in using computerized technologies, as well as assess the relationship this education has with role performance and level of clinical experience.	(n=3), nurses from partially computerized ICU (n=3)	Semi-structured, in-depth interviews; Thematic analyses, categorizing;	of using computerized technologies. The level of confidence in using computerized technologies was clearly related to years of experience and differentiated clinical nursing roles, and reflected whether a nurse worked in a fully- or partially-computerized unit.	
Snooks, H.A., Williams, A.M., Griffiths, L. J., Peconi, J., Rance, J., Snelgrove, S., Sarangi, S., Wainwright, P., Cheung, W-Y., 2008, United Kingdom	To understand the impact of telenursing from the perspective of nurses involved in its provision as well as in more traditional roles	Nurses (n=92) working in NHSDW (National Health Service Direct Wales) Two focus groups: Telephone service nurses; other nurses (n=13)	Qualitative study design; Structured questionnaires, focus groups; Thematic analysis, inductive analysis;	Respondents represented a highly educated workforce from a range of healthcare specialties. 'Two-thirds reported improved job satisfaction after the implementation of new technologies. All focus group participants reported that decision-support software as well as the remote nature of the consultation had developed their nursing skills. Participants reported opportunities for skill development although the role could be stressful. All of the respondents agreed that the service was popular among callers, but that nurses from other sectors raised concerns about whether telenursing was 'real' nursing, the evidence base supporting the service, and access by disadvantaged groups.	QARI 5/10
Zuzelo, P.R., Gettis, C., Whitekettle Hansell, A., Thomas, L., 2008, USA	To describe the influence of technologies on registered nurses' (RN's) practice, as well as discuss which technology characteristics encourage or hinder correct use.	Registered nurses (n=31)	Qualitative research method; Focus-group interviews; Content analysis;	Content analysis revealed that technologies enhanced nursing practice by improving direct care processes, patient outcomes, and work environments. Working with inefficient systems in terms of delivery, use, and repair challenged nurses, while physically-unfriendly equipment increased burdens to nurses' work.. Technologies led to changing nurse role expectations and altered healthcare team dynamics. Technology-use systems require monitoring and regular evaluation. System gaps create problems that potentially increase error risk and contribute to nurse dissatisfaction.	QARI 9/10

Table 2. Analysis of the quantitative findings, presented as the percentages of study participants who agreed with a statement regarding digitalization.

HEALTHCARE PROFESSIONALS' COMPETENCE IN DIGITALIZATION	Authors and year of publication				
	Kijsanayotin et al. (2009)	Koivunen et al. (2014)	Sands et al. (2012)	Secginli et al. (2014)	Wilson et al. (2013)
Participant sample	n=1323	n=146	n=18	n=325	PRE n=40 POST n=36
COMPETENCE					
Core competencies of telephone triage and telenursing	-	-	-	-	-
Opening the call	-	-	95%	-	-
Mental status examination	-	-	62%	-	-
Risk assessment	-	-	49%	-	-
Planning and action	-	-	58%	-	-
Call termination	-	-	74%	-	-
Referral and reporting	-	-	26%	-	-
Documentation	-	-	50%	-	-
SKILLS					
Use of health IT[1]	-	-	-	-	-
Use for providing care and reporting	85%	-	-	-	-
Use for management and administration	74%	-	-	-	-
Communication use	52%				
ATTITUDES					
Intention to use health IT[1]	-	-	-	-	
Performance expectancy	88%	-	-	-	-
Effort expectancy	79%	-	-	-	-
Social influence	79%	-	-	-	-
Voluntariness	69%	-	-	-	-
Facilitating conditions	78%	-	-	-	
Attitude toward using the WCD[2]	-	-	-	-	pre 79%, post 63%
Perceived behavioral control	-	-	-	-	pre 71%, post 57%
Beliefs concerning the benefits of ICT[3] use		64%	-	80%	-
Beliefs concerning barriers to EHR[4] use	-	-	-	65%	-
Motivation to use health IT	-	85%	-	-	-
Instrument	No name of instrument provided, Likert-type 1-7 scale	Team Climate Inventory (TCI): Participate safety and Support for innovation Likert 1-5, Task orientation Likert 1-7; Burkes´ ICT attitude questionnaire, Likert 1-5 scale	Mental Health Telephone Triage (MHTT), Competencies Observation Tool, Percent scale	No name of instrument provided, Likert 1-5 -scale	Theory of Planned Behaviour (TPB) questionnaire, Likert 1-7 scale

[1] IT - Information technology
[2] WCD - Wireless Communication Devise
[3] ICT - Information and Communication Technology

[4] EHR - Electronic Health Record

Table 3. Factors related to the findings of healthcare professionals' competence in digitalization, presented as the percentages of respondents that agree with a statement regarding digitalization in healthcare.

Factors	Outcomes				
	Motivation to use ICT[1]	Beliefs of the benefits of the use of ICT[1]	Beliefs of the benefits of the use of EHR[2]	Beliefs of the barriers of the use of EHR[2]	Intention to use health WCD[3]
Original study (participants)	Koivunen et al. 2014 (n=146)	Koivunen et al. 2014 (n=146)	Secginli et al. 2014 (n=325)	Secginli et al. 2014 (n=325)	Wilson et al. 2013 (PRE n=40, POST n=36)
Job position	p=0.05	p=0.03	p=0.05	p=0.01	-
Registered nurse	85%	65%	-	-	-
Practical nurse	80%	61%	-	-	-
Nurse manager	89%	67%	-	-	-
			-	-	-
Nurse/midwives	-	-	77%	62%	-
Other healthcare professionals	-	-	89%	46%	-
Hospital	-	p=0.05	-	-	-
A	-	66%	-	-	-
B	-	61%	-	-	-
Team climate		-	-	-	-
Participant safety	72% p=0.02	-	-	-	-
Support for innovation	65% p=0.04	-	-	-	-
Task orientation	67% p=0.04	-	-	-	-
Perceived behavioral control	-	-	-	-	p<0.01
Pre-implementation	-	-	-	-	71%
Post-implementation	-	-	-	-	57%
Attitude toward using WCD[3]	-	-	-	-	p<0.01
Pre-implementation	-	-	-	-	79%
Post-implementation	-	-	-	-	63%

[1] ICT - Information and Communication Technology
[2] EHR - Electronic Health Record
[3] WCD - Wireless Communication Devise
- not included in the study

Table 4. Thematic synthesis of qualitative findings

MAIN THEMES	ANALYTICAL THEMES	DESCRIPTIVE THEMES
Healthcare professionals' competence in digitalization requires strong professional knowledge and skills	Competence in digitalization requires that healthcare professionals are able to recognize ethical issues and make autonomous decisions	Healthcare professionals have to be able to make autonomous and intuitive decisions Technology usage can cause ethical problems
	Competence in digitalization requires the healthcare professional to have ample knowledge of clinical practice	Healthcare professionals need strong clinical knowledge Telenurses require knowledge of the nursing service system
	Competence in digitalization requires the healthcare professional to possess a wide variety of professional skills	Social interaction skills are required when using tele-technology Communication skills are required when using tele-technology Healthcare professionals need a range of practical skills Healthcare professionals need skills linked to patient safety Healthcare professionals need to be able to prioritize and rank the urgency of a case
Healthcare professionals' competence in digitalization is influenced by their specific attitudes, which are created through experiences	Competence in digitalization depends on the healthcare professional's personal factors	Healthcare professionals demonstrated negative attitudes towards technology education A lack of motivation, along with prejudices, inhibited technology usage Healthcare professionals' experiences and background influence their ability and confidence to use technology Change resistance negatively affected technology usage Age influences the ability to learn how to use technology
	Versatile experiences of technology usage influence a healthcare professional's competence in digitalization	Technologies have contradictory influences on quality of care and the care relationship Technology can make healthcare professionals feel uncertain Healthcare professionals feared losing practical skills and clinical judgement Technology usage can cause stress Benefits of technology usage motivated nurses to use technology Healthcare professionals felt negative emotions while using tele-technology Technology usage requires voluntariness and personal intention Technology usage caused frustration
Healthcare professionals' competence in digitalization in is influenced by psychosocial and organizational predictors	Digitalization in healthcare is changing healthcare practices	Technology influences team work Technology impacts practical nursing Technology influences healthcare professionals' roles by expanding them Technology increases healthcare professionals' resources for teaching/education
	Competence in digitalization requires organizational and collegial support	Organizational and manager support influences technology usage. Social influence affected technology usage Technology usage requires collegial support
	Competence in digitalization requires regular education	Healthcare professionals need regular training and support for technology use Auditing practices and monitoring are operative ways to provide individual support Information technology education positively influences healthcare professionals' skills

	Healthcare professionals experience practical problems concerning technology usage
Competence in digitalization requires regular technology usage	Technological skills influenced the use of technology Technological skills are needed for using tele-technology Technology integration was eased by technology usage and hands-on education Technology usage was a supportive way to develop new skills

Search keywords group 1: health care* or health science* or caring science* or physiotherap* or physical therap* or nurs* or midwi* or prosthetist or orthopt* or medical technolog* or clinical laboratory scient* or medical laboratory scientific offic* or emergency medical technician-paramedic* or paramedic* or elderly care* or dental technic* or dental technolog* or podiatr* or rehabilitation counsel* or naprapath* or optic* or optometr* or osteopath* or radiograph* or social services* or dental hygien* or public health nurse* or community health nurse* or health visitor* or occupational therap*

Search keywords group 2: competenc* or knowledge or skill* or attribute or attitude* or expertise or know-how or capability or capacity or qualification* or abilit*

Search keywords group 3: digitalization or digitalisation or technology or e-health or equipment

Search keywords group 4: healthcare AND primary or special* or homecare or homebased care or outpatient or inpatient or polyclinic or self-care

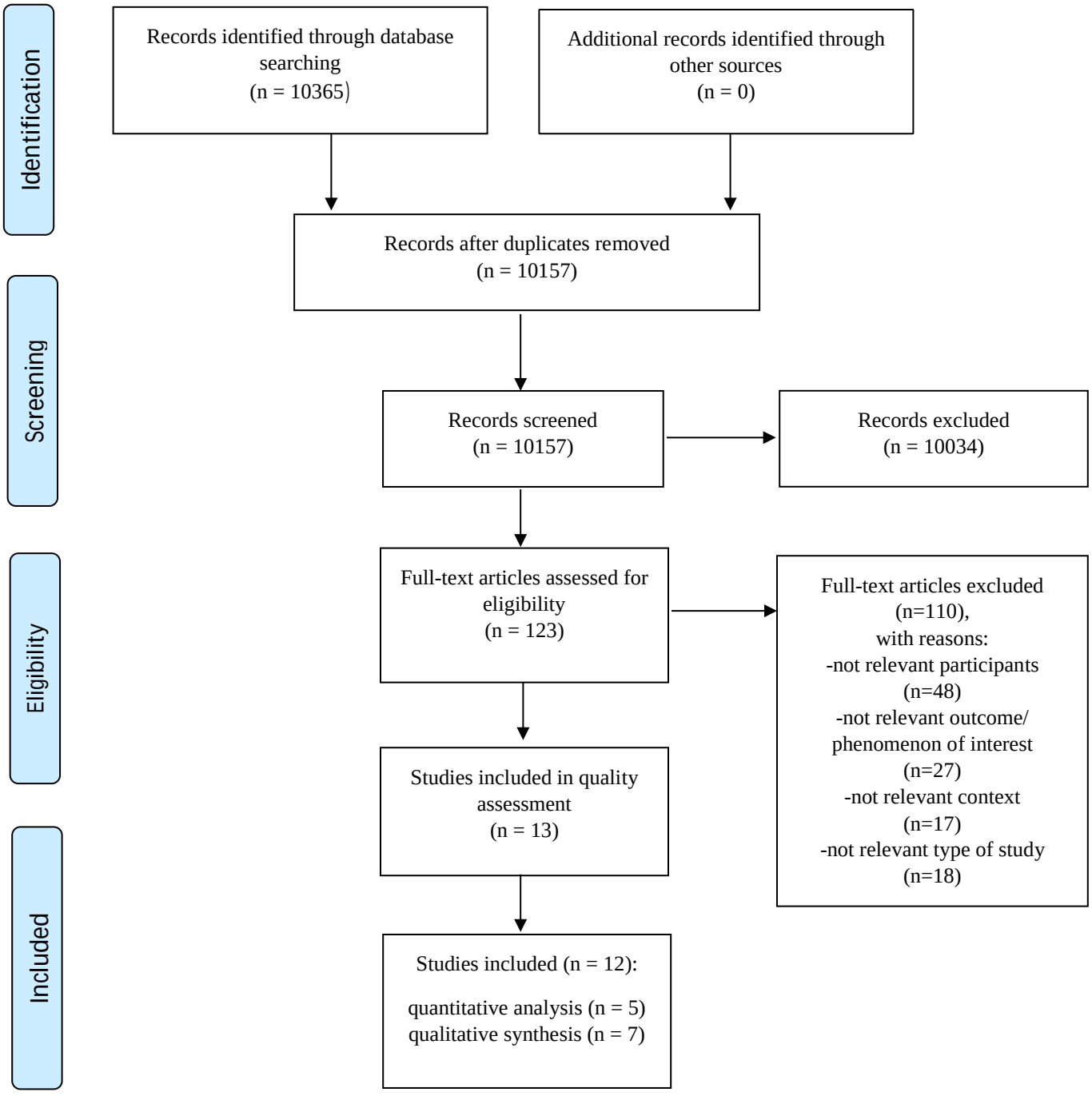

Figure 1. PRISMA flow diagram of study selection process.

PRISMA 2009 Checklist

Supplementary File 1.

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title page
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Figure 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5-7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6 & Table1
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6&Table1

PRISMA 2009 Checklist

Supplementary File 1.

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6-7

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Figure1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	6&12
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8-13
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8-13
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-13
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	13-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	15
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	15-16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

PRISMA 2009 Checklist

Supplementary File 1.

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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