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Measuring Duration of Kangaroo Mother Care for Neonates: A Scoping Review

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Key words:

Kangaroo mother care, low birthweight, neonatal, prematurity

Abstract

Background: Kangaroo mother care (KMC) is an evidence-based intervention to improve neonatal survival. Optimal duration of skin-to-skin contact is unclear partly because accuracy of duration measurement methods has not been rigorously evaluated. We conducted a scoping review of KMC skin-to-skin contact duration measurement methods, also assessing if validitationwas undertaken.

Methods: We searched MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus, International Standard Randomised Controlled Trial Number Registry, Medrxiv, and OpenGrey. Publications with primary data on KMC duration were included. We excluded short procedural skin-to-skin care studies.

Results: A total of 213 publications were included, of which 54 (25%) documented a method of measuring KMC duration. Only 20 publications (9%) provided a detailed description of the duration measurement method, and none reported validity. Most studies used caregiver reports (29, 54%) or healthcare worker observations (17, 31%). Other methods included independent observers and electronic monitoring devices.

Conclusion: Only 9% of KMC studies reporting duration documented the measurement method applied and no studies were found with documented validation of duration measurement methods. Accurate and comparable data on the dose response of KMC will require duration measurement methods to be validated against a gold standard such as an independent observer.

Key notes

- KMC is high-impact for survival of low birthweight neonates, but there are few rigorous evaluations of duration required for impact. Reliable data on the dose response of KMC depends on the reliability of assessing KMC duration.
- This scoping review found most of the 213 studies mentioning KMC duration (159, 75%) did not describe the methods used, and those that did were mainly reliant on maternal report (29, 54%) or health worker report (17, 31%), both of which have limitations in accuracy.
- To increase comparability and rigour of measuring KMC duration, accuracy is needed in measurement methods and hence a validation study of gold standard (independent observer) versus maternal report and healthcare worker report would be of value.

Introduction

Globally, an estimated 2.3 million neonatal deaths occurred in 2021 (1). More than 80% of neonatal deaths occur in babies who are low birthweight [LBW, ≤2500 grams (g)], due to being born preterm, small-for-gestational age, or both (2). Major mortality reductions could be achieved by improving facility-based care of small and sick neonates in low- and middle-income countries (LMIC) (2-4). Kangaroo mother care (KMC) as a component of this small and sick newborn care is associated with decreased mortality, sepsis, hypothermia, hypoglycaemia, and length of hospital stay compared to conventional incubator care among clinically stable newborns (5, 6). A WHO-led trial recently reported a 25% reduction in mortality within 28 days among babies born weighing 1000-1799 g who received KMC immediately after birth, relative to those who received standard care with KMC after stabilisation (7). Hence, the WHO has released updated guidelines recommending KMC for all LBW newborns, even prior to stabilisation (8).

KMC is a package including early, continuous, and prolonged skin-to-skin contact (SSC), usually with the mother; promotion of exclusive breastmilk feeding; early hospital discharge; and adequate support and close follow-up at home (9). Duration of KMC is considered important in achieving beneficial health outcomes (10). However, previous research has suggested that continuous KMC for 24 hours a day may be difficult to achieve; for example, women may have complications or be post-caesarean section or find long hours challenging due to incompatibility with household activities or trying to sleep while continuing KMC (11). Clinicians and administrators need to make changes in infrastructure (e.g., showers, toilets) and enable other family members to share in KMC (8).

Higher duration of KMC in a given 24-hour period has been demonstrated using descriptive data to be associated with lower mortality risk (12). However, the evidence base on the recommended frequency and duration of KMC for neonatal survival requires more rigorous evaluation [9, 15]. Dose-response studies could inform families and clinicians to optimize outcomes and be more efficient for inputs. Such studies require objective and accurate methods of measuring the duration of KMC.

The aim of this scoping review was therefore to explore available evidence on differing methodologies of measuring KMC duration. Specific objectives were to: 1) develop a framework for categorisation of measurement methods identified in the published and grey literature; 2) abstract and assess studies with KMC duration data to describe the measurement methods used; and 3) describe any studies identified which validated duration measurement methods.

Methodology

Study design

We conducted a scoping review of the published and grey literature in accordance with established guidance for conducting scoping review from the Joanna Briggs Institute (13). The review protocol was registered with Open Science Framework (14). Selection of relevant papers, screening, and data charting were conducted by two independent reviewers (VST, EML) to minimise selection bias.

Search strategy

We searched the MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus, and Latin American and Caribbean Health Sciences Literature databases, as well as the WHO International Clinical Trials Registry Platform and the International Standard Randomised Controlled Trial Number Registry. We also searched Medrxiv and OpenGrey libraries for relevant unpublished studies. We screened all references of relevant systematic reviews identified as well as the websites of the Kangaroo Foundation and the International Network of Kangaroo Care. WHO guidelines and Google Scholar were searched for relevant publications. Searches were last updated on 21 November 2022 and were limited to the English language but not to the date of publication. Search terms were based on those relating to KMC and LBW/prematurity as well as KMC measurement/monitoring. The search was conducted with assistance of a library clinical research specialist at the British Medical Association.

Management of search results

The search results were exported as RSI files to the Mendeley reference management system (© 2009-2013, Mendeley Ltd.). Duplication removal as well as title and abstract screening were done using Mendeley. The search results were shared with the second reviewer through a Mendeley group. Retrieved publications from the search were screened for suitability and relevance based on the information in the titles and abstracts. Initially a randomly selected trial set of search results (10% of total number) were screened for inclusion based on title and abstract information by both reviewers and, where necessary, clarifications/adjustments to the inclusion criteria were made, aiming for an agreement rate of >80%. A third reviewer was consulted in cases of disagreement (CJT). Full text articles were screened by two reviewers for inclusion and data charting. An initial pilot set was screened by both reviewers to assess agreement rates before sharing the analysis of the bulk of included full text articles.

Eligibility Criteria

Publications were included if they presented primary data on KMC among preterm or LBW newborns and referred to duration of the skin-to-skin component of KMC or KMC monitoring/measurement. Publications referring to short procedural skin-to-skin care, such as for routine postnatal care or pain control, and with no ongoing KMC were excluded.

Data abstraction

We generated a data charting form by identifying variables that would inform the objectives of the scoping review. Data points of interest included KMC duration, methods used to measure the duration and the validation of the method used. Detailed methodological description was defined

as a study that explained the tools used to document KMC duration measurement, the interval of the observations and how the total or daily KMC duration was calculated from the observations.

Results

Our search strategy identified 3542 publications, of which 213 presented primary data on duration of KMC. Only 54 (25%) of 213 publications stated the method used to measure KMC duration (Figure 1). More than half of these publications (109, 51%) were clinical trials and the majority were carried out in LMIC settings (139, 65%). Nearly two-thirds (135, 63%) had a sample size of >50 participants and just under half reported on KMC duration of more than 2 hours (102, 48%).

Of the 54 publications that described methods used to measure the duration of KMC, four different methodological categories were identified: caregiver report, healthcare worker report, independent observation, and electronic monitoring device. A method was identified as a healthcare worker report if a person involved in the routine care of study participants reported on KMC duration, and as an independent observation if the person reporting on duration was not involved in the routine care of study participants. Some studies used more than one method, and caregiver reports were either self-reported or based on KMC charts/diaries.

No existing framework for categorisation of the methods used to measure KMC duration was found in the reviewed publications, nor was any basis for the choice of the method used provided. Figure 2 illustrates our proposed framework for the categorisation of KMC measurement methods.

Most of the publications that documented the method used to measure KMC duration used caregiver reports (n=29, 54%) followed by healthcare worker report (n=17, 32%). Other methods included independent observation, a combination of healthcare worker and caregiver report, and a combination of electronic device, healthcare worker, and caregiver monitoring (Figure 1).

Nine (31%) of the 29 publications that used caregiver report described the method used to measure KMC duration. Seven of these 9 publications utilised KMC charts/diaries to report the duration of SSC (15-21), while the remaining 2 mentioned self-report without indicating if documentation was done (22, 23). Four publications (24-27) used more than one method of measuring KMC duration. Of these, 3 (24-26) compared caregiver report with healthcare worker report and one (27) used healthcare worker report and an electronic monitoring device. In the latter study, the device was used in the home setting in combination with caregiver report to evaluate whether it could reliably capture the duration of KMC episodes (27).

Three publications used independent observers (28-30) who were not part of the healthcare team. No publication used video recording to monitor KMC duration although video was used to assess other aspects of SSC, such as mother-baby interaction (Figure 2).

Only 20 (9%) publications (15-25, 27-35) with primary data on KMC duration described the measurement method used (Figure 1), and this was in varying degrees of detail (Table 1). Of these 20 publications, 11 (55%) were from LMICs (15, 22, 23, 27-34) and 9 (45%) were from high-income countries (16-21, 24, 25, 35). Nine (45%) of these publications used caregiver report (Figure 1), of which 7 documented the tool used for monitoring KMC duration (charts) (15-21) and 2 mentioned self-report (Table 1) (22, 23). The majority (64%) of the publications that used caregiver report were conducted in high-income countries (16-21), all of which documented the interval of observations. None of the publications gave a description of how the total or daily KMC duration was computed from the reports/observations (table 1).

Three of the 4 publications that used healthcare worker report were conducted in LMICs (32-34). Only 1 of these 4 documented the tool used for monitoring (33), 3 documented the interval of observations (33-35), and 1 described how the daily KMC duration was calculated (34).

The 3 publications that combined caregiver and healthcare worker report documented the tool used to measure KMC duration (24-26), but only 2 documented the interval of observations, and none explained how the daily duration was computed (25, 31). The publication that used a combination of an electronic device, healthcare worker report, and caregiver report documented the interval of monitoring KMC duration but did not document the tool used or how the daily duration was computed(27). The publications that used independent observers documented the interval of observations and described how the daily KMC duration was computed (28-30).

None of the publications with primary KMC duration data validated the method used to measure KMC duration. Only 1 publication measured the accuracy of a new device used to monitor SSC compared to healthcare worker report and caregiver report (27). Direct observation by healthcare workers was used as the reference standard against which an electronic monitoring device was compared for the purposes of accuracy; however, no systematic validation was conducted. Maternal report was used to test the reliability of the electronic device to capture the duration of

KMC at home. Four additional publications verified the consistency of measurements but did not undertake systematic validation (20, 24, 25, 33).

Discussion

In this scoping review, we found 213 publications on KMC of which 54 (25%) documented a method for measuring duration. Only 20 (9%) publications provided a detailed description of the KMC duration measurement method, and none reported validity. Most studies with a detailed description used caregiver report (9, 45%) or healthcare worker report (4, 20%). No framework for categorisation of KMC duration measurement methods was identified, and there was a lack of justification for the choice of method used for individual publications.

The observation that most studies did not document methods used to assess KMC duration is in accord with a previous systematic review, which found that more than 85% of studies did not include data on observations of SSC practice, and that 45% lacked a description of SSC initiation and stopping criteria (36).

The lack of reliable measurement for the intervention dose (KMC duration) is an impediment to interpreting the evidence when meta-analyses that combine studies with different KMC measurement methods are used (37, 38). Hence, although it is plausible that higher KMC duration could improve neonatal health outcomes (39, 40), the evidence remains incomplete without more rigorously validated methods for measuring the dose of KMC. The only study that validated KMC measurement reported duration but did not validate the methods used to measure duration (29). This calls for studies to validate KMC duration measurement methods against a gold standard to enable accurate data on KMC duration as an exposure, compared to outcomes such as mortality and morbidity.

Our new framework for categorising KMC duration measurement methods could be helpful for future studies to report on methods used – essentially these are mainly caregiver report and healthcare worker report, both of which have challenges. Similarly, there is limited information on the recommended duration of SSC for LBW neonates and standardised operational definitions could improve this evidence base (36). In addition, this framework could help in guiding the selection and refining of indicators in routine information systems for assessing KMC duration as a marker for the quality of KMC (41). Chan and others have proposed indicators in the KMC measurement framework to include the duration of SSC (36, 41), and the proposed framework for KMC duration measurement in this review will be helpful for the measurement of this indicator.

This scoping review is the first to assess the description and validation of KMC duration measurement methods. Selection and data abstraction were conducted by two independent reviewers to minimise the risk of selection bias. We excluded 5 publications for which no English version was available; however, this is unlikely to change our overall findings. We did not review journal supplementary materials for the included publications, which might have additional information on the methodology such as validation.

Conclusion

KMC is a high impact intervention for survival of LBW neonates, but there is limited rigorous evaluation on the duration required. Reliable data on the dose response of KMC depends on the reliability of assessing its duration. This scoping review found most studies of KMC duration (91%) did not describe the methods used, and those that did were mainly reliant on caregiver report or healthcare worker report, both of which have limitations. Clarity is needed in reporting KMC duration measurement methods to increase comparability and rigour, and a validation study of gold standard versus caregiver report and healthcare worker report would be of value.

Conflict of interest

The authors have no conflict of interest declare.

Authors' contributions

VST conceptualised the study, wrote the protocol, analysed and interpreted the data, and wrote the first draft of the manuscript. VST, EML, and CJT selected the publications and abstracted the data. MMM, CJT, MN, and JEL interpreted the data and critically revised the manuscript. All authors reviewed the manuscript and approved the final version.

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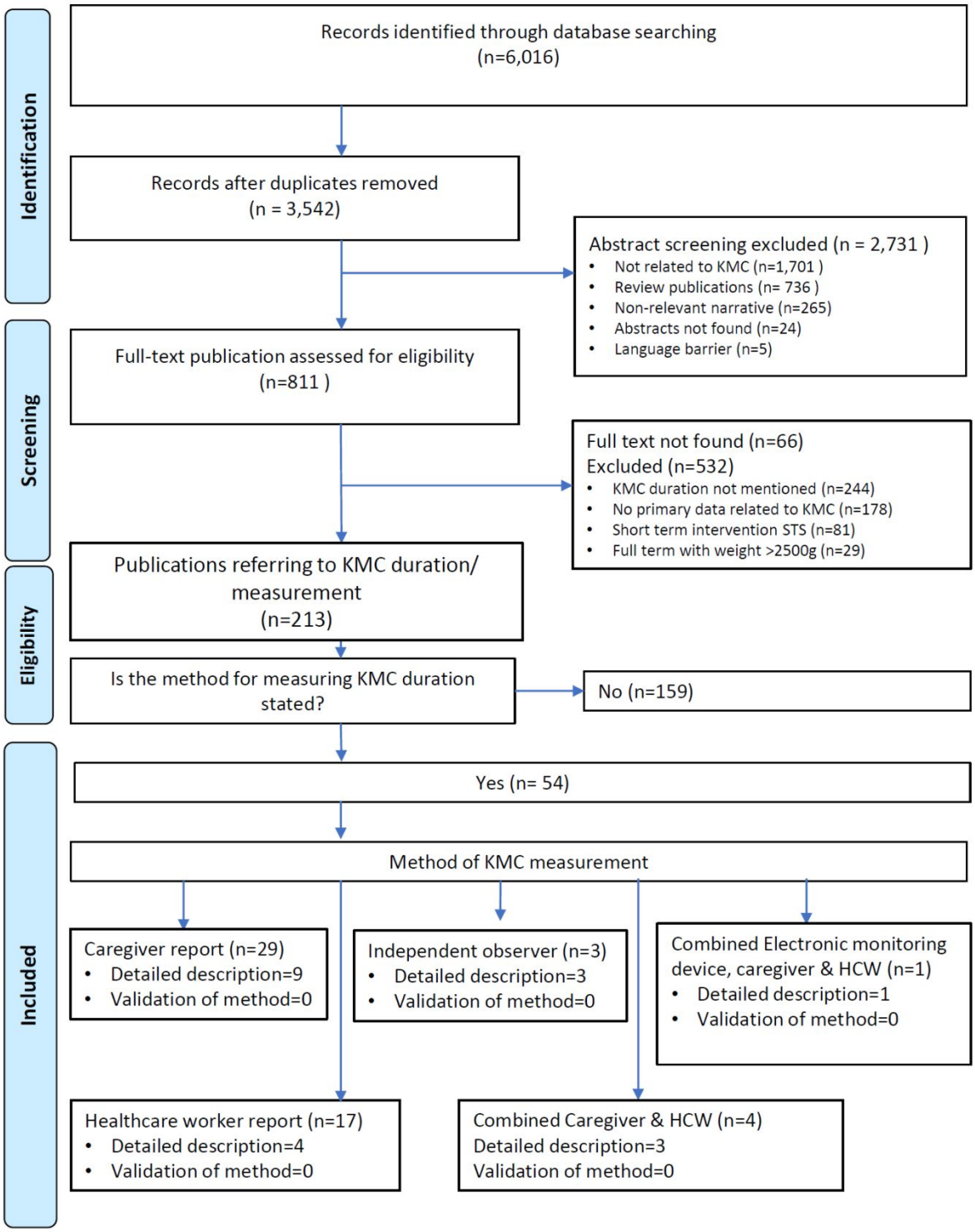
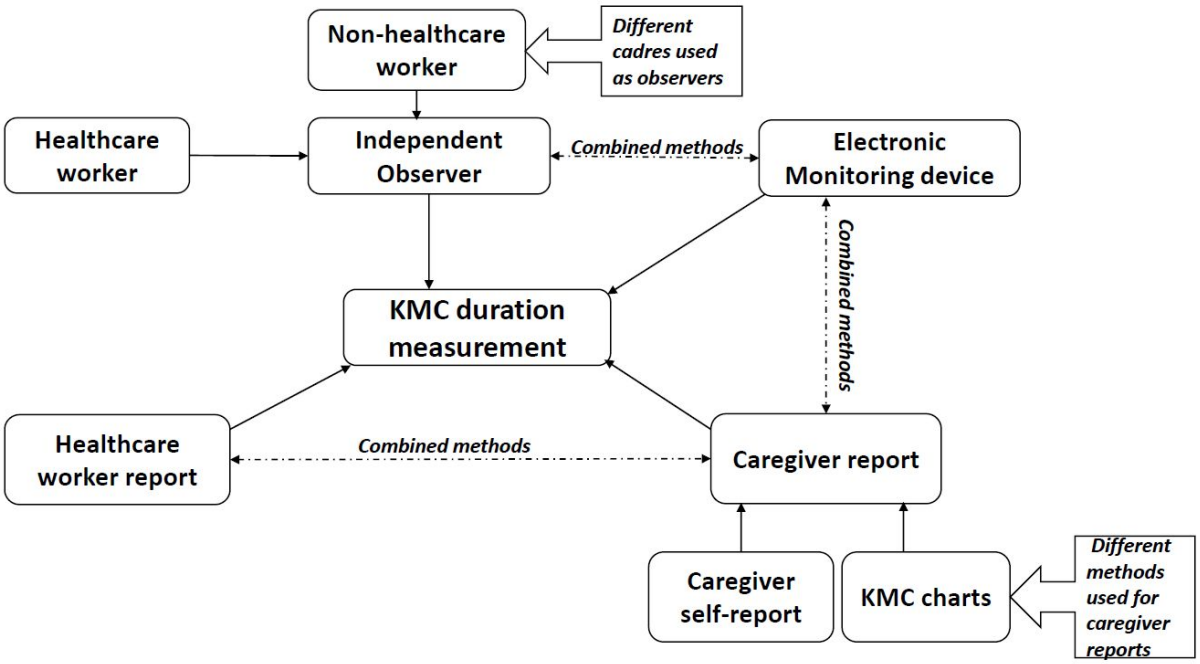
Figure 1: PRISMA flow diagram of search results and study inclusion process



KMC=Kangaroo Mother Care, STS=Skin to Skin, HCW=Health care worker

Figure 2. Proposed framework for categorisation of KMC measurement methods.



Commonly used methods to measure duration of KMC (Kangaroo Mother Care), (◄·····►) = methods used in combination, caregiver reports use self-report or KMC charts and independent observers can be healthcare workers or non-healthcare workers.

Table 1. Publications with a detailed description of KMC duration measurement

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
M. J. F. Goudard; 2022	Skin-to-skin contact and deaths in new-borns weighing up to 1800 grams: a cohort study	Observational study; 405	Brazil	Caregiver & Healthcare worker	SSC time was recorded on card by the health team at the beginning, then, parents performed the registration, under the supervision of healthcare workers.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Jegannathan; 2022	Quality improvement initiative to improve the duration of Kangaroo Mother Care in tertiary care neonatal unit of South India	Observational study; 86	India	Caregiver report (KMC charts)	KMC Charts were given to KMC mothers to mark daily hours of KMC by mothers.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Joshi; 2022	Quality improvement in Kangaroo Mother Care: learning from a teaching hospital	Observational study; 86	India: NICU level unknown	Caregiver report (self-report)	The nurse noted the previous day's KMC hours and other information as reported by the mother.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
Nahya Salim; 2021	Kangaroo mother care: EN-BIRTH multi-country validation study	Observational study; 840	Tanzania, Napal & Bangladesh	Independent observer	Observers monitored components of KMC hourly in some settings and 12-hourly in other settings.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented.

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑= Yes ☐=No.

KMC=Kangaroo Mother Care, KC= Kangaroo Care, NICU= Neonatal Intensive Care Unit, EN-BIRTH= Every Newborn Birth Indicators Research Tracking in Hospitals, STS=Skin to Skin, SSC=Skin-to-skin care, HCW=Health care worker, CG=Caregiver

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
E. A. Adejuyigbe; 2021	Impact of continuous Kangaroo Mother Care initiated immediately after birth on survival of newborns with birth weight between 1.0 to < 1.8 kg	RCT; 4200	Ghana, Tanzania, Malawi, Nigeria & India	Independent observer	Information on the duration of SSC contact and the duration of hospital stay was collected by research assistants	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
H. Brotherton; 2021	Impact of early kangaroo mother care versus standard care on survival of mild-moderately unstable new-borns <2000 grams	RCT; 279	The Gambia: NICU level not specified	Healthcare worker report	Research nurses observed and recorded KMC duration and position. Documented timing of each KMC session, KMC provider and reason for coming out of KMC position.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
K. Chavula; 2020	Improving Skin-to-Skin Practice for new-borns in Kangaroo Mother Care in Malawi through the use of a customized baby wrap: A randomized control trial	RCT; 301	Malawi; NICU level II	Caregiver report (self-report)	Mothers reported practicing SSC post-discharge & duration more than half the day and more than half the night post-discharge.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
C. Sahlen Helmer; 2020	A Randomized Trial of Continuous Versus Intermittent Skin-to-Skin Contact After Premature Birth and the Effects on Mother-Infant Interaction	RCT; 31	Sweden; NICU level unknown	Caregiver report (KMC charts)	Parents in continuous SSC documented who provided SSC and whether they were off SSC for any reason. Parents in the intermittent group registered when and for how long they provided SSC.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
B.S. Tandberg; 2018	Parent-Infant Closeness, Parents' Participation, and Nursing Support in Single-Family Room and Open Bay NICUs	Observational; 64	Norway: NICU level unknown	Caregiver report (KMC chart)	Parents recorded the duration of SSC care in a KMC diary. Diary entries were made daily for the first 14 days following inclusion in the study. Parents reported hour by hour during these 14 days.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Rao; 2018	Continuous, real-time monitoring of neonatal position and temperature during Kangaroo Mother Care using a wearable sensor: a techno-feasibility pilot study	Observational; 12	India: NICU level III	Electronic monitoring device, healthcare worker's direct observation & Maternal self-report	Baby's position captured as presence of "touch" between the device and the skin of baby/mother was compared against reported/ observed KMC episodes". In the hospital, the research nurse annotated the starting and ending times of KMC by direct observation. At home KMC duration was self-reported by the mother. Direct observation was the "reference standard" in the hospital against which the device was compared for purposes of validation.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑*= Yes* ☐*=No.*

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
H.C. Watkins; 2018	Observation study showed that the continuity of skin-to-skin contact with low-birthweight infants in Uganda was suboptimal	Observational; 12	Uganda: NICU level II	Independent observer	Continuous observation of infants began after birth and up to day 7 of life, discharge, or death, whichever came first. The total duration of hours spent in SSC was calculated by adding together the duration of all individual SSC sessions on a day. If an infant received at least 8 hours of SSC, it was considered continuous KMC, and any fewer hours of SSC per day was documented as intermittent KMC.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☑ Calculation of daily KMC duration documented
P. Oras; 2016	Skin-to-skin contact is associated with earlier breastfeeding attainment in preterm infants	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Skin to skin duration was recorded by the parents or by staff on a detailed form. Median daily SSC duration was the data used for the study.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Soni; 2016	The presence of physician champions improved Kangaroo Mother Care in rural western India	Observational; 648	India: NICU level II	Healthcare worker report	Nursing staff documented KMC duration using a standardized form & recorded information for eight days. The charts were incorporated into the neonate's medical notice updated daily by the nurses and reviewed daily by the physician.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
J. Pervin; 2015	Implementing Kangaroo mother care in a resource-limited setting in rural Bangladesh	Observational; 423	Bangladesh: NICU level I	Healthcare worker report	Nursing attendants noted the beginning and end of every skin-to-skin contact session and calculated skin-to-skin contact time for each session. The times of each session in the 24h period was added together to determine total skin-to-skin contact duration per day.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented
J. Gonya; 2013	Factors associated with maternal visitation and participation in skin-to-skin care in an all-referral level IIIc NICU	Observational; 32	USA: NICU level III	Caregiver report (KMC chart)	A log was provided to mothers to record when they visited the small baby NICU, if they participated in SSC, how long they participated in SSC, and if there were any issues involved in the SSC process.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
Y.T. Blomqvist; 2013	Initiation and extent of skin-to-skin care at two Swedish neonatal intensive care units	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Time of initiation of SSC and who provided this care were recorded continuously in the infants' medical charts by either the parents or the NICU staff. The reliability of parents' registrations of the time spent with SSC had been assessed prior to the study.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
R. Flacking; 2013	Influence of NICU co-care facilities and skin-to-skin contact on maternal stress in mothers of preterm infants	Mixed methods feasibility study; 300	Sweden: NICU level III	Caregiver report (KMC chart)	Caregivers provided KMC duration self-reports using calendars. Parents marked the initiation and ending of each SSC episode. At the end of the 2-week period, the nurse revisited the mother, collected the calendar and provided a new calendar for the following 2-week period.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Flacking; 2011	Positive Effect of Kangaroo Mother Care on Long-Term Breastfeeding in Very Preterm Infants	Observational; 300	Sweden: NICU level unknown	Caregiver report (KMC chart)	KMC data gathered through self-reports by caregivers in the format of calendars. Parents marked the initiation and ending of each skin-to-skin episode rounded to the nearest 5- or 10-minute interval.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
G.C. Anderson; 2003	Mother-Newborn Contact in a Randomized Trial of Kangaroo (Skin-to-Skin) Care	RCT; 91	USA: NICU level unknown	Caregiver report (KMC chart)	Contact logs used to document KMC duration (when the contact began and ended) & by whom. Caregivers completed the contact log and researcher verified each entry with the mothers at the end of each 8-hour shift.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Feldman; 2003	Skin-to-skin contact (Kangaroo Care) accelerates autonomic and neuro-behavioural maturation in preterm infants	Observational; 70	Israel: NICU level unknown	Healthcare worker report	During KC infants were observed by the nurses who recorded the exact times when the mothers and infants remained in skin-to-skin contact and when the infant returned to standard incubator care.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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Database: Ovid MEDLINE Search Strategy:

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1 infant, low birth weight/ or infant, small for gestational age/ or infant, very low birth weight/ or infant, extremely low birth weight/ or infant, premature/ or infant, extremely premature/ (80630)

2 (low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp. (113774)

3 Premature Birth/ (14139)

4 (preterm birth$ or premature birth$).mp. (29803)

5 shorter gestation.mp. (212)

6 preterm pregnancy.mp. (127)

7 (sga or lbw or vlbw).mp. (15987)

8 or/1-7 (149424)

9 Kangaroo-Mother Care Method/ (445)

10 (kangaroo mother care or kangaroo care).mp. (996)

11 skin to skin.mp. (6463)

12 9 or 10 or 11 (7070)

13 8 and 12 (873)

14 ((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (323)

15 (duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (121)

16 13 or 14 or 15 (1236)

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Pg 1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Pg 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Pg 5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	Pg 5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Pg 6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Pg 7
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Pg 6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Pg 27
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pg 7
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Pg 7
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Pg 7
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not done
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Pg 7-8

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Pg 19
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Pg 9-10
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not done
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Pg 9
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Pg 21-26
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Pg 12
Limitations	20	Discuss the limitations of the scoping review process.	Pg 13
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Pg 13
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Pg 14

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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Measuring Duration of Kangaroo Mother Care for Neonates: A Scoping Review

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Measuring Duration of Kangaroo Mother Care for Neonates: A Scoping Review

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Key words:Kangaroo Mother Care, low birthweight, neonatal, prematurity

Abstract

Objectives: Kangaroo mother care *(*KMC) is high impact for survival of low birthweight neonates, but there are few rigorous evaluations of duration required for impact. We conducted a scoping review of KMC skin-to-skin contact duration measurement methods and assessed their validation.

Design: Scoping review in accordance with Joanna Briggs Institute guidance for conducting scoping review.

*Data sources:*MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus(AIM), Latin American and Caribbean Health Sciences Literature(LILACS), Clinical trials.gov, International Clinical Trials Registry Platform (WHO ICTRP), International Standard Randomised Controlled Trial Number (ISRCTN) Registry, Medrxiv, and OpenGrey were searched through November 2022.

Eligibility criteria for selecting studies: Publications with primary data on KMC duration were included. We excluded short procedural skin-to-skin care studies.

Data extraction and synthesis: Selection and data abstraction were conducted by two independent reviewers. A data charting form based on the variables of interest was used to abstract data.

Results: A total of 213 publications were included, of which 54 (25%) documented a method of measuring KMC duration. Only 20 publications (9%) provided a detailed description of the

duration measurement method, and none reported validity. Most studies used caregiver reports (29, 54%) or healthcare worker observations (17, 31%). Other methods included independent observers and electronic monitoring devices.

Conclusion: Only 9% of KMC studies reporting duration documented the measurement method applied and no studies were found with documented validation of duration measurement methods. Accurate and comparable data on the dose response of KMC will require duration measurement methods to be validated against a gold standard such as an independent observer.

Strength and limitations of the study

- First review to assess KMC duration measurement description and validation.
- Selection and data abstraction were conducted by two independent reviewers.
- Excluded five publications for which no English version was available.
- Did not review journal supplementary materials for the included publications.

Protocol registration number in Open Science Framework: DOI 10.17605/OSF.IO/463DG.

Data availability statement

Data sharing not applicable as no datasets generated or analysed for this study.

Introduction

Globally, an estimated 2.3 million neonatal deaths occurred in 2022(1). More than 80% of neonatal deaths occur amongst those who are low birthweight [LBW, ≤2500 grams (g)], due to being born preterm, small-for-gestational age, or both (2). Mortality risk is highest in low-income and middle-income countries (LMICs) due to gaps in neonatal care (3). Major mortality reductions could be achieved by improving facility-based care of small and sick neonates in these countries (2, 4, 5). Kangaroo mother care (KMC) as a component of this small and sick newborn care is associated with decreased mortality, sepsis, hypothermia, hypoglycaemia, and length of hospital stay compared to conventional incubator care among clinically stable neonates (6-8). A World Health Organisation (WHO)led trial reported a 25% reduction in mortality within 28 days among neonates born weighing 1000-1799 g who received KMC immediately after birth, relative to those who received standard care with KMC after stabilisation (9). Based on these findings and additional evidence from a systematic review(10), WHO updated guidelines recommending KMC for all preterm or LBW neonates to be initiated as soon as possible after birth in the healthcare facility or at home and should be given for 8–24 hours per day (11).

KMC is the care of preterm or LBW neonates in continuous and prolonged (8–24 hours per day, for as many hours as possible) skin-to-skin contact (SSC) recommended to be initiated immediately after birth with support for exclusive breastfeeding or breast-milk feeding (12). Duration of KMC is considered important in achieving beneficial health outcomes (8, 10, 13, 14). However, previous research has suggested that continuous KMC for 24 hours a day may be difficult to achieve; for example, women may have complications or be post-caesarean section or

find long hours challenging due to incompatibility with household activities or trying to sleep while continuing KMC (15). Clinicians and administrators need to make changes in infrastructure (e.g., showers, toilets) and enable other family members to share in KMC (11). Higher duration of KMC in a given 24-hour period has been demonstrated using descriptive data and meta-analyses to be associated with lower mortality risk (8, 16). Evidence also shows that some desired effects disappear when the KMC duration is 2 hours or less (17) . However, the evidence base on the recommended frequency and duration of KMC for neonatal survival requires more rigorous evaluation (9, 15). Dose-response studies could inform families and clinicians to optimize outcomes and be more efficient for inputs. Such studies require objective and accurate methods of measuring the duration of KMC.

The aim of this scoping review was therefore to explore available evidence on the methods used to measure KMC duration. Specific objectives were to: 1) develop a framework for categorisation of measurement methods identified in the published and grey literature; 2) assess studies with KMC duration data to describe the measurement methods used; and 3) describe any studies identified which validated duration measurement methods.

Methodology

Study design

We conducted a scoping review of the published and grey literature in accordance with established guidance for conducting scoping review from the Joanna Briggs Institute (18). The review protocol was registered with Open Science Framework (19). Selection of relevant papers, screening, and data charting were conducted by two independent reviewers (VST, EML) to minimise selection bias.

Search strategy

We searched the MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus, Latin American and Caribbean Health Sciences Literature (LILACS), Clinical trials.gov, International Clinical Trials Registry Platform(WHO ICTRP) and the International Standard Randomised Controlled Trial Number (ISRCTN) Registry. We also searched Medrxiv and OpenGrey libraries for relevant unpublished studies. We screened all references of relevant systematic reviews identified as well as the websites of the Kangaroo Foundation and the International Network of Kangaroo Care. WHO guidelines and Google Scholar were searched for relevant publications. Searches were last updated on 21 November 2022 with no language or date of publication limitations. Search terms were based on those relating to KMC and LBW/prematurity as well as KMC measurement/monitoring (supplementary file appendix 1). The search was conducted with assistance of a library clinical research specialist at the British Medical Association.

Management of search results

The search results were exported as RSI files to the Mendeley reference management system (© 2009-2013, Mendeley Ltd.). Duplication removal as well as title and abstract screening were done using Mendeley. The search results were shared with the second reviewer through a Mendeley group. Retrieved publications from the search were screened for suitability and relevance based on the information in the titles and abstracts. Initially a randomly selected trial set of search results (10% of total number) were screened for inclusion based on title and abstract information by both reviewers and, where necessary, clarifications/adjustments to the inclusion criteria were made, aiming for an agreement rate of >80%. A third reviewer was consulted in cases of disagreement (CJT). Articles were screened by two reviewers for inclusion and data charting. An initial pilot set was screened by both reviewers to assess agreement rates before sharing the analysis of the bulk of included articles.

Eligibility Criteria

Publications were included if they presented primary data on KMC among preterm or LBW newborns and referred to duration of the skin-to-skin component of KMC or KMC monitoring/measurement. Publications referring to short procedural skin-to-skin care, such as delivery room routine skin to skin care and pain control procedures which did not fit in the definition of KMC(12), were excluded.

Data abstraction

We generated a data charting form by identifying variables that would inform the objectives of the scoping review. Data points of interest included KMC duration, methods used to measure the duration and the validation of the method used. Detailed methodological description was defined as a study that explained the instruments used to document KMC duration measurement, the interval of the observations and how the total or daily KMC duration was calculated from the observations.

Patient and Public Involvement

There was no patient or public involvement in this review.

Ethical approval

This study, being a scoping review, does not contain any personal or medical information about an identifiable individual and no ethical approvals or patient consent were sought.

Results

Our search strategy identified 3542 publications, of which 213 presented primary data on KMC duration. Only 54 (25%) of 213 publications documented the method used to measure KMC duration (Figure 1). Of the 213 publications, 139 (65%) were carried out in LMIC, 109 (51%) were clinical trials, 135 (63%) had a sample size of >50 participants and 102 (48%) reported on daily KMC duration of more than 2 hours.

KMC duration measurement methods

Of the 54 publications that documented the methods used to measure KMC duration, four different methodological categories were identified: caregiver report, healthcare worker report, independent observation, and electronic monitoring device. A method was identified as a healthcare worker report if a person involved in the routine care of study participants reported on KMC duration, and as an independent observation if the person reporting on duration was not involved in the routine care of study participants. Some studies used more than one method, and caregiver reports were either self-reported through interviews or based on KMC charts/diaries.

No existing framework for categorisation of the methods used to measure KMC duration was found in the reviewed publications, nor was any basis for the choice of the method used provided. Figure 2 illustrates our proposed framework for the categorisation of KMC measurement methods.

Of the 54 publications that documented the method used to measure KMC duration 29 (54%) used caregiver reports and 17 (32%) used healthcare worker reports. Other methods included independent observation, a combination of healthcare worker and caregiver report, and a combination of electronic device (wearable sensor for determining skin contact), healthcare worker, and caregiver monitoring (Figure 1).

KMC duration measurement description. Nine (31%) of the 29 publications that used caregiver report described the method used to measure KMC duration. Seven of these 9 publications utilised KMC charts/diaries to report the duration of SSC (20-26), while the remaining 2 mentioned self-report through interviews (27, 28). Four publications (29-32) used more than one method of

measuring KMC duration. Of these, 3 (29, 31, 32) compared caregiver report with healthcare worker report and one (30) used healthcare worker report and an electronic monitoring device to monitor skin to skin contact. In the latter study, the device was used in the home setting in combination with caregiver report to evaluate whether it could reliably capture the duration of KMC episodes (30).

Three publications used independent observers (33-35) who were not part of the healthcare team. No publication used video recording to monitor KMC duration although video was used to assess other aspects of SSC, such as mother-baby interaction.

Only 20 (9%) out of 213 publications (20-30, 32-40) with primary data on KMC duration described in detail the measurement method used (Figure 1), and this was in varying degrees of detail (supplementary table 1). Of these 20 publications, 11 (55%) were from LMICs (20, 27, 28, 30, 32-36, 38, 39) and 9 (45%) were from high-income countries (21-26, 29, 31, 40). Nine (45%) out of the 20 publications used caregiver report (Figure 1), of which 7 documented the tool used for monitoring KMC duration (charts) (20-26) and 2 mentioned self-report (supplementary table 1) (27, 28). The majority (64%) of the publications that used caregiver report were conducted in high-income countries (21-26), all of which documented the interval of observations. None of the publications gave a description of how the total or daily KMC duration was computed from the reports/observations (supplementary table 1).

Three of the 4 publications that used healthcare worker report were conducted in LMICs (36, 38, 39). Only 1 of these 4 documented the tool used for monitoring (38), 3 documented the interval of observations (38-40), and 2 described how the daily KMC duration was calculated (38, 39).

The 3 publications that combined caregiver and healthcare worker report documented the tool used to measure KMC duration (29, 31, 32), but only 2 documented the interval of observations, and none explained how the daily duration was computed (29, 32). The publication that used a combination of an electronic device, healthcare worker report, and caregiver report documented the interval of monitoring KMC duration but did not document the tool used or how the daily duration was computed(30). The publications that used independent observers documented the interval of observations and described how the daily KMC duration was computed (33-35).

Validation of the measurement methods

None of the publications with primary KMC duration data validated the method used to measure KMC duration. Only 1 publication measured the accuracy of a new device used to monitor skin to skin contact compared to healthcare worker report and caregiver report (30). Direct observation by healthcare workers was used as the reference standard against which an electronic monitoring device was compared for the purposes of accuracy; however, no validation was conducted. Maternal report was used to test the reliability of the electronic device to capture the duration of KMC at home. Four additional publications verified the consistency of measurements but did not undertake validation of the methods used (25, 29, 31, 38). Two of these studies only compared the agreement between the observation by the healthcare workers and the parents without comparing with the set gold standard(29, 31), while the other two only used a second person to verify entries without calculation of the agreement(25, 38).

Discussion

In this scoping review, we found 213 publications on KMC of which 54 (25%) documented a method for measuring duration. Only 20 (9%) publications provided a detailed description of the KMC duration measurement method, and none reported validity. Most studies with a detailed description used caregiver reports (9, 45%) or healthcare worker report (4, 20%). No framework for categorisation of KMC duration measurement methods was identified, and there was a lack of justification for the choice of method used for individual publications.

The observation that most studies did not document methods used to assess KMC duration is in accord with a previous systematic review, which found that more than 85% of studies did not include data on observations of skin to skin contact practice, and that 45% lacked a description of skin to skin contact initiation and stopping criteria (41). Similarly, a most recent review that generated evidence leading to policy change by WHO found that 19% (5 out of 27) of the included studies did not report on duration of KMC(10).

The lack of reliable measurement for the intervention dose (KMC duration) is an impediment to interpreting the evidence when meta-analyses that combine studies with different KMC measurement methods are used (42, 43). Hence, although it is plausible that higher KMC duration could improve neonatal health outcomes (44, 45), the evidence remains incomplete without more rigorously validated methods for measuring the dose of KMC. This is seen by variations in evidence generated by different reviews where the Cochrane review (2016) found KMC reduction on mortality was only when the daily duration was 20 hours or more(6), while another found significant benefit when daily duration was at least 8 hours(10). There were no published studies on validation of methods used to measure KMC duration. This calls for studies to validate KMC duration measurement methods against a gold standard (a reliable method for continuous monitoring of KMC) to enable accurate data on KMC duration as an exposure, compared to outcomes such as mortality and morbidity. Video recording has been used in skin to skin care studies mainly for short duration like heel pricks procedures where by the camera focuses on the neonate's face not the environment(46, 47). This could be an alternative as a gold standard against

which the commonly used methods in KMC studies could be validated. However, for continuous video recording of KMC has ethical challenges like limitations of anonymity, recording other non-research related private experiences of the participants which might cause reluctance of the ethical committees to allow its use (48). The use of artificial intelligence (AI) platforms like it has been tried in a drug adherence trial could be a best alternative for a gold standard to evaluate the commonly used KMC duration measurement methods (49). This trial utilized visual confirmation of ingestion of the drug by using the AI platform mobile app and the same can be used to confirm skin to skin contact in KMC studies(49).

Although WHO recommends KMC duration of at least 8 hours a day (11), there is limited evidence on the minimum duration of KMC with beneficial clinical effects given that the evidence base used to draw the recommendation found insufficient data on KMC duration less than 8 hours(10). Therefore, standardised operational definitions which could improve this evidence base (41). In addition, our framework could help in guiding the selection and refining of indicators in routine information systems for assessing KMC duration as a marker for the quality of KMC (50). Chan and others have proposed indicators in the KMC measurement framework to include the duration of skin to skin contact (41, 50), and the proposed framework for KMC duration measurement in this review will be helpful for the measurement of this indicator.

Strength and limitations of the study

Strengths

- First review to assess the description and validation of KMC duration measurement methods.
- Selection and data abstraction were conducted by two independent reviewers.

Limitations

- We excluded 5 publications for which no English version was available and could not get translation.

- We did not review journal supplementary materials for the included publications.

Conclusion

KMC is a high impact intervention for survival of LBW neonates, but there is limited rigorous evaluation on the duration required. Reliable data on the dose response of KMC depends on the reliability of assessing its duration. This scoping review found most studies of KMC duration (91%) did not describe the methods used, and those that did were mainly reliant on caregiver report or healthcare worker report, both of which have limitations. Clarity is needed in reporting KMC duration measurement methods to increase comparability and rigour, and a validation study of gold standard versus caregiver report and healthcare worker report would be of value.

Conflict of interest

The authors have no conflict of interest declare.

Authors' contributions

Victor S. Tumukunde conceptualised the study, wrote the protocol, analysed and interpreted the data, and wrote the first draft of the manuscript. Victor S. Tumukunde, Eva M. Loucaides, and Cally J. Tann selected the publications and abstracted the data. Melissa M. Medvedev, Cally J. Tann, Moffat Nyirenda, and Joy E. Lawn interpreted the data and critically revised the manuscript. All authors reviewed the manuscript and approved the final version.

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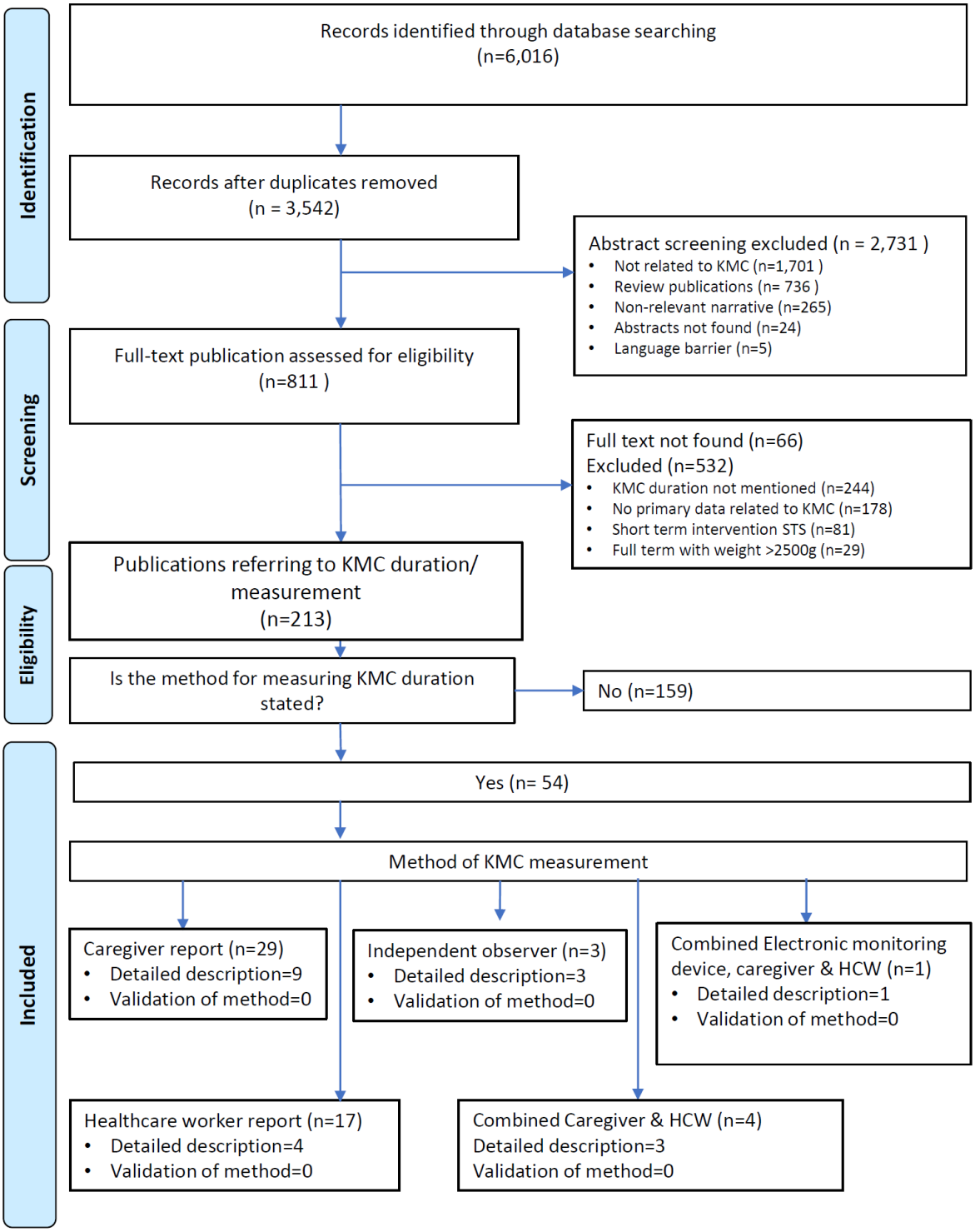
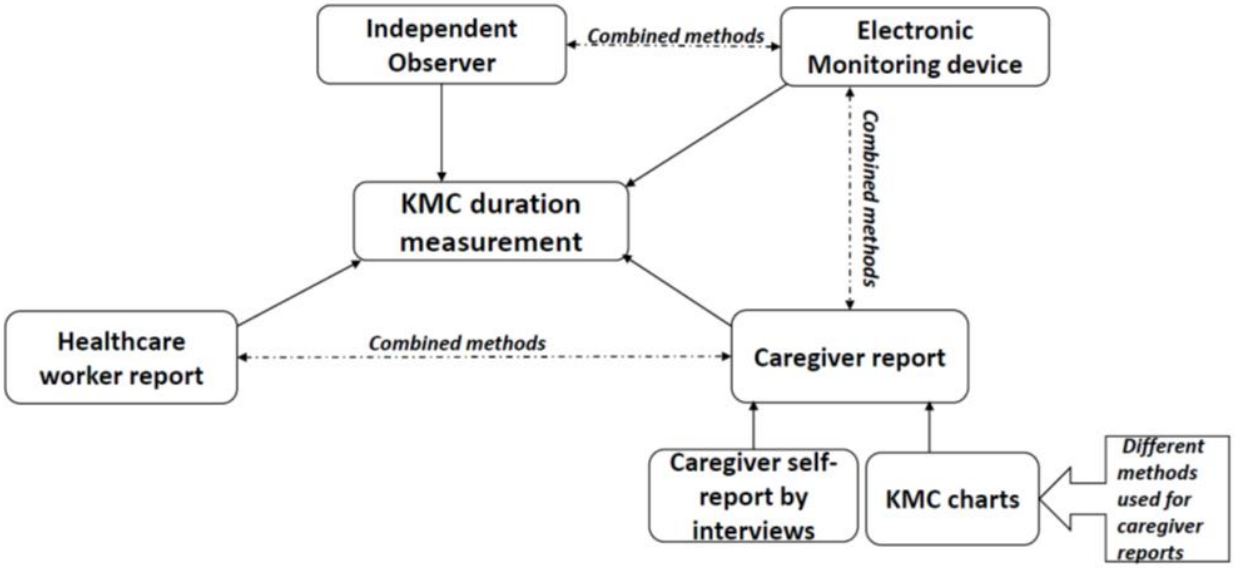
Figure 1: PRISMA flow diagram of search results and study inclusion process



KMC=Kangaroo Mother Care, STS=Skin to Skin, HCW=Health care worker

Figure 2. Proposed framework for categorisation of KMC measurement methods.



Commonly used methods to measure duration of KMC (Kangaroo Mother Care), (◄·····►) = methods used in combination, caregiver reports use self-report or KMC charts and independent observers can be healthcare workers or non-healthcare workers.

Appendix 1: Search strategies

	Ovid MEDLINE(R) **Date: 22/11/2022**	**Results per line**
1	infant, low birth weight/ or infant, small for gestational age/ or infant, very low birth weight/ or infant, extremely low birth weight/ or infant, premature/ or infant, extremely premature/	89966
2	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	123783
3	Premature Birth/	19559
4	(preterm birth$ or premature birth$).mp.	35716
5	shorter gestation.mp.	229
6	preterm pregnancy.mp.	132
7	(sga or lbw or vlbw).mp.	18124
8	or/1-7	164261
9	Kangaroo-Mother Care Method/	688
10	(kangaroo mother care or kangaroo care).mp.	1265
11	skin to skin.mp.	7174
12	or/9-11	7943
13	8 and 12	1106
14	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	374
15	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	151
16	or/13-15	1549

	Embase **Date: 22/11/2022**	**Results per line**
1	low birth weight/ or small for date infant/	56972
2	very low birth weight/ or extremely low birth weight/	17072
3	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	202428
4	prematurity/	119803
5	(preterm birth$ or premature birth$).mp.	41903
6	shorter gestation.mp.	289
7	preterm pregnancy.mp.	204
8	(sga or lbw or vlbw).mp.	27042
9	or/1-8	225402
10	kangaroo care/	1724
11	(kangaroo mother care or kangaroo care).mp.	2070
12	skin to skin.mp.	10333
13	or/10-12	11652
14	9 and 13	1594
15	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	540
16	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	216
17	or/14-16	2217

	APA PsycInfo **Date: 22/11/2022**	**Results per line**
1	Birth Weight/	3453
2	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	10046
3	premature birth/	6254
4	(preterm birth$ or premature birth$).mp.	7931
5	shorter gestation.mp.	42
6	preterm pregnancy.mp.	2
7	(sga or lbw or vlbw).mp.	2008
8	or/1-7	13930
9	(kangaroo mother care or kangaroo care).mp.	183
10	skin to skin.mp.	519
11	or/9-10	615
12	8 and 11	187
13	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	56
14	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	21
15	or/12-14	249

	Cochrane Central Register of Controlled Trials (CENTRAL) and Cochrane Database of Systematic Reviews (CDSR) **Date: 22/11/2022**	**Results per line**
#1	MeSH descriptor: [Infant, Low Birth Weight] explode all trees	2338
#2	MeSH descriptor: [Infant, Premature] explode all trees	4277
#3	"low birth weight" or "small for gestational age" or "small gestational age" or "small for date" NEXT infant* or "low birth weight" or premature NEXT infant* or premature NEXT neonate* or prematurity or preterm NEXT infant* or preterm NEXT neonate* or "premature babies" or "preterm babies" or "premature baby" or "preterm baby" or premature NEXT newborn* or preterm NEXT newborn*	19540
#4	MeSH descriptor: [Premature Birth] this term only	1814
#5	preterm NEXT birth* or premature NEXT birth*	4614
#6	"shorter gestation"	11
#7	"preterm pregnancy"	26
#8	sga or lbw or vlbw	3218
#9	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8	22856
#10	MeSH descriptor: [Kangaroo-Mother Care Method] this term only	111
#11	"kangaroo mother care" or "kangaroo care"	651
#12	"skin to skin contact" or "skin to skin care"	547
#13	#10 or #11 or #12	1002

	Clinicaltrials.gov	**Results**
	Date: 18/11/2022	
	kangaroo OR "skin to skin"	119

	WHO International Clinical Trials Registry Platform (ICTRP)	**Results**
	Date: 18/11/2022	
	kangaroo	203

	The ISRCTN registry	**Results**
	Date: 21/11/2022	
	Kangaroo https://www.isrctn.com/search?q=kangaroo+	12

	Latin American and Caribbean Health Sciences Literature (LILACS)	**Results**
	Date: 21/11/2022	
	Kangaroo	315

	MedRxiv	**Results**
	Date: 21/11/2022	
	“skin to skin”	166

	African Index Medicus	**Results**
	Date: 21/11/2022	
	Kangaroo	9

	Open Grey libraries, references from relevant systematic reviews and websites of the Kangaroo Foundation	**Results**
	Date: 21/11/2022	
	Open Grey libraries: search term “skin to skin” AND Search terms Kangaroo care or kangaroo unit* **References and google scholar:** "kangaroo mother care" or "kangaroo care" OR “skin to skin contact" or "skin to skin care"	175

Table 1. Publications with a detailed description of KMC duration measurement

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
M. J. F. Goudard; 2022	Skin-to-skin contact and deaths in new-borns weighing up to 1800 grams: a cohort study	Observational study; 405	Brazil	Caregiver & Healthcare worker	SSC time was recorded on card by the health team at the beginning, then, parents performed the registration, under the supervision of healthcare workers.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Jegannathan; 2022	Quality improvement initiative to improve the duration of Kangaroo Mother Care in tertiary care neonatal unit of South India	Observational study; 86	India	Caregiver report (KMC charts)	KMC Charts were given to KMC mothers to mark daily hours of KMC by mothers.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Joshi; 2022	Quality improvement in Kangaroo Mother Care: learning from a teaching hospital	Observational study; 86	India: NICU level unknown	Caregiver report (self-report)	The nurse noted the previous day's KMC hours and other information as reported by the mother.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
Nahya Salim; 2021	Kangaroo mother care: EN-BIRTH multi-country validation study	Observational study; 840	Tanzania, Napal & Bangladesh	Independent observer	Observers monitored components of KMC hourly in some settings and 12-hourly in other settings.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented.

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑= Yes ☐=No.

KMC=Kangaroo Mother Care, KC= Kangaroo Care, NICU= Neonatal Intensive Care Unit, EN-BIRTH= Every Newborn Birth Indicators Research Tracking in Hospitals, STS=Skin to Skin, SSC=Skin-to-skin care, HCW=Health care worker, CG=Caregiver

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
E. A. Adejuyigbe; 2021	Impact of continuous Kangaroo Mother Care initiated immediately after birth on survival of newborns with birth weight between 1.0 to < 1.8 kg	RCT; 4200	Ghana, Tanzania, Malawi, Nigeria & India	Independent observer	Information on the duration of SSC contact and the duration of hospital stay was collected by research assistants	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
H. Brotherton; 2021	Impact of early kangaroo mother care versus standard care on survival of mild-moderately unstable new-borns <2000 grams	RCT; 279	The Gambia: NICU level not specified	Healthcare worker report	Research nurses observed and recorded KMC duration and position. Documented timing of each KMC session, KMC provider and reason for coming out of KMC position.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
K. Chavula; 2020	Improving Skin-to-Skin Practice for new-borns in Kangaroo Mother Care in Malawi through the use of a customized baby wrap: A randomized control trial	RCT; 301	Malawi; NICU level II	Caregiver report (self-report)	Mothers reported practicing SSC post-discharge & duration more than half the day and more than half the night post-discharge.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
C. Sahlen Helmer; 2020	A Randomized Trial of Continuous Versus Intermittent Skin-to-Skin Contact After Premature Birth and the Effects on Mother-Infant Interaction	RCT; 31	Sweden; NICU level unknown	Caregiver report (KMC charts)	Parents in continuous SSC documented who provided SSC and whether they were off SSC for any reason. Parents in the intermittent group registered when and for how long they provided SSC.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
B.S. Tandberg; 2018	Parent-Infant Closeness, Parents' Participation, and Nursing Support in Single-Family Room and Open Bay NICUs	Observational; 64	Norway: NICU level unknown	Caregiver report (KMC chart)	Parents recorded the duration of SSC care in a KMC diary. Diary entries were made daily for the first 14 days following inclusion in the study. Parents reported hour by hour during these 14 days.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Rao; 2018	Continuous, real-time monitoring of neonatal position and temperature during Kangaroo Mother Care using a wearable sensor: a techno-feasibility pilot study	Observational; 12	India: NICU level III	Electronic monitoring device, healthcare worker's direct observation & Maternal self-report	Baby's position captured as presence of "touch" between the device and the skin of baby/mother was compared against reported/ observed KMC episodes". In the hospital, the research nurse annotated the starting and ending times of KMC by direct observation. At home KMC duration was self-reported by the mother. Direct observation was the "reference standard" in the hospital against which the device was compared for purposes of validation.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
H.C. Watkins; 2018	Observation study showed that the continuity of skin-to-skin contact with low-birthweight infants in Uganda was suboptimal	Observational; 12	Uganda: NICU level II	Independent observer	Continuous observation of infants began after birth and up to day 7 of life, discharge, or death, whichever came first. The total duration of hours spent in SSC was calculated by adding together the durations of all individual SSC sessions on a day. If an infant received at least 8 hours of SSC, it was considered continuous KMC, and any fewer hours of SSC per day was documented as intermittent KMC.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☑ Calculation of daily KMC duration documented
P. Oras; 2016	Skin-to-skin contact is associated with earlier breastfeeding attainment in preterm infants	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Skin to skin duration was recorded by the parents or by staff on a detailed form. Median daily SSC duration was the data used for the study.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Soni; 2016	The presence of physician champions improved Kangaroo Mother Care in rural western India	Observational; 648	India: NICU level II	Healthcare worker report	Nursing staff documented KMC duration using a standardized form & recorded information for eight days. The charts were incorporated into the neonate's medical notice updated daily by the nurses and reviewed daily by the physician.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
J. Pervin; 2015	Implementing Kangaroo mother care in a resource-limited setting in rural Bangladesh	Observational; 423	Bangladesh: NICU level I	Healthcare worker report	Nursing attendants noted the beginning and end of every skin-to-skin contact session and calculated skin-to-skin contact time for each session. The times of each session in the 24h period was added together to determine total skin-to-skin contact duration per day.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented
J. Gonya; 2013	Factors associated with maternal visitation and participation in skin-to-skin care in an all-referral level IIIc NICU	Observational; 32	USA: NICU level III	Caregiver report (KMC chart)	A log was provided to mothers to record when they visited the small baby NICU, if they participated in SSC, how long they participated in SSC, and if there were any issues involved in the SSC process.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
Y.T. Blomqvist; 2013	Initiation and extent of skin-to-skin care at two Swedish neonatal intensive care units	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Time of initiation of SSC and who provided this care were recorded continuously in the infants' medical charts by either the parents or the NICU staff. The reliability of parents' registrations of the time spent with SSC had been assessed prior to the study.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
R. Flacking; 2013	Influence of NICU co-care facilities and skin-to-skin contact on maternal stress in mothers of preterm infants	Mixed methods feasibility study; 300	Sweden: NICU level III	Caregiver report (KMC chart)	Caregivers provided KMC duration self-reports using calendars. Parents marked the initiation and ending of each SSC episode. At the end of the 2-week period, the nurse revisited the mother, collected the calendar and provided a new calendar for the following 2-week period.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Flacking; 2011	Positive Effect of Kangaroo Mother Care on Long-Term Breastfeeding in Very Preterm Infants	Observational; 300	Sweden: NICU level unknown	Caregiver report (KMC chart)	KMC data gathered through self-reports by caregivers in the format of calendars. Parents marked the initiation and ending of each skin-to-skin episode rounded to the nearest 5- or 10-minute interval.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
G.C. Anderson; 2003	Mother-Newborn Contact in a Randomized Trial of Kangaroo (Skin-to-Skin) Care	RCT; 91	USA: NICU level unknown	Caregiver report (KMC chart)	Contact logs used to document KMC duration (when the contact began and ended) & by whom. Caregivers completed the contact log and researcher verified each entry with the mothers at the end of each 8-hour shift.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Feldman; 2003	Skin-to-skin contact (Kangaroo Care) accelerates autonomic and neuro-behavioural maturation in preterm infants	Observational; 70	Israel: NICU level unknown	Healthcare worker report	During KC infants were observed by the nurses who recorded the exact times when the mothers and infants remained in skin-to-skin contact and when the infant returned to standard incubator care.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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Measuring Duration of Kangaroo Mother Care for Neonates: A Scoping Review

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Key words:Kangaroo Mother Care, low birthweight, neonatal, prematurity

Abstract

Objectives: Kangaroo mother care (KMC) is high-impact for survival of low birthweight neonates, but there are few rigorous evaluations of duration required for impact. We conducted a scoping review of KMC duration measurement methods and assessed their validation.

Design: Scoping review in accordance with Joanna Briggs Institute guidance for conducting scoping review.

*Data sources:*MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus(AIM), Latin American and Caribbean Health Sciences Literature(LILACS), Clinical trials.gov, International Clinical Trials Registry Platform (WHO ICTRP), International Standard Randomised Controlled Trial Number (ISRCTN) Registry, Medrxiv, and OpenGrey were searched through November 2022

Eligibility criteria for selecting studies: Publications with primary data on KMC duration were included. We excluded short procedural skin-to-skin care studies.

Data extraction and synthesis: Selection and data abstraction were conducted by two independent reviewers. A data charting form based on the variables of interest was used to abstract data.

Results: A total of 213 publications were included, of which 54 (25%) documented a method of measuring KMC duration. Only 20 publications (9%) provided a detailed description of the duration measurement method, and none reported validity. Most studies used caregiver reports (29, 54%) or healthcare worker observations (17, 31%). Other methods included independent observers and electronic monitoring devices.

Conclusion: Only 9% of KMC studies reporting duration documented the measurement method applied and no studies were found with documented validation of duration measurement methods.

Accurate and comparable data on the dose response of KMC will require duration measurement methods to be validated against a gold standard such as an independent observer.

Strength and limitations of the study

- Unrestricted search across databases and grey literature reduced publication bias.
- Selection and data abstraction were conducted by two independent reviewers.
- Pilot testing and support from a clinical research specialist ensured precise data collection.
- Excluded five publications for which no English version was available.
- Did not review journal supplementary materials for the included publications.

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Introduction

Globally, an estimated 2.3 million neonatal deaths occurred in 2022(1). More than 80% of neonatal deaths occur amongst those who are low birthweight [LBW, ≤2500 grams (g)], due to being born preterm, small-for-gestational age, or both (2). Mortality risk is highest in low-income and middle-income countries (LMICs) due to gaps in neonatal care (3). Major mortality reductions could be achieved by improving facility-based care of small and sick neonates in these countries (2, 4, 5). Kangaroo mother care (KMC) as a component of this small and sick newborn care is associated with decreased mortality, sepsis, hypothermia, hypoglycaemia, and length of hospital stay compared to conventional incubator care among clinically stable neonates(6-8). A World Health Organisation (WHO)led trial recently reported a 25% reduction in mortality within 28 days among neonates born weighing 1000-1799 g who received KMC immediately after birth, relative to those who received standard care with KMC after stabilisation (9). Based on these findings and additional evidence from a systematic review(10), WHO updated guidelines recommending KMC for all preterm or LBW neonates to be initiated as soon as possible after birth in the healthcare facility or at home and should be given for 8–24 hours per day (11).

KMC is the care of preterm or LBW neonates in continuous and prolonged (8–24 hours per day, for as many hours as possible) skin-to-skin contact (SSC) recommended to be initiated immediately after birth with support for exclusive breastfeeding or breast-milk feeding (12). Duration of KMC is considered important in achieving beneficial health outcomes (8, 10, 13, 14). However, previous research has suggested that continuous KMC for 24 hours a day may be difficult to achieve; for example, women may have complications or be post-caesarean section or find long hours challenging due to incompatibility with household activities or trying to sleep while continuing KMC (15). Policy makers, and healthcare administrators should improve facility

infrastructure and implement policies that encourage family support and involvement in KMC to improve duration (11).

Higher duration of KMC in a given 24-hour period has been demonstrated using descriptive data and meta-analyses to be associated with lower mortality risk (8, 16). Evidence also shows that some desired effects disappear when the KMC duration is 2 hours or less(17) . However, the evidence base on the recommended frequency and duration of KMC for neonatal survival requires more rigorous evaluation [9, 15]. Dose-response studies could inform families and clinicians to optimize outcomes and be more efficient for inputs. Such studies require objective and accurate methods of measuring the duration of KMC.

The aim of this scoping review was therefore to explore available evidence on the methods used to measure KMC duration. Specific objectives were to: 1) develop a framework for categorisation of measurement methods identified in the published and grey literature; 2) assess studies with KMC duration data to describe the measurement methods used; and 3) describe any studies identified which validated duration measurement methods.

Methodology

Study design

We conducted a scoping review of the published and grey literature in accordance with established guidance for conducting scoping review from the Joanna Briggs Institute (18). The review protocol was registered with Open Science Framework (19). Selection of relevant papers, screening, and data charting were conducted by two independent reviewers (VST, EML) to minimise selection bias.

Search strategy

We searched the MEDLINE, Embase, Cochrane Library, PsycINFO, African Index Medicus, Latin American and Caribbean Health Sciences Literature(LILACS), Clinical trials.gov, International Clinical Trials Registry Platform(WHO ICTRP) and the International Standard Randomised Controlled Trial Number (ISRCTN) Registry. We also searched Medrxiv and OpenGrey libraries for relevant unpublished studies. We screened all references of relevant systematic reviews identified as well as the websites of the Kangaroo Foundation and the International Network of Kangaroo Care. WHO guidelines and Google Scholar were searched for relevant publications. Searches were first done 15th October 2020 last updated on 21st November 2022 with no language or date of publication limitations. Search terms were based on those relating to KMC and LBW/prematurity as well as KMC measurement/monitoring (supplementary file appendix 1). The search was conducted with assistance of a library clinical research specialist at the British Medical Association.

Management of search results

The search results were exported as RSI files to the Mendeley reference management system (© 2009-2013, Mendeley Ltd.). Duplication removal as well as title and abstract screening were done using Mendeley. The search results were shared with the second reviewer through a Mendeley group. Retrieved publications from the search were screened for suitability and relevance based on the information in the titles and abstracts. Initially a randomly selected trial set of search results (10% of total number) were screened for inclusion based on title and abstract information by both reviewers and, where necessary, clarifications/adjustments to the inclusion criteria were made, aiming for an agreement rate of >80%. A third reviewer was consulted in cases of disagreement (CJT). Articles were screened by two reviewers for inclusion and data charting. An initial pilot set was screened by both reviewers to assess agreement rates before sharing the analysis of the bulk of included articles.

Eligibility Criteria

Publications were included if they presented primary data on KMC among preterm or LBW newborns and referred to duration of the skin-to-skin component of KMC or KMC monitoring/measurement. Publications referring to short procedural skin-to-skin care, such as delivery room routine skin to skin care and pain control procedures which did not fit in the definition of KMC(12), were excluded.

Data abstraction

We generated a data charting form by identifying variables that would inform the objectives of the scoping review. Data points of interest included KMC duration, methods used to measure the

duration and the validation of the method used. Detailed methodological description was defined as a study that explained the instruments used to document KMC duration measurement, the interval of the observations and how the total or daily KMC duration was calculated from the observations.

Patient and Public Involvement

There was no patient or public involvement in this review.

Results

Our search strategy identified 3542 publications, of which 213 presented primary data on KMC duration. Only 54 (25%) of 213 publications documented the method used to measure KMC duration (Figure 1). Of the 213 publications, 139 (65%) were carried out in LMIC, 109 (51%) were clinical trials, 135 (63%) had a sample size of >50 participants and 102 (48%) reported on daily KMC duration of more than 2 hours.

KMC duration measurement methods

Of the 54 publications that documented themethods used to measure KMC duration, four different methodological categories were identified: caregiver report, healthcare worker report, independent observation, and electronic monitoring device. A method was identified as a healthcare worker report if a person involved in the routine care of study participants reported on KMC duration, and as an independent observation if the person reporting on duration was not involved in the routine care of study participants. Some studies used more than one method, and caregiver reports were either self-reported through interviews or based on KMC charts/diaries.

No existing framework for categorisation of the methods used to measure KMC duration was found in the reviewed publications, nor was any basis for the choice of the method used provided. Figure 2 illustrates our proposed framework for the categorisation of KMC measurement methods.

Of the 54 publications that documented the method used to measure KMC duration 29 (54%) used caregiver reports and 17 (32%) used healthcare worker reports. Other methods included independent observation, a combination of healthcare worker and caregiver report, and a combination of electronic device (wearable sensor for determining skin contact), healthcare worker, and caregiver monitoring (Figure 1).

KMC duration measurement description. Nine (31%) of the 29 publications that used caregiver report described the method used to measure KMC duration. Seven of these 9 publications utilised KMC charts/diaries to report the duration of SSC (20-26), while the remaining 2 mentioned self-report through interviews (27, 28). Four publications (29-32) used more than one method of measuring KMC duration. Of these, 3 (29, 31, 32) compared caregiver report with healthcare worker report and one (30) used healthcare worker report and an electronic monitoring device to

monitor skin to skin contact. In the latter study, the device was used in the home setting in combination with caregiver report to evaluate whether it could reliably capture the duration of KMC episodes (30).

Three publications used independent observers (33-35) who were not part of the healthcare team. No publication used video recording to monitor KMC duration although video was used to assess other aspects of SSC, such as mother-baby interaction.

Only 20 (9%) out of 213 publications (20-30, 32-40) with primary data on KMC duration described in detail the measurement method used (Figure 1), and this was in varying degrees of detail (supplementary table 1). Of these 20 publications, 11 (55%) were from LMICs (20, 27, 28, 30, 32-36, 38, 39) and 9 (45%) were from high-income countries (21-26, 29, 31, 40). Nine (45%) out of the 20 publications used caregiver report (Figure 1), of which 7 documented the tool used for monitoring KMC duration (charts) (20-26) and 2 mentioned self-report (supplementary table 1) (27, 28). The majority (64%) of the publications that used caregiver report were conducted in high-income countries (21-26), all of which documented the interval of observations. None of the publications gave a description of how the total or daily KMC duration was computed from the reports/observations (supplementary table 1).

Three of the 4 publications that used healthcare worker report were conducted in LMICs (36, 38, 39). Only 1 of these 4 documented the tool used for monitoring (38), 3 documented the interval of observations (38-40), and 2 described how the daily KMC duration was calculated (38, 39).

The 3 publications that combined caregiver and healthcare worker report documented the tool used to measure KMC duration (29, 31, 32), but only 2 documented the interval of observations, and none explained how the daily duration was computed (29, 32). The publication that used a combination of an electronic device, healthcare worker report, and caregiver report documented the interval of monitoring KMC duration but did not document the tool used or how the daily duration was computed(30). The publications that used independent observers documented the interval of observations and described how the daily KMC duration was computed (33-35).

Validation of the measurement methods

None of the publications with primary KMC duration data validated the method used to measure KMC duration. Only 1 publication measured the accuracy of a new device used to monitor skin to skin contact compared to healthcare worker report and caregiver report (30). Direct observation by healthcare workers was used as the reference standard against which an electronic monitoring device was compared for the purposes of accuracy; however, no validation was conducted. Maternal report was used to test the reliability of the electronic device to capture the duration of KMC at home. Four additional publications verified the consistency of measurements but did not undertake validation of the methods used (25, 29, 31, 38). Two of these studies only compared the agreement between the observation by the healthcare workers and the parents without comparing with the set gold standard(29, 31), while the other two only used a second person to verify entries without calculation of the agreement(25, 38).

Discussion

In this scoping review, we found 213 publications on KMC of which 54 (25%) documented a method for measuring duration. Only 20 (9%) publications provided a detailed description of the KMC duration measurement method, and none reported validity. Most studies with a detailed description used caregiver report (9, 45%) or healthcare worker report (4, 20%). No framework for categorisation of KMC duration measurement methods was identified, and there was a lack of justification for the choice of method used for individual publications.

The observation that most studies did not document methods used to assess KMC duration is in accord with a previous systematic review, which found that more than 85% of studies did not include data on observations of KMC practice, and that 45% lacked a description of KMC initiation and stopping criteria (41). Similarly, a most recent review that generated evidence leading to policy change by WHO found that 19% (5 out of 27) of the included studies did not report on duration of KMC(10).

The lack of reliable measurement for the intervention dose (KMC duration) is an impediment to interpreting the evidence when meta-analyses that combine studies with different KMC measurement methods are used (42, 43). Hence, although it is plausible that higher KMC duration could improve neonatal health outcomes (44, 45), the evidence remains incomplete without more rigorously validated methods for measuring the dose of KMC. This is seen by variations in evidence generated by different reviews where the Cochrane review (2016) found KMC reduction on mortality was only when the daily duration was 20 hours or more(6), while another found significant benefit when daily duration was at least 8 hours(10). There were no published studies on validation of methods used to measure KMC duration. This calls for studies to validate KMC duration measurement methods against a gold standard (a reliable method for continuous monitoring of KMC) to enable accurate data on KMC duration as an exposure, compared to outcomes such as mortality and morbidity. Video recording has been used in skin to skin care studies mainly for short duration like heel pricks procedures where by the camera focuses on the neonate's face not the environment(46, 47). This could be an alternative as a gold standard against which the commonly used methods in KMC studies could be validated. However, for continuous video recording of KMC has ethical challenges like limitations of anonymity, recording other non-research related private experiences of the participants which might cause reluctance of the ethical

committees to allow its use (48). The use of artificial intelligence (AI) platforms like it has been tried in a drug adherence trial could be a best alternative for a gold standard to evaluate the commonly used KMC duration measurement methods (49). This trial utilized visual confirmation of ingestion of the drug by using the AI platform mobile app and the same can be used to confirm skin to skin contact in KMC studies(49).

Although WHO recommends KMC duration of at least 8 hours a day (11), there is limited evidence on the minimum duration of KMC with beneficial clinical effects given that the evidence base used to draw the recommendation found insufficient data on KMC duration less than 8 hours(10). Therefore, standardised operational definitions which could improve this evidence base (41). In addition, our framework could help in guiding the selection and refining of indicators in routine information systems for assessing KMC duration as a marker for the quality of KMC (50). Chan and others have proposed indicators in the KMC measurement framework to include the duration of skin to skin contact (41, 50), and the proposed framework for KMC duration measurement in this review will be helpful for the measurement of this indicator.

Strength and limitations of the study

Strengths

This scoping review had several strengths. It followed Joanna Briggs Institute guidelines and was pre-registered on the Open Science Framework, ensuring transparency and methodological rigor. Two independent reviewers were involved, with a third resolving any disagreements, which minimized bias during study selection and data charting. The search strategy was comprehensive, covering both published and grey literature across multiple databases, with no restrictions on language or publication date. This helped reduce publication bias and expanded the scope of the review. Additionally, support from a clinical research specialist and pilot testing ensured accurate data collection and consistent analysis.

Limitations

The review had several limitations and potential biases. By focusing solely on KMC duration and monitoring, we might have excluded studies on related practices, such as short procedural skin-to-skin care, potentially narrowing the scope and limiting relevant insights. Although the search had no language restrictions, five studies were excluded due to unavailable translations, which could reduce the comprehensiveness of the findings. Additionally, we did not review supplementary materials from included studies might have resulted in the omission of critical information, introducing bias in data interpretation and affecting the overall robustness of the review. These factors may have led to selective inclusion and gaps in the evidence base.

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Conclusion

KMC is a high impact intervention for survival of LBW neonates, but there is limited rigorous evaluation on the duration required. Reliable data on the dose response of KMC depends on the reliability of assessing its duration. This scoping review found most studies of KMC duration (91%) did not describe the methods used, and those that did were mainly reliant on caregiver report or healthcare worker report, both of which have limitations. Clarity is needed in reporting KMC duration measurement methods to increase comparability and rigour, and a validation study of gold standard versus caregiver report and healthcare worker report would be of value.

Conflict of interest

The authors have no conflict of interest declare.

Ethical approval statement

No ethical approval or informed consent was sought as this manuscript does not contain any personal or medical information about an identifiable individual.

Authors' contributions

VST conceptualised the study, wrote the protocol, analysed and interpreted the data, and wrote the first draft of the manuscript. VST, EML, and CJT selected the publications and abstracted the data. MMM, CJT, MN, and JEL interpreted the data and critically revised the manuscript. All authors reviewed the manuscript and approved the final version. VST is responsible for the overall content as the guarantor

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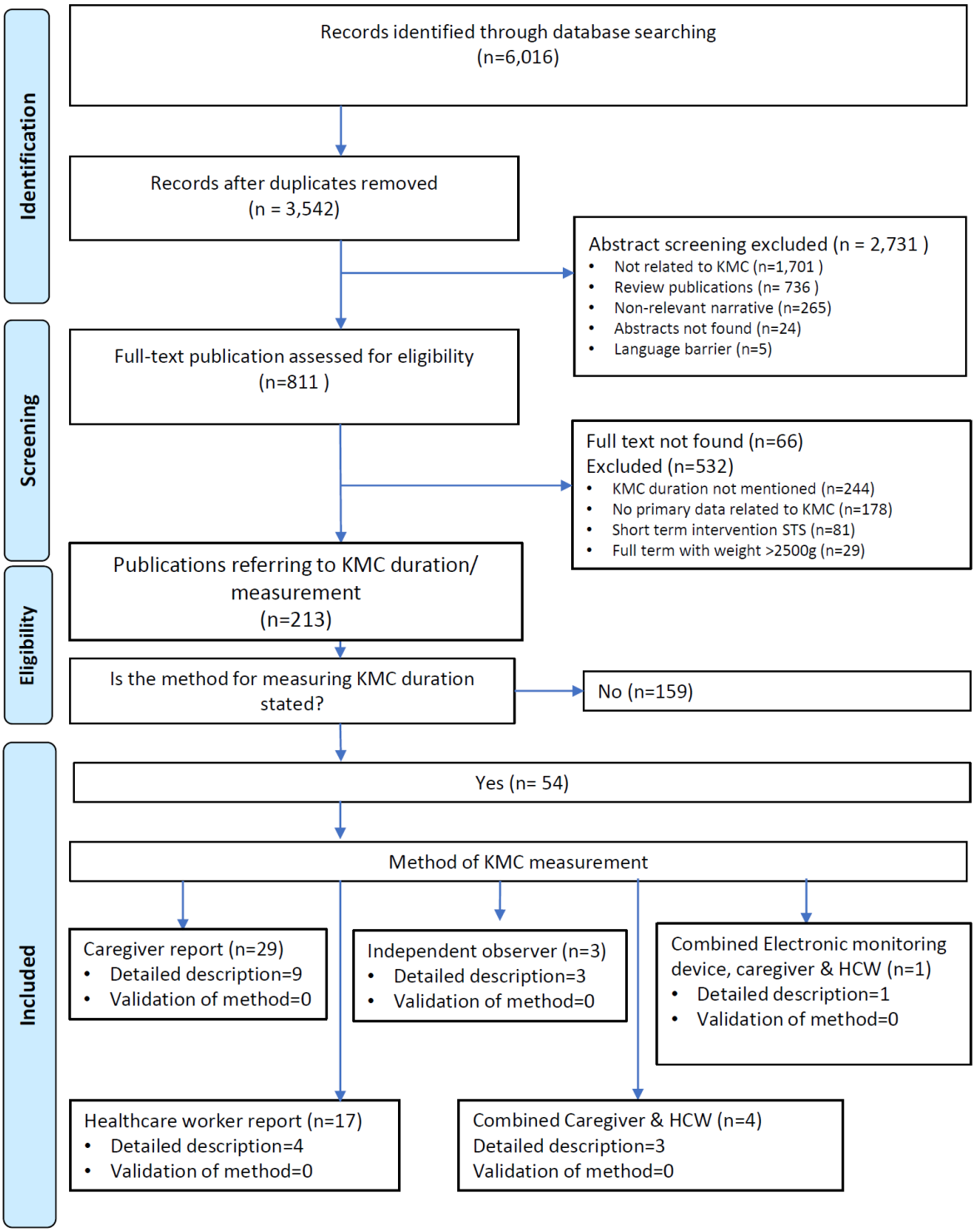
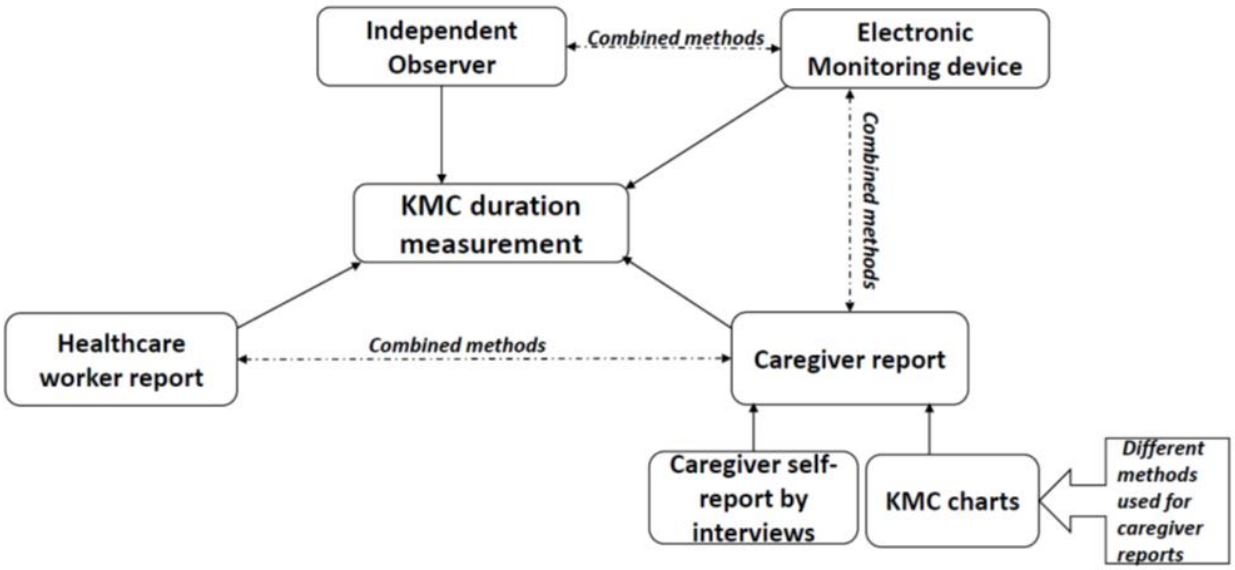
Figure 1: PRISMA flow diagram of search results and study inclusion process



KMC=Kangaroo Mother Care, STS=Skin to Skin, HCW=Health care worker

Figure 2. Proposed framework for categorisation of KMC measurement methods.



Commonly used methods to measure duration of KMC (Kangaroo Mother Care), (◄·····►) = methods used in combination, caregiver reports use self-report or KMC charts and independent observers can be healthcare workers or non-healthcare workers.

Appendix 1: Search strategies

	Ovid MEDLINE(R) **Date: 22/11/2022**	**Results per line**
1	infant, low birth weight/ or infant, small for gestational age/ or infant, very low birth weight/ or infant, extremely low birth weight/ or infant, premature/ or infant, extremely premature/	89966
2	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	123783
3	Premature Birth/	19559
4	(preterm birth$ or premature birth$).mp.	35716
5	shorter gestation.mp.	229
6	preterm pregnancy.mp.	132
7	(sga or lbw or vlbw).mp.	18124
8	or/1-7	164261
9	Kangaroo-Mother Care Method/	688
10	(kangaroo mother care or kangaroo care).mp.	1265
11	skin to skin.mp.	7174
12	or/9-11	7943
13	8 and 12	1106
14	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	374
15	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	151
16	or/13-15	1549

	Embase **Date: 22/11/2022**	**Results per line**
1	low birth weight/ or small for date infant/	56972
2	very low birth weight/ or extremely low birth weight/	17072
3	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	202428
4	prematurity/	119803
5	(preterm birth$ or premature birth$).mp.	41903
6	shorter gestation.mp.	289
7	preterm pregnancy.mp.	204
8	(sga or lbw or vlbw).mp.	27042
9	or/1-8	225402
10	kangaroo care/	1724
11	(kangaroo mother care or kangaroo care).mp.	2070
12	skin to skin.mp.	10333
13	or/10-12	11652
14	9 and 13	1594
15	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	540
16	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	216
17	or/14-16	2217

	APA PsycInfo **Date: 22/11/2022**	**Results per line**
1	Birth Weight/	3453
2	(low birth weight or small for gestational age or small gestational age or small for date infant$ or low birth weight or premature infant$ or premature neonate$ or prematurity or preterm infant$ or preterm neonate$ or premature babies or preterm babies or premature baby or preterm baby or premature newborn$ or preterm newborn$).mp.	10046
3	premature birth/	6254
4	(preterm birth$ or premature birth$).mp.	7931
5	shorter gestation.mp.	42
6	preterm pregnancy.mp.	2
7	(sga or lbw or vlbw).mp.	2008
8	or/1-7	13930
9	(kangaroo mother care or kangaroo care).mp.	183
10	skin to skin.mp.	519
11	or/9-10	615
12	8 and 11	187
13	((monitor$ or measur$ or adher$) adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	56
14	(duration adj10 (kangaroo mother care or kangaroo care or "skin to skin")).mp.	21
15	or/12-14	249

	Cochrane Central Register of Controlled Trials (CENTRAL) and Cochrane Database of Systematic Reviews (CDSR) **Date: 22/11/2022**	**Results per line**
#1	MeSH descriptor: [Infant, Low Birth Weight] explode all trees	2338
#2	MeSH descriptor: [Infant, Premature] explode all trees	4277
#3	"low birth weight" or "small for gestational age" or "small gestational age" or "small for date" NEXT infant* or "low birth weight" or premature NEXT infant* or premature NEXT neonate* or prematurity or preterm NEXT infant* or preterm NEXT neonate* or "premature babies" or "preterm babies" or "premature baby" or "preterm baby" or premature NEXT newborn* or preterm NEXT newborn*	19540
#4	MeSH descriptor: [Premature Birth] this term only	1814
#5	preterm NEXT birth* or premature NEXT birth*	4614
#6	"shorter gestation"	11
#7	"preterm pregnancy"	26
#8	sga or lbw or vlbw	3218
#9	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8	22856
#10	MeSH descriptor: [Kangaroo-Mother Care Method] this term only	111
#11	"kangaroo mother care" or "kangaroo care"	651
#12	"skin to skin contact" or "skin to skin care"	547
#13	#10 or #11 or #12	1002

	Clinicaltrials.gov	**Results**
	Date: 18/11/2022	
	kangaroo OR "skin to skin"	119

	WHO International Clinical Trials Registry Platform (ICTRP)	**Results**
	Date: 18/11/2022	
	kangaroo	203

	The ISRCTN registry	**Results**
	Date: 21/11/2022	
	Kangaroo https://www.isrctn.com/search?q=kangaroo+	12

	Latin American and Caribbean Health Sciences Literature (LILACS)	**Results**
	Date: 21/11/2022	
	Kangaroo	315

	MedRxiv	**Results**
	Date: 21/11/2022	
	“skin to skin”	166

	African Index Medicus	**Results**
	Date: 21/11/2022	
	Kangaroo	9

	Open Grey libraries, references from relevant systematic reviews and websites of the Kangaroo Foundation	**Results**
	Date: 21/11/2022	
	Open Grey libraries: search term “skin to skin” AND Search terms Kangaroo care or kangaroo unit* **References and google scholar:** "kangaroo mother care" or "kangaroo care" OR “skin to skin contact" or "skin to skin care"	175

Table 1. Publications with a detailed description of KMC duration measurement

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
M. J. F. Goudard; 2022	Skin-to-skin contact and deaths in new-borns weighing up to 1800 grams: a cohort study	Observational study; 405	Brazil	Caregiver & Healthcare worker	SSC time was recorded on card by the health team at the beginning, then, parents performed the registration, under the supervision of healthcare workers.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Jegannathan; 2022	Quality improvement initiative to improve the duration of Kangaroo Mother Care in tertiary care neonatal unit of South India	Observational study; 86	India	Caregiver report (KMC charts)	KMC Charts were given to KMC mothers to mark daily hours of KMC by mothers.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Joshi; 2022	Quality improvement in Kangaroo Mother Care: learning from a teaching hospital	Observational study; 86	India: NICU level unknown	Caregiver report (self-report)	The nurse noted the previous day's KMC hours and other information as reported by the mother.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
Nahya Salim; 2021	Kangaroo mother care: EN-BIRTH multi-country validation study	Observational study; 840	Tanzania, Napal & Bangladesh	Independent observer	Observers monitored components of KMC hourly in some settings and 12-hourly in other settings.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented.

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑= Yes ☐=No.

KMC=Kangaroo Mother Care, KC= Kangaroo Care, NICU= Neonatal Intensive Care Unit, EN-BIRTH= Every Newborn Birth Indicators Research Tracking in Hospitals, STS=Skin to Skin, SSC=Skin-to-skin care, HCW=Health care worker, CG=Caregiver

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
E. A. Adejuyigbe; 2021	Impact of continuous Kangaroo Mother Care initiated immediately after birth on survival of newborns with birth weight between 1.0 to < 1.8 kg	RCT; 4200	Ghana, Tanzania, Malawi, Nigeria & India	Independent observer	Information on the duration of SSC contact and the duration of hospital stay was collected by research assistants	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
H. Brotherton; 2021	Impact of early kangaroo mother care versus standard care on survival of mild-moderately unstable new-borns <2000 grams	RCT; 279	The Gambia: NICU level not specified	Healthcare worker report	Research nurses observed and recorded KMC duration and position. Documented timing of each KMC session, KMC provider and reason for coming out of KMC position.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
K. Chavula; 2020	Improving Skin-to-Skin Practice for new-borns in Kangaroo Mother Care in Malawi through the use of a customized baby wrap: A randomized control trial	RCT; 301	Malawi; NICU level II	Caregiver report (self-report)	Mothers reported practicing SSC post-discharge & duration more than half the day and more than half the night post-discharge.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
C. Sahlen Helmer; 2020	A Randomized Trial of Continuous Versus Intermittent Skin-to-Skin Contact After Premature Birth and the Effects on Mother-Infant Interaction	RCT; 31	Sweden; NICU level unknown	Caregiver report (KMC charts)	Parents in continuous SSC documented who provided SSC and whether they were off SSC for any reason. Parents in the intermittent group registered when and for how long they provided SSC.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑*= Yes* ☐*=No.*

KMC=Kangaroo Mother Care, KC= Kangaroo Care, NICU= Neonatal Intensive Care Unit, EN-BIRTH= Every Newborn Birth Indicators Research Tracking in Hospitals, STS=Skin to Skin, SSC=Skin-to-skin care, HCW=Health care worker, CG=Caregiver

First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
B.S. Tandberg; 2018	Parent-Infant Closeness, Parents' Participation, and Nursing Support in Single-Family Room and Open Bay NICUs	Observational; 64	Norway: NICU level unknown	Caregiver report (KMC chart)	Parents recorded the duration of SSC care in a KMC diary. Diary entries were made daily for the first 14 days following inclusion in the study. Parents reported hour by hour during these 14 days.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
S. Rao; 2018	Continuous, real-time monitoring of neonatal position and temperature during Kangaroo Mother Care using a wearable sensor: a techno-feasibility pilot study	Observational; 12	India: NICU level III	Electronic monitoring device, healthcare worker's direct observation & Maternal self-report	Baby's position captured as presence of "touch" between the device and the skin of baby/mother was compared against reported/ observed KMC episodes". In the hospital, the research nurse annotated the starting and ending times of KMC by direct observation. At home KMC duration was self-reported by the mother. Direct observation was the "reference standard" in the hospital against which the device was compared for purposes of validation.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented

Detailed methodological description of; 1) tools used to document KMC duration monitoring, 2) the interval of the observations and, 3) how the total or daily KMC duration was calculated from the observations ☑*= Yes* ☐*=No.*

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
H.C. Watkins; 2018	Observation study showed that the continuity of skin-to-skin contact with low-birthweight infants in Uganda was suboptimal	Observational; 12	Uganda: NICU level II	Independent observer	Continuous observation of infants began after birth and up to day 7 of life, discharge, or death, whichever came first. The total duration of hours spent in SSC was calculated by adding together the durations of all individual SSC sessions on a day. If an infant received at least 8 hours of SSC, it was considered continuous KMC, and any fewer hours of SSC per day was documented as intermittent KMC.	☐ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☑ Calculation of daily KMC duration documented
P. Oras; 2016	Skin-to-skin contact is associated with earlier breastfeeding attainment in preterm infants	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Skin to skin duration was recorded by the parents or by staff on a detailed form. Median daily SSC duration was the data used for the study.	☑ Mention of data collection tool used to record KMC duration. ☐ Interval of observation documented. ☐ Calculation of daily KMC duration documented
A. Soni; 2016	The presence of physician champions improved Kangaroo Mother Care in rural western India	Observational; 648	India: NICU level II	Healthcare worker report	Nursing staff documented KMC duration using a standardized form & recorded information for eight days. The charts were incorporated into the neonate's medical notice updated daily by the nurses and reviewed daily by the physician.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
J. Pervin; 2015	Implementing Kangaroo mother care in a resource-limited setting in rural Bangladesh	Observational; 423	Bangladesh: NICU level I	Healthcare worker report	Nursing attendants noted the beginning and end of every skin-to-skin contact session and calculated skin-to-skin contact time for each session. The times of each session in the 24h period was added together to determine total skin-to-skin contact duration per day.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☑ Calculation of daily KMC duration documented
J. Gonya; 2013	Factors associated with maternal visitation and participation in skin-to-skin care in an all-referral level IIIc NICU	Observational; 32	USA: NICU level III	Caregiver report (KMC chart)	A log was provided to mothers to record when they visited the small baby NICU, if they participated in SSC, how long they participated in SSC, and if there were any issues involved in the SSC process.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
Y.T. Blomqvist; 2013	Initiation and extent of skin-to-skin care at two Swedish neonatal intensive care units	Observational; 104	Sweden: NICU level III	Caregiver report & healthcare worker	Time of initiation of SSC and who provided this care were recorded continuously in the infants' medical charts by either the parents or the NICU staff. The reliability of parents' registrations of the time spent with SSC had been assessed prior to the study.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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First author, year	Publication title	Study design & sample size	Setting: country; level of NICU	Method for KMC duration	Method details	Comments
R. Flacking; 2013	Influence of NICU co-care facilities and skin-to-skin contact on maternal stress in mothers of preterm infants	Mixed methods feasibility study; 300	Sweden: NICU level III	Caregiver report (KMC chart)	Caregivers provided KMC duration self-reports using calendars. Parents marked the initiation and ending of each SSC episode. At the end of the 2-week period, the nurse revisited the mother, collected the calendar and provided a new calendar for the following 2-week period.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Flacking; 2011	Positive Effect of Kangaroo Mother Care on Long-Term Breastfeeding in Very Preterm Infants	Observational; 300	Sweden: NICU level unknown	Caregiver report (KMC chart)	KMC data gathered through self-reports by caregivers in the format of calendars. Parents marked the initiation and ending of each skin-to-skin episode rounded to the nearest 5- or 10-minute interval.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.
G.C. Anderson; 2003	Mother-Newborn Contact in a Randomized Trial of Kangaroo (Skin-to-Skin) Care	RCT; 91	USA: NICU level unknown	Caregiver report (KMC chart)	Contact logs used to document KMC duration (when the contact began and ended) & by whom. Caregivers completed the contact log and researcher verified each entry with the mothers at the end of each 8-hour shift.	☑ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented
R. Feldman; 2003	Skin-to-skin contact (Kangaroo Care) accelerates autonomic and neuro-behavioural maturation in preterm infants	Observational; 70	Israel: NICU level unknown	Healthcare worker report	During KC infants were observed by the nurses who recorded the exact times when the mothers and infants remained in skin-to-skin contact and when the infant returned to standard incubator care.	☐ Mention of data collection tool used to record KMC duration. ☑ Interval of observation documented. ☐ Calculation of daily KMC duration documented.

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