Rural and Remote Health www.rrh.org.au
James Cook University ISSN 1445-6354

REVIEW ARTICLE

The effectiveness of continuing education programmes for health workers in rural and remote areas: a systematic review and meta-analysis

AUTHORS


[#]Yanan Wu[1] Masters Degree, Student


[#]Xuefeng Wei[2] Masters Degree, Student


Liying Zhou[3] Masters Degree, Student


Fenfen E[4] Masters Degree, Student


Yiliang Zhu[5] Dr, Professor


Meng Xu[6] Masters Degree, Student


Nan Chen[7] Masters Degree, Student


Xue Shang[8] Masters Degree, Student


Kangle Guo[9] Masters Degree, Student


Yanfei Li[10] Masters Degree, Student


Kehu Yang[11] Dr, Professor


Xiuxia Li[12] Dr, Professor *

[#]Contributed equally

CORRESPONDENCE

*Prof Xiuxia Li lixiuxia@lzu.edu.cn

AFFILIATIONS

[1, 2, 3, 4, 6, 7, 8, 10, 11, 12] Health Technology Assessment Center/Evidence-Based Social Science Research Center, School of Public Health, Lanzhou University, Lanzhou, China; Evidence Based Medicine Center, School of Basic Medical Sciences, Lanzhou University, Lanzhou, China; and Key Laboratory of Evidence Based Medicine and Knowledge Translation of Gansu Province, Lanzhou, 730000, China

[5] School of Medicine, University of New Mexico, Albuquerque, NM 87107, USA

[9] Gansu Provincial Hospital, Lanzhou, 730000, China

PUBLISHED

30 November 2023 Volume 23 Issue 4

HISTORY

RECEIVED: 4 March 2023

REVISED: 29 May 2023

ACCEPTED: 18 July 2023

CITATION

Wu Y, Wei X, Zhou L, E F, Zhu Y, Xu M, Chen N, Shang X, Guo K, Li Y, Yang K, Li X. The effectiveness of continuing education programmes for health workers in rural and remote areas: a systematic review and meta-analysis. Rural and Remote Health 2023; 23: 8275. https://doi.org/10.22605/RRH8275

ABSTRACT:

Introduction: Health workers in rural and remote areas shoulder heavy responsibilities for rural residents. This systematic review aims to assess the effectiveness of continuing education programs for health workers in rural and remote areas.

Methods: Eight electronic databases were searched on 28 November 2021. Randomized controlled trials (RCTs) and quasi-experimental studies evaluating the effectiveness of continuing education for health workers in rural and remote areas were included. The quality of the studies was assessed using the risk of bias tool provided by Effective Practice and Organization of Care. A meta-analysis was performed for eligible trials, and the other findings were presented as a narrative review because of inconsistent study types and outcomes.

Results: A total of 17 studies were included, four of which were RCTs. The results of the meta-analysis showed that compared to no intervention, continuing education programs significantly improved the knowledge awareness rate of participants (odds ratio=4.09, 95% confidence interval 2.51–6.67, $p<0.05$). Qualitative analysis showed that 12 studies reported on the level of knowledge of participants, with all showing positive changes. Eight studies measured the performance of health workers in rural and remote areas, with 87.50% ($n=7$) finding improved performance. Two studies reported on the impact of continuing education programs for health workers in rural and remote areas on patient health, with only one showing a positive change. One study from India measured the health of communities, which showed a positive change.

Conclusion: The results of this study showed that continuing education programs are an effective way to address the lack of knowledge and skills among health workers in rural and remote areas. Few studies have examined the effectiveness of education programs for health workers in rural and remote areas in improving patient health outcomes. It is not yet known whether the delivery of continuing education programs to health workers in rural areas has a positive impact on patient and community health. Future attention should continue to be paid to the impact on these outcomes.

Keywords:

continuing education programs, health workers, meta-analysis, narrative synthesis, performance.

FULL ARTICLE:

Introduction

The inequitable distribution of health workers within various countries has led to an imbalance between the supply and demand of health services in many regions[1,2]. Rural and remote areas have historically struggled with shortages of health workers[3]. Even in high-income countries, people in rural and remote areas experience a range of health problems. And due to socioeconomic factors, increased health risk factors, and poverty, their health status often differs significantly from that of metropolitan residents[4,5]. Rural and remote residents, therefore, have substantial healthcare needs. Health workers in rural and remote areas undoubtedly require a specific set of skills. For example, healthcare providers are called upon to treat a variety of diseases, provide multiple health services, and perform a wide variety of procedures[6-10]. It can be seen that health workers in rural and remote areas shoulder heavy responsibilities as gatekeepers of the health of rural residents[11].

Previous studies have shown that health workers in rural and remote areas have limited knowledge and service capacity to meet the medical service needs of residents. For instance, studies from China showed that most primary health workers have low levels of education and are not adequately equipped to provide high-

quality services[12,13]. Moreover, studies in rural New Mexico reported many barriers for health workers in accessing valuable information resources[14,15]. Many studies have confirmed that existing primary health workers perform poorly in both preventive and clinical services, such as chronic disease management diagnosis and treatment of tuberculosis, and antibiotic prescribing[16-18].

An effective measure to enhance the health service capacity of health workers is to provide continuing education programs. Continuing medical education is part of the lifelong learning process that all physicians undertake from career to retirement. All physicians need to undertake lifelong learning to 'maintain, develop or increase the knowledge, skills, professional performance and relationships used to provide services to patients, the public or the profession', while being able to update their medical knowledge[19]. Through continuous learning, rural and remote health workers are constantly updating themselves to meet the needs of patients for health services, as well as their professional development[20]. In a growing number of journal articles and professional reports, academics and policymakers are seeing the role of continuing medical education in improving health outcomes, particularly physician performance and patient health status[21-23]. Since the mid-1960s, many organizations, including the World Health Organization, governmental and non-governmental organizations, have conducted continuing education programs for rural health workers[24]. These programs are currently widely used in many countries and aim to improve the capacity of health workers in rural and remote areas to provide basic national health services to reduce health inequalities across regions, ethnicities and groups[25-27].

Several studies have investigated the effectiveness of continuing education programs for health workers in rural and remote areas. However, a systematic review or meta-analysis on this topic is lacking. The objective of the present study was to evaluate the effectiveness of continuing education for health workers in rural and remote areas by conducting a systematic review and meta-analysis.

Methods

Search strategy

Our findings were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline[28]. Four electronic databases for studies published in English (PubMed, Cochrane Library, Web of Science, and EMBASE) and four published in Mandarin (Chinese Biomedical database, Chinese National Knowledge Infrastructure, Wanfang Data, and VIP) were comprehensively searched from inception to 28 November 2021. We did keyword and MeSH searches as follows: 'rural' AND ('health worker' OR 'physician' OR 'doctor') AND ('education' OR 'training') AND 'control', and the specific search strategy is shown in Appendix I. We checked reference lists of relevant reviews for additional studies.

Inclusion and exclusion criteria

Types of studies: It was anticipated that there would be very few randomized controlled trials (RCTs) involving continuing education for health workers in rural and remote areas, and a broader range of study designs was included based on the recommendations of the Cochrane Effective Practice and Organization of Care (EPOC) group. RCTs, cluster-randomized controlled trials (cRCTs), non-randomized controlled trials (nRCTs), controlled before and after (CBA) studies, interrupted time series studies, and repeated measure studies were assessed. Study protocols and incomplete studies were excluded.

Types of participants: The participants we included were all categories of health workers, both professionals and lay health workers, who provide healthcare services in rural and remote areas. Health professionals included physicians, nurses, midwives, nursing assistants, pharmacists, physiotherapists, occupational therapists, dentists, dental assistants, laboratory technicians, dispensers, medical assistants or clinical officers, and radiographers[29]. We defined a lay health worker as any health worker who performs functions related to healthcare delivery, is trained in some way to provide these functions, but has received no formal professional or paraprofessional certificate or tertiary education degree[30].

Types of interventions: We included any form of study involving continuing education programs that was defined explicitly; was conducted as a single intervention; and aimed to produce changes in health workers' knowledge, performance or patient outcomes. We anticipated that the control group would be no intervention.

Types of outcome measures: We included studies that reported:

- knowledge (the degree to which health workers have mastered the knowledge involved in continuing education activity)
- performance (the degree to which health workers do what the continuing education activity intended them to be able to do in their practices)
- patient health (the degree to which the health status of patients improves as a result of changes in the practice behavior of health workers)
- community health (the degree to which the health status of a community of patients changes as a result of changes in the practice behavior of health workers).

Study selection and data extraction

Studies were selected independently by two reviewers, and disagreements were resolved in consultation with a third reviewer. After eliminating duplicates, titles and abstracts were read to exclude irrelevant studies, after which the full text was assessed for final study inclusion.

Two reviewers extracted data independently using a standardized study form, which included study information (ie year of publication and first author's name, geographic location, setting, and study design), characteristics of participants (ie population type, sample size), intervention characteristics (ie education form, education content, intervention time, comparison group, and length of follow-up), and outcomes. Any disagreement was resolved through discussion. If the data were not available, we tried to contact the study authors.

Assessment of risk of bias in included studies

The risk of bias was assessed using tools provided by EPOC[31,32] and was done independently by the two review authors. Each item was classified as low, high, or unclear risk of bias, and the results were displayed by summary plots. A third review author was consulted, and consensus was reached when there was disagreement on the assessment.

Data synthesis and analysis

Odds ratio (OR) with 95% confidence interval (CI) was used to indicate the merger effect because the included studies reported dichotomous data, and $p<0.05$ was statistically significant. Heterogeneity between the results was assessed by the c^2 test and I^2 test, and if there was significant heterogeneity ($p<0.05$ or $I^2>50\%$), a random-effects model was used; otherwise, a fixed-effects model was used. Review Manager (RevMan) v5.4 (Cochrane; https://revman.cochrane.org/info) was used for statistical calculations of all data. In addition, because of the lack of consistency in measurement results, studies that could not be meta-analyzed were reviewed by using a narrative synthesis. The methodology was as follows: effects were summarized by training content, with expected outcomes categorized into four main domains: knowledge, behavior, patient health, and community health. Findings were classified as 'positive' (+) if there were statistically significant positive changes in all measures. Where studies did not include inferential statistics, results were classified as 'positive' (+) if they were reported as positive by the study authors. If some but not all measurements reported positive results, the study results were classified as 'partially positive' (+/0). Findings were categorized as 'no effect' (0) if there were no statistically significant changes. Findings were categorized as 'negative effect' (–) if there was a statistically significant negative change.

Ethics approval

This research was done without patient or public involvement, so ethics approval was not required.

Results

Study selection

Figure 1 shows the PRISMA flowchart. In the search strategy, a total of 16 021 citations were found, of which 9063 remained after removing duplicates. Of these, 8986 studies were excluded by browsing titles and abstracts. After excluding irrelevant studies, the 77 remaining full-text studies were assessed for eligibility. Sixty studies were excluded because of studies being irrelevant to topics (n=5), insufficient information (n=17), wrong population (n=19), non-single continuing education programs (n=3), and control group not 'no intervention' (n=16).

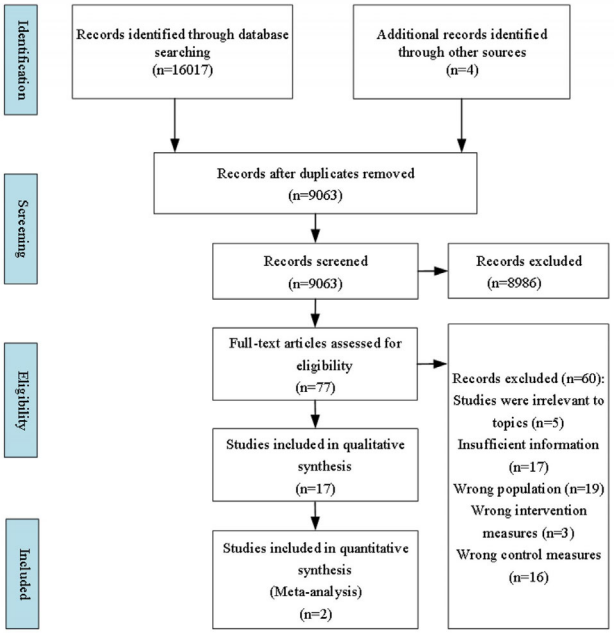


Figure 1: A flow diagram of the literature screening process and results.

Study characteristics

Table 1 summarizes the general characteristics of the included studies[33-49]. Three of the 17 studies were distributed in high-income countries, eight from upper-middle-income countries, five from lower-middle-income countries, and one from low-income countries (according to World Bank country classification)[50], all of which were published between 1994 and 2021. Study designs included RCTs (n=4), cRCTs (n=5), nRCTs (n=5), CBA (n=2), and repeated measure studies (n=1). The studies were mainly conducted in schools (n=3), health centers (n=2), communities (n=2), and websites (n=2), and six studies did not report training sites. Primary components of interventions included workshop, course, case-based learning, multifaceted educational programs, individual training, and digital training. The training covered four categories: clinical medicine, public health (eg neonatal and maternal care, chronic disease, infectious disease, mental health care), general skills (which include computer information system application skills, and medical research skills), and pharmacy. The overall length of the intervention ranged from 3 hours to 5 years. Twelve studies assessed outcomes immediately after the end of the intervention. Additional follow-up analyses were conducted in five studies, ranging from 3 months to 2 years.

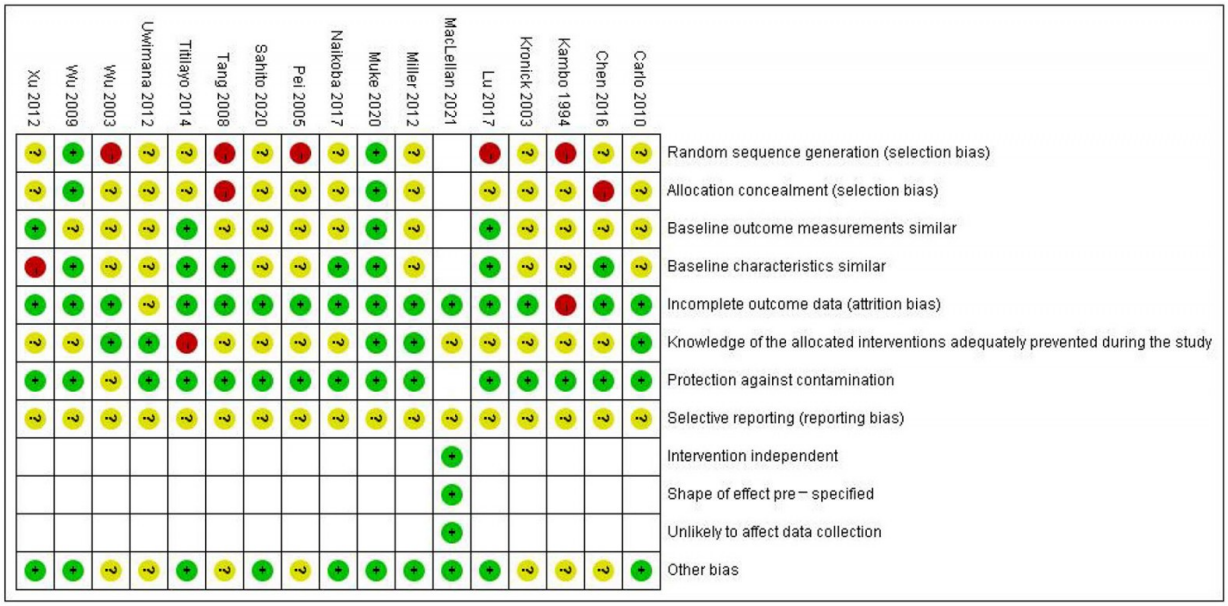
Table 1: Characteristics of the 17 experimental studies included in the review[33-49]; the control for all studies was 'no intervention'

Study (country)	Setting (study design)	Sample size	Intervention	Training duration	Follow-up	Training content	Outcomes
Carlo 2010 [ref. 33] (US)	Community (cRCT)	NR	Workshop	25 months	Postinterventio n	Public health Neonatal and maternal care	Patient health
Chen 2016 [ref. 34] (China)	School + hospital + community (cRCT)	I:8, C:4	Course	12 months	Postintervention	Public health Chronic disease	Knowledge, patient health
Kambo 1994 [ref. 35] (India)	NR (nRCT)	I:22, C:NR	Workshop	11 days	2 years	Public health	Community health
Kronick 2003 [ref. 36] (US)	NR (RCTs)	I:30, C:40	Individual training	3 h	3 months	General skills† Scientific research	Performance
Lu 2017 [ref. 37] (China)	Health center (nRCT)	I:257, C:225	Workshop	6 months	Postintervention	Pharmacy	Knowledge, performance
MacLellan 2021 [ref. 38] (Canada)	School (repeated measure)	I:30, C:30	Multifaceted educational program	5 years	Postintervention	General skills† Scientific research	Knowledge, performance
Miller 2012 [ref. 39] (Pakistan)	Website (cRCT)	I:288 (277), C:257 (257)	Workshop	8 days	19 months	Public health Neonatal and maternal care	Knowledge, performance
Muke 2020 [ref. 40] (India)	Website (RCT)	I:14 (12), C:14 (11)	Digital training	48 h	Postintervention	Public health Mental health care	Performance
Naikoba 2017 [ref. 41] (Uganda)	Health center (cRCT)	I:20 (19), C:20	Individual clinical coaching	9 months	Postintervention	Public health Infectious disease	Knowledge
Pei 2005 [ref. 42] (China)	School (nRCT)	I:232, C:337	Workshop	NR	Postintervention	Public health Infectious disease control	Knowledge
Sahito 2020 [ref. 43] (Pakistan)	School (CBA)	I:35, C:NR	Workshop	NR	Postintervention	Public health Infectious disease control	Knowledge
Tang 2008 [ref. 44] (China)	NR (nRCT)	I:31, C:41	Workshop	NR	Postintervention	Public health Infectious disease control	Knowledge, performance
Titilayo 2014 [ref. 45] (Nigeria)	NR (CBA)	I:20, C:27	Workshop	1 week	3 and 6 months	Public health Neonatal and maternal care	Knowledge
Uwimana 2012 [ref. 46] (South Africa)	Community (cRCT)	I:39, C:50	Workshop + practic al training	10 months	Postintervention	Public health Infectious disease control	Performance
Wu 2003 [ref. 47] (China)	NR (nRCT)	I:262, C:376	Workshop	NR	Postintervention	Clinical medicine	Knowledge
Wu 2009 [ref. 48] (China)	NR (RCT)	I:322, C:312	Workshop	NR	6 months	Public health Chronic disease	Knowledge
Xu 2012 [ref. 49] (China)	Hospital (RCT)	I:80, C:60	Case-based learning	51 days	Postintervention	Public health	Knowledge, performance

† Include computer information system application skills and medical research skills
C, control group. CBA, controlled before and after study. cRCT cluster-randomized controlled trial. I, intervention group. NR, not reported. nRCT, non-randomized controlled trial. RCT, randomized controlled trial

Risk of bias

Eight studies were assessed as having a high risk of bias, nine as having an unclear risk of bias. The most common sources of high risk of bias were random sequence generation (five studies) and allocation concealment (two studies). One trial had information suggesting that outcome measures were not blinded. Seventeen studies had no available protocol and insufficient evidence to comment on any selective reporting bias. Seven studies had other bias entries rated as unclear because they did not report funding information. A summary of the risk of bias is provided (Fig2).



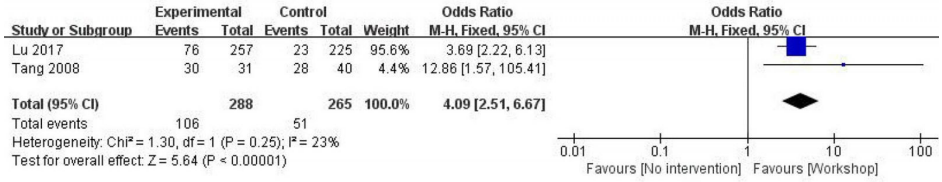
+, low risk of bias. –, high risk of bias. ?, unclear.

Figure 2: Summary of review authors' judements about each risk of bias item.

Meta-analysis

Two nRCTs[37,44], both from China, and including 553 health workers, evaluated the effectiveness of continuing education programs on health workers' knowledge awareness rate.

Compared with no intervention, the meta-analysis results (Fig3) demonstrated that continuing education programs have significantly improved the medical knowledge awareness rate of health workers in rural and remote areas (OR=4.09, 95%CI 2.51–6.67, $p<0.05$).



Events, number of participants who are aware of medical knowledge. M–H, Mantel–Haenszel hierarchical analysis.

Figure 3: Effectiveness of continuing education on awareness rate in rural and remote health workers.

Qualitative analysis

Effectiveness based on different training content: A qualitative analysis of the included studies was carried out using a narrative synthesis, and the results were summarized by educational content and type of outcomes measured. A summary of these findings is presented in Table 2.

Table 2: Summary of the educational content and corresponding outcomes for the studies

Training content	Country	No. of studies	Change in effect for each outcome			
			Knowledge†	Performance¶	Patient health§	Community health‡
Clinical medicine	China	1	+ [ref. 47]			
	Other countries	0				
Public health	China	5	+ [ref. 34], +, [ref. 42] + [ref. 44], + [ref. 48], + [ref. 49]	+ [ref. 44], + [ref. 49]	+ [ref. 34]	
	Other countries	8	+ [ref. 39], + [ref. 41], + [ref. 43],+ [ref. 45]	+ [ref. 39], + [ref. 40], + [ref. 46]	+/0 [ref. 33]	+ [ref. 35]
General skills	China	0				
	Other countries	2	+ [ref. 38]	+/0 [ref. 36], + [ref. 38]		
Pharmacy	China	1	+ [ref. 37]	+ [ref. 37]		
	Other countries	0				

+, positive effect. 0, no effect. – negative effect +/0, mixed effect (some measured variables showed positive effects and the others showed no effects).
† Includes health worker knowledge test scores and knowledge pass rate
¶ Includes health worker work skills and health service delivery status
§ Includes patient morbidity, patient mortality and patient disease control
‡ Includes community health service utilization

Knowledge: Twelve studies[34,37-39,41-45,47-49] measured the knowledge of health workers in rural and remote areas, and all showed that continuing education programs improved the knowledge level of rural and remote health workers compared with no intervention.

In terms of clinical knowledge, only one study[47] from China showed that continuing education programs improved rural and remote health workers' knowledge of the diagnosis and treatment of common diseases compared with no intervention ($p<0.01$).

In terms of public health knowledge, five studies from China[34,42,44,48,49] and four studies from Pakistan[39,43], Uganda[41] and Nigeria[45] reported on the public health knowledge of rural and remote health workers. Compared with no intervention, all nine studies included[34,39,41-45,48,49] reported positive and significant differences in the outcomes of continuing education programs. Compared to the control group, continuing education programs significantly improved rural and remote health workers' knowledge of chronic disease management (all $p<0.05$)[34,48], neonatal and maternal care (all $p<0.05$)[39,45], basic public health services (all $p<0.05$)[49], and infectious disease control (all $p<0.05$)[41-44].

In terms of general skills, a study from Canada showed improvement in scientific research methods and writing skills ($p<0.0005$)[38].

In terms of pharmacy knowledge, a study from China showed improvement in antithrombotic drug knowledge among health workers ($p<0.001$)[37].

Performance: Eight studies[36-40,44,46,49] measured the behavior of rural and remote health workers. Seven studies[37-40,44,46,49] showed that continuing education programs improved rural and remote health worker performance compared with no intervention, and only one[36] showed mixed effects of continuing education programs on rural and remote health worker performance.

In public health, two studies from China[44,49] and three studies from Pakistan[39], India[40] and South Africa[46] reported on the performance of health workers in rural and remote areas. Existing studies[39,40,44,46,49] have shown positive changes in the performance of rural and remote health workers, compared to a control group. Continuing education programs significantly improved the skills of rural and remote health workers in safe vaccination practices ($p<0.05$)[44] and basic public health services practices ($p<0.05$)[49], the skills of rural and remote midwives in neonatal and maternal care ($p<0.01$)[39], and the capacity of health workers in rural and remote areas to assess depression ($p<0.01$)[40].

Also, one study[46] showed that continuing education programs increased the rate of screening for tuberculosis and sexually transmitted infections symptoms and tracing of tuberculosis contacts among rural and remote health workers (all $p<0.001$).

In terms of general skills, two studies[36,38] from the US reported changes in health workers' performance. One study[36] showed mixed effects; specifically, the intervention group significantly increased the frequency of accessing the internet to solve patient-related problems, the comfort level of accessing online databases, and the frequency of accessing online databases compared with the control group (all $p<0.05$). However, the intervention group did not change significantly compared with the control group in terms of the frequency of using email to solve patient-related problems ($p=0.924$) or the comfort level of accessing email ($p=0.237$). The other study[38] showed that continuing education programs can improve the scientific research skills of rural and remote health workers ($p<0.0005$).

In terms of pharmacy, only one study[37] from China showed that continuing education programs improved health workers' understanding of the correct use of antithrombotic drugs ($p<0.001$).

Patient health: Two studies[33,34] reported on the health status of patients in public health. One study[34] from China showed that continuing education programs improved blood pressure control and prevalence of hypertension in patients with hypertension compared with no intervention ($p<0.05$). A study[33] from the US showed mixed effects on patient health in developing countries, as evidenced by a significant reduction in the 7-day stillbirth rate and no significant change in perinatal mortality.

Community health: One study[35] from India measured the health of communities, and showed a positive change in the community use of contraceptives ($p<0.001$).

Discussion

Continuing medical education programs, an essential component of the global health delivery system, have emerged as an appropriate way to change the educational issues of health providers and healthcare behavior within the healthcare system[51]. Studies have shown that continuing education programs can improve the knowledge, professional ability, and performance of health workers[51-54]. Despite a growing body of empirical research on the subject, the effectiveness and impact of continuing education programs in rural and remote areas has not been fully explored[55].

This review examined the evidence for the effectiveness of continuing education programs in improving rural and remote health worker knowledge and performance, patient health, and community health. We included 17 published RCTs or quasi-experimental studies in high-income countries ($n=3$), upper-middle-income countries ($n=8$), lower-middle-income countries ($n=5$), and low-income countries ($n=1$). However, the review found limited evidence to support the overall impact of these continuing education programs on rural and remote health workers and patient outcomes. In particular, only two studies reported on the impact on patient health and only one study reported on the impact on community health. In addition, the results of this review should be interpreted with caution because of the risk of bias in the included studies.

The results reported showed that Chinese studies have focused more on improving the knowledge of health workers through continuing education programs than those from other countries. The seven studies from China[34,37,42,44,47-49] that were included in the qualitative analysis all reported the outcome of health worker knowledge, 42.9% ($n=3$) reported on health worker performance, 14.3% ($n=1$) reported on patient health, and no studies reported on overall community health. In contrast, of the 10 published studies from other countries, 50% ($n=5$) reported the health worker knowledge outcome, 50% ($n=5$) reported health worker performance, 10% ($n=1$) reported on patient health and 10% reported on community health. It is clear that China's current measures of the effectiveness of training for rural health workers are mainly concerned with improving the knowledge of health workers. This suggests that researchers, especially in China, should evaluate the effectiveness of continuing education programs for health workers in rural and remote areas in terms of health worker knowledge and performance, patient health and community health.

Considering the large variation in the types of included studies and outcome indicators, only two of the nRCTs[37,44] from China included in our meta-analysis reported knowledge awareness rate as an outcome. The results showed that in China, continuing education programs contributed to improve rural and remote health worker knowledge compared to no intervention. Although the statistical heterogeneity of the two studies was small, the number of studies was insufficient to explain the effect. In addition, both of the studies were at risk of bias on random sequence generation, and one was also at risk of bias on allocation concealment. This suggests that the level of knowledge of rural and remote health workers as an indicator in this area needs to be further investigated in a large-scale study to reduce the associated bias and thus better elucidate the effectiveness of continuing education programs for rural and remote health workers on this outcome.

The narrative synthesis results suggest that in most of the included studies, continuing education programs may have contributed to improved rural and remote health worker knowledge and performance compared to no intervention. Knowledge improvement covers a wide range of areas, including clinical medicine, public health, general skills and pharmacy. Improvements in knowledge in clinical medicine are evident in the treatment of common diseases among health workers. In the area of public health, there was a significant improvement in the knowledge of health workers in rural areas in the prevention and treatment of chronic diseases (hypertension), infectious diseases (HIV and tuberculosis), maternal and neonatal care, and immunization after receiving continuing education programs. There was also a significant improvement in knowledge of medical science research and pharmacology (antithrombotic drugs for ischemic stroke) among health workers in rural and remote areas. Performance improvements were also seen in the areas of public health, general skills, and pharmacy. In the area of public health, significant improvements in immunization skills, neonatal and maternal care skills, mental illness (depression assessment), and screening for infectious diseases (tuberculosis and sexually transmitted diseases) were seen among rural and remote health workers compared to the control group.

Moore et al[56] pointed out that the evaluation of the effectiveness of health workers' continuing education should not be limited to

health workers' performance, but should be based on a multidimensional evaluation of health workers' performance, competence, patient health status and community health. Of the 17 studies we included, only two[33,34] reported on the impact on patient health and only one[35] reported on the impact on community health. Other studies have only looked at the impact on the knowledge and performance of health workers. Clearly, little attention has been paid to the ultimate goal of improving the knowledge and skills of health workers, which is to improve health outcomes for patients and communities. However, one of our included studies[34] showed that continuing education programs in rural areas significantly improved blood pressure control and significantly reduced the prevalence of hypertension in patients with hypertension. One included study[35] showed that continuing education programs in rural areas resulted in positive changes in contraceptive use in the community. However, the number of studies included means that it is not possible to conclude with certainty whether continuing education programs in rural areas have a positive impact on patient and community health. In addition, it is worth noting that none of the original studies included looked at the cost-effectiveness of continuing education programs in rural areas and it is suggested that this aspect could be further explored in the future. Therefore, it is not clear from the available evidence in terms of patient and community health outcomes whether it is cost-effective to spend significant time, human, material and financial resources on continuing education programs for health workers in rural and remote areas. Therefore, there remains a need to continue to provide evidence of patient health in relation to continuing education programs in the future.

Gaps in urban or rural public health systems threaten the continuity of a healthy public health system[57]. It is important to actively implement public health services in rural and remote areas[58]. The results showed that most of the current continuing education programs in rural and remote areas involves public health-related content, which matches the basic situation in rural and remote areas. There are only two studies on clinical medicine and pharmaceutical continuing education programs in the world, and both are in China. More and higher-quality evidence is still needed to synthesize the effectiveness of continuing education programs for rural health workers in clinical medicine and pharmacy content. Two studies from Canada reported on the effectiveness of continuing education programs in general skills for rural and remote health workers[36,38], and there are currently no studies from China reporting this outcome. However, studies from China showed rural and remote health workers still need to improve general skills[59,60]. Health workers in rural and remote areas, due to socioeconomic constraints, have little direct access to quality educational resources, and internet-based online education programs can help resolve this disparity in access. Many health workers have difficulties in general skills such as the use of computers and other electronic devices[60,61]. In addition, it may be more effective for health workers in rural and remote areas to develop the ability to access information if they are able to do so. Therefore, general skills can have an important impact on rural and remote health workers, and further studies are still needed to provide sufficient evidence to explore the impact of continuing education programs on this outcome.

Strengths and limitations

First, in contrast to other studies, we used a comprehensive and systematic search strategy to ensure the validity of the results obtained. Second, compared with the study of Dowling et al[62], we conducted a comprehensive analysis of the included studies by a combination of qualitative and quantitative methods. Third, we systematically collected and analyzed RCTs and quasi-experimental studies on the impact of continuing education programs on health workers in rural and remote areas. Fourth, we not only considered changes in the level of knowledge and competence of health workers, but also included studies involving patient health and community health to comprehensively assess the effectiveness of continuing education programs in rural and remote areas. Fifth, we categorized the effectiveness of continuing education programs according to the content of continuing education programs and discussed it.

Some limitations of this study should also be mentioned. First, some studies were not included because of data availability limitations, although we did our best to search the databases and attempt to obtain relevant literature in the included literature references. Second, most of the included studies did not report biases such as those in selection and reporting, and there was an unclear or high risk of bias. Larger, higher-quality RCTs or quasi-experimental studies will therefore need to be designed to assess the impact of continuing education programs on health workers in rural and remote areas. Third, our previous findings were based entirely on currently included studies, and existing results need to be updated periodically as new relevant studies emerge. Fourth, the lack of consistency in the included literature measures means that outcome indicators other than knowledge awareness are only described qualitatively and future studies in this area should continue to be looked at to produce more convincing evidence.

Conclusion

Compared with no intervention, continuing education programs might be beneficial for rural and remote health workers' knowledge and performance. Because of the limited number and quality of included studies, the impact of continuing education programs on patient health and overall community health is unclear. There is no doubt that more high-quality research is needed to fully elucidate the impact of continuing education programs for health workers on patient health outcomes in rural and remote areas.

Funding

This research is supported by the General Program of National Natural Science Foundation of China (Project No. 72074103).

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES:

1 World Health Organization. *The world health report 2006. Working together for health.* 2006. Available: web link (Accessed 28 November 2021).

2 World Health Organization. *Increasing access to health workers in remote and rural areas through improved retention: global policy recommendations.* 2010. Available: web link (Accessed 13 March 2022

3 MacQueen IT, Maggard-Gibbons M, Capra G, Raaen L, Ulloa JG, Shekelle PG, et al. Recruiting rural healthcare providers today: a systematic review of training program success and determinants of geographic choices. *Journal of General Internal Medicine* 2018; **33(2):** 191-199. DOI link, PMid:29181791

4 Anderson TJ, Saman DM, Lipsky MS, Lutfiyya MN. A cross-sectional study on health differences between rural and non-rural US counties using the County Health Rankings. *BMC Health Services Research* 2015; **15:** 441. DOI link, PMid:26423746

5 Subedi R, Greenberg TL, Roshanafshar S. Does geography matter in mortality? An analysis of potentially avoidable mortality by remoteness index in Canada. *Health Reports* 2019; **30(5):** 3-15.

6 Rourke J. Perspectives on rural medical care in Ontario. *Canadian Family Physician* 1991; **37:** 1581-1647.

7 Hays RB, Craig ML, Wise AL, Nichols A, Mahoney MD, Adkins PB, et al. A sampling framework for rural and remote doctors. *Australian Journal of Public Health* 1994; **18(3):** 273-276. DOI link, PMid:7841256

8 Glazebrook RM, Harrison SL. Obstacles and solutions to maintenance of advanced procedural skills for rural and remote medical practitioners in Australia. *Rural and Remote Health* 2006; **6(4):** 502. DOI link, PMid:17107272

9 Henry LR, Hooker RS, Yates KL. The role of physician assistants in rural health care: a systematic review of the literature. *Journal of Rural Health* 2011; **27(2):** 220-229. DOI link, PMid:21457316

10 Baker E, Schmitz D, Epperly T, Nukui A, Miller CM. Rural Idaho family physicians' scope of practice. *Journal of Rural Health* 2010; **26(1):** 85-89. DOI link, PMid:20105273

11 Ogden J, Preston S, Partanen RL, Ostini R, Coxeter P. Recruiting and retaining general practitioners in rural practice: systematic review and meta-analysis of rural pipeline effects. *Medical Journal of Australia* 2020; **213(5):** 228-236. DOI link, PMid:32696519

12 Zhao Y, Cui S, Yang J, Wang W, Guo A, Liu Y, et al. Basic public health services delivered in an urban community: a qualitative study. *Public Health* 2011; **125(1):** 37-45. DOI link, PMid:21145087

13 Yip WC-M, Hsiao WC, Chen W, Hu S, Ma J, Maynard A. Early appraisal of Chin's huge and complex health-care reforms. *Lancet* 2012; **379(9818):** 833-842. DOI link, PMid:22386036

14 Eldredge JD, Carr R, Broudy D, Voorhees RE. The effect of training on question formulation among public health practitioners: results from a randomized controlled trial. *Journal of the Medical Library Association* 2008; **96(4):** 299-309. DOI link, PMid:18974808

15 Eldredge JD, Carr RD. Public health informatics training in New Mexico. *Journal of the Medical Library Association* 2007; **95(3):** 343-346. DOI link, PMid:17641772

16 Ranson MK, Chopra M, Atkins S, Dal Poz MR, Bennett S. Priorities for research into human resources for health in low- and middle-income countries. *Bulletin of the World Health Organization* 2010; **88(6):** 435-443. DOI link, PMid:20539857

17 Hou J, Michaud C, Li Z, Dong Z, Sun B, Zhang J, et al. Transformation of the education of health professionals in China: progress and challenges. *Lancet* 2014; **384(9945):** 819-827. DOI link, PMid:25176552

18 Mash R, Almeida M, Wong WC, Kumar R, von Pressentin KB. The roles and training of primary care doctors: China, India, Brazil and South Africa. *Human Resources for Health* 2015; **13:** 93. DOI link, PMid:26637305

19 Davis D. Does CME work? An analysis of the effect of educational activities on physician performance or health care outcomes. *International Journal of Psychiatry in Medicine* 1998; **28(1):** 21-39. DOI link, PMid:9617647

20 Peck C, McCall M, McLaren B, Rotem T. Continuing medical education and continuing professional development: international comparisons. *British Medical Journal* 2000; **320(7232):** 432-435. DOI link, PMid:10669451

21 Institute of Medicine (US) Committee on Quality of Health Care in America. *Crossing the quality chasm: a new health system for the 21st century.* Washington (DC): National Academies Press, 2001.

22 McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. The quality of health care delivered to adults in the United States. *New England Journal of Medicine* 2003; **348(26):** 2635-2645. DOI link, PMid:12826639

23 Leape LL, Berwick DM. Five years after To Err Is Human: what have we learned? *JAMA* 2005; **293(19):** 2384-2390. DOI link, PMid:15900009

24 Kim JM, Koh KW, Oak CH, Jung WH, Kim SH, Park DH. Assessment of village health worker training program in Tuguegarao, Philippine. *Journal of Preventive Medicine and Public Health* 2009; **42(6):** 377-385. DOI link, PMid:20009484

25 Ingram M, Sabo S, Rothers J, Wennerstrom A, de Zapien JG. Community health workers and community advocacy: addressing health disparities. *Journal of Community Health* 2008; **33(6):** 417-424. DOI link, PMid:18584315

26 Nemcek MA, Sabatier R. State of evaluation: community health workers. *Public Health Nursing* 2003; **20(4):** 260-270. DOI link, PMid:12823786

27 Kronick J, Blake C, Munoz E, Heilbrunn L, Dunikowski L, Milne WK. Improving on-line skills and knowledge. A randomized trial of teaching rural physicians to use on-line medical information. *Canadian Family Physician* 2003; **49:** 312-317.

28 Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009; **6(7):** e1000097. DOI link, PMid:19621072

29 Kiwanuka SN, Rutebemberwa E, Nalwadda C, Okui O, Ssengooba F, Kinengyere AA, et al. Interventions to manage dual practice among health workers. *Cochrane Database of Systematic Reviews* 2011; **7.** DOI link, PMid:21735429

30 Lewin SA, Dick J, Pond P, Zwarenstein M, Aja G, van Wyk B, et al. Lay health workers in primary and community health care. *Cochrane Database of Systematic Reviews* 2005; **1.** DOI link

31 Higgins JPT, Thomas J (Eds). *Cochrane handbook for systematic reviews of interventions.* 2019. Available: web link (Accessed 20 January 2022).

32 Cochrane Effective Practice and Organisation of Care (EPOC). *EPOC Resources for review authors.* 2017. Available: web link (Accessed 1 March 2022).

33 Carlo WA, Goudar SS, Jehan I, Chomba E, Tshefu A, Garces A, et al. Newborn-care training and perinatal mortality in developing countries. *New England Journal of Medicine* 2010; **362(7):** 6146-6123. DOI link, PMid:20164485

34 Chen C. *Evaluation of blood pressure control effect of rural middle-aged and elderly patients with hypertension promoted by village doctor training.* Master thesis. China: Shandong University, 2016.

35 Kambo IP, Gupta RN, Kundu AS, Dhillon BS, Saxena HM, Saxena BN. Use of traditional medical practitioners to delivery family planning services in Uttar Pradesh. *Studies in Family Planning* 1994; **25(1):** 32-40. DOI link, PMid:8209393

36 Kronick J, Blake C, Munoz E, Heilbrunn L, Dunikowski L, Milne WK. Improving on-line skills and knowledge – a randomized trial of teaching rural physicians to use on-line medical information. *Canadian Family Physician* 2003; **49:** 312-317.

37 Lu Y, Yang W, Wu X, Ling Z, Peng L, Chen B. Application of knowledge to antithrombotic drugs intervention in ischemic stroke by village doctors. *Chinese Journal of Stroke* 2017; **12(9):** 790-793.

38 MacLellan C, Bethune C, Heeley T, Graham W, Button C, Asghari S. Assessing a research training programme for rural physicians. *Canadian Journal of Rural Medicine* 2021; **26(3):** 103-109. DOI link, PMid:34259223

39 Miller PC, Rashida G, Tasneem Z, Haque MU. The effect of traditional birth attendant training on maternal and neonatal care. *International Journal of Gynaecology and Obstetrics* 2012; **117(2):** 148-152. DOI link, PMid:22424659

40 Muke SS, Tugnawat D, Joshi U, Anand A, Khan A, Shrivastava R. et al. Digital training for non-specialist health workers to deliver a brief psychological treatment for depression in primary care in India: findings from a randomized pilot study. *International Journal of Environmental Research and Public Health* 2020; **17(17):** 6368. DOI link, PMid:32883018

41 Naikoba S, Senjovu KD, Mugabe P, McCarthy CF, Riley PL, Kadengye DT, et al. Improved HIV and TB knowledge and competence among mid-level providers in a cluster-randomized trial of one-on-one mentorship for task shifting. *Journal of Acquired Immune Deficiency Syndromes* 2017; **75(5):** e120-e127. DOI link, PMid:28406806

42 Pei Z, Li Y. The training of rural doctors can be seen from the test results of knowledge of prevention and treatment of infectious diseases. *Journal of Anhui Health Vocational and Technical College* 2005; **5:** 73-74.

43 Sahito A, Ahmed S, Fatmi Z. Covering the last mile for vaccination: feasibility and acceptability of traditional birth attendant-based referral system in hard-to-reach areas in rural Pakistan. *Journal of Global Health* 2020; **10(2):** 021303. DOI link, PMid:33437466

44 Tang Y, Li H, Zhang X, Wang X, Gao Li, Liu C. Evaluation on implementation effect of preventive vaccination safe injection intervention measures in some counties of Gansu Province. *Chinese Primary Health Care* 2008; **12:** 888-890.

45 Titilayo OD, Okanlawon FA. Assessment of mobile health nursing intervention knowledge among community health nurses in Oyo State, Nigeria. *African Journal of Medicine and Medical Science* 2014; **43:** 147-155.

46 Uwimana J, Zarowsky C, Hausler H, Jackson D. Training community care workers to provide comprehensive TB/HIV/PMTCT integrated care in KwaZulu-Natal: lessons learnt. *Journal of Tropical Medicine and International Health* 2012; **17(4):** 488-496. DOI link, PMid:22296235

47 Wu Y, Xie S, Wang Z. Discussion on continuing medical education and training for rural doctors. *Chinese Rural Health Service Administration* 2003; **10:** 6-7.

48 Wu X, Luo S, Chen B, Lu Y, Gan C, Yang Y, Wang K. Evaluation of intervention effect on knowledge, attitude and behavior level of hypertension guidelines in village doctors. *Guangxi Medical Journal* 2009; **4:** 910-911.

49 Xu S. *A preliminary study on the training mode of village doctors in border minority areas of Yunnan Province.* Master thesis. China: Kunming Medical University, 2012.

50 Hamadeh N, Van Rompaey C, Metreau E, Eapen SG. *New World Bank country classifications by income level: 2022-2023.* Available: web link (Accessed 12 January 2022).

51 Zarei M, Mojarrab S, Bazrafkan L, Shokrpour N. The role of continuing medical education programs in promoting Iranian nurses, competency toward non-communicable diseases, a qualitative content analysis study. *BMC Medical Education* 2022; **22(1):** 731. DOI link, PMid:36280836

52 Mitchell H, Lucas C, Charlton K, McMahon A. Models of nutrition-focused continuing education programs for nurses: a systematic review of the evidence. *Australian Journal of Primary Health* 2018; **24(2):** 101-108. DOI link, PMid:29362024

53 Griscti O, Jacono J. Effectiveness of continuing education programmes in nursing: literature review. *Journal of Advanced Nursing* 2006; **55(4):** 449-456. DOI link, PMid:16866840

54 Eslamian J, Moeini M, Soleimani M. Challenges in nursing continuing education: a qualitative study. *Iran Journal of Nursing and Midwifery Research* 2015; **20(3):** 378-386.

55 Walia GS, Wong AL, Lo AY, Mackert GA, Carl HM, Pedreira RA, et al. Efficacy of monitoring devices in support of prevention of pressure injuries: systematic review and meta-analysis. *Advances in Skin and Wound Care* 2016; **29(12):** 567-574. DOI link, PMid:27846030

56 Moore DE, Jr., Green JS, Gallis HA. Achieving desired results and improved outcomes: integrating planning and assessment throughout learning activities. *Journal of Continuing Education in the Health Professions* 2009; **29(1):** 1-15. DOI link, PMid:19288562

57 Meit M, Knudson A. Why is rural public health important? A look to the future. *Journal of Public Health Management and Practice* 2009; **15(3):** 185-190. DOI link, PMid:19363397

58 Berkowitz B. Rural public health service delivery: promising new directions. *American Journal of Public Health* 2004; **94(10):** 1678-1681. DOI link, PMid:15451730

59 Song J, Yin W, Feng Z, Tang C, Wen Q, Chen Z, et al. Study on the current situation and demand of on-the-job training for rural doctors in Shandong Province. *Chinese Health Service Management* 2017; **34(5):** 378-380.

60 Wang Y, Yang L, Li S, Zheng S, Zhang X. Study on the current situation and needs of training for rural doctors in Sichuan Province. *Health Economics Research* 2015; **2:** 24-27.

61 Hu B, Ma L, Xu P, Wu Y. Analysis of the current situation and demand for training of health personnel in village health offices in Kashgar region. *Maternal and Child Health Care of China* 2017; **32(9):** 1829-1832.

62 Dowling S, Last J, Finnigan H, Cullen W. Continuing education for general practitioners working in rural practice: a review of the literature. *Education for Primary Care* 2018; **29(3):** 151-165. DOI link, PMid:29623773

APPENDIX I:

Appendix I: Search Strategy

Search strings in English (9341 in total)

Pubmed

#1 Rural Health Services [Mesh]
#2 (village OR rural OR Remote OR barefoot OR grassroots) [Title/Abstract]
#3 #1 OR #2
#4 Health Personnel [Mesh] OR General practitioners [MeSh Terms]
#5 ("Health Worker" OR "Health Workers" OR doctor* OR physician OR Physicians OR "general practitioner" OR "General practitioners" OR "health care provider" OR "Health care providers" OR midwives OR midwife OR Nurses OR "health Personnel") [Title/Abstract]
#6 #4 OR #5
#7 Education [Mesh]
#8 (training OR education OR teaching OR course OR courses OR lesson OR lessons) [Title/Abstract]
#9 #7 OR #8
#10 (control OR controls OR controlled OR random OR randomized OR "nonrandom" OR non-random OR "nonrandomized" OR non-randomized OR "Randomized Controlled Trials" OR "Non-Randomized Controlled Trials" OR "RCT" OR "Quasi-experimental Research" OR "Quasi-experimental study" OR "Quasi-experiment")[Title/Abstract]
#11 "Randomized Controlled Trials as Topic" [Mesh] OR "Non-Randomized Controlled Trials as Topic"[Mesh]
#12 #10 OR #11
#13 #3 AND #6 AND #9 AND #12
Number of search results: 2089

Embase

#1 village:ab,ti OR rural:ab,ti OR rustic:ab,ti OR remote:ab,ti OR barefoot:ab,ti OR grassroots:ab,ti OR underserved:ab,ti
#2 'health care planning'/exp OR 'rural health care'/exp
#3 #1 OR #2
#4 'health worker':ab,ti OR 'health workers':ab,ti OR doctor*:ab,ti OR physician*:ab,ti OR 'general practitioner':ab,ti OR 'general practitioners':ab,ti OR clinician*:ab,ti OR 'health provider':ab,ti OR 'health providers':ab,ti OR nurse*:ab,ti OR 'health professional':ab,ti OR 'health professionals':ab,ti OR midwives:ab,ti OR midwife:ab,ti OR 'health workforce':ab,ti OR 'health human resources':ab,ti OR 'health personnel':ab,ti OR 'health personnels':ab,ti
#5 'health care personnel'/exp OR 'physician'/exp OR 'general practitioner'/exp
#6 #4 OR #5
#7 train*:ab,ti OR educat*:ab,ti OR teach*:ab,ti OR course*:ab,ti
#8 'education'/exp OR 'training'/exp OR 'teaching'/exp OR 'education distance'/exp
#9 #7 OR #8
#10 'RCT':ab,ti OR 'clinical trial':ab,ti OR 'single-blind':ab,ti OR 'double-blind':ab,ti OR random*:ab,ti OR placebo:ab,ti OR blind*:ab,ti
#11 'randomized controlled trial (topic)'/exp
#12 #10 OR #11
#13 #3 AND #6 AND #9 AND #12
Number of search results: 3275

Cochrane Library

#1 MeSH descriptor: [Rural Health Services] explode all trees
#2 (village OR rural OR Remote OR barefoot OR grassroots): ti,ab,kw
#3 #1 OR #2
#4 MeSH descriptor: [Health Personnel] explode all trees
#5 MeSH descriptor: [General practitioners] explode all trees
#6 ("Health Worker" OR "Health Workers" OR doctor* OR physician OR Physicians OR "general practitioner" OR "General practitioners" OR "health care provider" OR "Health care providers" OR midwives OR midwife OR Nurses OR "health Personnel"): ti,ab,kw
#7 #4 OR #5 OR #6
#8 MeSH descriptor: [Education] explode all trees
#9 (training OR education OR teaching OR course OR courses OR lesson OR lessons): ti,ab,kw
#10 #8 OR #9
#11 #3 AND #7 AND #10
Number of search results: 2186

Web of Science

#1 TS= (village OR rural OR Remote OR barefoot OR grassroots)
#2 TS= ("Health Worker" OR "Health Workers" OR doctor* OR physician OR Physicians OR "general practitioner" OR "General practitioners" OR "health care provider" OR "Health care providers" OR midwives OR midwife OR Nurses OR "health Personnel")
#3 TS= (training OR education OR teaching OR course OR courses OR lesson OR lessons)
#4 TS= (control OR controls OR controlled OR random OR randomized OR "nonrandom" OR non-random OR "nonrandomized" OR non-randomized OR "Randomized Controlled Trials" OR "Non-Randomized Controlled Trials" OR "RCT" OR "Quasi-experimental Research" OR "Quasi-experimental study" OR "Quasi-experiment")
#5 #1 AND #2 AND #3 AND #4
Number of search results: 1791

Search strings in Chinese (6676 in total)

中国知网（CNKI）

#1:(农村 + 乡村 + 村卫生室 + 基层 + 偏远) 篇关摘
#2:(医生 + 医师 + 卫生人员 + 医务人员 + 村医 + 赤脚医生) 篇关摘
#3:(培训 + 培养 + 教育 + 教学 + 课程 + 远程 + 网络 + 视频 + 在线 + 短信 + 电话) 篇关摘
#4:(对照 + 随机 + 非随机 + 准实验研究 + 类实验研究) 篇关摘
#5: #1 AND #2 AND #3 AND #4
检索结果数量: 3366

万方数据（WanFang data）

#1:(农村 OR 乡村 OR 村卫生室 OR 基层 OR 偏远) 题名或关键词

#1: (农村 OR 乡村 OR 村卫生室 OR 基层 OR 偏远) 题名或关键词
#2: (医生 OR 医师 OR 卫生人员 OR 医务人员 OR 村医 OR 赤脚医生) 题名或关键词
#3: (培训 OR 培养 OR 教育 OR 教学 OR 课程 OR 远程 OR 网络 OR 视频 OR 在线 OR 短信 OR 电话) 题名或关键词
#4: (对照 OR 随机 OR 非随机 OR 准实验研究 OR 类实验研究) 题名或关键词
#5: #1 AND #2 AND #3 AND #4
检索结果数量: 479

中国生物医学文献数据库（CBM）
#1: (农村 OR 乡村 OR 村卫生室 OR 基层 OR 偏远) 常用字段：智能
#2: (医生 OR 医师 OR 卫生人员 OR 医务人员 OR 村医 OR 赤脚医生) 常用字段：智能
#3: (培训 OR 培养 OR 教育 OR 教学 OR 课程 OR 远程 OR 网络 OR 视频 OR 在线 OR 短信 OR 电话) 常用字段：智能
#4: (对照 OR 随机 OR 非随机 OR 准实验研究 OR 类实验研究) 常用字段：智能
#5: #1 AND #2 AND #3 AND #4
检索结果数量: 1645

维普（VIP）
#1: (农村 OR 乡村 OR 村卫生室 OR 基层 OR 偏远) 摘要
#2: (医生 OR 医师 OR 卫生人员 OR 医务人员 OR 村医 OR 赤脚医生) 摘要
#3: (培训 OR 培养 OR 教育 OR 教学 OR 课程 OR 远程 OR 网络 OR 视频 OR 在线 OR 短信 OR 电话) 摘要
#4: (对照 OR 随机 OR 非随机 OR 准实验研究 OR 类实验研究) 摘要
#5: #1 AND #2 AND #3 AND #4
检索结果数量: 1186