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SCOPING REVIEW

Cognitive mental workload of emergency nursing: A scoping review

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Abstract

Aim: Emergency nurses work in an environment of high cognitive mental workload. Excessive cognitive mental workload may result in patient harm and nurses' burnout. Therefore, it is necessary to understand nurses' subjective experience of cognitive workload. This scoping review aimed to curate literature about the subjective experience of cognitive mental workload reported by nurses and psychometric measures of the phenomenon.

Design: The scoping review was conducted in accordance with JBI methodology and reported using PRISMA extension for scoping review checklist.

Methods: A priori protocol was created with Peer Review of Electronic Search Strategies checklist and registered in the OSF registry. Databases including PubMed, CINAHL, ProQuest, Scopus, Science Direct, Web of Science and Google Scholar were searched. Published reports were reviewed against the eligibility criteria by performing Title and Abstract screening, followed by Full-text screening. The initial search yielded 1373 studies. Of these, 57 studies met the criteria for inclusion in this study.

Results: The search revealed five general measures of cognitive mental workload and their variations. Only one customised measure specifically for medical–surgical nurses was found in the study. Identified measures were collated and categorised into a framework for conceptual clarity. NASA Task Load Index and its variations were the most popular subjective measure of cognitive mental workload in nursing. However, no measure or self-report scale customised for emergency nurses was identified.

Patient or Public Contribution: The findings of this scoping review can inform future research into the cognitive mental workload of nurses. The findings have implications for workplace health and safety for nurses and patients.

KEYWORDS
cognitive load, cognitive workload, emergency nurse, measure, mental workload, nurse, scale, self-report, subjective scale, workload

1 | INTRODUCTION

Overcrowding, technological advancements in health care, increased incidence of violence, workforce shortage, skill mix issues and the rise of various medical challenges, perpetually complicate the working environment of nurses. This panoply of factors in their work environments contributes to nurses' high cognitive mental workload (CMW) experiences (Yuan et al., 2023). With finite human cognitive resources (Sweller, 1988), when encountered with high cognitive demand, human beings experience high workload that can contribute to error, slowing or decline in performance and missed tasks (Van Acker et al., 2018). Nurses experiencing high CMW because of interruptions (Forsyth et al., 2018; Kim et al., 2019) and constant multitasking under time pressure (Weigl et al., 2016), can experience diminished vigilance, sensory information processing, decision-making, judgement and task performance due to scarcity in cognitive resources. Thus, the imbalance between cognitive resources and the cognitive demand perceived by nurses as high cognitive mental workload, may contribute to slowing or substandard performance and or decision making, compromising patient safety and quality of care (Weigl et al., 2016). Furthermore, Pourteimour et al. (2021) enumerate burnout, depersonalisation, low satisfaction, physical fatigue and high turnover intentions in emergency nurses as consequences of high CMW. Hence, high CMW is highlighted as a reason for the concerning global shortage of nurses (Yuan et al., 2023). In short, high CMW has a statistically significant role in causation of two major current global healthcare sector challenges, such as health worker-related errors and the global shortage of nurses. Optimisation and management of CMW of nurses is essential for sustainable and safe health care (Weigl et al., 2016).

Effective CMW optimisation in workplaces can be achieved if strategies are meticulously planned and based on sound CMW measures of the phenomenon (Van Acker et al., 2018). Therefore, it is vital to use conceptually accurate and practically viable measure of CMW to plan optimisation strategy. There are various performance, physiological and self-report measures of (Longo et al., 2022; Van Acker et al., 2018). Self-report or subjective measures are popular due to their simplicity, practicality and the importance given to perception and experience of task performer (Yuan et al., 2023). Being a complex and intrinsic phenomenon, measures of CMW are constantly evolving with conflicting perspectives about their conceptual and empirical credibility (Longo et al., 2022; Van Acker et al., 2018). Longo et al. (2022) highlights the importance of comprehending advancements in the area of CMW measurements. Literature searches that explore CMW measures, scales and tools in health care (Kremer et al., 2022), and use of a particular subjective scale, the NASA Task Load Index in nursing (Yuan et al., 2023) are gradually emerging. However, there seems to be limited literature that specifically investigates measures uniquely developed for quantifying CMW experiences of emergency nurses. There is also scarcity in scholarly work that provides a conceptual framework for CMW in nursing. To fill this gap in the literature, the objective of this scoping review is to map electronically accessible literature on subjective CMW scales utilised in nursing profession. The mapping will enable us to present a conceptual framework of subjective CMW scales that can be referenced for future research. In addition, we aim to identify unique CMW subjective indicators that are specifically relevant to measure emergency nurses' CMW experiences.

2 | BACKGROUND

2.1 | The concept of cognitive mental workload

There is no agreed conceptualisation and definition for CMW documented in the literature (Kremer et al., 2022; Longo et al., 2022). Various terms have been found in the literature to represent this latent construct depending on the discipline (e.g. psychology, education, human factors), including cognitive load, cognitive workload and mental load (Longo et al., 2022; Van Acker et al., 2018). Van Acker et al. (2018) summarise the various perspectives as the mismatch between cognitive resources and cognitive demands.

Earlier conceptualisations described mental workload as the load imposed on cognition during a task (Moray, 1979) and the limitations of working memory available to meet cognitive demand (Sweller, 1988). Although definitions differ, the commonality noted in all these definitions is that the phenomenon of CMW arises when the limited cognitive resources are unable to meet the cognitive demand that arises during human information processing (Van Acker et al., 2018). Conceptual analysis of the construct by Van Acker et al. (2018, p. 359) describes 'mental workload is a subjectively experienced physiological processing state, revealing the interplay between one's limited and multidimensional cognitive resources and the cognitive work demands being exposed to'.

For this review, the aggregate term cognitive mental workload (CMW) will be used except where discipline-specific terms are required for clarity. Furthermore, CMW is described as an experience perceived by the task performers due to incompatibility between available cognitive effort or resources to meet the cognitive demand during internal information processing, sorting, prioritising and reprocessing during daily activities, task performance or decision-making.

Van Acker et al. (2018) argue that the lack of an agreed conceptualisation makes operationally defining and measuring the phenomenon complicated. Measuring or quantifying CMW has been a subject of controversies and arguments for many decades (Longo et al., 2022; Van Acker et al., 2018). Three main modalities of measuring CMW are identified in the literature: self-report measures, objective measures and performance measures (Van Acker et al., 2018). Van Acker et al. (2018) affirm that despite multiple modalities for measuring CMW, none can be identified as a 'gold standard' comprehensive measure.

Internal information processing and concomitant CMW are implicit, intangible phenomena; therefore, the subjective experience can only be expressed by individuals who are experiencing it (Van

Acker et al., 2018). Additionally, the perception of CMW experiences varies with individual task performers based on their internal cognitive construct (Guastello et al., 2015), interaction between their environment and the characteristics as well as demand of the task (Van Acker et al., 2018). Therefore, subjective quantification of CMW may necessitate customised models for different types of work and work environments.

2.2 | Complexity of nursing work

Nurses' work has been described as turbulent (Jennings et al., 2022) and non-linear (Sitterding et al., 2012; Wolf et al., 2006). Wolf et al. (2006) reported that nurses constantly display cognitive stacking and cognitive shift during their work. Cognitive stacking is the list of tasks that a nurse must balance at any given time during patient care. These stacked tasks could be patient care-related or non-patient care-related responsibilities which may include constant monitoring, planning, prioritising, clinical judgement, clinical decision-making and providing emotional support to families as well as patients, all the while ignoring and concealing their own emotions. Nurses' focus constantly shifts from patient to patient, and task to task, depending on their patients' care needs and circumstances called cognitive shift. These complex cognitive activities demand and consumes extensive cognitive resources. Sitterding et al. (2012) reported on the extensive situational awareness demanded from nurses during patient care amidst multitasking, interruption, distractions and disturbances. Similarly, Jennings et al. (2022) describes the workflow of nurses as fragmented, intricate, chaotic and complicated with turbulence under time pressure posing high risk of near misses and adverse events.

Empirical evidence of emergency nurses' high CMW is reported in several studies (Bakhoum et al., 2021; Forsyth et al., 2018; Kim et al., 2019; Yuan et al., 2023). Forsyth et al. (2018) reported that emergency nurses experience an average of 85 interruptions in a shift and was concerned about the cognitive demand imposed on them. Kim et al. (2019) explored the effect of interruption on the mental workload of emergency nurses in simulation setting and found a statistically significant positive correlation. Whereas the time motion study by Bakhoum et al. (2021) pinpointed the effect of information technology on emergency nurses' cognitive workload experiences. The meta-analysis of 31 quantitative study including 16,189 nurses performed by Yuan et al. (2023) reported that mental workload experiences of nurses estimated using NASA TLX were documented to be high. The same study also informed that emergency nurses experienced the highest level of mental workload of all other specialist nurses.

2.3 | Justification for the scoping review

A preliminary search on 06th of June 2022, of research study registries such as PROSPERO, MEDLINE, Figshare, Open Science Framework and JBI evidence synthesis was conducted. There was no research into the measurement of the subjective cognitive mental workload of emergency nurses. Hence, the search was extended from subjective CMW quantification studies of 'emergency nurses' to 'nurses' in general. The approach of expanding the scoping review to all 'nurses' was with the intention that, broadening of search could yield greater results.

Currently, nurses' workloads are often measured based on objective measures like patient care needs, demands or number of patients under care. These measures do not reflect the actual workload, especially the mental workload perceived by nurses (Neill, 2006). Due to the implicit nature, only the task performer can express what they experience in the form of mental workload (Van Acker et al., 2018). According to Van Acker et al. (2018) strategies implemented based on arbitrary measures (i.e. patient care needs and patient numbers) cannot effectively optimise CMW experience of task performer in real life. Hence, Yuan et al. (2023) recommended further research attention in nurses' subjective quantification of mental workload. There is a systematic literature review on cognitive workload measures in health care settings in general (Kremer et al., 2022) and a meta-analysis on nurses' overall estimation of mental workload using the popular subjective scale, the Nasa Workload Index (NASA TLX) (Yuan et al., 2023). However, there is a gap in knowledge about subjective CMW measures, particularly for emergency nurses.

The objective of this scoping review was to explore and map firsthand web accessible research results of subjective CMW quantification measures in nursing profession. The aim was to identify subjective CMW scales, tools and self-reports currently used in the nursing profession giving main attention to emergency nurses.

3 | METHODOLOGY

3.1 | Design

This scoping review was conducted under the guidance of JBI methodology for evidence synthesis by following PRISMA extension for Scoping Reviews checklist (Aromataris & Munn, 2021). A priori protocol was developed and reviewed by stakeholders before registration in Open Science Framework registries, under the name *Subjective Measure of Cognitive Workload for Emergency nurses: Scoping Review Protocol* (https://doi.org/10.17605/OSF.IO/8MJ7Z). As there was no human or animal participation in this study, no formal ethical approval was sought to conduct this study.

The question that guided this review was: How is cognitive mental workload subjectively measured within the nursing profession? The sub-question was: What subjective measures of cognitive mental workload are currently used for emergency nurses? The main scoping review question can be elaborated based on PCC (Population, Concept and Context) approach and is illustrated along with the description in Table 1.

TABLE 1 Application of PCC approach in scoping review.

Research question: How is cognitive mental workload subjectively measured within the nursing profession?		
PCC- population, concept, context	**Description**	**Keywords**
Population: Nurse	Nurses are defined as those health professionals or clinicians providing direct patient care in hospital settings, who completed a generalised nursing education, meet registration requirements as a nurse and are authorised by the regulatory board of the country to practice nursing.	Nurse
Concept: Cognitive Mental workload	Cognitive mental workload is described as the experience perceived by nurses during patient care due to incompatibility between available cognitive effort or resources to meet the cognitive demand during internal information processing	Cognitive workload, Mental workload, Cognitive load
Context: Subjective measure or Self-report	Subjective measure is a scale or tool used to quantify and document a construct or a behaviour domain by the individual who experiences the phenomenon.	Self-report Subjective measure, Subjective scale

3.2 | Search methods

Parsimonious search strategy for this scoping review was decided in consultation with an expert health science librarian. The identified search strategies of all databases along with the search log in Excel was peer reviewed by an expert health science librarian. Peer review of electronic search strategy (PRESS) check list (McGowan et al., 2016), authenticated by *JBI Manual for Evidence Synthesis* (Aromataris & Munn, 2021) was adopted for this review process. The search strategy developed for PubMed is provided in Appendix 1. Databases including PubMed, CINAHL, ProQuest, Scopus, Science Direct, Web of Science and Google Scholar were searched for research reports for this scoping review. Search for grey literature in *e-theses online services* (*ETHOS*) and *Grey Literature Report database* did not yield any results. Other than keyword searches relevant scholarly reports were handpicked by reviewing titles in Google Scholar. The last database search and citations were retrieved on 30th September 2022. Study reports identified from the database search were entered and collated in EndNote X9. After removing the duplicate citations in Endnote X9, the remaining citations were uploaded to System for the Unified Management, Assessment and Review of Information (JBI SUMARI) for title and abstract screening as well as full-text screening.

The citations of retrieved studies were individually screened by two reviewers independently in JBI SUMARI at the Title and Abstract level. Conflicts were resolved by discussion with members of the research team. This was followed by full-text screening of studies based on the inclusion and exclusion tool in Table 2, which evolved during the screening process under discussion with stakeholders.

3.3 | Study selection

Web-published scholarly work on CMW of nurses who provide direct care to patients in hospital settings; in which a subjective self-report or scale or tool measured the CMW in real-life setting are included for this scoping review. The elaborate inclusion–exclusion criteria for study selection with the amendments from the published priori are provided in Table 2.

To widen the breadth of studies to meet the purpose of scoping review asserted by JBI Manual, we did not limit by year, language, study design, age of the participants, outcome and quality of the study. The cognitive load during work compared to any types of learning or study activity is entirely different. Hence, the only limit applied was to exclude CMW-related scholarly work during learning or studying. In terms of non-English studies, attempts were made to retrieve English translations of the reports with the help of expert librarians.

The term 'workload' was constantly used to represent the CMW or just physical workload or both in many screened reports. As the current scoping review is about the subjective measure of CMW, those studies pertinent to just physical workload of the nurses were excluded from the review. Whereas those studies in which cognitive or mental aspect of workload was the subject of the study, but described as just 'workload', were included in the scoping review. Yet it created confusion due to the vagueness in describing the phenomenon. Whenever there was confusion, the decisions on eligibility were made in consultation with stakeholders.

3.4 | Search outcome

A final total of 57 research reports or studies were included in this scoping review. The list of included studies is given in the supplementary document. The search process and outcome are diagrammatically represented in Figure 1 using PRISMA 2020 flow diagram for new systematic reviews (Page et al., 2021) and the description of the process is elaborated as follows.

The initial number of scholarly works retrieved for this evidence generation from various databases was 1373. Among the reports, 61 scholarly works were identified as thesis or dissertation. About 472 duplicates were removed using the automation tool embedded in the software, and 20 citations were removed manually. Titles

TABLE 2 Eligibility criteria for this study.

Category	Initial inclusion criteria	Initial exclusion criteria	Amendments from initial priory protocol, before full-text review
Population	Registered Nurses providing direct care to patients in hospital setting	Patients Healthcare professionals other than nurses like doctors, surgeons, physiotherapist, etc Non-healthcare professionals like pilots, sailors, etc Caregivers that do not qualify to be registered as a nurse. Nurses who are not providing direct care to patients Nursing students who are not yet registered as a nurse.	If the study is about clinicians and nurses are just a part of the population, such studies will be excluded. That is, studies that investigate only nurses' cognitive workload are included in this scoping review.
Concept	Cognitive mental workload experiences of nurses during direct patient care	Physical workload alone CMW experiences during learning and studying	Studies that investigate the cognitive workload of nurses during simulation or laboratory settings will be excluded from the study. That is, only real-life cognitive workload measure studies are included.
Context	Subjective cognitive or mental workload tools, scales or instruments that are used in nursing.	Objective measures, scales, instruments or tools of cognitive workload will be excluded. Primary and secondary measures of performance to assess cognitive workload will be excluded. Physiological measures to assess cognitive workload will also be excluded.	
Types of evidence source	The following evidence generations that is available in English or English translation is accessible in full text will be included in the study: Primary research: experimental, qualitative, quantitative and mixed method studies. Grey literature (Thesis and dissertations)	Conference reports, letters, individual case reports, text, opinion papers, Editorials, quality improvement projects, presentation abstracts, quality improvement project, brief reports, fully published quality improvement projects, policy position papers will not be included in this study. All non-English literature without an accessible abstract in English will not be included in the review in the area nurses' cognitive mental workload.	Only web-published scholarly work that meets the inclusion criteria, available in English or with web accessible English translation are included

and abstracts of 923 studies were entered in to JBI SUMARI for title and abstract screening. In this step, 181 studies were chosen for full-text retrieval while 742 records were excluded based on the inclusion–exclusion criteria. From 181 reports, full text of nine records were not available for download even with the help of expert librarians. Full text of retrieved 115 reports were excluded due to various reason. The reason for study report exclusion and the step are described in the PRISMA 2020 flow diagram. The final total of 57 studies were eligible for inclusion.

3.5 | Data extraction

Data extraction of 10 randomly selected research reports were performed by using the data extraction tool reported from the pre-published priori protocol of the scoping review. After consulting with the scoping review team further amendments were made. Headings included in the revised data extraction tools were aim of the study, number of participants, type of nurse participants, study site, construct studied, cognitive workload tools used in the study. Extracted data were entered into Excel sheet for analysis. Any divergence or confusion during the data extractions were discussed with the team and decisions were made based on consultation.

4 | RESULTS

The identified 57 reports of research studies pertaining to subjective CMW quantification were mapped according to the geographic location of the study, characteristics of the study, and the speciality of nurses' population based on area of work. Identified scales, tools and self-reports were collated and categorised to formulate a framework for clarity.

4.1 | Mapping of study reports by geographic location

The majority of studies, 56% ($n=32$) are from Asian countries, with studies from Iran topping the list ($n=32\%$). European studies and

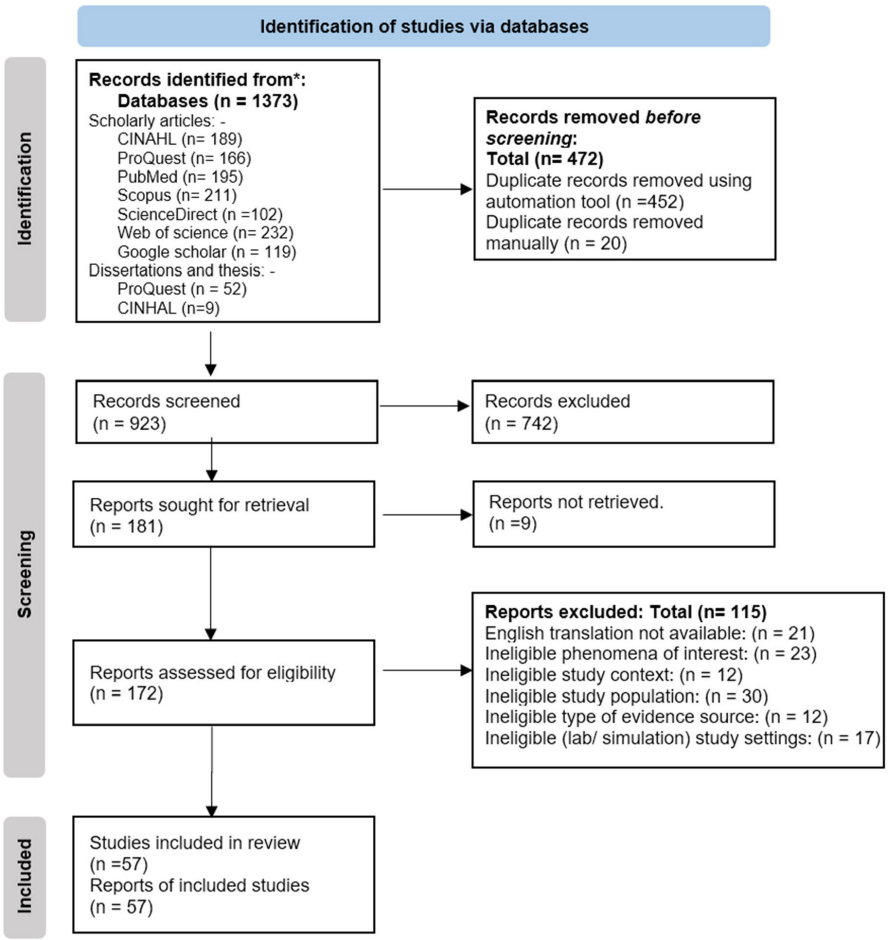


FIGURE 1 PRISMA flow diagram.

North American studies are only 5% (3 studies) each. The combined total of studies from United States of America ($n=19$) and Iran ($n=18$) contributed to 65% of the total selected studies. That is the maximum number of studies were from United States as shown in Graph 1.

The earliest documented report of research on nurses' subjective CMW was reported by Gregg (1993) from the United States. Since then, a gradual progression in knowledge contribution is evident from United States. A steady publication of reports was also noted in Indonesia since 2017. Table 3 shows that the first three studies from Iran were reported in 2015. Since then, an exponential growth in literature is noted. Most studies from China were reported during or after 2020. 51% ($n=29$) of the total included studies were reported from 2019 to 2022, September. All 57 studies were reported in the last three decades.

4.2 | Characteristics of the selected studies

Among the 57 included web-accessible research reports, only four thesis reports met the criteria for this study, while others were publications in journals. The majority of studies (72%) were cross-sectional in design. The next common type of study was longitudinal (12%) in which subjective workload scales were administered during work or immediately after the end of the workday. No study used qualitative methods for their research enquiry. Also, none of these studies used data from an existing daily self-report scale employed by nurses to document and communicate their experience of CMW during non-research settings. Few mixed method studies ($n=3$) and case studies ($n=3$) were also on the list of eligible studies. About 54% ($n=31$) of these studies were multisite studies and 46% ($n=26$) were single site studies. Additionally, there was no documentation of any of these studies conducted in rural or remote settings.

4.3 | Mapping of literature based on speciality of nurses (participants)

Most nurse participants included in the study are named based on the area of their work or speciality. For example, nurses working in intensive care units are called ICU nurses, and nurses in cardiac care units are called CCU nurses. Studies were conducted either on a population of nurses who work in same speciality (ICU nurses) or nurses from multiple specialities like ICU and ED nurses together. Additionally, study participants were addressed in the studies as just nurses where the speciality of the nurses was not specified.

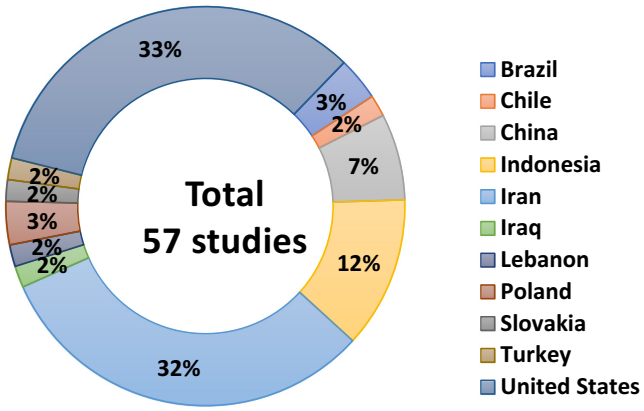
Studies with multi-speciality nurse populations contributed to 44% (25) of the total studies. Comparatively, many single speciality studies focused on ICU nurses (21%). In 32% of included studies, ICU nurses were either recognised as a part of a group studied or are

individually studied. Only two studies, Forsyth et al. (2018), Barzani and Dal Yilmaz (2022) had emergency nurses as study participants. In another three studies, emergency nurses were included as a part of the study population. Thus only 9% of the studies where related to or about emergency nurses. Most of the emergency nurse-related studies (4 out of 5 studies) were reported in 2019 or after.

Overall population of nurses irrespective of their specialities, studied in all 57 research, cumulated to 14,103 nurses. The total number of ICU nurses studied are 8182, which is about 58% of the total population of nurses studied in this review. While the total number of emergency nurses studied cumulated to 162, which is 1.1% of the total population of nurses in 57 studies.

4.4 | Mapping of subjective cognitive mental workload scales used in nursing

NASA workload index (NASA TLX) was adopted by 34 out of 57 studies included in this scoping review. NASA TLX was developed to measure the subjective workload of pilots after extensive simulation-based research by Hart and Staveland (1988). Similar scales, tools or instruments that were developed in non-healthcare industries, are denoted as General scales in this scoping review.



GRAPH 1 Web publications of scholarly reports from various countries.

The subjective Workload Assessment Technique (SWAT) was another general scale created by Reid and Nygren (1988) that was used by Lebet et al. (2021) and Holden et al. (2011) to study CMW in nurses. The Meister Questionnaire was used by Polish researchers in nursing (Debska et al., 2017). Rating Scale Mental Effort (RSME) of Zijlstra and Van Doorn (1985) was employed only in two included studies to measure the CMW experience of nurses. Mental Workload Subjective Scale, called ESCAM, a 20-item scale in Spanish was used by Ceballos-Vasquez et al. (2015), to study the mental workload of ICU nurses. Lastly, certain studies included own questionnaires developed during their own study (Li, 2009) or from previous research (Holden et al., 2015) to measure the subjective workload of nurses. These questionnaires cannot be classified under scales, but the purpose of those items was to measure CMW and was included in this study.

During the review, it was also evident that the general scales for measuring CMW were modified for specific needs (Wilson et al., 2011) or adapted to different languages or cultures (Widyanti et al., 2013). Psychometrically validated, multiple versions of NASA TLX were identified in this scoping review. NASA TLX in Turkish (Sönmez et al., 2016), Persian (Habibi et al., 2015), Chinese (Shan et al., 2021) and Farsi (Nasirizad Moghadam et al., 2021) measured the nurses' perception of CMW in the included studies. Other than language translations, NASA TLX were also modified by omission or addition of subscales to meet the requirement of individual research. For example, Forsyth et al. (2018) studied workload of emergency nurses, using Surgery Task Load Index (SURG-TLX). SURG TLX is an amendment of NASA TLX by Wilson et al. (2011) to measure surgeons' cognitive workload. Gregg (1993) revised NASA TLX to quantify the CMW of cardiac care unit (CCU), cardiovascular-intensive care nurses (CV-ICU) called Nursing Task Load Index (NTLI). NTLI was

TABLE 3 Yearly web publications from various countries.

	1993	2006	2009	2011	2015	2016	2017	2018	2019	2020	2021	2022	Grand Total
Brazil							1					1	2
Chile					1								1
China										1	2	1	4
Indonesia							1	1	2	2		1	7
Iran					3	2	1	2	3	1	5	1	18
Iraq												1	1
Lebanon												1	1
Poland							1		1				2
Slovakia					1								1
Turkey							1						1
United States	1	1	1	2	3		1	4	3		2	1	19
Grand total	1	1	1	2	8	2	6	7	9	4	9	7	57

the first cited scale modified specifically for nurses and was the first study that measured the subjective CMW of nurses. Cumulatively, 77% of the total studies (37 NASA TLX and 10 variations of NASA TLX studies) in this review were performed by NASA TLX or a form of NASA TLX.

Utilisation of other general scale modifications was also documented in literature. Huggins and Claudio (2018) applied Continuous-Subjective Workload Assessment Technique (C-SWAT), a variation of SWAT proposed by Luximon and Goonetilleke (2001). Zhang et al. (2020) whereas modified and measured the psychometric properties of Chinese version of Leppink et al. (2013)'s measuring different types of cognitive load (MDT- CL) scale among 222 ICU nurses.

Subjective workload assessment for nurses (SWAN) was the only scale that was specifically developed to measure the CMW of nurses, specifically, medical–surgical nurses. The scale was proposed by Neill (2006) in a web-published thesis report. Later, Neill and Davis (2015) psychometrically validated SWAN in another study among 188 medical–surgical nurses.

Complexity Assessment and Monitoring to Ensure Optimal Outcomes (CAMEO) II & III acuity tools for paediatric intensive care unit (PICU) nurses were designed by Connor et al. (2022). The scale is a patient acuity scale, but it claims to measure 'the cognitive workload complexity' of nurses while CAMEO II claims to measure 'nursing cognitive workload' (Connor et al., 2022, p. 146). For comprehensiveness, the research report was included due to the claim of measuring nurses' cognitive workload.

4.5 | Mapping of daily CMW self-report scale

In most of the studies, the CMW scales are part of a survey rather than a daily self-report scale. Only 22% of included studies, used a subjective CMW scales as a daily self-report to inform CMW experiences during or after work for their research. In two longitudinal studies done by Tubbs-Cooley et al. (2018; 2019), the data of subjective workload of nurses were collected through a self-report tool completed at the end of every shift during the study period. While Dhaini et al. (2022) collected data through a small survey tool with embedded NASA TLX at the end of every shift for 90 days. Connor et al. (2022) report the incorporation of CAMEO II in the existing hospital health record system to facilitate self-report during each shift; to calculate patient acuity by measuring nurses' work complexity. In a nutshell, none of the scales in included studies is used by nurses in daily practice for self-reporting of their CMW experiences.

5 | DISCUSSION

The scoping review of 57 scholarly reports revealed valuable information of the current subjective CMW measures utilised in nursing. Most popular CMW scale was NASA TLX. Two scales were modified or developed specifically for specialist nurses but did not gain popularity both in practice and in research. It is also clear that, there is rarely any daily self-report system for measuring, communicating and documenting nurses' CMW experiences. The findings of this scoping review are summarised in Table 4, using the PAGER (Patterns, Advances, Gaps, Evidence for practice and Research recommendations) framework posited by Bradbury-Jones et al. (2022) along with a detailed discussion.

Comparatively, the large number of studies in nurse's CMW quantification from United States could be explained based on major technological advancements for safe healthcare delivery. Other than a few countries of Asia and North America, a general scarcity of literature is evident in the field of nurses' subjective quantification of CMW. Although we are unsure about the reason for the visible research interest in Iranian nurses' CMW, a pattern was noted during this scoping review. More than 50% of total studies from Iran were performed in collaboration or by the department of occupational health engineers. Their research interest in the area does not seem to be an incidental effect of the pandemic as their initial studies were published in 2015 (Habibi et al., 2015; Mirzaei et al., 2015). However, the recent pandemic has clearly accelerated the research activities of the group of scientists.

Proliferation in literature or the sudden global research attention towards the welfare of nurses due to COVID-19 pandemic was explicit during the scoping review. The tendency is apparent from the research studies reported from China during the period of the COVID pandemic (Shan et al., 2021; Zhang et al., 2020). This visible research interest in nurses could be a natural reaction to the intense media attention received by nurses during the pandemic or could be a genuine interest in nurses' welfare. Though the reason is not clear, undoubtedly there is an intense need for further research in all settings and arenas of nurses' CMW to ensure the welfare of nurses and to sustain safe/ quality healthcare delivery in the midst of alarming global nurses' shortage.

The results of this scoping review prove that emergency nurses' CMW experiences are comparatively less studied. The Meta-analytical study by Yuan et al. (2023) established that emergency nurses experience the highest CMW levels than all other nursing specialities. Although CMW is highlighted as the major causative factor for healthcare-related errors (Wolf et al., 2006) and emergency department being infamous for the highest nursing error rates (Abbaszadeh et al., 2021), the findings of this scoping review and meta-analytical review by Yuan et al. (2023) substantiates the scarcity of research in emergency nurses' CMW. Hence, further knowledge generation in the field of emergency nurses' CMW is necessary to ensure safe and quality health care.

5.1 | Utilisation of subjective workload scales and the concept of workload

Literature asserts that CMW is a complex, multidimensional phenomenon that is confusing in definition and nomenclature (Longo et al., 2022; Van Acker et al., 2018). Similarly, vagueness noted in

TABLE 4 Summary of the scoping review findings.

Pattern	Advances	Gaps	Evidence for practice	Research recommendations
NASA TLX and its variations were the most popular scale in nursing research. ICU nurses was the most studied group of nurses. Confusion on the definition of CMW and application of various scales was evident in literature. Two scales, NTLI and SWAN are the only nurse-specific scales but did not receive popularity. The CMW scales are confined to nurses' research and did not reach practice.	The growing body of nursing literature in CMW quantification could be an indication of interest development in safe and quality health care, by shifting focus by alleviating the cause of human error rather than treating the aftermath of error. The proliferation of research in subjective CMW of nurses in the last 5 years indicates a gradual boost of interest in nurses' welfare.	Limited subjective CMW quantification studies of emergency nurses than ICU nurses. General dearth of CMW subjective quantification in all specialisations of nursing No customised CMW scales for emergency nurses and all other nurses, except medical-surgical nurses and CCU and CV-ICU nurses There is no daily self-report scale for nurses to measure, document and report their day-to-day experiences of CMW. No research from rural and remote settings on CMW experiences of nurses. Lack of qualitative enquiries in subjective CMW measurements and self-reports.	The proposed framework of identified CMW scales could form a point of reference for researchers and practitioners to choose the appropriate scales for daily reporting and measuring of their CMW experiences. Reduce the gap between research and practice by encouraging the use of scale in practice to measure the CMW of clinicians. The result of the study could encourage further practice-based enquiries to measure the CMW experiences and encourage the development of optimisation strategies to reduce unintentional patient harm and nurses' burnout due to CMW.	Creation of new customised psychometrically validated scales for various specialities of nurses, to understand the depth of their experiences and curb the issue of CMW for establishing safe quality health care and to ensure work–life well-being. Develop self-report scales for nurses to subjectively measure, document and communicate their cognitive mental workload experiences. More qualitative research is necessary to understand the depth of CMW experiences of nurses in various specialties of nursing and settings such as urban, rural and remote.

the included study regarding the conceptualisation of CMW and the domain that the chosen scale was targeted to measure. When Hart and Staveland (1988) introduced NASA TLX, the scale was introduced as a modality to measure workload as a whole. In their study, the term 'workload' was used to describe the overall construct of both physical and cognitive aspect of workload. After all, the two sides of the workload are inextricably linked. This is evident from Hart and Staveland's (1988), p. 140) description of workload as 'the cost incurred by a human operator to achieve a particular level of performance'. When Reid and Nygren (1988) proposed the scale, 'Subjective Workload Assessment Technique' (SWAT), the target construct for measurement was mentioned as 'mental workload'. That is, the scale was developed to measure 'mental workload', but the name of the scale says 'workload'. On the other hand, Reid and Nygren (1988) clarify that the term 'workload' meant only manual or physical labour for decades. Similar elusiveness of the concept of CMW in the literature may have created confusion among researchers, and it was reflected in the scholarly works during this scoping review.

Forsyth et al. (2018) administered SURG TLX, a variation of NASA TLX to collect data on the subjective workload of emergency nurses during interruption. The term used in their published report was 'workload'. Their report does not clarify if the term workload represents the comprehensive domain like Hart and Staveland (1988) or does it represent only the physical aspect of workload. The use of an objective workload tool in the same study to measure the cognitive performance of participants provided the indirect clue that the term 'workload' represented the overall workload. Meanwhile, Nasirizad Moghadam et al. (2021) used NASA TLX to measure specifically the construct, mental workload in their study. In the same study, another scale, Nursing Activity score was used to measure the physical workload separately. That means, although NASA TLX was used in this study, both physical workload and mental workload was treated as a separate entity. Hoogendoorn et al. (2021) whereas used NASA TLX to measure the perceived physical workload of ICU nurses and hence had to exclude from this review. In summary, NASA's TLX was used to measure various aspects of workload that might have been raised as a result of the confusion created by the conceptualisation of the CMW.

5.2 | Subjective cognitive mental workload scales in nursing

Scales detected from 57 studies, can be classified into five categories based on their origin and modifications. The findings are illustrated in a framework as shown in Figure 2. The five identified categories are listed as follows: 1. General scales; 2. Modifications of general scales; 3. General scales adapted to health care settings; 4. General scales adapted to nursing profession; 5. Specialised scales developed for specialist nurses.

Five general scales along with their multiple variations and a nurse specialised scale was identified in this scoping review. It is

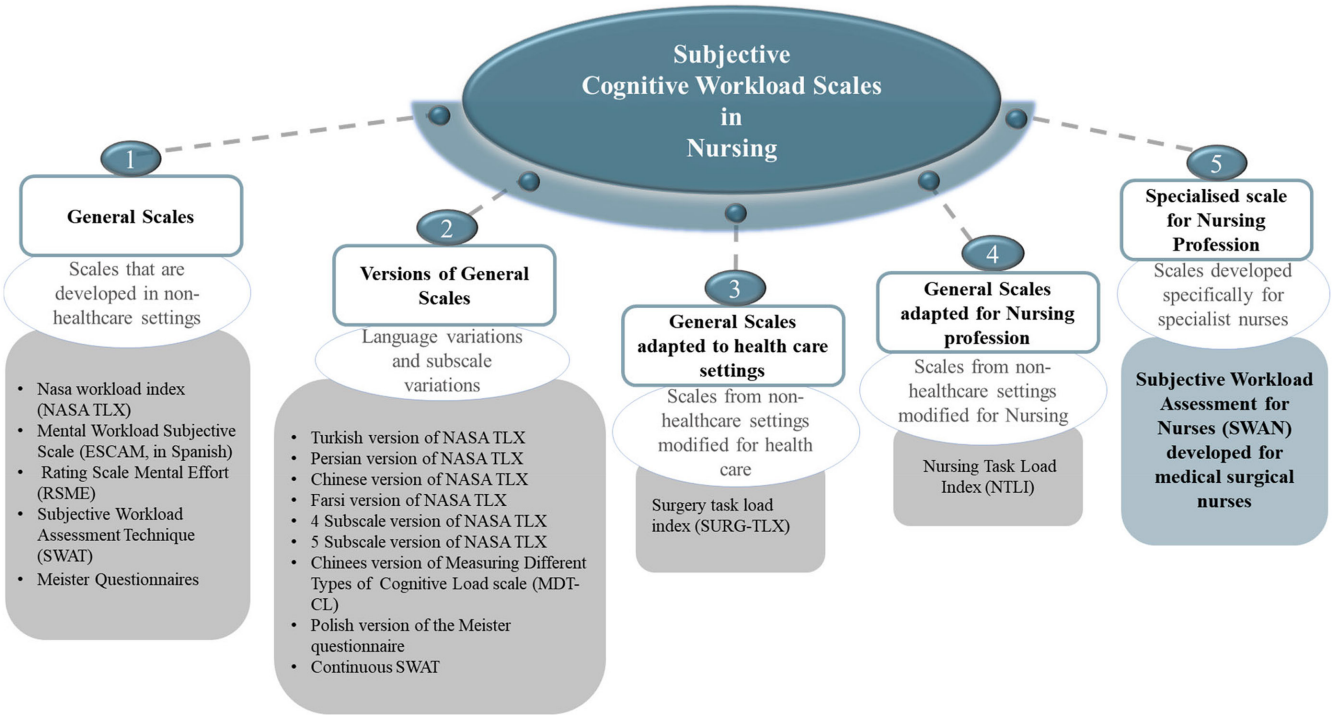


FIGURE 2 Current subjective cognitive mental workload scales in the nursing profession.

clear that, NASA TLX and its variations are the most popular subjective CMW scales in nursing-related research. This is consistent with the finding of Yuan et al. (2023). The metanalysis of Yuan et al. (2023) recovered 17 studies that used NASA TLX for measuring mental workload of nurses. The popularity of NASA TLX among researchers for measuring CMW of nurses could be due to the easy accessibility and the proven psychometric validity in multiple research settings.

The lack of popularity of nurse-specific subjective CMW scales can be confirmed by the fact that none of the studies in this scoping review used the scales. Gregg (1993) customised the NASA TLX for CCU and CV-ICU nurses and developed NTLI, the first customised scale in nursing profession. This research activity was recovered from a web published thesis. Similarly, the only nurse-specific scale, SWAN developed by Neill (2006) was discovered in a web-published thesis. Documentation of SWAN and NTLI was only in web-published thesis could be the reason why the scales never gained popularity. SWAN was psychometrically validated later and published in a peer-reviewed journal (Neill & Davis, 2015). Even after the psychometric validation in 2016, SWAN did not receive visible research and practitioner attention. The reason for this lack of popularity could be due to unawareness about the existence of these customised scales or the obliviousness of the benefits of using customised scales to measure CMW experiences specific to nursing specialities. Like the unpopularity of nurses' specific CMW scale, lack of interest in developing new specific scale for specialist nurses is uncertain. At the same time, there could be other scales that exist in unpublished scholarly activities, but it is inaccessible for use in daily practice and research. In short, there is a shortage of accessible customised CMW scales, especially for emergency nurses.

Connor et al. (2022) meanwhile, claims CAMEO II as cognitive workload scale to measure the cognitive workload and CAMEO III to measure the cognitive workload complexity for PICU nurses. It seems like both scales measure patient acuity, operationalised through measuring nursing work complexity during patient care. Hence, it cannot be included under the subjective CMW scale list for nurses.

5.3 | Daily self-report of nurses' CMW experiences

Other than CAMEO scales none of the identified scales were used as a self-report scale in nurses' practice. Even though it is an acuity report, there is empirical evidence that the scales assisted nurse leaders in staffing projections (Connor et al., 2022).

Similarly, CMW self-report scales for nurses specifically developed for each speciality area could generate valuable information regarding their CMW experiences. Van Acker et al. (2018) state that implementation of CMW optimisation strategies can be hindered in the absence of an appropriate scale to measure the phenomenon. In this scoping review, none of the scholarly works provides empirical evidence of a scale being used by nurses to report their daily CMW experiences after or during their work. Scales identified in this scoping review were mostly incorporated into a survey or daily reports collected only during research. Despite the awareness of CMW-related sequalae to nurses and patients, none of the studies testified to the existence of a daily self-report for nurses to measure,

document and communicate their daily CMW experiences during or after work. If there are no such reporting system of CMW for nurses, then a major question arises against the current quantification methods of nurses' CMW and the credibility of current CMW optimisation strategies for nurses.

5.4 | Limitations

Although all attempts were made to ensure the comprehensiveness of this evidence generation, there are multiple limitations to this study. Being a mapping study, quality assessment of the study report is beyond the scope of this study and is not recommended by JBI evidence synthesis principles. Similarly, the peer-review status of all included studies cannot be established. That is, as the aim of this study was to map all the research activities, studies were included without reviewing the quality or peer-review status. Another limitation of this scoping review is that it could not include various research works that are unpublished, not listed in the searched databases or may not have an accessible English translation. Therefore, the results of the scoping review may have to be read with caution.

6 | CONTRIBUTION TO FUTURE

Through this work we provide a mapping of literature on the contemporary subjective CMW measures in nursing. Our scoping review succeeded in developing a framework of all currently used scales for subjective quantification of the construct in nursing profession. This framework will form a point of reference for future researchers, practitioners and policy makers to use and further develop measure to optimise CMW of nurses and other clinicians. Additionally, the study illuminated the gaps in literature to promote future research.

7 | CONCLUSION

Nurses' high CMW experiences constitute unintentional patient harm due to human error and can compromise their well-being resulting in burnout and high turnover. Therefore, understanding the current modalities to measure nurses' CMW experiences, mapping the literature in the area of interest and illuminating the gap in knowledge was essential for future healthcare planning. The scoping review succeeded in mapping the available literature and identified the scale adopted by nursing profession for subjective quantification of cognitive mental workload. The identified scales were collated and categorised to form a framework for future reference. The increasing number of research in the arena is encouraging but there are multiple gaps in the literature that were discussed in this scoping review. Shortage of customised subjective scales for many specialities nurse, especially emergency nurses, and lack of a self-report tool among 57 studies included in this scoping review was an alarming finding. Optimisation of cognitive mental workload of nurses based on sound measures is essential for a sustainable health care. Therefore, further research in subjective cognitive mental workload quantification and development of customised scales of nurses in various specialities is essential.

AUTHOR CONTRIBUTIONS

AS: Conceptualisation; project administration; article screening; formal analysis; visualisation; manuscript original drafting. LB: Supervision; manuscript review and editing. SR: Article screening; supervision and manuscript review. PM: Supervision; manuscript review and editing. All authors read and approved the final draft that was submitted for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

All data created or scrutinised in this study are included in this study or available as supplementary documents.

ETHICS STATEMENT

As there was no human or animal participation in this study, no formal ethical approval was sought to conduct this study.

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APPENDIX 1

Search Strategy for PubMed Database

(Nurs* OR ("nurses"[MeSH Terms]) OR ("Nursing Staff, Hospital"[Mesh]))
AND
("cognitive workload" OR "Mental workload" OR "mental pressure" OR "task load" OR "Cognitive pressure" OR "mental pressure" OR "cognitive pressure" OR(("Cognition"[Mesh]) AND ("Workload"[Mesh])))
NOT
(Learn*)

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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