Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Experiences and needs of nursing students during pandemic outbreaks: A systematic overview of the literature

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ABSTRACT

Background: Recent epidemics have placed overwhelming demands on health systems, leading at times to the deployment of nursing students during the crisis. Little is known about the impact this experience has on students. Although studies have explored nursing students' knowledge about infection control, there are no specific recommendations regarding how these issues should be addressed in nurse education.
Purpose: To conduct a comprehensive systematic overview of the literature concerning nursing students in the context of emerging infectious disease epidemics or pandemics caused by zoonotic viruses.
Methods: Systematic overview.
Results: Forty-eight articles were included. Five themes were identified: education; knowledge, concern about risk and preventive behaviour; willingness to work during a pandemic outbreak; experiences and emotional impact; and ethical dilemmas.
Conclusions: There is a need to enhance nurse education to ensure that students have adequate education in infection prevention and control and the opportunity to develop the skills and attitudes required to provide care to infected patients during a pandemic. The outcomes of these education programmes would need to be evaluated using valid and reliable instruments so as to enable comparisons to be made to prepare future nurses to deal with new pandemics in an increasingly globalized world.

Background

Coronavirus illness known as COVID-19 is the most devastating pandemic the world has faced this century, with over 20.7 million confirmed infections and more than 751,000 deaths worldwide, according to data for 14 August 2020 published by the World Health Organization (WHO) (2020). Since the 2002–2004 outbreak of severe acute respiratory syndrome (SARS) in China and South-East Asia, several pandemics have been declared a Public Health Emergency of International Concern (PHEIC) by the WHO. These include the 2009 swine and avian flu pandemic (H1N1), with the first outbreak in the United States of America (USA); Middle Eastern respiratory syndrome (MERS), first identified in Saudi Arabia in 2012 and which has since been reported in 27 countries; the 2014 outbreak of Ebola virus disease (EVD) in West Africa; and now the SARS-CoV-2 pandemic that originated in China towards the end of 2019 and which has since spread throughout the world. All these pandemics involve human-to-human transmission of a zoonotic virus.

Each of these pandemics has placed overwhelming demands on health systems, leading at times to the deployment of nursing students as auxiliary staff (Collado-Boira et al., 2020; Heung et al., 2005; Jackson et al., 2020; Monforte-Royo & Fuster, 2020). Some authors have questioned the advisability of this measure (Dewart et al., 2020; Hayter & Jackson, 2020), and it is unclear to what extent nursing students are sufficiently prepared to respond to a health crisis of such magnitude. Recent studies have described the impact that caring for patients during an outbreak can have on the mental wellbeing of health professionals (Brooks et al., 2018; Li, Yang, et al., 2020; Rajkumar, 2020; Xiao et al., 2020a), with nurses being the most at-risk group (Kim & Choi, 2016; Lee et al., 2005; Sun et al., 2020). However, very few studies have examined the impact it may have on nursing students (Heung et al., 2005; Li, Wang, et al., 2020; Wong et al., 2004). One qualitative study carried out

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in Hong Kong concluded that working during the SARS outbreak in 2003 served to affirm the professional identity of nursing students and promoted a feeling of self-growth (Heung et al., 2005).

More recently, researchers have recognized the need to assess nursing students' knowledge, attitudes and risk perception in relation to infectious disease outbreaks (Elrggal et al., 2018; Yonge et al., 2007), as well as their willingness to work during a pandemic (Patel et al., 2017; Yonge et al., 2010), especially EVD (Chilton et al., 2016; Etokidem et al., 2018). In a number of countries that have been affected by epidemics, specific education programmes have been developed for nursing students (Ferranti et al., 2016; McNiel & Elertson, 2017; Wu et al., 2009). More widely it has also been necessary to adapt existing nurse education programmes in response to lockdown measures (as confinement of the population, social distancing, mobility restriction and quarantine in the case to be COVID-19 positive or have been in contact with COVID-19 person) (Choi & Kim, 2016; Docking, 2003; McCormack, 2020). However, there are no specific recommendations regarding the education that nursing students require in this respect, and there is as yet no comparative study of the skills they need in order to care for patients during a pandemic. Consequently, an overview of research conducted to date could be a useful guide in preparing nursing students for future events of this kind, and it would also identify areas in which further studies are needed to improve our ability to respond to public health emergencies. To this end, our aim here was to conduct a comprehensive systematic overview of the literature concerning nursing students in the context of emerging infectious disease epidemics or pandemics caused by zoonotic viruses and which have been declared a PHEIC by the WHO.

Methods

Design

We conducted a systematic overview of the literature.

Search strategy

The PubMed, CINAHL, PsycINFO and Web of Science databases were searched since their inception up to May 2020 using medical subject heading (MeSH) terms and free-text keywords (Search date: May 2020). Several trials were needed to determine the final search strategy, which is shown in Table 1. The search was carried out by a single researcher (CMR) and the results were imported to the ProQuest RefWorks citation management software and the Rayyan (Ouzzani et al., 2016) screening tool in order to remove duplicates and select studies.

Inclusion/exclusion criteria

Table 1
Final search strategy implemented in PubMed.

	Terms used in PubMed	Number of hits
#1	Nursing student[MeSH Terms]	24,372
#2	Nurs* undergraduate	7967
#3	Health care student	75,375
#4	Health science student	58,763
#5	Pre-licensure nurse	173
#6	#1 OR #2 OR #3 OR #4 OR #5	124,672
#7	Pandemic[MeSH terms]	43,602
#8	Infectious disease outbreak[MeSH terms]	97,821
#9	COVID-19 OR coronavirus OR SARS-CoV-2	15,899
#10	SARS OR Severe Acute Respiratory Syndrome	14,336
#11	MERS OR Middle East Respiratory Syndrome	18,922
#12	H1N1 OR influenza, human	20,878
#13	Ebola OR ebolavirus	9204
#14	#7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13	148,205
#15	#6 AND #14	607
#16	Aids[MeSH terms]	76,190
#17	Measles	29,081
#18	#15 NOT #16 NOT #17	557

- Population: Nursing students
- Phenomenon of interest: Zoonotic viruses transmitted via direct physical contact or airborne respiratory transmission and which have caused epidemics or pandemics declared a PHEIC by the WHO, for example, SARS, MERS, avian and swine flu, EVD and COVID-19.
- Study design: Studies could use any kind of design (quantitative or qualitative) and we considered all types of publication (theoretical, commentaries, reflections, etc.).
- Language: Only documents written in English or Spanish were ultimately included (these being the working languages of the research team).
- We excluded studies that examined attitudes towards the flu vaccine and those focused on common influenza. Doctoral theses and grey literature, such as press releases or blog posts, were also excluded.

Study selection

The process of selecting studies was carried out by two researchers (CMR, BGF) working independently and in accordance with PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009), and it involved three stages: 1) review of the title, 2) review of the abstract, and 3) review of the full text, based on the aforementioned inclusion criteria. The reasons for excluding a full text were recorded. Any discrepancies regarding the eligibility of studies for inclusion were discussed and resolved by consensus among the two researchers.

Rigour and quality appraisal

Given that our aim was to describe and synthesize the literature to date so as to provide a comprehensive overview, we opted not to exclude studies on the basis of their quality. Although Grant and Booth (2009) argue that evaluating study quality may be considered optional when conducting a systematic overview, we nonetheless decided to rate the quality of empirical studies using a structured checklist designed for both quantitative and qualitative studies (Hawker et al., 2002). This quality appraisal considered nine domains: abstract, introduction, method, sampling, analysis, ethics and bias, results, transferability and implications. Each domain was given a rating between 1, indicating poor quality, and 4, considered good quality. The total quality score therefore ranges from a minimum of 9 to a maximum of 36. Four authors (LW, MM, CA and LM) completed the quality appraisal together, and this was then checked by BGF and CMR. The Hawker et al. (2002) ratings for empirical studies are shown in Table 2. All ratings were between 18 and 34.

Data extraction and analysis and synthesis of results

We designed an ad hoc data extraction matrix to record the following information: author(s), year of publication, country where the study was conducted, study design, sample, data collection, pandemic or threat referred to in the study, aim of the study and main findings. These data were extracted by the research team.

Analysis and synthesis

Descriptive thematic analysis of the data in the extraction matrix, and especially of the main objectives and findings of the studies, revealed five themes related to the aim of this overview. This analysis was carried out by CMR and BGF and was verified by the other members of the research team. Due to the nature of this study, ethical approval was not required.

Results

The initial search strategy retrieved a total of 1466 documents (search date: May 25, 2020), and a hand search of their reference lists

Table 2
Classification of the articles included according to the main themes identified by this review, the country where the study was conducted and the pandemic outbreak or threat referred to

Main themes	Author(s), reference, year	Country	Pandemic or threat referred to
Education (n = 23)	Docking, 2003	Singapore	SARS
	Thompson, 2003	China	SARS
	Thompson et al., 2004	China	SARS
	Ingwerson, 2009	USA	Avian influenza
	Wu et al., 2009	Taiwan	SARS
	Downes, 2015	USA	EVD
	Stirling et al., 2015	Saudi Arabia	MERS
	Vizcaya-Moreno et al., 2015	Spain	EVD
	Ferranti et al., 2016	USA	EVD
	McNiel & Elertson, 2017	USA	EVD
	Patel et al., 2018	USA	EVD
	Choi et al., 2020	China	COVID-19
	De Tantillo & Christopher, 2020	USA	COVID-19
	Dewart et al., 2020	Canada	COVID-19
	Escalera-Antezana et al., 2020	Bolivia & Colombia	COVID-19
	Hayter & Jackson, 2020	UK	COVID-19
	Iserson, 2020	USA	COVID-19
	Jackson et al., 2020	Australia	COVID-19
	Leigh et al., 2020	UK	COVID-19
	McCormack, 2020	UK	COVID-19
	Ng & Or, 2020	China	COVID-19
	Swift et al., 2020	UK	COVID-19
	Taylor et al., 2020	UK	COVID-19
Knowledge, concern about risk and preventive behaviour (n = 18) (n = 14 as a primary objective)	Yonge et al., 2007	Canada	Avian influenza
	Wu et al., 2009	Taiwan	SARS
	Yonge et al., 2010	Canada	Avian influenza
	Stirling et al., 2015	Saudi Arabia	MERS
	Chilton et al., 2016	USA	EVD
	Choi & Kim, 2016	South Korea	MERS
	Ferranti et al., 2016	USA	EVD
	Kim & Choi, 2016	South Korea	MERS
	Elrggal et al., 2018	Saudi Arabia	MERS
	Etokidem et al., 2018	Nigeria	EVD
	Patel et al., 2018	USA	EVD
	Cervera-Gasch et al., 2020	Spain	COVID-19
	Escalera-Antezana et al., 2020	Bolivia & Colombia	COVID-19
	Modi et al., 2020	India	COVID-19
(n = 4 as a secondary objective)	Tzeng & Yin, 2006	Taiwan	Avian influenza
	Tzeng & Yin, 2008	Taiwan	Avian influenza
	Rosychuk et al., 2008	Canada	Avian influenza
	Natan et al., 2015	Israel	Avian influenza
Willingness to work during a pandemic outbreak (n = 10)	Tzeng & Yin, 2006	Taiwan	Avian influenza
	Tzeng & Yin, 2007	Taiwan	Avian influenza
	Rosychuk et al., 2008	Canada	Avian influenza
	Yonge et al., 2010	Canada	Avian influenza
	Natan et al., 2015	Israel	Avian influenza
	Chilton et al., 2016	USA	EVD
	Patel et al., 2017	USA	Infectious disease outbreaks
	Etokidem et al., 2018	Nigeria	EVD
	Osuafor et al., 2019	South Africa	EVD
	Santana-López et al., 2019	Spain	Pandemic influenza
Experiences and emotional impact of a pandemic outbreak (n = 9)	Wong et al., 2004	China	SARS
	Heung et al., 2005	China	SARS
	Stirling et al., 2015	Saudi Arabia	MERS
	Edwards et al., 2019	USA	EVD
	Collado-Boira et al., 2020	Spain	COVID-19
	Fowler & Wholeben, 2020	USA	COVID-19
	Li, Wang, et al., 2020	China	COVID-19
	Monforte-Royo & Fuster, 2020	Spain	COVID-19
	Swift et al., 2020	UK	COVID-19
Ethical dilemmas (n = 4)	D'Aquin, 2020	USA	COVID-19
	Hayter & Jackson, 2020	UK	COVID-19
	McCormack, 2020	UK	COVID-19
	Kam et al., 2020	China	SARS

COVID-19: Coronavirus disease 2019 caused by SARS-CoV-2; EVD: Ebola virus disease; MERS: Middle East respiratory syndrome; SARS: Severe acute respiratory syndrome.

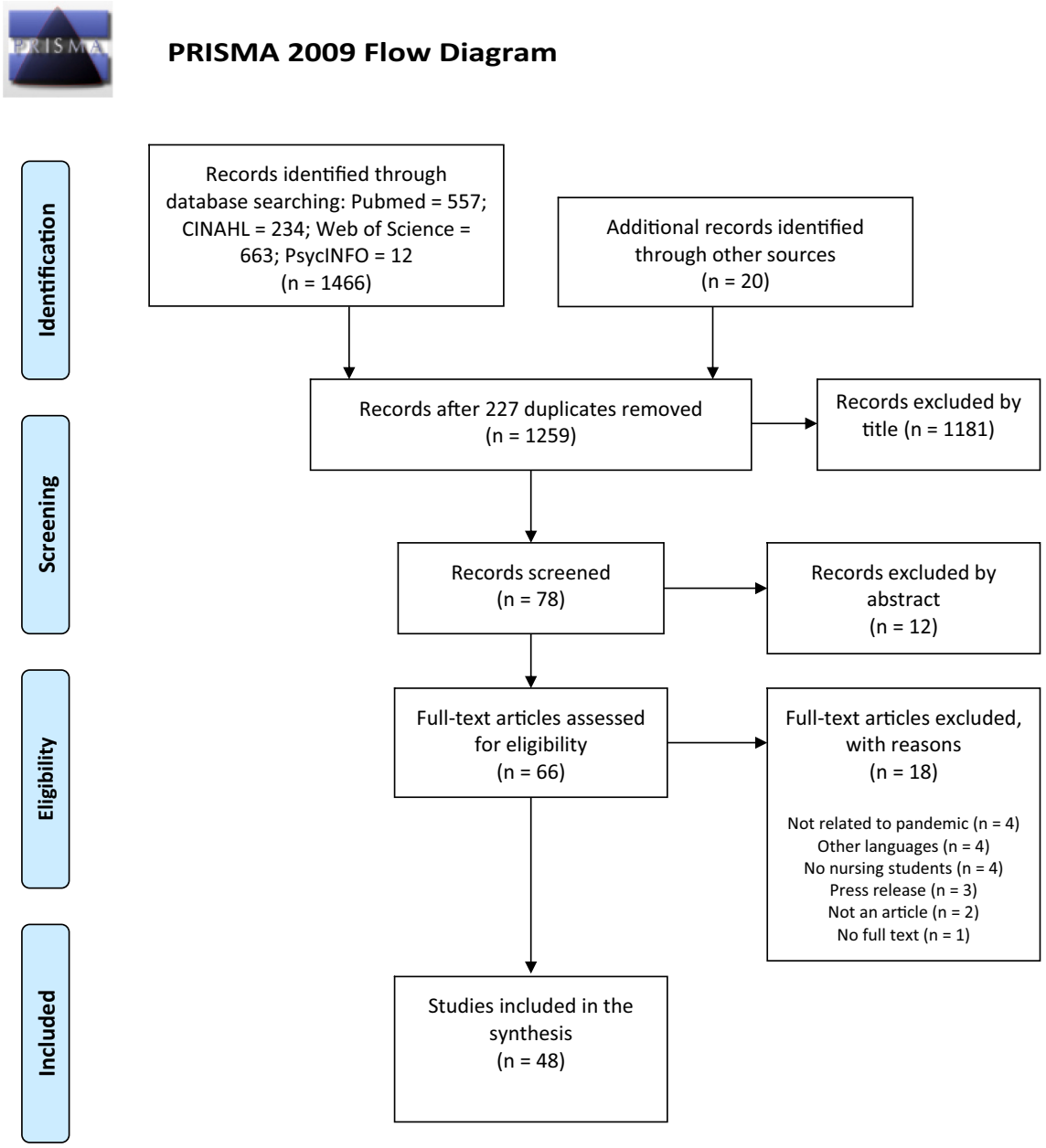
identified a further seven articles. In addition, publication alerts notified us of thirteen more articles that were published between the date of the initial search and the time of writing, and these were also included. Duplicates (n = 227) were eliminated. Figure 1 shows the PRISMA flow diagram for the process of selecting articles. The 48 articles that were included for review were published between 2003 and 2020, and their main characteristics are summarized in Supplementary Table.

In terms of geographical distribution, studies were most frequently conducted in the USA (n = 12), followed by China (n = 8), the United Kingdom (UK) (n = 5), Spain (n = 5), Canada (n = 4), Taiwan (n = 3), South Korea (n = 2) and Saudi Arabia (n = 2). Other countries in which a single study was carried out were Australia, Bolivia/Colombia, India, Israel, Singapore, Nigeria and South Africa.

The majority of studies were quantitative (n = 24), primarily with a cross-sectional design (n = 23), although there was also one quasi-experimental pre/post study with control group and one cohort study. There were three qualitative studies. The remaining articles were commentaries or reflections (n = 11), editorials (n = 7), a letter to the editor (n = 1), a case report (n = 1) and the description of an adaptation of medical education (n = 1).

The pandemics most commonly referred to by the studies are COVID-19 and EVD (with 19 and 9 articles, respectively), followed by influenza outbreaks (H5N1 and H1N1), SARS and MERS (with 8, 7 and 4 articles, respectively). One study concerned possible infectious disease pandemics in general. Articles published up until 2005 referred to the 2003 SARS outbreak and the 2003–2005 H5N1 avian influenza outbreak in South-East Asia. Studies on Ebola began to be published following the 2014 EVD outbreak in West Africa, and 15 articles related to the COVID-19 pandemic have been published in 2020.

Data analysis revealed five main themes that have been addressed in studies on pandemics and nursing students: 1) education; 2) knowledge,



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

Fig. 1. PRISMA flow diagram studies selection.

concern about risk and preventive behaviour; 3) willingness to work during a pandemic outbreak; 4) experiences and emotional impact on nursing students; and 5) ethical dilemmas. Table 2 classifies the articles included in this overview according to these five themes, the country where the study was carried out and the pandemic or threat referred to.

1. Education

Education and knowledge about pandemics is a key theme that is addressed in 47.9% of the studies reviewed. In particular, the need to adapt nurse education is one of the first concerns to emerge in the context of an outbreak. The first three publications on pandemics and nursing students appeared in response to the 2003 SARS outbreak (Docking, 2003; Thompson, 2003; Thompson et al., 2004). These articles reflect on the deployment of nursing students within the health system in order to respond to the health crisis, and they suggest the need to ensure that nurses are trained in universal precaution measures and infection control. In addition, and given the need to suspend clinical placements, it is considered important to be flexible so as to enable students to be placed within other settings. These ideas are reflected in the first quasi-experimental study, conducted in Taiwan, which evaluated the effectiveness of an education programme implemented in 2005–2006 with the aim of improving nursing students' understanding and practice of infection control measures with SARS patients, using validated scales as assessment tools (Wu et al., 2009). In a similar study, academic staff from the College of Nursing in Saudi Arabia describe their experience with the MERS outbreak (Stirling et al., 2015) and the changes made to the curriculum in response to the crisis. In this case, clinical placements were suspended and replaced with increased hours in clinical laboratories so that students could continue to practice their skills. Ingwerson (2009), in the USA, similarly reflects on whether students could gain skills by being involved in vaccine administration in the case of a flu pandemic. In the context of the current COVID-19 pandemic, nurse educators in Canada have reflected on the responsibilities that health systems and universities have in terms of continuing to train nurses during these challenging times (Dewart et al., 2020).

The EVD outbreak in West Africa has led to calls for appropriate education for nursing students in the USA (Downes, 2015; Ferranti et al., 2016; McNiel & Elertson, 2017; I. Patel et al., 2018) and Spain (Vizcaya-Moreno et al., 2015) in order to prevent future threats. The five articles propose education courses aimed at improving not only students' knowledge but also their skills and attitudes in relation to EVD patients. The Spanish study describes the use of simulation education in the use of personal protective equipment (Vizcaya-Moreno et al., 2015).

With respect to the COVID-19 pandemic, a number of recent commentaries have discussed the suspension of clinical placements and the possible deployment of nursing students as auxiliary staff during the crisis (Hayter & Jackson, 2020; Iserson, 2020; Jackson et al., 2020). One concern that has been raised in relation to this measure is that it might undervalue the importance of nurses' theoretical knowledge as compared with the more practical aspects of their role (McCormack, 2020). The paper by Swift et al. (2020) is co-authored by nursing students, discusses both the potential rewards of their volunteering for deployment in the health system, as well as their concerns about doing so. Of relevance to this issue, Taylor et al. (2020) highlight the importance of teaching empathy and resilience to nursing students to help them cope with the adverse effects of a pandemic.

Finally, Choi et al. (2020) discuss some of the lessons learned during the process of reorganizing the learning environment so that final-year students could still graduate on time. One of the issues they highlight is the need for online learning activities to be flexible and adapted to students' availability. Leigh et al. (2020) and De Tantillo and Christopher (2020) also provide examples of digital tools developed as a result of lockdown, while Ng and Or (2020) describe the use of virtual classroom education on hand hygiene.

Overall, a total of eight different education initiatives for nursing students have been described (Downes, 2015; Escalera-Antezana et al., 2020; Ferranti et al., 2016; McNiel & Elertson, 2017; Patel et al., 2018; Stirling et al., 2015; Vizcaya-Moreno et al., 2015; Wu et al., 2009). Four of these were proactive interventions integrated into the teaching curriculum (McNiel & Elertson, 2017; Patel et al., 2018; Vizcaya-Moreno et al., 2015; Wu et al., 2009), one formed part of a degree programme, although it was introduced in response to an epidemic (Stirling et al., 2015), two were independent courses (Downes, 2015; Ferranti et al., 2016) and one involved education symposia on COVID-19 open to both health professionals and students (Escalera-Antezana et al., 2020). In all but one of these initiatives (Escalera-Antezana et al., 2020) it is specified that the content of education was based on the response guidelines of the USA Centers for Disease Control and Prevention (CDC) and/or those of the Ministry of Health of the country in question, and in all cases the participants included experts in zoonosis. The duration of education programmes varied considerably, from a pre-recorded 10-min session (Patel et al., 2018), through courses lasting 3–5 h (Escalera-Antezana et al., 2020; McNiel & Elertson, 2017; Vizcaya-Moreno et al., 2015) or a full day (Downes, 2015; Ferranti et al., 2016), to a 16-h programme split into one-hour sessions (Wu et al., 2009). All but one of the articles (Escalera-Antezana et al., 2020) describes the content and teaching methods, and in all cases the education addressed knowledge, clinical skills or decision making, and/or attitudes towards or confidence in providing care to infected patients.

2. Knowledge, concern about risk and preventive behaviour

Improving students' knowledge about a pandemic and enabling them to acquire skills, attitudes and confidence in caring for patients was a main objective in 14 of the articles included, and a secondary objective in four. These articles report the degree of knowledge that nursing students have about managing or preventing the infectious disease in question. Some articles classified under this theme also feature in the previous theme (Education), while others are also relevant to the next theme we will discuss (Willingness to work during a pandemic outbreak).

Regarding the design of empirical studies, one was a quasi-experimental study with control and intervention groups and it examined the effectiveness of an educational intervention aimed at improving nursing students' knowledge, practice and confidence in relation to the SARS outbreak in Taiwan (Wu et al., 2009). Four articles were pre/post intervention studies that evaluated students' level of knowledge after educational programmes or education related to the epidemic of interest (Escalera-Antezana et al., 2020; Ferranti et al., 2016; Patel et al., 2018; Stirling et al., 2015). The remaining 13 articles reported cross-sectional studies that gathered data through surveys or questionnaires. One recent article reflects on whether health care students have sufficient knowledge about pandemics (Cervera-Gasch et al., 2020).

In addition to evaluating students' knowledge about an epidemic, eight studies also explored their attitudes towards caring for infected patients and their ability to apply their knowledge in practice (Chilton et al., 2016; Choi & Kim, 2016; Elrggal et al., 2018; Etokidem et al., 2018; Ferranti et al., 2016; Kim & Choi, 2016; Patel et al., 2018; Wu et al., 2009). The other studies only evaluated the level of knowledge, alongside other variables such as students' concerns or prevention measures (Escalera-Antezana et al., 2020; Modi et al., 2020; Natan et al., 2015; Rosychuk et al., 2008; Stirling et al., 2015; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2007; Yonge et al., 2010).

With respect to the type of questionnaires or scales used, these generally differed across studies, with the exception of the following, whose authors form part of the same research group: the studies by Choi and Kim (2016) and Kim and Choi (2016); the two studies by Tzeng and Yin (2006, 2008); and the studies by Yonge et al. (2007, 2010) and Rosychuk et al. (2008).

Only five of the 18 studies reported psychometric data for the

Table 3
Characteristics of the instruments used to assess knowledge, skills or attitudes in relation to a given pandemic outbreak in the studies included in this review

Author(s), year, country, pandemic or threat referred to	Scale or concept measured	Underlying theoretical framework	Number of items	Item response format	Language & time to complete the questionnaire	Validity and reliability
Yonge et al., 2007, 2010; Rosychuk et al., 2008, Canada, avian influenza	General knowledge about avian flu	Not reported	5 items	Five-point Likert scale (1 = very unlikely, 5 = very likely)	English; time not reported	Not reported
	Risk perception		4 items			
	Willingness to volunteer		11 items			
	Treatment		Not reported			
	Allocation of resources		Not reported			
Wu et al., 2009, Taiwan, SARS	Knowledge Scale about standard and additional infection control precautions	Items formulated and established based on CDC guidelines;	15 items	11 true/false and 4 multiple-choice questions	Not reported; 20–35 min	Reliability: 0.79
	Application Scale: includes three different real-world clinical scenarios followed by statements based on CDC guidelines	Scales adapted from prior studies (Calabro et al., 1998; Chan et al., 2002)	13 statements	Yes/No		Not amenable to psychometric testing
	Confidence Scale		8 statements	Yes/No		Reliability: 0.86
Stirling et al., 2015, Saudi Arabia, MERS	Knowledge about MERS	Based on Ministry of Health	Not reported	Not reported	English and Arabic; time not reported	Not reported
	Lessons learned about MERS		Not reported	Not reported		
Chilton et al., 2016, USA, EVD	Survey of Nursing Student Self-reported Knowledge of EVD	Based on CDC guidelines	1 item	Rated poor (0) to excellent (4)	English; time not reported	An exploratory factor analysis of the seven-item willingness-to-treat scale revealed a single-factor solution. Reliability: Cronbach's alpha of 0.92
	Willingness to Treat and Perceptions of Duty to Treat		7 items	Three items positively framed: How likely are you to take an action, rated from 0 (very unlikely) to 4 (very likely). Four items negatively framed: How likely are you to refuse to take a certain action, rated from 0 (very unlikely) to 4 (very likely).		
Choi & Kim, 2016 Kim & Choi, 2016, South Korea, MERS	Knowledge about MERS-CoV: cause of MERS, test, treatment, prevention	MERS-related knowledge based on response guidelines of the CDC and the Korea Centres for Disease Control and Prevention and on the questions used to survey health care workers' knowledge in a previous study (Khan et al., 2014)	16 items	Likert scale from 1 (not relevant) to 4 (very relevant)	Not reported	Knowledge: reliability (Kuder-Richardson 20): 0.79
	Attitude towards MERS-CoV		9 items	Likert scale from 1 (Not at all) to 5 (Absolutely yes)		Attitude: reliability (Cronbach's alpha) 0.79
	Perceived risk of acquiring MERS-CoV		1 item	Descriptive 5-point scale from 1 (Not at all) to 5 (Absolutely yes)		Preventive behaviour: reliability (Cronbach's alpha) 0.85
	Preventive behaviour against MERS-CoV: use of public places, avoidance of people coughing, cleaning and disinfection, hand washing		10 items	Each item could be answered as "Performed" (1) or "Not performed"/ "Not applicable" (0)		
Ferranti et al., 2016, USA, EVD	Knowledge retention	According to CDC guidelines	13 items	Correct/Incorrect or True/ False	English; 15 min	Not reported
	Concerns about the risk of EVD: risk as a health care provider; risk as a resident		2 items	Four ordinal categories (0 = not at all to 3 = extremely)		Cronbach's alpha coefficient of 0.865
	Confidence in addressing EVD: confidence in discussing EVD with family, in answering questions about EVD transmission, in conveying a calm message about the general public's risk for EVD		3 items	Not reported		Reliability: Cronbach's alpha of 0.905.
Elrggal et al., 2018, Saudi Arabia, MERS	Knowledge about MERS, including causes, sources of transmission, mortality, clinical manifestations, prevention strategies and risk groups for MERS	Structured questionnaire developed using the style and format of some of the questions used in two previous studies (Khan et al., 2014; Kharma et al., 2015)	9 items	Three possible levels (yes, no, I don't know). A score of 1 was given for each correct answer.	English; time not reported	Authors state that the presentation and validity of the questionnaire were undertaken by experienced academic and senior pharmacy students.
	Sources of knowledge about MERS		1 item	Open question		
	Attitudes and beliefs about MERS		5 items	5-point Likert scale (1 = strongly agree, 2 = agree, 3		

(*continued on next page*)

Table 3 (*continued*)

Author(s), year, country, pandemic or threat referred to	Scale or concept measured	Underlying theoretical framework	Number of items	Item response format	Language & time to complete the questionnaire	Validity and reliability
				= neutral, 4 = disagree and 5 = strongly disagree).		
Patel et al., 2018, USA, EVD	Knowledge about EVD: transmission	Questionnaire similar to the one developed by Akram et al. for leishmaniasis and by Arief et al. for the Zika virus	10 items	Yes/true, No/false, or unsure	English; 20–25 min	Not reported
	Knowledge about EVD: prevention		16 items	5-point Likert scale (1 = strongly agree; 5 = strongly disagree)		
Etokidem et al., 2018, Nigeria, EVD	Sources of information about EVD	Not reported	1 item	Open question	Not reported	Not reported
	Knowledge about EVD		6 items	Open questions		
	Attitude towards people with EVD		5 items	1 open question and 4 dichotomous yes/no		
	Practice regarding EVD prevention		11 items	Dichotomous yes/no		
Escalera-Antezana et al., 2020, Bolivia and Colombia, COVID-19	Knowledge about COVID-19	Not reported	5 items	Dichotomous correct/ incorrect statement	Spanish; time not reported	Not reported
Modi et al., 2020, India, COVID-19	Knowledge and infection control	Adapted from the CDC guidelines	17 items	Not reported	Not reported	Not reported

CDC: Centers for Disease Control and Prevention, Atlanta, USA; COVID-19: Coronavirus disease 2019 caused by SARS-CoV-2; EVD: Ebola virus disease; MERS: Middle East respiratory syndrome; SARS: Severe acute respiratory syndrome.

instruments used (Chilton et al., 2016; Choi & Kim, 2016; Ferranti et al., 2016; Kim & Choi, 2016; Wu et al., 2009) (two of these articles correspond to the same research group). Table 3 summarizes the characteristics of the instruments or measures used, the theoretical framework on which they are based, the number of items and the response format, the language in which the instruments were presented, the time needed to complete them and information regarding validity and reliability, when reported.

3. Willingness to work during a pandemic outbreak

Ten studies have examined nursing students' willingness to work or volunteer during a pandemic outbreak (Chilton et al., 2016; Etokidem et al., 2018; Natan et al., 2015; Osuafor et al., 2019; Patel et al., 2017; Rosychuk et al., 2008; Santana-López et al., 2019; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2010). They are all surveys that evaluate students' attitudes, fears and willingness to work in the event of a pandemic, and they all stress the importance of knowing to what extent future nurses would be willing to provide care to infected patients in their country.

Five of the studies were carried out in response to the threat of an avian influenza pandemic, two in Taiwan (Tzeng & Yin, 2006; Tzeng & Yin, 2008), two in Canada (Rosychuk et al., 2008; Yonge et al., 2010) and one in Israel (Natan et al., 2015). Three studies explore students' willingness to work in the context of EVD, and they were conducted in the USA (Chilton et al., 2016), Nigeria (Etokidem et al., 2018) and South Africa (Osuafor et al., 2019). Another study carried out in the USA examines willingness to work in the event of an outbreak of MERS or EVD (Natan et al., 2015), while the most recent publication concerns a possible influenza epidemic in Spain (Santana-López et al., 2019). Six of these studies focus exclusively on nursing students (Chilton et al., 2016; Etokidem et al., 2018; Natan et al., 2015; Osuafor et al., 2019; Tzeng & Yin, 2006; Yonge et al., 2010), whereas the others also include healthcare students and health workers (Patel et al., 2018; Santana-López et al., 2019; Tzeng & Yin, 2008) or university staff (Rosychuk et al., 2008) in addition to nursing students.

The instruments used to collect data varied across studies, and in most cases they were designed ad hoc by the researchers, although some authors adapted instruments used in previous studies (Akram et al., 2015; Arief et al., 2017; Calabro et al., 1998; Chan et al., 2002; Khan et al., 2014; Kharma et al., 2015). The two Canadian studies (Rosychuk et al., 2008; Yonge et al., 2010) were conducted by the same research team and they use the same instrument to evaluate the willingness of members of the university community to volunteer in the event of an influenza pandemic. The other studies explore willingness to work, although this is referred to using slightly different terms: willingness to work (Etokidem et al., 2018; Natan et al., 2015; Patel et al., 2017), willingness to treat (Chilton et al., 2016; Osuafor et al., 2019), willingness to care (Osuafor et al., 2019; Tzeng & Yin, 2006) or willingness to provide care (Tzeng & Yin, 2008) or willingness to nurse patients (Osuafor et al., 2019).

In addition to exploring the willingness to volunteer or to work during a pandemic, all the studies evaluated respondents' attitudes towards doing so and the factors that may make them more or less willing. The factors identified as making students' less willing to volunteer or work during a pandemic are: a) fear of infection (Etokidem et al., 2018; Osuafor et al., 2019; Patel et al., 2017; Rosychuk et al., 2008; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2010); b) perceived lack of personal protective equipment (Tzeng & Yin, 2006; Tzeng & Yin, 2008); c) family opposition to their involvement (Osuafor et al., 2019); d) fear of infecting family members (Santana-López et al., 2019; Tzeng & Yin, 2006; Tzeng & Yin, 2008), which was greater than the fear of becoming infected themselves; e) cultural factors (Osuafor et al., 2019); and f) the mortality rate associated with the pandemic (Patel et al., 2017). Conversely, the factors identified as increasing students' willingness to work or volunteer during a pandemic are: a) perception of good personal health (Rosychuk et al., 2008; Santana-López et al., 2019; Yonge et al., 2010); b) previous experience of volunteerism (Rosychuk et al., 2008); c) availability of personal protective equipment (Natan et al., 2015; Rosychuk et al., 2008; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2010); d) knowledge about the virus, its transmission, and management of the pandemic, etc. (Chilton et al., 2016; Natan et al., 2015; Santana-López et al., 2019; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2010); e) self-confidence and high score on self-efficacy

(Natan et al., 2015; Rosychuk et al., 2008; Tzeng & Yin, 2006); f) awareness of a shortage of health professionals (Rosychuk et al., 2008; Tzeng & Yin, 2008); g) knowing that they are supported by their university and that the professors and staff of the university are available for students' support (Rosychuk et al., 2008; Yonge et al., 2010); and h) the moral duty to help, a factor common to all the studies that explored this theme.

The results are mixed regarding whether those who volunteer should, given the risk of infection, be compensated for doing so. Most participants in the study by Yonge et al. (2010) did not consider it necessary to offer monetary compensation to volunteers, and neither did they believe that compensation should be paid to volunteers who fall ill or to the families of those who die as a result of their duties. A majority of respondents did, however, think that volunteers should have priority access to health care resources. On this same issue, the studies by Natan et al. (2015), in Israel, and Osuafor et al. (2019), in South Africa, suggest that being paid or provided with medical insurance may be incentives that increase the willingness to work.

In general, the factors associated with a greater willingness to work during a pandemic appear to carry more weight than do those factors which make it less likely. For example, the study carried out in Taiwan (Tzeng & Yin, 2006) found that despite nurses' fear of infection and concerns about a lack of personal protective equipment, 56.9% expressed a willingness to work. Similarly, 67.9% of nursing students in the study by Yonge et al. (2010) were willing to volunteer, and 70.7% saw this as a moral duty. Etokidem et al. (2018) report that 54.2% of students were willing to work during the epidemic. In the study by Natan et al. (2015), 49% of students were willing to work in the event of a pandemic, and 75% were confident (perceived self-efficacy) that they had sufficient skills to perform many tasks. As regards the factors that would affect their willingness to report for duty, these were primarily financial incentives (mentioned by 76% of students) and protective equipment (69% of students). The study by Osuafor et al. (2019) conducted in South Africa and related to EVD reports the lowest percentage for willingness to care for patients (44.8%).

In relation to the two studies that examined attitudes across different groups of students, the results indicate that nursing students expressed greater fear and less willingness to work during a pandemic, as compared with medical students (Patel et al., 2017; Tzeng & Yin, 2008). In both studies the authors attribute this finding to the fact that nurses, given the nature of their role, are more at risk of becoming infected than are medics. In the Spanish study (Santana-López et al., 2019) that compared health workers and nursing students, 52.8% of healthcare workers said they would be willing to work longer hours in the event of an influenza pandemic, compared with 69.1% of nursing students.

4. Experiences and emotional impact of a pandemic outbreak on nursing students

Six studies and three commentaries have examined the emotional impact that experiencing a pandemic may have on nursing students. The first two studies were carried out in Hong Kong by Wong et al. (2004) and Heung et al. (2005) in the context of the 2003 SARS outbreak. The former investigated perceived stress among healthcare students and found that this was higher among nursing as compared with medical students. The authors hypothesized that nurses perceived a higher risk of infection due to their prolonged contact with patients (Wong et al., 2004). Heung et al. (2005) conducted a qualitative study of 10 nursing students and found that working during the SARS outbreak had been perceived as an opportunity to affirm their professional identity and for personal growth. In the context of the MERS outbreak in Saudi Arabia, academic staff from the College of Nursing developed a programme to meet the educational and emotional needs of students, which included education in infection prevention and control measures, as well as a helpline to inform anxious nursing students and their families about risk and offer support (Stirling et al., 2015). The authors claim that students became more resilient as a result of the education and support offered.

Edwards et al. (2019) analysed the reflective journals completed by eight nursing students who were on clinical placement in a hospital in Texas (USA) at the time a patient with EVD was admitted. The students described a range of emotions, both positive (opportunity to learn, personal satisfaction) and negative (fear, concern), while other themes to emerge were the idea of nursing as a calling and the importance of personal protection. The study by Li, Ge, et al. (2020) found that psychological distress was common among healthcare students during the COVID-19 outbreak in China.

In a recently published study, Collado-Boira et al. (2020) conducted semi-structured interviews with final-year medical and nursing students using an open-ended questionnaire hosted online. Students were asked for their opinion regarding the possibility of their being deployed in the health system, the reasons why they would or would not accept, and their main feelings and fears. Fear of the risk of infection emerged as one of the main themes.

The paper by Fowler and Wholeben (2020) reflects on how the high stress associated with the COVID-19 pandemic has the potential to re-traumatize those nurses and nursing students who have experienced traumatic events earlier in their lives. In a similar vein, Monforte-Royo and Fuster (2020) highlight the need to provide emotional support to those nursing students who have been deployed as auxiliary staff during the COVID-19 outbreak, and they also stress the importance of ongoing research so as to understand the impact that their experiences may have in the short, medium and long term. Finally, Swift et al. (2020), in a paper co-authored with nursing students in the UK, reflect on the potential risks and rewards associated with the deployment of nursing students within the NHS. Some of the key themes to emerge were the negative feelings experienced by students who decide not to incorporate in the health care system as auxiliary staff, the risks involved for those who do sign up and the sense of reward.

5. Ethical dilemmas

The literature includes three reflections (d'Aquin, 2020; Hayter & Jackson, 2020; McCormack, 2020) related to the COVID-19 pandemic and a study (Kam et al., 2020) that considers ethical issues in the care of SARS patients. The latter surveyed final-year nursing students in Hong Kong and explored their attitudes in relation to duty of care, resource allocation (how to distribute protective gowns and masks) and deciding which patients should be admitted to critical care units. The authors report that 96.1% of students would not agree to participate in the intubation of a patient with SARS if adequate protective measures were not available.

The three reflections consider the dilemmas that arise from the deployment of nursing students as auxiliary staff in response to a health crisis, exposing them to unnecessary risk (Hayter & Jackson, 2020) before they have completed their education (McCormack, 2020). One of the reflections is written by a graduate nurse student, in which she questions her preparedness for responding to the challenges of the COVID-19 pandemic (d'Aquin, 2020).

Discussion

This systematic overview considers 48 studies of nursing students in the context of emerging infectious disease epidemics or pandemics caused by zoonotic viruses, and it provides a comprehensive summary of research to date. Analysis of the studies included revealed five themes of interest: education; knowledge, concern about risk and preventive behaviour; willingness to work during a pandemic outbreak; experiences and emotional impact; and ethical dilemmas.

One issue to emerge from this overview is the impact which social distancing, isolation and quarantine measures have had on nurse education, with classroom teaching quickly being switched to distance learning via digital technologies. Flexibility has also been necessary with

Author	Criteria 1		Criteria 2		Criteria 3	Criteria 4
	Contributed to conception or design	Contributed to acquisition, analysis, or interpretation	Drafted the manuscript	Critically revised the manuscript	Gave final approval	Agrees to be accountable for all aspects of work ensuring integrity and accuracy
Goni-Fuste, B		x	x	x	x	x
Wennberg, L		x		x	x	x
Martin-Delgado, L		x	x		x	x
Alfonso-Arias, C		x		x	x	x
Martin-Ferreres ML		x		x	x	x
Monforte-Royo, C	x	x	x	x	x	x

regard to clinical placements, relocating students to settings without isolation measures. This does not have to undermine their education, since any clinical setting may provide opportunities for learning, as noted in the scoping review by Stoffels et al. (2019). Edwards et al. (2019) analysed the reflective journals of eight nursing students who were on clinical rotation in a hospital to which a patient with EVD was admitted. Although the students understood the decision to move them to a different unit, they also saw their initial placement as an important learning opportunity.

The reports by Docking (2003) in Singapore, Thompson (2003) in Hong Kong and Stirling et al. (2015) in Saudi Arabia propose that clinical skills can continue to be taught in safe settings, although clearly this is only possible if face-to-face contact with academic staff is permitted. The lockdown measures introduced by most countries in response to the current COVID-19 pandemic led to the suspension of classroom teaching, and alternatives therefore had to be found to enable final-year students to graduate. In a recent communication by the European Commission on the free movement of health professionals and minimum harmonization of education in relation to COVID-19 emergency measures it is acknowledged that some Member States may wish to recognize the professional experience that students have gained as auxiliary staff, thus enabling students to graduate on time and in accordance with EU-level requirements. This question of how to continue with nurse education in the midst of a pandemic is also the subject of a recent paper by nurse educators in Canada (Dewart et al., 2020). However, although nursing students have, during previous epidemics, been deployed as auxiliary staff, the advisability of doing so has also been questioned (Dewart et al., 2020; Hayter & Jackson, 2020). This is an important issue that merits careful reflection. However, despite the comprehensive nature of the present overview, the available data do not enable us to offer a definitive opinion. One problem is that we do not know how many nursing students across different countries have worked as auxiliary staff during a pandemic. Furthermore, although one of the themes identified in this overview was the emotional impact of working during a pandemic on nursing students, more studies, and especially qualitative studies, are needed to analyse their experiences in greater depth. While the three qualitative studies conducted to date do provide important information, the picture remains incomplete. One of these studies only considers students' sense of professional identity (Heung et al., 2005). Another does aim to explore students' experiences more generally, but the context is their clinical rotation in a hospital to which a patient with EVD was admitted, rather than during a pandemic (Edwards et al., 2019). The third study, conducted recently in Spain (Collado-Boira et al., 2020), analyses the written responses of final-year medical and nursing students to an open-ended questionnaire that explored their feelings and opinions about the option of being deployed with immediate effect in the context of the COVID-19 pandemic. The analysis does not distinguish between medical and nursing students, and it is not specified whether the responses correspond to students who did or did not volunteer for early deployment, or how long students may have been working in this capacity. As regards quantitative studies, there are three reports that examine some aspect of the impact which working during a pandemic may have on nursing students. Once again, however, despite providing information of interest, the findings are not broken down according to whether or not students actually worked as auxiliary staff. Another point to consider is that no longitudinal studies have yet been conducted, and hence nothing is known about the possible medium- and long-term impact of these work experiences. There is clearly an urgent need for research on these questions so as to determine whether these future nurses might subsequently be more susceptible to distress or even more likely to abandon their professional career, not least because stress during the study-to-work transition is known to be a risk factor in this respect (Labrague & McEnroe-Petitte, 2018). Two qualitative studies have explored professional nurses' experiences of providing care during a pandemic and they describe the co-existence of positive and negative feelings (i.e. wanting to help alongside a fear of becoming infected), as well as high levels of psychological distress after the crisis was over (Kim, 2018; Sun et al., 2020). Some quantitative studies also report on the emotional distress experienced by nurses during a health emergency (Brooks et al., 2018; Li, Ge, et al., 2020; Rajkumar, 2020; Xiao et al., 2020b), although once again, there are no longitudinal studies of the medium- and long-term impact on professional nurses.

Another aspect to emerge from this overview is the need to find creative ways of enabling students to complete their education on schedule despite the suspension of clinical placements. This issue of flexibility in relation to the acquisition of clinical skills has, in fact, been discussed previously in the literature (Stoffels et al., 2019). What the current pandemic highlights is the need to be open to the possibility of new learning environments and activities that remain possible despite lockdown restrictions, for example, telephone consultations for patients.

Providing nursing students with education in infection prevention and control and the opportunity to develop the skills and attitudes required to care for infected patients is another theme to emerge from this overview. Eighteen of the 48 studies reviewed mention some form of education intervention and analyse students' level of knowledge, attitudes and behaviour upon completion. Although most of the interventions are based on CDC guidelines, there is no standard approach and the authors describe activities that vary in content, duration and the teaching methods used. Neither is there consensus over whether such education should be formally incorporated into degree programmes. Nevertheless, the authors have sought to define the professional skills that nursing students need to acquire in order to be prepared for a health emergency of the kind we are currently facing, since the majority of studies include an evaluation of students' knowledge, skills and attitudes towards caring for infected patients (Chilton et al., 2016; Choi & Kim, 2016; Elrggal et al., 2018; Etokidem et al., 2018; Ferranti et al., 2016; Kim & Choi, 2016; Patel et al., 2018; Wu et al., 2009). Given the growing number of pandemics that have been declared a PHEIC in recent years, it may be that this knowledge and these skills should be incorporated as core components of nurse education programmes. This is a question that merits urgent consideration by the relevant academic

institutions and professional organizations. As regards the instruments used to evaluate students' knowledge and skills, these also varied across the studies reviewed, and only four research teams report reliability and validity data for the tools used. This highlights the need for a more standardized application of valid and reliable instruments so as to enable comparisons to be made regarding the effectiveness of different education interventions.

Six of the studies that we classified under the theme 'knowledge, concern about risk and preventive behaviour' (Chilton et al., 2016; Etokidem et al., 2018; Natan et al., 2015; Patel et al., 2018; Rosychuk et al., 2008; Yonge et al., 2010) also address the third theme identified in this overview, namely students' willingness to work during a pandemic outbreak. Concerns about the capacity of health systems to cope with pandemics have led researchers to explore how students feel about the possibility of being deployed as auxiliary staff. However, these studies tend to be framed in hypothetical terms, and as yet there is no study that reports the number of students who were actually deployed during a pandemic. In addition, the fact that these studies use a variety of terms to refer to the question of interest (willingness to work, willingness to care, or to treat, etc.) makes comparison of results somewhat difficult.

Various studies have reported an association between students' willingness to work and their level of knowledge about infection prevention and control (Chilton et al., 2016; Natan et al., 2015; Santana-López et al., 2019; Tzeng & Yin, 2006; Tzeng & Yin, 2008; Yonge et al., 2010), that is to say, the greater their awareness of how the virus is transmitted and of protective measures, etc., the more likely they are to express a willingness to care for infected patients. Accordingly, the availability of personal protective equipment, and measures to reduce the risk of their family members becoming infected, are key factors in determining students' willingness to work or volunteer, which is consistent with previous research showing that adequate protection is a predictor of qualified nurses' willingness or intention to work during a pandemic outbreak (Kollie et al., 2017; Martin, 2011; Martin et al., 2013). This issue is closely related to the moral duty to help that students feel, which may override their fear of infection. Several authors have linked this to their willingness to work (Devnani, 2012; Kollie et al., 2017; Lam et al., 2018), and some studies suggest that the moral duty to help is felt more acutely by nursing students than by qualified staff (Etokidem et al., 2018; Santana-López et al., 2019).

The results of this overview highlight the need for further research aimed at designing effective education in infection prevention and control measures that can be incorporated into nurse education programmes. Given the key role that nurses have played, and will continue to play, during pandemic outbreaks, this will help to ensure that future nurses are adequately prepared for the health challenges that lay ahead. Developing valid and reliable instruments for assessing their knowledge and exploring the factors that influence their willingness to work is also important. Another issue that needs to be investigated is the impact that the experience of working during a pandemic has on nursing students in the short, medium and long term. Studies that examine the needs of students during a health emergency are likewise required so as to design adequate support mechanisms for them.

Strengths and limitations of this overview

One of the strengths of this study is the broad search strategy used to extract the literature, which included manual review of the reference lists of articles retrieved through the electronic search. In addition, two independent reviewers selected studies for inclusion, and all the research team participated in the quality appraisal of empirical studies, both qualitative and quantitative (Hawker et al., 2002). As regards limitations, the first concerns the nature of the studies included, which are a mixture of commentaries and empirical studies. We opted to include all published material so as to gain as broad an insight as possible into the study phenomenon, although it was not possible to evaluate the quality of commentaries. Another issue concerns the language of publication. We only included studies written in English or Spanish, as these are the working languages of the research team, but this criterion meant that two articles published in German and one in French were excluded from the review. Finally, the heterogeneity of the published reports, as well as of their objectives and outcomes, prevented us from carrying out an integrative synthesis or meta-analysis, and hence the findings of this overview do not go beyond the more descriptive level.

Conclusions

This systematic overview offers a comprehensive analysis of studies that have considered the situation of nursing students during health emergencies produced by emerging epidemics. Education is a key issue addressed in the studies reviewed, and several education interventions for students have been described, most of them based on CDC guidelines. However, there is no consensus regarding the content, duration or teaching methods used. The relative effectiveness of these programmes is also unclear as a variety of different instruments have been used to evaluate students' knowledge. Research suggests that students' level of knowledge about infection prevention and control measures influences their willingness to work during a pandemic outbreak, with students themselves highlighting the importance of personal protective equipment. However, their sense of a moral duty to help during a pandemic appears to outweigh their fear of becoming infected. It is unclear what impact the experience of working during a pandemic may have on nursing students, whether in the short term or later in their professional career.

We believe that the results of this overview could help nurse educators and professional nursing organizations to design effective education in infection prevention and control and patient care during pandemics, thus helping to ensure that future nurses are better prepared to respond to events of this kind.

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