Review Article

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The Effects of Online Continuing Education for Healthcare Professionals: A Systematic Scoping Review

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Abstract: Continuing education offers healthcare professionals the opportunity to adapt to the many changes in society and to improve their skills and knowledge to provide optimal care for patients. As technology evolves, healthcare workers can benefit from virtual peer-to-peer and mentor interactions with digital technology as a platform for continuing professional development (CPD). Nevertheless, healthcare professionals' experiences in CPD in online learning settings have not been tackled clearly. The aim of our systematic scoping review is to investigate the effects of distance and hybrid learning settings in continuing education on learning outcomes and perceptions among healthcare professionals. A quantitative literature search was conducted following the preferred reporting items for systematic reviews and meta-analyses scoping research, allowing data collection of healthcare study scores from previous articles tackling the subject. A total of 17 articles met the inclusion criteria and were reviewed. We identified four main categories of learning outcomes: knowledge acquisition, skills and performance, participants' attitudes toward training, satisfaction, confidence, and self-efficacy. This systematic scoping review highlights that continuing distance education improves health professional learning outcomes. Continuing education in online learning setting allow more learning accessibility for healthcare professionals, as it was found to be a solution for temporal and physical constraints.

Keywords: continuing education, healthcare professionals, learning outcomes, systematic scoping review

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1 Introduction

In response to the occurrence of new diseases, the development of new treatment regimens, and the demand for evidence-based practice, health professionals are constantly required to acquire updated knowledge and skills (Byungura, Nyiringango, Fors, Forsberg, & Tumusiime, 2022). Due to their busy schedules, health professionals cannot spend time in classrooms since they need to take care of patients on a daily basis (Taras, 2023). Keeping up with the latest advances in diagnosis and treatment was found to be easier, more convenient, and more efficient through e-learning (Taras, 2023). Hence, online learning has become popular among health professionals throughout the world for continuing professional development (CPD) (Byungura et al., 2022).

CPD is central to healthcare professionals' lifelong learning, updating both their knowledge and skills (Mlambo, Silén, & McGrath, 2021). CPD programs are learning experiences that enhance and develop professionals' practices and abilities through attending meetings that involve updates on clinical aspects relevant to a healthcare professional role, lectures, monitoring interactions, and giving presentations at conferences (Ramani, McMahon, & Armstrong, 2019).

As technology evolves, healthcare workers can benefit from virtual peer-to-peer and mentor interactions with digital technology as a platform for CPD (Guillaume, Troncoso, Duroseau, Bluestone, & Fullerton, 2022). Indeed, individuals from the healthcare sector can, through online CPD courses, benefit from the flexibility it enables, allowing them to fit their learning around their other work priorities in healthcare institutions. Thus, distance learning can offer a solution for the continuing education of health professionals. Through e-learning, professionals can learn from anywhere and at any time (Dahlke, Hunter, & Amoudu, 2020). e-Learning has become a mainstream option for healthcare professionals in recent years due to the Coronavirus disease 2019 (COVID-19) pandemic that has prompted changes in learning formats (Bacher-Hicks et al., 2021). There are two kinds of e-learning settings: synchronous,

which connects students and instructors in real time, and asynchronous, which allows students to study from anywhere at any time using pre-recorded materials (Lawn, Zhi, & Morello, 2017). In asynchronous learning, learners are responsible for leading their own learning according to their own schedules, which is particularly helpful for healthcare professionals who have irregular work schedules (Kimura, Matsunaga, Barroga, & Hayashi, 2023).

According to the National Center for Education Statistics of the United States (2019), distance education is defined as "education that uses one or more technologies to deliver instruction to students who are separated from the instructor and to support regular and substantive interaction between the students and the instructor synchronously or asynchronously." In addition, hybrid learning is described "as the combination of traditional teaching and online approaches and learning technologies that offer synchronous and asynchronous teaching tools" (Dziuban, Graham, Moskal, Norberg, & Sicilia, 2018) and provides students with a high level of independence and control over their learning (Hsu & Hsieh, 2013). The creation of common spaces, the virtual classroom, or the use of synchronous and asynchronous tools allows teachers and learners to manage their learning situations. For example, e-learning, both in online and hybrid learning settings, offers greater flexibility and varied pedagogical formats that meet the specific needs of caregivers (De Fátima Goulão, 2014). This article focuses on CPD in online, hybrid, synchronous and asynchronous learning settings

Literature has revealed that self-efficacy, confidence, satisfaction, and knowledge can help healthcare practitioners reflect on formal and informal CPD experiences and present evidence of learning (Manley et al., 2018). In point of matter, research about healthcare training has studied self-efficacy, (Abusubhiah, Walshe, Creedon, Noonan, & Hegarty, 2023; Mugisha, 2015; Makopoulou et al., 2019), considering it to be a direct influence on social learning. Indeed, the authors support that high self-efficacy increases the likelihood of perseverance and learning even under adverse circumstances. Thus, self-efficacy is an essential psychological factor reflecting on healthcare CPD training. Another factor studied to reflect CPD training efficacity on healthcare professionals is confidence (Bhatnagar & Srivastava, 2012; Kuo & Belland, 2016; Manley et al., 2018). Studies reveal the importance of satisfaction in reflecting caregivers' quality of CPD training, as it is directly related to the positive attitudes of healthcare professionals toward continuing education (Gil-Lacruz, Gracia-Pérez, & Gil-Lacruz, 2019). In the same study field testing the quality of CPD training of healthcare professionals, studies have underlined the role of knowledge, performance, and skills as predictors to achieve better CPD training (Filipe, Silva, Stulting, & Golnik, 2014; Mlambo et al., 2021).

1.1 Academic Satisfaction (AS) in Healthcare Education: A Driver of Learning Persistence and Better Confidence

Research shows that a significant correlation exists between healthcare career satisfaction and CPD implementation (Hariyati & Safril, 2018). In fact, AS is a strong driver of the learning persistence of online students (Lakhal, Khechine, & Mukamurera, 2021). AS is defined as the impact of processes that take place during learning in which learners participate or have participated (Wu, Hsieh, & Lu, 2015). The authors also pointed out that AS influences the motivation of individuals to learn (Doménech-Bétoret et al., 2017). AS is explained, on the one hand, by the perceived value of tasks and, on the other hand, by students' academic expectations. In e-learning context, the interaction between the learner and the content and the interaction between the learner and the trainer are predictors of learner satisfaction (Kuo & Belland, 2016). Learners' confidence in their ability to use technology effectively and their knowledge can affect their level of interaction in an e-learning course (Kuo & Belland, 2016).

1.2 Knowledge/Skills Acquisition and Performance During Healthcare Education

According to Filipe et al. (2014), CPD involves educational activities to increase medical competence in knowledge and skills. Continuing education for healthcare professionals is necessary because of the rapid changes in the healthcare system and the significant changes in the profession. Therefore, continuing education enables the professional development of healthcare professionals and helps to meet public health needs (Willott, Sakashita, Gendenjamts, & Yoshino, 2018). Continuing education allows healthcare professionals not only to improve their knowledge and skills but also to strengthen their team spirit (Filipe et al., 2014). Continuing education allows those professionals to improve their knowledge and skills and also strengthen their team spirit by being challenged to develop and master multidisciplinary teamwork during CPD training (Filipe et al., 2014). The systematic review by Rowe et al. (2012) reported that blended learning improved clinical skills in continuing education learners. Furthermore, the study by Liu et al. (2016) shows that blended learning has a consistently positive effect on knowledge acquisition. The study by Rouleau et al. (2019) also found that the highest performance scores were observed in learners using an e-learning device. Due to its flexibility and accessibility, e-learning has been found to

improve learning, knowledge/skills, and performance (Regmi & Jones, 2020).

We found two review research investigating continuing distance education for healthcare professionals. First, the meta-synthesis by Mlambo et al. (2021) on nurses' experiences of CPD; this qualitative study does not involve distance learning per se. The second study is an integrative review by Pavloff, Farthing, and Duff (2017), which aims to determine the current continuing education needs of rural and remote registered nurses internationally. However, this study is not specific to continuing education. Therefore, we chose to conduct the present systematic review to address this observed gap in the scientific literature: we aim to study the effects of distance and hybrid learning settings on the continuing education of healthcare professionals in terms of learning perceptions and outcomes.

2 Research questions and hypotheses

The importance of covering the gap in the literature in the last decade, as well as revealing the possible outcomes, has led to answer the following research questions:

- Research question 1: is CPD in online and blended settings effective for healthcare professionals?
- Research question 2: what are the learning outcomes of CPD in online and blended learning programs for healthcare professionals?

3 Method

Following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) framework, a scoping review describing the area of healthcare professionals' educational continuity was contrived (Page et al., 2021). Records were identified from different database sources following a Cochrane approach (Chandler & Hopewell, 2013): PubMed, Web of Science Core Collection (Thomson Reuters), and PsycINFO (Ovid). According to Shaw (2022), it's been a decade of dramatic growth for Health Professions Education. Hence, empirical and quantitative studies published between 2012 and 2022 were included in this systematic review. During this period, research focusing on healthcare continuing education increased with the increasing demand for clinical information technology, and number of health information managers, according to the Healthcare Management degree guide (2021). Alongside, the article retrieved adopted case studies, quantitative survey, or action-oriented research as research strategies. The research languages of the articles retrieved were in English, and the review method of the articles was independent, including peers or experts with clinical, methodological, or technical expertise. Articles' quality was evaluated according to the journals' metrics in which they were published. Literature not published in journals were not included.

Papers included in this review were selected upon the following inclusion critera: (a) documents that included in their title, abstract, and keywords (from the author and/or plus), the words: nurs* OR "health* professionals" OR "health* practitioners" OR "health* executive" OR caregiver AND online OR blended OR "distance learning" OR hybrid OR "e-learning" OR elearning AND "continuing education" OR "lifelong education" OR "lifelong learning" OR "continuing training" OR "continuing learning" OR "synchronous" OR "asynchronous. It is important to note that "formal education" and "informal education" or similar concepts were not intentionally included or excluded as search terms in this review. Studies were only included if they were conducted with healthcare professional learners from tertiary healthcare (nurses, midwives, doctors, physicians and paramedics, caregivers in palliative care, and healthcare professionals in different hospital departments) in continuing education.

In addition, the studies had to include at least one of the terms of continuing education and a distance learning setting in the title or abstract and a distance learning setting in the title or abstract (Table A1).

348 references were identified by Boolean search, and one reference was added manually, making a total of 349 references, as shown in Figure 1. Using Zotero electronic library, duplicates were removed by an automated tool, and 336 references were selected and sought for retrieval. Of these, 136 met the inclusion criteria of our research: studies showing study design, enrolled population, learning setting, data types, and key measures (when applicable, knowledge and skill acquisition, satisfaction with the training program, self-efficacy, confidence, performance, and learning experience).

After screening, 119 studies were excluded for the following exclusion criteria: studies that do not target education continuity, studies on population other than healthcare professionals, studies that do not show or test learning outcomes, studies that are not empirical and not quantitative, studies targeting professionals in retraining, undergraduates or students in initial academic programs, and studies without full-text availability: 17 were included as eligible in the analysis (Figure 1).

This meta-analysis includes 17 documents describing the learning outcomes of healthcare professionals in

continuing education between 2012 and 2022, involving N = 26,636 subjects in total. Data retrieved from articles in this review were pretest and posttest outcomes on knowledge skills and performance, attitude, satisfaction, self-efficacy, and confidence for effect size assumption, as well as research method, studied variables and aims, and data collection instrument/scale.

Articles included in this review are listed in Table A1. Although the search covered the period between 2012 and 2022, no articles met the inclusion criteria in 2013, 2015, and 2022.

3.1 Effect Size Calculation

We extracted effect sizes from each study using relevant summary statistics. In most cases, the studies reported the means and standard deviations of the pre- and posttests or the means and standard deviations of the experimental and comparison groups, when applicable. Therefore, we were able to calculate the effect sizes as shown in Table A2. Finally, for studies with missing statistical data, we were unable to calculate effect sizes.

4 Results

Out of the selected articles, the population mostly examined in the studies are healthcare professionals in general (n = 8), nurses in specific (n = 7), and caregivers (n = 2). Articles held for review sought to test CPD learning outcomes based on five different categories. Indeed, most studies measured the effect of online training on knowledge, skills acquisition, and performance (n = 12), perceptions of learning (n = 6), satisfaction (n = 4), self-efficacy (n = 3), and confidence (n = 3) (Table A2). Although this study considered both blended and online learning settings, only Wu et al. (2020) study focused on examining CPD learning outcomes based on a blended learning setting.

4.1 Knowledge, Skills, and Performance Gains from Online Continuing Education

Twelve studies analyzed knowledge, skills, and performance as learning outcomes of online continuing education for healthcare professionals. These studies showed that participants significantly improved their knowledge,

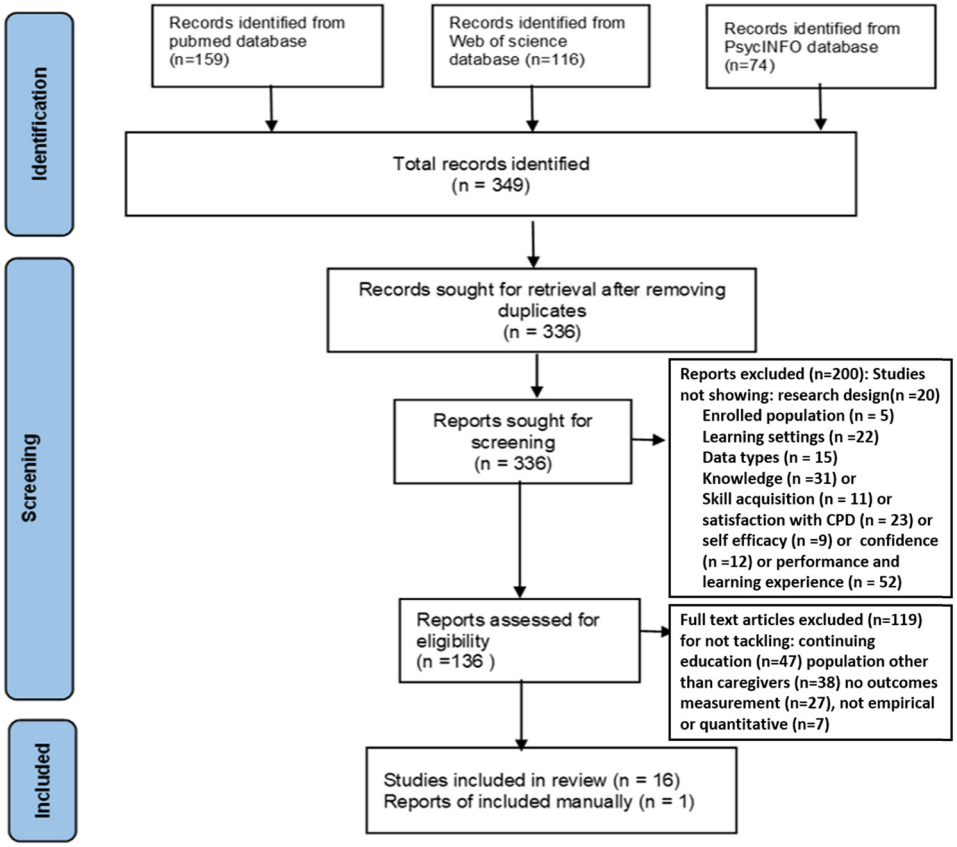

Figure 1: PRISMA flowchart summarizing the process for the identification of eligible articles.

skills, and performance after the online training program. Different subgroups within these 12 studies were identified. Indeed, eight studies compared learners' results between pre- and posttest, with systematic significant differences with large effect sizes in students' mean knowledge and skills scores. The effect sizes range from $d = 0.93$ (Colleran et al., 2012) to $d = 2.8$ (Rakototiana & Rajabo, 2017) (Table A2). However, for the studies by Harvey et al. (2018) and Streed, Gouskova, Rice, and Paasche-Orlow (2021), we were unable to calculate effect sizes because of missing data. The only study about adult learners in blended learning (Wu et al., 2020) show a significant increase in knowledge and skills between pre- and posttest ($t = 10.33$, $p < 0.001$, $d = 1.288$). In addition, the study by Bryan et al. (2020) measured knowledge, skills, and performance after online CPD training for healthcare professionals. For this study, we were unable to calculate the effect size because of missing data. Finally, two studies compare the acquisition of knowledge, skills, and performance between the experimental group (EG) and the comparison group. The study by Liu, Chu, and Chen (2014) held on nurses in a nursing management program showed that the EG performed better on knowledge than the control group (CG) (respectively, $d = 2.644$, $d = -0.287$), while the study by Das Graças Silva Matsubara and De Domenico (2016) showed that whereas both groups yielded positive change, the comparison group had better results on performance than the EG (respectively, $d = 1.224$, $d = 0.602$).

4.2 Attitudes and Satisfaction about the Online Continuing Education Programs

Six studies examined participants' attitudes toward continuing online education programs, out of which three studies compared learners' pre- and posttest. Overall, studies show that participants' attitudes and learning experiences improved significantly after the training. The studies of McCalla-Graham and De Gagné (2015) (in a nursing acute care program), Colleran et al. (2012) (in diabetes disparities training), and Santiago de Araújo Pio, Gagliardi, Suskin, Ahmad, and Grace (2020) (in cardiac rehabilitation program) found significant improvement in adult learners' attitudes between pre- and posttest, respectively ($t = 3.995$, $p = 0.001$, $d = 0.818$; $t = 4.24$, $p < 0.001$, $d = 0.93$; $p < 0.05$, $d = 0.62$). Wu and colleagues' (2020) blended learning study showed a significant increase in attitudes ($t = 6.81$, $p < 0.001$, $d = 0.514$).

The study by D'Aloja et al. (2020) investigated participants' attitudes after training: they found that participants displayed a positive attitude toward CPD training, thanks to the relevance and effectiveness of the distance learning course. However, the effect size could not be calculated as the study only presented percentage data. Finally, one study compared the attitude scores of rural *vs*. urban nurses in an online training program about communication skills (Xing et al., 2018): the total attitude score of rural nurses was significantly higher than that of urban nurses in four aspects, including convenience and flexibility, interaction with facilitators and students, positive learning experience, and improved nursing care ($p < 0.001$, $d = 0.326$).

Four studies have investigated adult learners' satisfaction with online training. The researchers measured satisfaction at the end of the course. The studies of Bryan et al. (2020), McCalla-Graham and De Gagné (2015), Rakototiana and Rajabo (2017), and Lawani et al. (2021) show that participants were satisfied with the content of the training and the knowledge gained during the training. Effect sizes could not be calculated as statistical data were not presented in the studies.

4.3 Self-efficacy and Confidence after the Online Continuing Education Program

Two out of the three studies analyzing learners' self-efficacy use a pre- and posttest experimental setting in distance learning situations. The study of Santiago de Araújo Pio et al. (2020) found that e-learning improved adult learners' self-efficacy after training ($p < 0.001$, $d = 1.753$), whereas the study of Forbat, Liu, and Koerner (2020) about training caregivers in palliative care about Cancer Caregiving Tasks showed a slight decrease in self-efficacy among the learners. Quantitative data from the study were not available. Finally, the blended learning study by Wu et al. (2020) concluded that the self-efficacy of adult learners in blended learning increased after the training ($t = 11.23$, $p < 0.001$, $d = 1.114$).

Four studies analyzed participants' confidence. Out of the four studies, two measured healthcare professionals' confidence about their skills by comparing pre- and posttest results. Colleran et al. (2012) and Harvey et al. (2018) found that participants' confidence increased significantly after training in clinical, nonclinical, and professional skills ($p < 0.001$, $d = 0.91$; $t = 25.75$, $p < 0.001$, $d = 1.15$, respectively). The study of Liu et al. (2014) compared caregivers' confidence between the experimental (distance learning setting) and comparison (in-situ traditional learning setting) groups: the EG displayed a higher skill confidence score than the comparison group ($p < 0.001$, $d = 0.784$; $p < 0.001$, $d = 0$, respectively).

5 Discussion

The aim of this article was to conduct a systematic scoping review of quantitative research on the effects of distance and blended learning settings in continuing education on healthcare professionals' learning outcomes. The systematic review revealed several variables related to positive learning outcomes: knowledge/skill acquisition; attitude and satisfaction towards the training program; self-efficacy and confidence.

Most studies reported a significant increase in knowledge, skills, and performance of healthcare professionals as results of online continuing education. Our results confirm those of Balls (2010) who found that continuing distance education improved nurses' professional standards through the skills and knowledge acquired. The review of Du et al. (2013) about distance learning for nurse education also showed that the highest performance scores were observed for learners in a distance learning setting. For Regmi and Jones (2020), thanks to its flexibility and accessibility, distance learning plays a significant impact on learning, knowledge/skills, and performance improvement in health science education.

Six studies showed that learners' attitudes toward online continuing education improved after training. Our results are in line with those of Lera, Taxtsoglou, Iliadis, Frantzana, and Kourkouta (2020) who demonstrated learners' positive and favorable attitudes toward the distance learning of nurses, given that this learning setting is adapted to their needs and working conditions. Another study by Chong et al. (2016) highlighted that nurses' attitudes toward distance learning through digital devices were found to be positive, especially when organizational support is provided to promote the accessibility of communication technology facilities for the nurses "to motivate their involvement in e-learning" (p. 370). The most positive points highlighted by learners were first the flexibility of learning and the saving of time (Lera et al., 2020).

The three studies found that participants were satisfied with both the courses and their contents. In an e-learning context, the quality of the interaction between the learner and the content, as well as the interaction between the learner and the trainer, appear to be predictors of learner satisfaction. Adult learners, in general, who have difficulties in using technology will have more difficulties in interacting with their peers and the instructor, which will impact their level of satisfaction (Kuo & Belland, 2016). A second study shows that healthcare professionals are satisfied with the e-learning setting because of the quality of the content, the importance of social interactions, the flexibility or efficiency, and the convenience of the technology (Rouleau et al., 2019). However, technological challenges of courses and internet access issues can impact learner satisfaction in online and hybrid continuing education (Kyaw et al., 2019). It is then important to recognize that medical field learners in a blended learning environment would be more satisfied with the course than those in distance learning. This result is in line with the study of Muñoz-Castro, Valverde-Gambero, and Herrera-Usagre (2020) aforementioned in our literature.

We found three studies assessing the self-efficacy of healthcare professional learners in continuing education. Our results are mixed: only two out of three studies show an improvement in healthcare professionals' self-efficacy after training. In the study of Rouleau et al. (2019), self-efficacy is higher among nursing students in an e-learning setting than students in a traditional on-campus setting (Rouleau et al., 2019). In e-learning and blended learning, self-efficacy beliefs play a significant role in learners' academic success. In such learning settings, technologies need to be easy to use, on the one hand, and learners need to feel socially supported by digital platforms, on the other hand, which leads to enhancing their self-efficacy and better persistence in the online course (Diep et al., 2019).

The three studies that assessed the healthcare professionals "confidence in the training showed that the participants" confidence improved after the continuing education session. Those results are in line with the review of Brunero, Jeon, and Foster (2012) who found that following continuing education programs, nurses improved their confidence in stress reduction as well as in the nurse/patient relationship. In addition, the study by Almutairi and Ludington (2016) showed that continuing (on-campus) education can improve the confidence level of healthcare professionals in their knowledge and skills.

Overall, the recorded studies show that healthcare professionals significantly improved their knowledge, skills, performance, confidence, self-efficacy, satisfaction, and their attitudes toward learning after CPD in both blended and online learning settings, in comparison with on-site learning.

Continuing education or lifelong learning is an important current issue for healthcare professionals. They must engage in lifelong learning, as their profession is linked to human life and must respond to the needs and health of patients (Mi & Riley-Doucet, 2016). It is essential that healthcare professionals deepen and regularly update their knowledge.

The scientific literature demonstrates the positive effect of distance learning on the continuing education of healthcare professionals. Such a learning setting allows adult students' flexibility of location and access to content that

promotes their learning (Morán et al., 2020). Studies have shown that healthcare professionals, and nurses in particular, prefer to take online courses, as this learning setting is more suited to their working conditions and needs (Lera et al., 2020).

However, this modality has limitations regarding interactions between students and teachers and may isolate individuals (Lahti et al. 2014, cited by Morán et al., 2020) if not provided with sufficient organizational support (Chong et al., 2016). Therefore, social support from peers and teachers is essential to reduce loneliness, lack of attention, and failure in distance learning (Vayre & Vonthron, 2016).

Blended learning is a means to overcome the limitations of full online learning. Our results show that distance learning has positive outcomes on participants' knowledge, skills, performance, self-efficacy, satisfaction, and confidence. One limitation of this study is that it focused on data gathered from articles exclusively studying CPD in online and blended learning settings. We suggest further research, including research held on on-site CPD, to compare in depth the differences between on-site and online/blended learning in CPD training programs. It would be interesting for educators and future research to focus on the use of learning digital tools available online in learning settings for healthcare professionals, as in Chaker, Gallot, Binay, and Hoyek (2021), who studied the effects of using a 3D interactive tool to study human anatomy.

In conclusion, the adoption of online and hybrid learning for CPD by health professionals is aligned with some aspects of caregivers' perceptions and learning outcomes in off-site learning settings. The outcome of this article enlightens the common aspects found in the last decade of field studies that should be considered in CPD for healthcare distance training. The benefits brought by online CPD training for caregivers were found in knowledge, performance, skills, attitude, confidence, satisfaction, and self-efficacy levels. As part of their CPD programs, health institutions should inform their staff regularly about the benefits of online learning initiatives. As earlier studies have shown, online CPD is an important strategy for improving knowledge and skills within the healthcare sector. In addition, outcomes highly encourage further concern on several factors that must be in place for online learning for CPD to be effective: ensuring the reliability of internet connectivity and devices, as well as encountering challenges to adopting online learning for CPD on an individual, institutional, technological, and instructional level.

Conflict of interest: The authors state no conflict of interest.

Data availability statement: Data generated or analyzed during this study are not available due to the nature of this research (systematic review). This manuscript reports the data in text, and thus, it does not support any repository data.

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Appendices

Table A1: Summary of documents included in the literature review

	Authors	Aim of study	Sample total (*N* = 26,636)	Measures	Outcomes	Limits	Recommendation
1	Apostolidis et al. (2014)	To describe a web-based framework to support caregivers of patients with dementia	Caregivers (*n* = 21)	Evaluation of the APSAD system	Caregivers need communication Training to improve collaboration between caregivers	A lot of abandonment Participant lacks experience with the Internet	
2	Bryan et al. (2020)	Demonstrate that an interprofessional audience can benefit from an e-learning program on dementia	Interprofessional staff (social workers, nurses, physicians, and psychologists) (*n* = 1,546)	Level 1 evaluation based on the Kirkpatrick model: measures satisfaction and perceived usefulness Level 2 assessment measures change in skills, knowledge, and attitudes	Satisfaction with the program program for advancing cognitive disorders education for rural staff (PACERS) and the knowledge gained Acquisition of new knowledge: improving patient care for dementia	Voluntary participants: favorable evaluation of the training Not enough time to know if the training has changed participants' behavior	More studies on dementia care in dementia care facilities as there is not enough knowledge on the subject
3	Colleran et al. (2012)	To determine whether an interactive distance learning program is an effective modality for training community health workers to become members of the diabetes healthcare team	Community health workers (*n* = 23)	Diabetes Confidence Scale Diabetes Knowledge Scale multi-directional knowledge transfer	Participants' confidence improved in both clinical and nonclinical skills Participants showed an improvement in their attitude toward the severity of diabetes Positive relationships between changes in participants' attitudes about the severity of diabetes and changes in attitudes about the psychological impact of diabetes the role of patient autonomy and participants' confidence in clinical skills		

(Continued)

Table A1: *Continued*

	Authors	Aim of study	Sample total (*N* = 26,636)	Measures	Outcomes	Limits	Recommendation
4	D'Aloja et al. (2020)	To describe the participants' profiles and investigate the perceived quality of the training programs and their potential in delivering evidence-based clinical knowledge to healthcare professionals	Health professionals (*n* = 21 532): Midwives (*n* = 14 187) Obstetricians (*n* = 3,716) Anesthesiologists (*n* = 1,896) Specialists in other medical disciplines (*n* = 1,733)	Quality and effectiveness of the courses	As to relevance, quality, and effectiveness of the courses, more than 86% of participants had a "positive/very positive" perception, and 98% of those who left a nonmandatory open-ended feedback message in the evaluation form wrote a positive comment	This study did not assess the impact of the courses on participants' clinical skills	
5	Das Graças Silva Matsubara and De Domenico (2016)	To compare the learning outcomes of the professionals participating in classroom learning versus distance learning	Nurses (*n* = 97)	Questionnaire measure Learning outcomes Evaluation of the Constructivist On-Line Learning Environment Survey experience	For joining the program, the EG excelled over the CG The performance of both groups was statistically significant (*P* = 0.005), and the CG had a greater advantage (40.4%)	The instrument used to evaluate the performance did not contain an answer to the alternative option "do not know"	
6	Forbat et al. (2020)	Designing and testing a distance learning intervention for caregivers	Caregivers in palliative care (*n* = 255)	CASES tool: measuring self-efficacy Cancer Caregiving Tasks, Consequences and Needs Questionnaire (CaTCoN) The Preparedness for Caregiving Scale	Slight decrease in self-efficacy Improved perception of being able to carry out the tasks of the caregiver	Relatively educated population	Future studies: reducing the impact of intervention beyond the caregiver
7	Harvey et al. (2018)	Highlighting online learning outcomes with a focus on effectiveness to increase learner confidence in the learning objectives of cancer control	Health professionals (*n* = 1,328), nurses (75.19%) in oncology and primary care	Kirkpatrick evaluation model Level 1: Learner satisfaction Level 2: Learning outcomes (confidence)	1 point increase in average learner confidence between pre- and postassessment Knowledge increased (91.59%) and the emergence of new skills	No comparison group	Necessary for primary care providers to participate in continuing education to improve care coordination
8	Lawani et al. (2021)	To investigate how user-centered design and theory-based design contribute to the development of a distance learning program for	Family physicians, nurses, and social workers (*n* = 99)	E-learning activity evaluations	The especially liked the narrated slides, the quiz that informed them of actual patient numeracy levels, and the film depicting a	Non-random study sample may also have affected the results by introduction of selection bias	

(Continued)

Table A1: *Continued*

	Authors	Aim of study	Sample total (*N* = 26,636)	Measures	Outcomes	Limits	Recommendation
		professionals to increase their shared decision-making (SDM) with older people living with neurocognitive disorders and their caregivers		Decision boxes (DBs) evaluations	simulated patient encounter during which SDM is implemented Several participants also expressed their satisfaction with the informational content of the DBs, especially the information about the options		
9	Liu et al. (2014)	To describe the development and preliminary effectiveness of a digital case management education program	Nurses (*n* = 40)	Learning effectiveness of e-learning Questionnaires pre and posttest	Post-hoc testing showed that the total knowledge mean scores and skill confidence scores for the intervention group posttest were significantly higher than the posttest scores of the comparison group	Limited number of participants	Further studies with a larger sample size and compliance with the consolidated standards of reporting trials are recommended to ensure the effectiveness of such case management e-learning programs
10	McCalla-Graham and De Gagné (2015)	Develop an online continuing education course on continence care	Community health nurses (*n* = 24)	30-item user interface (UI) Knowledge Scale	Significant differences in mean scores of participants' knowledge and attitude between pre- and posttest	No generalization of results	Online training can be effective in improving the knowledge and attitudes of community health nurses
				15-item UI Attitude Scale	The mean WEPS score was 4.25: nurses satisfied with the training	No long-term data on the certified natural health professional programs' knowledge and attitudes regarding UI	
				20-item Web-based Educational Program Satisfaction (WEPS) Scale			
11	Rakototiana and Rajabo (2017)	Compare the knowledge acquisition among practitioners Heads of Health Based Center for the management of hypertension in two training modalities, one interactive, via Internet and other noninteractive, via DVD	Physicians and paramedics (*n* = 92), Internet (*n* = 56), and DVD (*n* = 36)	10-items satisfaction	The overall satisfaction rate is the same for both learning settings Knowledge acquisition increased in both learning settings (DVD/distance)	Not randomization of the leaders of health based center	

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Table A1: *Continued*

	Authors	Aim of study	Sample total (N = 26,636)	Measures	Outcomes	Limits	Recommendation
		in the three regions of Madagascar					
12	Rhodes, Visker, Larson, and Cox (2019)	Evaluating the effectiveness of a rapid e-learning module for the professional development of school nurses in the management of diabetes in schools	School nurses pretest (n = 678) and posttest (449)	Knowledge of diabetes management	Increase in nurses' knowledge between pre- and posttest	Independent sample design Voluntary nature of participation	Improving the study by matching individual pre- and posttests and determining the significance of individual improvements in knowledge
13	Santiago de Araújo Pio et al. (2020)	Describe the process of developing the tool and assessing its effectiveness on learners' knowledge, attitudes, self-efficacy, and practice	Health professionals in cardiology (n = 21)	Assess participants' characteristics, knowledge about Cardiac Rehabilitation (CR) attitudes, and self-efficacy	The online course increased their knowledge, self-efficacy, and positive attitudes		Evaluation and wider dissemination in CR
14	Streed et al. (2021)	To determine whether the module can improve knowledge of issues relating to older sexual and gender minority (SGM) people	Health professionals (n = 311)	Performance Knowledge	Test performance has improved in all occupations Improves knowledge in four learning areas	Limitations of the study include its cross-sectional design, which does not assess long-term retention	Include SGM content in all training programs
15	Thukral et al. (2012)	To evaluate the effectiveness of web-based distance learning in improving knowledge and skills in essential newborn care among practicing healthcare professionals	Nurses (n = 98)	25 Multiple choice questions and 10 objective structured clinical examination objective structured clinical examination (OSCE) skill stations	There was significant increase in knowledge A significant improvement in the posttest OSCE scores of all participant groups except one: skill scores The course increased their confidence in daily work skills and resolved their doubts	The limitations of the study include the limited utility of this program in areas with no facility for information technology	Further studies are required to study the other benefits and comparison of this training activity with conventional classroom training and teaching
16	Wu et al. (2020)	Evaluate the effectiveness of the program on clinical skills, self-efficacy, attitudes, and learning outcomes	Nurse preceptors (n = 150)	30-item Clinical Teaching Competence Inventory 21-item Preceptor Self-Efficacy Questionnaire 18-item Attitude Toward Web-Based Continuing Learning Survey 32-item e-Learning Experience Questionnaire	Significant improvement of the measures	No CGs	It is important to provide nursing preceptors with pedagogical knowledge

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Table A1: *Continued*

	Authors	Aim of study	Sample total (*N* = 26,636)	Measures	Outcomes	Limits	Recommendation
17	Xing et al. (2018)	To evaluate Chinese nurses' attitude toward, and needs for, online learning, and to explore the differences in attitudes and needs between nurses working in rural and urban hospitals	Nurse (*n* = 529): Rural hospital (*n* = 236); urban hospital (*n* = 298)	28-item attitude toward online learning Nurse's need was measured by a multiple-choice questionnaire	The total attitude score of rural nurses was significantly higher than that of urban nurses Subscale rural nurses gave higher scores than urban nurses in four aspects, including convenience and flexibility, interaction with facilitators and students, positive learning experience, and improvement of nursing care No statistically significant differences compared to urban nurses	The needs for online learning were evaluated by a multiple-choice question: cannot validate results	Further studies should include samples from less-developed areas in China

For studies with different sample sizes between groups (experimental and comparison), we used Hedges' *g* to adjust effect sizes to correct for bias arising from small samples (Hedges & Olkin, 2014).

Table A2: The *learning outcomes* categories of the included studies

Study	Sample (total *N* = 26,636)	Outcomes	Research method	Statistics
Knowledge, skills and performance				
Wu et al. (2020)	Nurse preceptors (*n* = 150)	Increased knowledge and skills of participants after the training	Pre- and posttest	*t* = 10.33 Effect size Cohen: 1.288 Effect size Glass: 2.124 Common language effect size (CLES): 0.819
McCalla-Graham and De Gagné (2015)	Community health nurses (*n* = 24)	Significant differences in mean scores of participants' knowledge between pre- and posttest	Pre- and posttest	*t* = 3.787 Effect size Cohen: 1.342 Effect size Glass: 2.212 CLES: 0.829
Colleran et al. (2012)	Community health nurses (*n* = 23)	Improving participants' knowledge of diabetes improved clinical and nonclinical skills	Pre- and posttest	*t* = 4.24 Effect size: 0.93
Bryan et al. (2020)	Interprofessional staff (social workers, nurses, physicians, and psychologists) (*n* = 1,546)	Acquisition of new knowledge about dementia	Posttest	NA
Santiago de Araújo Pio et al. (2020)	Health professionals in cardiology (*n* = 21)	The online course improved participants' knowledge	Pre- and posttest	Pareid *t* = 3.90 Effect size Cohen: 1.733 Effect size Glass: 2.242 CLES: 0.89
Harvey et al. (2018)	Health professionals (*n* = 1,328), nurses (75.19%) in oncology and primary care	Increase in knowledge and emergence of new skills	Pre- and posttest	NA
Streed et al. (2021)	Health professionals (*n* = 311)	Improvement of knowledge in four broad learning objectives: (1) Terminology relevant to SGM persons; (2) History relevant to SGM persons; (3) Understanding relationship structures of SGM persons (4) Recognizing resources for SGM population	Pre- and posttest	NA
Rhodes et al. (2019)	School nurses pretest (*n* = 678) and posttest (*n* = 449)	Increase in nurses' knowledge between pre- and posttest	Pre- and posttest	Effect size d'Cohen: 2.148 CLES: 0.936
Rakototiana and Rajabo (2017)	Physicians and paramedics (*n* = 92)	Knowledge acquisition increased in both learning settings (DVD/distance)	Pre- and posttest	Effect size Cohen: 2.8 Effect size Glass: 2.8 CLES: 0.976
Thukral et al. (2012)	Nurses (*n* = 98)	There was a significant increase in knowledge and skills	Pre- and posttest	Effect size Cohen: 2.528 Effect size Glass: 3.048 CLES: 0.963
Liu et al. (2014)	Nurses (*n* = 40)	Post-hoc testing showed that the total knowledge mean scores for the intervention group posttest were significantly higher than the posttest scores of the comparison group	Comparison between experimental and comparison groups	Experimental group Effect size Cohen: 2.644 Effect size Glass: 3.105 Effect size CLES: 0.969 Comparison group

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Table A2: *Continued*

Study	Sample (total *N* = 26,636)	Outcomes	Research method	Statistics
Das Graças Silva Matsubara and De Domenico (2016)	Nurses (*n* = 97)	The performance of both groups was statistically significant (*P* = 0.005), and the CG had a greater advantage (40.4%)	Comparison between experimental and comparison groups	Effect size Cohen: 0.287 Effect size Glass: 0.245 Effect size CLES: 0.58 Effect size d Cohen resp. g Hedges *: 0.563 Experimental group Effect size Cohen: 0.602 Effect size Glass: 0.5 Effect size CLES: 0.665 Comparison group Effect size Cohen: 1.224 Effect size Glass: 1.228 Effect size CLES: 0.807
Attitude				
Wu et al. (2020)	Nurse preceptors (*n* = 150)	Significant improvement in attitudes	Pre- and posttest	*t* = 6.81 Effect size Cohen: 0.514 Effect size Glass: 0.524 CLES: 0.642
McCalla-Graham and De Gagné (2015)	Community health nurses (*n* = 24)	Significant differences in mean scores of participants' attitude between pre- and posttest	Pre- and posttest	*t* = 3.995 Effect size Cohen: 0.818 Effect size Glass: 0.71 CLES: 0.719
Colleran et al. (2012)	Community health workers (*n* = 23)	Participants showed an improvement in their attitude toward the severity of diabetes	Pre- and posttest	*t* = 4.24 Effect size: 0.93
Santiago de Araújo Pio et al. (2020)	Health professionals in cardiology (*n* = 21)	The online course increased their positive attitudes	Pre- and posttest	Effect size Cohen: 0.62 Effect size Glass: 0.831 CLES: 0.669
Xing et al. (2018)	Nurses (*n* = 529): Rural hospital (*n* = 236) Urban hospital (*n* = 298)	The total attitude score of rural nurses was significantly higher than that of urban nurses	Comparison between rural and urban nurses	Effect size Cohen: 0.326 CLES: 0.519
D'Aloja et al. (2020)	Health professionals (*n* = 21 532) Midwives (*n* = 14 187) Obstetricians (*n* = 3,716) Anesthesiologists (*n* = 1,896) Specialists in other medical disciplines (*n* = 1,733)	As to relevance, quality, and effectiveness of the courses, more than 86% of participants had a "positive/very positive" perception	Pre- and posttest	NA

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Table A2: *Continued*

Study	Sample (total *N* = 26,636)	Outcomes	Research method	Statistics
Satisfaction				
McCalla-Graham and De Gagné (2015)	Community health nurses (*n* = 24)	The mean WEPS score was 4.25: nurses satisfied with the training	Posttest	*t* = 6.81
Bryan et al. (2020)	Interprofessional staff (social workers, nurses, physicians, and psychologists) (*n* = 1,546)	Participants are satisfied with the PACERS program and the knowledge gained	Posttest	NA
Rakototiana and Rajabo (2017)	Physicians and paramedics (*n* = 92) Internet (*n* = 56) DVD (*n* = 36)	The overall satisfaction rate is the same for both learning setting	Posttest	NA
Lawani et al. (2021)	Family physicians, nurses, and social worker (*n* = 99)	Several participants also expressed their satisfaction with the informational content of the DBs, especially the information about the options	Posttest	NA
Self-efficacy				
Wu et al. (2020)	Nurse preceptors (*n* = 150)	Self-efficacy improved after the training	Pre- and posttest	*t* = 11.23 Effect size Cohen: 1.114 Effect size Glass: 1.219 CLES: 0.785
Forbat et al. (2020)	Caregivers in palliative care (*n* = 255)	Slight decrease in self-efficacy	Pre- and posttest	NA
Santiago de Araújo Pio et al. (2020)	Health professionals in cardiology (*n* = 21)	The online course improved participants' self-efficacy	Pre- and posttest	Effect size Cohen: 1.753 Effect size Glass: 2.379 CLES: 0.892
Confidence				
Colleran et al. (2012)	Community health workers (*n* = 23)	Participants' confidence improved in both clinical and nonclinical skills	Pre- and posttest	Effect size Cohen: 0.91
Harvey et al. (2018)	Health professionals (*n* = 1,328)	1 point increase in average learner confidence between pre- and postassessment	Pre- and posttest	*t* = 25.75 Effect size Cohen: 1.15
Liu et al. (2014)	Nurses (*n* = 40)	Post-hoc testing showed that the total skill confidence scores for the intervention group posttest were significantly higher than the posttest scores of the comparison group	Comparison between EG and comparison group	Experimental group Effect size Cohen: 0.784 Effect size Glass: 1 Effect size CLES: 0.71 Comparison group Effect size Cohen: 0 Effect size Glass: 0 Effect size CLES: 0.5