


BMJ Open Effects of mobile-based mindfulness meditation for mental health of nurses: a protocol for systematic review and meta-analysis

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ABSTRACT

Introduction Existing studies have shown that mobile-based mindfulness meditation (MMM) can have a certain impact on nurses' mental health problems, but its specific effect and the effect on specific mental health problems such as stress, anxiety, depression, mindfulness, well-being and resilience are not clear.

Methods and analysis This study protocol follows the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols guidelines. Electronic search through PubMed, Web of Science, EBSCO, Cochrane Library, CINAHL, PsycINFO, ERIC, Embase and three Chinese databases namely CNKI, Wan Fang and Chinese Biology Medicine disc. The inclusion criteria follow the PICO principle, which is defined translate the question into a searchable and answerable question. P (patient/population): clinical characteristics of patients; I (intervention or exposure): treatment measures or exposure factors of concern; C (comparison): control measure.; O (outcome): outcome indicator of concern. Registered nurses, preregistered nurses, midwives and nursing students will all be included, studies using MMM as intervention to improve mental health of nurses, compared with waitlist controls or traditional methods groups, outcomes assessment of stress, anxiety, depression, mindfulness, well-being and resilience will meet the inclusion criteria. Studies designed randomised controlled trials (RCTs) of quasiexperimental and written in English or Chinese will be eligible. Search time was from inception of each database to July 2022. Two reviewers screen and assess studies for inclusion and extract data independently; any dispute will be settled through discussion. If the discussion still fails, the third author will make a decision. For RCT, risk of bias will be assessed using Cochrane risk-of-bias tool for randomised trials (RoB 2), and for non-RCT studies, risk of bias in non-randomised studies of interventions (ROBINS-I) tool will be performed. Meta-analysis will be performed using RevMan software if sufficient number of comparable studies are retrieved.

Ethics and dissemination This is a study protocol of meta-analysis; no primary data will be collected, and no ethics assessment is required. The study results will be presented in a peer-reviewed scientific publication.

PROSPERO registration number CRD42021277932.

Strengths and limitations of this study

- This study protocol will be the first systematic review study on the effects of mobile-based mindfulness meditation on the mental health of nurses.
- This study adheres to the recommendations of the Cochrane handbook for systematic reviews of interventions strictly.
- A thorough and transparent approach will minimise the risk of possible biases.
- The quality of the evidence will be assessed to provide confidence in the effect estimate.
- One limitation is that due to the language limitation, some other important studies will be missed, which may produce the possibility of bias to the results.

INTRODUCTION

The insufficient human resources, high work pressure, frequent night shift, long-term direct or indirect exposure to environmental stimulation of patients' pain, sadness, and even death, low salary, heavy workload, violent injuries from patients and their families, COVID-19 effects and a series of other factors¹⁻⁷ seriously affect the mental health of nurses.⁸ In addition, the long-term lack of effective mental health support has caused serious mental health problems for nurses,⁹ which are manifested in a series of anxiety, depression and even job burnout.^{10 11} This complication may reduce the nursing quality and patient satisfaction, increase the medical error rate¹² and affect the clinical nursing outcome.¹³ Therefore, some interventions are necessary to improve the mental health of nurses.¹⁴

The intervention research on nurses' mental health is mainly about mindfulness meditation, which was initiated by American scholar Kabat Zinn in 1979.¹⁵ It aims to deal with stress and pain through mindfulness meditation, including self-regulation,

looking at problems from different angles, increasing the acceptance of current experience¹⁶ and promoting them to form a mentality of self-acceptance and recognition, to improve their mental health.¹⁷ Numerous studies have shown that mindfulness meditation can help nurses to cope with psychological pressure and prevent job burnout.^{18–21} Therefore, for nurses, mindfulness meditation is a strategy to prevent and manage stress, anxiety and job burnout effectively and improve their mental health.²² However, for such a specific group of nurses, due to busy daily work, minimal rest time, the particularity of scheduling, COVID-19 prevention and control requirements, and prohibition of mass gathering, convening everyone at the same time is difficult.

Through mobile devices (such as smart phones), online communication and learning can be carried out anytime and anywhere without time and space constraints,²³ which solves this problem well. Reports have shown that by 2020, the internet users in China have reached 800 million, of which 97.5% use smartphones and other mobile devices to surf the internet, indicating that smartphones and other mobile devices have high popularity and acceptance. Mobile-based mindfulness meditation (MMM) can effectively improve nurses' negative emotions, such as anxiety and depression, reduce pressure and enhance nurses' mental health. It plays an irreplaceable role in improving clinical nursing quality and maintaining the stability of nursing teams.²⁴

Nevertheless, the effects of MMM on the mental health of nurses have been controversial. Some studies have shown that MMM can significantly improve the resilience and release post-traumatic stress disorder of nurses,^{25–26} whereas another study have presented no statistical difference.²⁷ Although MMM has many potential advantages for resolving mental health problems, evidence confirming the effects of MMM on the mental health of nurses is currently lacking.

To the best of our knowledge, no meta-analysis of the effect of MMM on the mental health of nurses have been conducted. One systematic review²⁸ has reported that MMM significantly improves mental health. However, their study population included various subjects, such as healthcare students and professionals, rather than limited to nurses who have mental health problems. Stefanopoulou *et al*²⁹ reported that various digital interventions, including dialectical behavioural therapy, cognitive behavioural therapy and problem solving therapy, are effective in reducing the mental health problems of nurses, rather than only MMM intervention. Therefore, the effectiveness of MMM on mental health of nurses should be determined. In this study, we aim to evaluate the effects of MMM on the stress, anxiety, depression, mindfulness, well-being and resilience of nurses systematically.

METHODS

This systematic review and meta-analysis protocol was conducted in accordance with the Preferred Reporting

Items for Systematic Review and Meta-analysis Protocols guidelines.³⁰ This study protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO), registration number was CRD42021277932.

ELIGIBILITY CRITERIA

Study characteristics

Population

We will include registered nurses, preregistered nurses, midwives and nursing students. Registered nurses comprise all kinds of nurses in different hospitals and departments and primary care nurses. Nursing students consist of nursing students studying in college and nurse interns.

Intervention

We will include studies using mindfulness meditation, such as mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy, through mobile-based devices, such as smartphones, and personal digital assistants. The intervention is used to improve the mental health of nurses.

Comparator

We will include studies using waitlist controls or traditional methods. Traditional methods include face-to-face and online mindfulness meditation methods.

Outcomes

We will assess the outcomes of stress, anxiety, depression, mindfulness, well-being and resilience. Stress can be assessed by using different instruments, such as the Depression, Anxiety, and Stress Scale (DASS-21), the Perceived Stress Scale (PSS-10), etc. Anxiety will be measured using the General Health Questionnaire (GHQ-28), State-Trait Anxiety Inventory and so on. Depression can be assessed using the Quick Inventory of Depressive Symptomatology Self-Report, the Patient Health Questionnaire, the short German form of the Center for Epidemiological Studies' Depression Scale, etc. Mindfulness will be evaluated through the Five Facet Mindfulness Questionnaire, Mindful Attention Awareness Scale, etc. Well-being can be evaluated using, for example, the Warwick-Edinburgh Mental Well-being Scale, the WHO-Five Well-Being Index, the General Well-Being Schedule, etc. Resilience will be measured using the Wagnild Resilience Scale, the Resilience Scale, the Connor-Davidson Resilience Scale, etc. Results produced by other scales that can also be applied to this outcome measurements will be included in the study.

Study design

We will include randomised controlled trials (RCTs) and quasiexperimental studies, focusing on mobile-based mindfulness meditation groups versus other traditional mindfulness meditation or waitlist control groups.

Setting

No restriction is imposed on specific treatment process and outcome measurement, although these data may be included for further analysis.

Time frame

There is no restriction on intervention duration and follow-up duration, although these data may be included for further analysis.

Report characteristics

We will include studies written in English or Chinese language. No restriction of publication year is applied, and search time was from inception of each database to July 2022. We will include research reported as intervention studies, grey literature and conference abstracts. Studies that contain sufficient information to assess eligibility for inclusion criteria will also be included.

Information sources

An electronic literature search will be conducted using PubMed, Web of Science, EBSCO, Cochrane Library, CINAHL, PsycINFO, ERIC, Embase and three Chinese databases namely CNKI, Wan Fang and Chinese Biology Medicine disc (CBM). The references of included studies will be searched to identify additional eligible studies. For grey literature, several databases, such as WHO database, PhD thesis/dissertation databases, and OpenGrey, will be systematically searched. For studies without full text or lacking of original data, we will try to contact the original author.

Search strategy

By consulting the literature and presearching PubMed, we established the search terms. Search terms related to 'mobile' contain: "mobile applications", "cell phone", "cell phone use", "mobile", "mobile applications", "mobile based", "mobile-based", "distance counseling", "app", "app based", "app-based", "software", "electronic", "digital", "smartphone", "phone", "online", "internet", "web", "e-health", "telehealth", "tele-based" and "telemedicine". We will use the Boolean operator 'OR' to combine the above words, with different syntaxes being adapted to each database.

Search terms related to 'mindfulness meditation' include: "mindfulness", "meditation", "mindfulness-based intervention", "MBSR", "mindfulness-based stress reduction", "mindfulness-based cognitive therapy" and "vipassana". The Boolean operator 'OR' will be used to combine the search terms, and different syntaxes will be adapted to each database.

The keywords used to capture the concept of 'nurse' are: "nurses", "nursing", "nurse midwives", "students, nursing", "nurs*", "nurse", "nurses", "nursing staff", "clinical nurse", "nursing", "nursing personnel", "registered nurse", "nursing students" and "nurse interns". Similarly, the Boolean operator 'OR' will be used to combine the search terms, and different syntaxes will be adapted to each database.

We will use the Boolean operator 'AND' to combine the previous three search terms, namely, "mobile", "mindfulness meditation" and "nurse". The retrieval time limitation is from the inception of each database to the present. Language will be restricted to English and Chinese. The references of included studies and any relevant systematic reviews will be searched for additional identified studies. For unsupported data or ongoing studies, we will try to contact the original authors. The search strategy of PubMed is shown in the online supplemental appendix.

Data management

The retrieved data results will be downloaded to the document-processing software EndNote X9 to have access to titles and abstracts. We will remove duplicate literature by comparing article titles and authors through the function 'Find duplicates' of EndNote X9.

Selection process

Two reviewers (BC and TY) will conduct the study selection process independently. The first step is preliminary screening. The citation information of the detected literature, such as title and abstract, is read to eliminate the obviously unqualified literature, and the full text of the potentially qualified literature is further screened. The second step is full-text screening. For the literature that may be qualified after preliminary screening, the methodological part of the full text should be carefully read and evaluated, and the relevant information in the literature should be extracted to determine whether the literature meets the inclusion criteria and whether the literature is included. The third step is to obtain additional information. Sometimes, even if the full text of the literature is obtained, it may still be impossible to determine whether to include it because the information provided is incomprehensive. Therefore, the literature with questions or differences should be included first, and then the author is contacted to obtain additional information before deciding on the choice or conducting further evaluation in the later selection process. The two authors will independently select the literature, including determining whether it is to be included and recording the reasons for exclusion. Any dispute will be settled through discussion. If the discussion still fails, a third author will make a decision. The selection process is carried out in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart.

Data collection process

Two authors will complete the data collection by filling in the data extraction form. Data collection includes the following information: (1) basic information of the included research, such as the number of included research, year of publication, citation, first author and contact information; (2) research methods and possible bias, such as information related to literature quality evaluation, including grouping and blind methods; (3) characteristics of the research object,

such as demographic characteristics, including the age and gender of the research object; (4) characteristics of intervention measures, such as mobile mindfulness intervention methods, approaches, duration of each intervention and intervention cycle; (5) research results, such as sample size, grouping, result measurement method, data type, statistical data and results; and (6) other information, such as important citations, funding agencies and potential conflicts of interest. Any dispute will be settled through discussion. If the discussion still fails, a third author will make a decision. The collected data will be input into the system evaluation management software RevMan V.5.3 for result analysis and reporting.

Data items

We will extract the following study characteristics and outcomes:

1. Methods: study design, duration of study and run-in period, number of study centres and location, study setting, withdrawals and date of study.
2. Participants: number, mean age, age range, gender, inclusion and exclusion criteria and reported differences between intervention and comparison groups.
3. Interventions: duration of mindfulness meditation, number of meditations, existence of defined standards of meditation, comparator and concomitant intervention.
4. Outcomes: primary and secondary outcomes specified and collected, and time points reported.
5. Notes: funding for study and notable conflicts of interest of all authors.

Outcomes and prioritisation

We will set stress, anxiety and depression as the primary outcome, assessed using different measurements, such as DASS-21 or PSS-10. Stress is a natural reflection of people in the face of tension, which will lead to individual worries and restless.³¹ Anxiety refers to an unpleasant complex emotional state, such as tension, uneasiness and worry caused by an individual's imminent and possible danger or threat.³² The clinical characteristics of depression are mainly manifested in depressed mood, slow thinking, reduced language and movement, and retardation.³³ Stress, anxiety and depression can significantly indicate the mental health level of nurses.³⁴ Outcome data will be expressed as mean±SD (M±SD). If data are offered in other forms such as median–range or median–IQR, M±SD will be calculated following the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions.³⁵

Secondary outcomes will be set as mindfulness, well-being and resilience. These three outcomes have a close positive correlation with mental health.³⁶ Improving mindfulness, well-being and resilience will help nurses efficiently handle mental health problems, such as stress, anxiety, and depression.³⁷

Risk of bias in individual studies

Two reviewers will assess the risk of bias for each included study independently. For RCTs, the risk of bias will be assessed using Cochrane risk-of-bias tool for randomised trials (RoB 2),³⁸ which includes seven criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete data outcomes, selective outcome reporting and other biases. Each criterion will be graded as high, unclear or low risk of bias. For non-RCT studies, the risk of biases in non-randomised studies of interventions (ROBINS-I) tool will be determined.³⁹ The biases include bias due to confounding, bias in the selection of study participants, bias in the classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, bias in the selection of the reported result and overall bias.

Anticipated methods for assessing the risk of bias of individual studies will be described, including whether the assessment will be done at the outcome or study level or both, and how the information will be used in data synthesis. Any dispute will be settled through discussion. If the discussion still fails, a third author will make a decision.

Data synthesis

Meta-analysis will be conducted using RevMan V.5.3 software. The weighted mean difference model will be used to analyse continuous data if all outcomes are measured using identical methods; otherwise, the standardised mean difference will be used. I^2 test will be conducted to assess the degree of heterogeneity of included studies. $I^2 > 50\%$ is identified as significant heterogeneity in accordance with the Cochrane handbook. The values of P and I^2 will be used to determine which model to choose. A fixed-effect model will be chosen if $p > 0.1$ and $I^2 < 50\%$, whereas a random-effect model will be selected if $p < 0.1$ and $I^2 > 50\%$. In addition, sensitivity analysis through the leave-one-out method and subgroup analysis will be performed within significant heterogeneity. All effective quantities will be expressed by 95% CIs. $p < 0.05$ will define statistical significance. If significant heterogeneity ($I^2 > 50\%$) founded, sensitivity analysis will be performed through the leave-one-out method. If sensitivity analysis still indicates great heterogeneity after removing any research results, then subgroup analysis will be carried out. They will be divided into subgroups via intervention methods, intervention duration or sample sized. If the source of heterogeneity cannot be found, it will be described in narrative terms.

Meta-bias

For all included studies, we will check if a registered study protocol is available and whether the protocol has been registered before the study is initialised. Moreover, we will screen the outcomes documented in the protocol against the reported outcomes to evaluate potential reporting bias. If more than or equal to 10 studies are available for

meta-analysis, a funnel plot will be used to quantify the extent of publication bias for the primary outcome by assessing funnel plot asymmetry visually and using Egger's test at a significance level of 5%.⁴⁰ If included studies are less than 10 in this meta-analysis, we will assess publication bias qualitatively on the basis of the characteristics of the included studies.

Confidence in cumulative evidence

The confidence of the final included studies will be assessed using the Grading of Recommendations Assessment, Development and Evaluation rating scale.⁴¹

Patient and public involvement

There was no patient or public involvement in the development in this protocol study.

DISCUSSION

This study protocol designs a plan for the systematic review and meta-analysis of the effects of MMM on the mental health, such as stress, anxiety, depression, mindfulness, well-being and resilience of nurses. With the constant attention paid to the mental health of nurses⁴² and the rapid development of mobile technology,²³ mindfulness decompression therapies based on mobile technology have been applied to the research of nurses' mental health. However, as far as we know, no systematic review exists at present. Therefore, our research will be the first systematic review on the effects of MMM on the mental health of nurses. Findings from this review will help illuminate the impact of MMM intervention on nurses. We will further analyse which aspects of MMM have a positive impact, no impact or even a reverse effect on mental health of nurses and explore the possible reasons. We aim to provide more scientific intervention methods and theoretical bases for the mental health of nurses.

ETHICS AND DISSEMINATION

This is a meta-analysis research protocol programme, which does not collect raw data and requires no ethical evaluation. The research results will be published in peer-reviewed scientific publications.

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Contributors BC, TY, LT, YS and YL designed the study and drafted the manuscript protocol. YW, LX and CX registered the methods on the PROSPERO website. HC critically revised the protocol and manuscript submitted. All authors read and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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REFERENCES

- Liu Y, Wang H, Chen J, *et al.* Emergency management of nursing human resources and supplies to respond to coronavirus disease 2019 epidemic. *Int J Nurs Sci* 2020;7:135–8.
- Khan HM. Workload pressure of nurses at an emergency satellite hospital in Peshawar Pakistan. *Eur J Public Health* 2020;30.
- Hassani MR, Behnamian J. A scenario-based robust optimization with a pessimistic approach for nurse rostering problem. *J Comb Optim* 2020;40:1–27.
- Alyami HM, Chan RJ, New K. End-of-life care preferences for people with advanced cancer and their families in intensive care units: a systematic review. *Support Care Cancer* 2019;27:3233–44.
- Lowe MA, Prapanjarosin A, Bakitas MA, *et al.* An exploratory study of the influence of perceived organizational support, coworker social support, the nursing practice environment, and nurse demographics on burnout in palliative care nurses. *J Hosp Palliat Nurs* 2020;22:465–72.
- Farid M, Purdy N, Neumann WP. Using system dynamics modelling to show the effect of nurse workload on nurses' health and quality of care. *Ergonomics* 2020;63:952–64.
- Sun N, Wei L, Shi S, *et al.* A qualitative study on the psychological experience of caregivers of COVID-19 patients. *Am J Infect Control* 2020;48:592–8.
- Laeque SH, Bilal A, Hafeez A, Harris LS, Atif B, Abdullah H, *et al.* Violence breeds violence: Burnout as a mediator between patient violence and nurse violence. *Int J Occup Saf Ergon* 2019;25:604–13.
- Sawyer AT, Bailey AK, Green JF, *et al.* Resilience, insight, self-compassion, and empowerment (rise): a randomized controlled trial of a psychoeducational group program for nurses. *J Am Psychiatr Nurses Assoc* 2021;6:107839032110333.
- Lee H-F, Chiang H-Y, Kuo H-T. Relationship between authentic leadership and nurses' intent to leave: the mediating role of work environment and burnout. *J Nurs Manag* 2019;27:52–65.
- Salvarani V, Rampoldi G, Ardenghi S, *et al.* Protecting emergency room nurses from burnout: the role of dispositional mindfulness, emotion regulation and empathy. *J Nurs Manag* 2019;27:765–74.
- Dodek PM, Norena M, Ayas N, *et al.* Moral distress is associated with general workplace distress in intensive care unit personnel. *J Crit Care* 2019;50:122–5.
- Dodek P, Norena M, Ayas N, *et al.* Moral distress in intensive care unit personnel is not consistently associated with adverse medication events and other adverse events. *J Crit Care* 2019;53:258–63.
- Bailey AK, Sawyer AT, Robinson PS. A psychoeducational group intervention for nurses: rationale, theoretical framework, and development. *J Am Psychiatr Nurses Assoc* 2021;107839032110011 16:107839032110011.
- Bostock S, Crosswell AD, Prather AA, *et al.* Mindfulness on-the-go: effects of a mindfulness meditation APP on work stress and well-being. *J Occup Health Psychol* 2019;24:127–38.
- Paulson S, Davidson R, Jha A, *et al.* Becoming conscious: the science of mindfulness. *Ann N Y Acad Sci* 2013;1303:87–104.
- Yang J, Tang S, Zhou W. Effect of mindfulness-based stress reduction therapy on work stress and mental health of psychiatric nurses. *Psychiatr Danub* 2018;30:189–96.

- 18 Guillaumie L, Boiral O, Champagne J. A mixed-methods systematic review of the effects of mindfulness on nurses. *J Adv Nurs* 2017;73:1017–34.
- 19 Ruiz-Fernández MD, Ortiz-Amo R, Ortega-Galán Ángela María, et al. Mindfulness therapies on health professionals. *Int J Ment Health Nurs* 2020;29:127–40.
- 20 Ghawadra SF, Abdullah KL, Choo WY, et al. Mindfulness-based stress reduction for psychological distress among nurses: a systematic review. *J Clin Nurs* 2019;28:3747–58.
- 21 Suleiman-Martos N, Gomez-Urquiza JL, Aguayo-Estremera R, et al. The effect of mindfulness training on burnout syndrome in nursing: a systematic review and meta-analysis. *J Adv Nurs* 2020;76:1124–40.
- 22 Taylor M, Hageman JR, Brown M. A mindfulness intervention for residents: relevance for pediatricians. *Pediatr Ann* 2016;45:e373–6.
- 23 Chen B, Wang Y, Xiao L, et al. Effects of mobile learning for nursing students in clinical education: a meta-analysis. *Nurse Educ Today* 2021;97:1–9.
- 24 Gracia Gozalo RM, Ferrer Tarrés JM, Ayora Ayora A, Gozalo RMG, Tarrés JMF, Ayora AA, et al. Application of a mindfulness program among healthcare professionals in an intensive care unit: effect on burnout, empathy and self-compassion. *Med Intensiva* 2019;43:207–16.
- 25 Reyes AT. A Mindfulness Mobile App for Traumatized COVID-19 Healthcare Workers and Recovered Patients: A Response to "The Use of Digital Applications and COVID-19". *Community Ment Health J* 2020;56:1204–5.
- 26 Reyes AT, Song H, Bhatta TR, et al. Exploring the relationships between resilience, mindfulness, and experiential avoidance after the use of a mindfulness- and acceptance-based mobile app for posttraumatic stress disorder. *Perspect Psychiatr Care* 2022;58:1–9.
- 27 Fiol-DeRoque MA, Serrano-Ripoll MJ, Jiménez R, et al. A mobile Phone-Based intervention to reduce mental health problems in health care workers during the COVID-19 pandemic (PsyCovidApp): randomized controlled trial. *JMIR Mhealth Uhealth* 2021;9:e27039.
- 28 Pospos S, Young IT, Downs N, et al. Web-based tools and mobile applications to mitigate burnout, depression, and suicidality among healthcare students and professionals: a systematic review. *Acad Psychiatry* 2018;42:109–20.
- 29 Stefanopoulou E, Hogarth H, Taylor M, et al. Are digital interventions effective in reducing suicidal ideation and self-harm? A systematic review. *J Ment Health* 2020;29:207–16.
- 30 Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1.
- 31 Balmus IM, Robea M, Ciobica A, et al. Perceived stress and gastrointestinal habits in college students. *Acta Endocrinol* 2019;15:274–5.
- 32 Balsamo M, Cataldi F, Carlucci L, Michela B, Fedele C, Leonardo C, et al. Assessment of anxiety in older adults: a review of self-report measures. *Clin Interv Aging* 2018;13:573–93.
- 33 Hammen C. Risk factors for depression: an Autobiographical review. *Annu Rev Clin Psychol* 2018;14:1–28.
- 34 Zerbini G, Ebigo A, Reicherts P, et al. Psychosocial burden of healthcare professionals in times of COVID-19 - a survey conducted at the University Hospital Augsburg. *Ger Med Sci* 2020;18:Doc05.
- 35 Pavel M-C, Casanova R, Estalella L, Mihai-Calin P, Raquel C, Laia E, et al. The effect of preoperative chemotherapy on liver regeneration after portal vein embolization/ligation or liver resection in patients with colorectal liver metastasis: a systematic review protocol. *Syst Rev* 2020;9:279.
- 36 Litvin S, Saunders R, Maier MA, et al. Gamification as an approach to improve resilience and reduce attrition in mobile mental health interventions: a randomized controlled trial. *PLoS One* 2020;15:e0237220.
- 37 Eaves JL, Payne N. Resilience, stress and burnout in student midwives. *Nurse Educ Today* 2019;79:188–93.
- 38 Sterne JAC, Savović J, Page MJ, et al. Rob 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019;366:l4898.
- 39 Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016;355:i4919.
- 40 Sterne JAC, Sutton AJ, Ioannidis JPA, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ* 2011;343:d4002.
- 41 Yang B, Mustafa RA, Bossuyt PM, et al. Grade guidance: 31. assessing the certainty across a body of evidence for comparative test accuracy. *J Clin Epidemiol* 2021;136:146–56.
- 42 Zeller JM, Johnson AM, Hoffman A, et al. Mindfulness training to improve nurse clinical performance: a pilot study. *West J Nurs Res* 2021;43:250–60.

Appendix:

Search strategies

PubMed

#1. mobile applications [MeSH Terms]

#2. cell phone [MeSH Terms]

#3. cell phone use [MeSH Terms]

#4. (((((((((((((((((((mobile [Title/Abstract])) OR (mobile applications [Title/Abstract])) OR (mobile based [Title/Abstract])) OR (mobile-based [Title/Abstract])) OR (distance counseling [Title/Abstract])) OR (app [Title/Abstract])) OR (app based [Title/Abstract])) OR (app-based [Title/Abstract])) OR (software [Title/Abstract])) OR (electronic [Title/Abstract])) OR (digital [Title/Abstract])) OR (smartphone [Title/Abstract])) OR (phone [Title/Abstract])) OR (online [Title/Abstract])) OR (internet [Title/Abstract])) OR (web [Title/Abstract])) OR (ehealth [Title/Abstract])) OR (telehealth [Title/Abstract])) OR (telebased [Title/Abstract])) OR (tele-based [Title/Abstract])) OR (telemedicine [Title/Abstract]))

#5. #1 OR #2 OR #3 OR #4

#6. Mindfulness [MeSH Terms]

#7. (((((((mindfulness [Title/Abstract])) OR (meditation [Title/Abstract])) OR (mindfulness-based intervention [Title/Abstract])) OR (MBSR [Title/Abstract])) OR (mindfulness-based stress reduction [Title/Abstract])) OR (mindfulness-based cognitive therapy [Title/Abstract])) OR (vipassana [Title/Abstract]))

#8. #6 OR #7

#9. Nurses [MeSH Terms]

#10. Nursing [MeSH Terms]

#11. nurse midwives [MeSH Terms]

#12. students, nursing [MeSH Terms]

#13. ((((((((((nurs* [Title/Abstract])) OR (nurse [Title/Abstract])) OR (nurses [Title/Abstract])) OR (nursing staff [Title/Abstract])) OR (clinical nurse [Title/Abstract])) OR (nursing [Title/Abstract])) OR (nursing personnel [Title/Abstract])) OR (registered nurse [Title/Abstract])) OR (nursing students [Title/Abstract])) OR (nurse interns [Title/Abstract]))

#14. #9 OR #10 OR #11 OR #12 OR #13

#15. #5 AND #8 AND #14