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

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Title page

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

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 (PRISMA-P) 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 (CBM). The inclusion criteria follow the PICO principle, registered nurses, pre-registered nurses, mid-wives, and nursing students will all be included, studies using MMM as intervention to improve mental health of nurses, compared to waitlist controls or traditional methods groups, outcomes assessment of stress, anxiety, depression, mindfulness, well-being, and resilience will meet the inclusion criteria. Studies designed randomized controlled trails (RCT) of quasi-experimental and written in English or Chinese will be eligible. 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 randomized trials (RoB 2), and for non-RCT studies, risk of bias in non-randomized 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, 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 designs a plan for the systematic review of the effects of MMM on the mental health, which will be the first systematic review study of the effects of MMM on the mental health of nurses.

Findings from this review will help illuminate the impact of MMM intervention on nurses.

Studies written in English or Chinese language will be consideration for inclusion. There are 5 million clinical nurses in China, which is highly representative in the world clinical nursing field. However, 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 factors[1–7], 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 rate[12], 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 experience[16], 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 (PTSD)

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 review[28] 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 behavioral therapy (DBT), cognitive behavioral therapy (CBT), and problem solving therapy (PST), 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 (PRISMA-P) 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. 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 (MBCT), through mobile-based devices, such as smartphones, and personal digital assistants (PDA). 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), and the Perceived Stress Scale (PSS-10). Anxiety will be measured using the General Health Questionnaire (GHQ-28), or State-Trait Anxiety Inventory (STAI). Depression can be assessed using the Quick Inventory of Depressive Symptomatology Self-Report (QIDS-SR), the Patient Health Questionnaire (PHQ-9), and the short German form of the Center for Epidemiological Studies' Depression Scale (CES-D). Mindfulness will be evaluated through the Five Facet Mindfulness Questionnaire (FFMQ). Well-being can be evaluated using, for example, the Warwick-Edinburgh mental wellbeing scale (WEMWBS), the WHO-Five Well-Being Index (WHO-5), and the General Well-Being Schedule (GWBS). Resilience will be measured using the Wagnild Resilience Scale (WRS), and the Resilience Scale.

Study design

We will include randomized controlled trials (RCTs) and quasi-experimental studies, focusing on mobile-based mindfulness meditation groups versus other traditional mindfulness meditation or wait-list 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. We will include research reported as intervention studies, gray 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 gray 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 pre-searching 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", "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", "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", "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 above 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 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 (CB and YT) 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 PRISMA flowchart.

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 informatio; 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; 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 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 centers 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 prioritization

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 ± standard deviation (M ± SD). If data are offered in other forms such as median–range or median–interquartile range, 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 randomized controlled trails (RCTs), the risk of bias will be assessed using Cochrane risk-of-bias tool for randomized 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 nonrandomized 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 5.3 software. The weighted mean difference (MD) model will be used to analyze continuous data if all outcomes are measured using identical methods; otherwise, the standardized mean difference (SMD) 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% confidence intervals (CI). $P < 0.05$ 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 initialized. 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 GRADE (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 nurses[42] 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 analyze 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.

Contributors: CB, YT, TL, and SYQ designed the study and drafted the manuscript protocol. WY, XL, and XCX registered the methods on the PROSPERO website. CH critically revised the protocol and manuscript submitted. All authors read and approved the final manuscript.

Competing interests: All authors declare that there is no conflict of interests.

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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

Dear Prof. Adrian Aldcroft,

We would like to submit the enclosed manuscript entitled "**Effects of mobile-based mindfulness meditation for mental health of Nurses: a protocol for systematic review and meta-analysis**" for possible publication in the *BMJ OPEN.*

No conflict of interest exists at the time of submission of this manuscript. The contents of this manuscript will not be copyrighted, submitted, or published elsewhere, while acceptance by the *BMJ OPEN* is under consideration. All authors have read and approved the final submitted version; all individuals listed as authors were eligible for authorship.

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. This study protocol follows the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) 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 (CBM). The inclusion criteria follow the PICO principle, registered nurses, pre-registered nurses, mid-wives, and nursing students will all be included, studies using MMM as intervention to improve mental health of nurses, compared to waitlist controls or traditional methods groups, outcomes assessment of stress, anxiety, depression, mindfulness, well-being, and resilience will meet the inclusion criteria. Studies designed randomized controlled trails (RCT) of quasi-experimental and written in English or Chinese will be eligible. 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 randomized trials (RoB 2), and for non-RCT studies, risk of bias in non-randomized 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. resuThis study protocol designs a plan for systematic review and meta-analysis that effects of MMM on mental health such as stress, anxiety, depression, mindfulness, well-being, and resilience of nurses. Findings from this review study will help illuminate the impact of MMM intervention on nurses, and to provide more scientific intervention methods and theoretical basis for mental health of nurse.

We deeply appreciate your consideration of our manuscript. We look forward to receiving comments from the reviewers. If you have any queries, please do not hesitate to contact me at the address below. Thank you in advance.

Best regards,

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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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Title page

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

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 (PRISMA-P) 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 (CBM). The inclusion criteria follow the PICO principle, registered nurses, pre-registered nurses, mid-wives, and nursing students will all be included, studies using MMM as intervention to improve mental health of nurses, compared to waitlist controls or traditional methods groups, outcomes assessment of stress, anxiety, depression, mindfulness, well-being, and resilience will meet the inclusion criteria. Studies designed randomized controlled trails (RCT) of quasi-experimental 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 randomized trials (RoB 2), and for non-RCT studies, risk of bias in non-randomized 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, 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 MMM 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 minimize 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 factors[1–7], 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 rate[12], 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 experience[16], 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 (PTSD) 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 review[28] 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 behavioral therapy (DBT), cognitive behavioral therapy (CBT), and problem solving therapy (PST), 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 (PRISMA-P) 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 (MBCT), through mobile-based devices, such as smartphones, and personal digital assistants (PDA). 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), et al. Anxiety will be measured using the General Health Questionnaire (GHQ-28), State-Trait Anxiety Inventory (STAI), and so on. Depression can be assessed using the Quick Inventory of Depressive Symptomatology Self-Report (QIDS-SR), the Patient Health Questionnaire (PHQ-9), the short German form of the Center for Epidemiological Studies' Depression Scale (CES-D), et al.

Mindfulness will be evaluated through the Five Facet Mindfulness Questionnaire (FFMQ), Mindful Attention Awareness Scale (MAAS), et al. Well-being can be evaluated using, for example, the Warwick-Edinburgh mental wellbeing scale (WEMWBS), the WHO-Five Well-Being Index (WHO-5), the General Well-Being Schedule (GWBS), et al. Resilience will be measured using the Wagnild Resilience Scale (WRS), the Resilience Scale, the Connor-Davidson Resilience Scale, et al. 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 randomized controlled trials (RCTs) and quasi-experimental studies, focusing on mobile-based mindfulness meditation groups versus other traditional mindfulness meditation or wait-list 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, gray 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 gray 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 pre-searching 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", "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", "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", "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 above 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 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 (CB and YT) 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 PRISMA flowchart.

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 informatio; 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; 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 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 centers 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 prioritization

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 ± standard deviation (M ± SD). If data are offered in other forms such as median–range or

median–interquartile range, 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 randomized controlled trails (RCTs), the risk of bias will be assessed using Cochrane risk-of-bias tool for randomized 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 nonrandomized 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 5.3 software. The weighted mean difference (MD) model will be used to analyze continuous data if all outcomes are measured using identical methods; otherwise, the standardized mean difference (SMD) 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% confidence intervals (CI). $P < 0.05$ 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 initialized. 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 GRADE (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 nurses[42] 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 analyze 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 program, which does not collect raw data and requires no ethical evaluation. The research results will be published in peer-reviewed scientific publications.

Contributors: CB, YT, TL, SYQ, and LY designed the study and drafted the manuscript protocol. WY, XL, and XCX registered the methods on the PROSPERO website. CH critically revised the protocol and manuscript submitted. All authors read and approved the final manuscript.

Competing interests: All authors declare that there is no conflict of interests.

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Data sharing statement: None declared.

Ethics approval statement: Not required.

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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

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item	Location where item is reported
ADMINISTRATIVE INFORMATION			**LINE**
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	38
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	/
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	70
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	4
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	409
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	/
Support:			
Sources	5a	Indicate sources of financial or other support for the review	/
Sponsor	5b	Provide name for the review funder and/or sponsor	/
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	/
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	41
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	46
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	145
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	201
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be	212

		repeated	
Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	242
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	248
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	271
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	290
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	304
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	325
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised	348
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)	351
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	356
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	364
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	367
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	379

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

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