Evaluation of the impact of kangaroo mother care on neonatal mortality and hospitalization: A meta-analysis

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
D – writing the article; E – critical revision of the article; F – final approval of the article

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Abstract

Introduction. The kangaroo mother care (KMC) technique for preterm and low-birthweight (LBW) neonates, which consists of skin-to-skin contact, is thought to have a beneficial impact on clinical outcomes. Hence, the current meta-analysis aims to evaluate the influence of KMC on neonatal mortality and length of hospitalization compared with conventional care.

Materials and methods. A systematic literature search of studies published between 1988 and 2021 found 24 trials involving 19,980 participants, of which 10,354 received KMC and 9626 were controls under conventional care. To measure the impact of applying KMC in preterm LBW neonates on mortality and the length of hospital stay, statistical analysis using dichotomous and continuous analysis methods was performed employing fixed and random models to calculate odds ratios (ORs) with 95% confidence intervals (95% CIs).

Results. Compared to the control group, the application of KMC in preterm LBW neonates resulted in significantly lower mortality (OR: 0.65, 95% CI: 0.44–0.97, $p = 0.03$) in a short term (within 2 months, $I^2 = 71\%$) and long term (3–12 months) (OR: 0.72, 95% CI: 0.59–0.87, $p = 0.0007$, $I^2 = 0\%$), and had no significant impact on the length of hospital stay (OR: –1.43, 95% CI: –2.88–0.02, $p = 0.05$, $I^2 = 86\%$).

Conclusions. In comparison with the control group, the implementation of KMC in preterm LBW neonates resulted in significantly lower mortality but had no significant impact on the length of hospitalization. More studies are needed to confirm the current findings.

Key words: preterm neonates, hospital stay, mortality, kangaroo mother care

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Introduction

Millions of babies are born each year in high-risk conditions around the world. According to the World Health Organization (WHO), these conditions include premature deliveries, newborns who are underweight for their gestational age (SGA), and newborns at risk of illnesses, death or developmental disabilities. Low-birthweight (LBW) newborns are born weighing less than 2500 g, while the term 'prematurity' is used if they are born before 37 weeks of gestation.[1]

Many procedures have been proven to reduce the burden of newborn illnesses and mortality, and are referred to as conventional or modern neonatal care processes. It is expensive and time-consuming to provide conventional newborn care for LBW infants because it necessitates the presence of qualified staff and long-term logistics. A baby's ability to adapt to life outside the womb is complex. In low-income countries, many LBW babies are admitted to hospitals each year because of a lack of financial and human resources dedicated to their care. A significant advance in their care would be made if the new interventions for LBW newborns were found to lower neonatal morbidity and mortality, as well as related expenditures.

The majority of infant deaths occur during the newborn period. Death within the first 28 days of life is believed to have occurred in 2.5 million people last year. Most of these were LBW newborns, with 2/3 of them being premature. The Every Newborn Action Plan launched by the United Nations International Children's Emergency Fund aims to reduce newborn mortality to 12 or below per 1000 live births and to provide kangaroo mother care (KMC) or other humanized care techniques to at least 75% of eligible children.[2]

The KMC is an effective and safe option for clinically stable infants, especially in developing nations in Africa and South Asia, where 12% and 60% of preterm infants are born, respectively.[1,2]

In Bogota, Colombia, in 1978, Rey and Martinez established KMC to encourage the early discharge of LBW, preterm and SGA babies. Overcrowding, lack of equipment, absence of prepared specialists, and high cross-infection rates are some of the reasons for this concept.[2] The KMC is a skin-to-skin contact-based care method for LBW and/or preterm infants at birth that is structured and defined by a protocol. By transferring the ability and responsibility of being the primary caregivers of their newborns to the mothers and families, this program hopes to empower these mothers and families to meet their babies' physical and emotional needs. The KMC includes the following: skin-to-skin contact, breast-to-skin contact, early discharge from the hospital (ideally), social support, and follow-up when it comes to proving the efficacy of KMC.[3–5] Admision criteria for KMC units include the following; infants with low weight under 2500 g, under 37 weeks gestational age, oxygen-dependent infants with oxygen saturation >90%, or those recieving nasal prongs. Studies and clinical trials evaluating KMC have several heterogeneity aspects such as weight of infants, which varied from <1500 g to 2500 g, time of KMC application, mode of application (continuous or intermittent), and length of the follow-up (1–12 months). A review of current evidence is needed to determine if KMC reduces LBW and preterm infants' mortality and the length of their hospital stay.

Objectives

The current study aimed to assess and evaluate the impact of applying the KMC technique in preterm LBW infants care on clinical outcomes such as mortality rate and length of hospitalization.

Materials and methods

Study selection

The main goals of our meta-analysis were to evaluate the effect of KMC application in preterm neonates on neonatal mortality and length of hospitalization compared to controls. Mortality rates and hospital stays from published clinical trials were analyzed using statistical analysis tools such as frequency rate, odds ratio (OR), relative risk, or mean difference (MD) with a 95% confidence interval (95% CI).

Only papers in English were included. The criteria for the inclusion of articles in the current meta-analysis were not constrained by the size of the studies, while studies not describing practical interventions, such as letters to editors, and review articles were excluded from the study. The meta-analysis model is depicted in Fig. 1.

The effect of KMC in preterm LBW neonates on mortality and length of hospital stay was compared to controls by performing a sensitivity analysis for each subcategory.

The inclusion criteria were as follows: 1) Prospective, randomized controlled trials and retrospective investigations

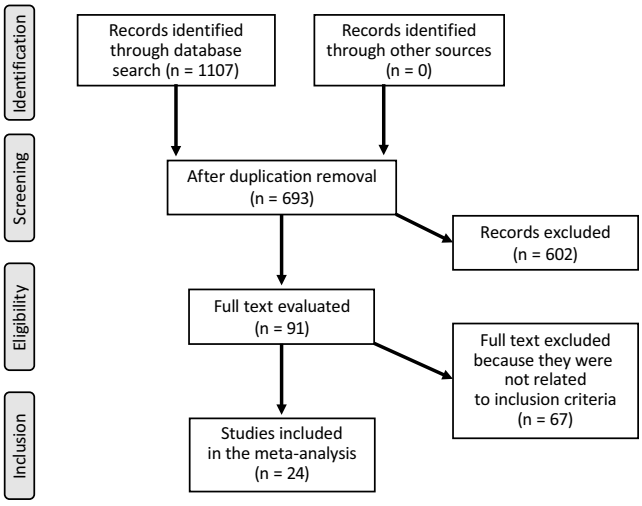

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram reflecting the mode of meta-analysis

were all eligible to be included in the research; 2) Subjects of the studies included preterm/LBW neonates; 3) Interventions used were KMC compared to control receiving conventional care.

The exclusion criteria were as follows: 1) Trials that did not examine the influence of KMC on length of hospital stay or mortality in preterm neonates; 2) Studies lacking parameters such as weight of the neonates; 3) Studies that did not compare the impact of KMC on mortality or hospital stay to conventional care.

Identification

A systematic deep literature search was accomplished using using PubMed, Embase and Cochrane Library. The search was conducted among studies published between 1988 and 2021 using the keywords 'kangaroo mother care', 'mortality', 'hospital stay', and 'preterm neonates', as shown in Table 1. Studies were identified using PICOS framework as follows: P (population) – preterm/LBW neonates; I (intervention/exposure) – KMC; C (comparison): KMC compared to controls; O (outcome) – mortality and hospital stay; S (study design) – randomized clinical trials. To eliminate duplicates, the research studies were grouped using EndNote software (Clarivate Analytics, London, UK). Furthermore, all title and abstract data were subjected to a thorough review to eliminate any information that did not include any risk variables or the influence of KMC on preterm neonates.

Screening

The subject-related and study data were collected using a standard format. The place of practice, first author's surname, subject's weight, design of the study, demographic data, sample size, primary outcome evaluation, treatment mode, duration of the study, categories, methods of statistical analysis, information source, and qualitative as well as quantitative evaluations were also collected using a traditional form.

Using the Cochrane Handbook for Systematic Reviews of Interventions v. 5.1, the Risk of Bias Tool was used to evaluate the quality of each study's methodology.[6]

Different levels of bias risk were used in the assessment

Three levels of bias risks were identified in the evaluation of the studies. When all quality criteria were met, the bias risk was judged low. When the criteria were not satisfied or only partially met, the risk was assessed as moderate. The risk was high in cases where all of the quality criteria were not met or included and when the paper also contained inconsistencies.

Statistical analyses

Using the random and fixed-effect model, the OR with a 95% CI was calculated using a dichotomous technique for mortality at 2 months and 12 months, and

Table 1. Search strategy for each database

Database	Search strategy
PubMed	#1: "kangaroo mother care" [MeSH terms] OR "mortality" [MeSH terms] OR "hospital stay" [all fields] #2: "skin-to-skin contact" [MeSH terms] OR "preterm neonate" [all fields] #3: #1 AND #2
Embase	#1: 'kangaroo mother care'/exp OR hospital stay'/exp OR 'skin-to-skin contact'/exp #2: 'preterm neonate'/exp OR 'mortality'/exp #3: #1 AND #2
Cochrane Library	#1: (kangaroo mother care):ti,ab,kw OR (mortality):ti,ab,kw OR (hospital stay):ti,ab,kw (word variations have been searched) #2: (skin-to-skin contact):ti,ab,kw OR (preterm neonate):ti,ab,kw (word variations have been searched) #3: #1 AND #2

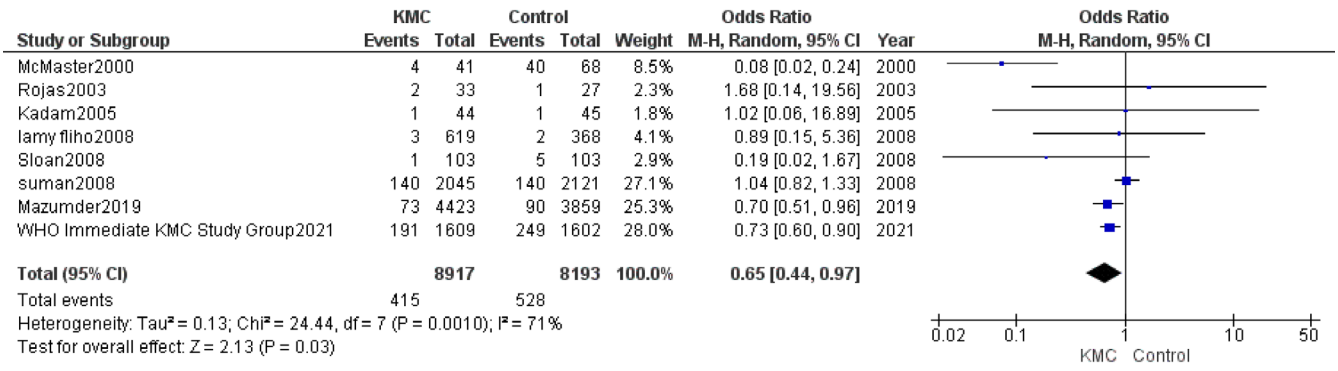

Fig. 2. A forest plot illustrating mortality rates after the application of kangaroo mother care (KMC) compared to controls in preterm neonates during the first 2 months of life

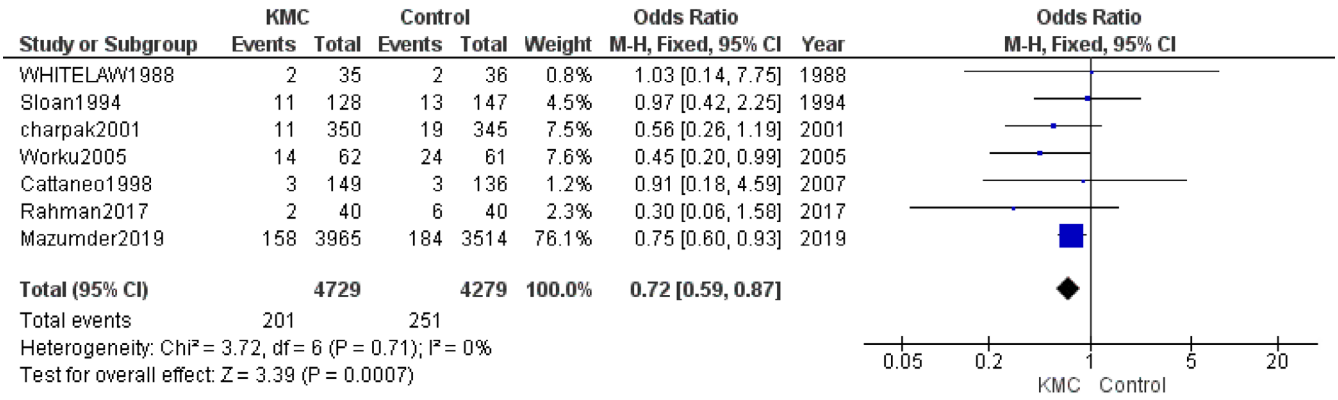

Fig. 3. A forest plot illustrating the mortality rate after the application of kangaroo mother care (KMC) compared to controls in preterm neonates during the 1st year of life

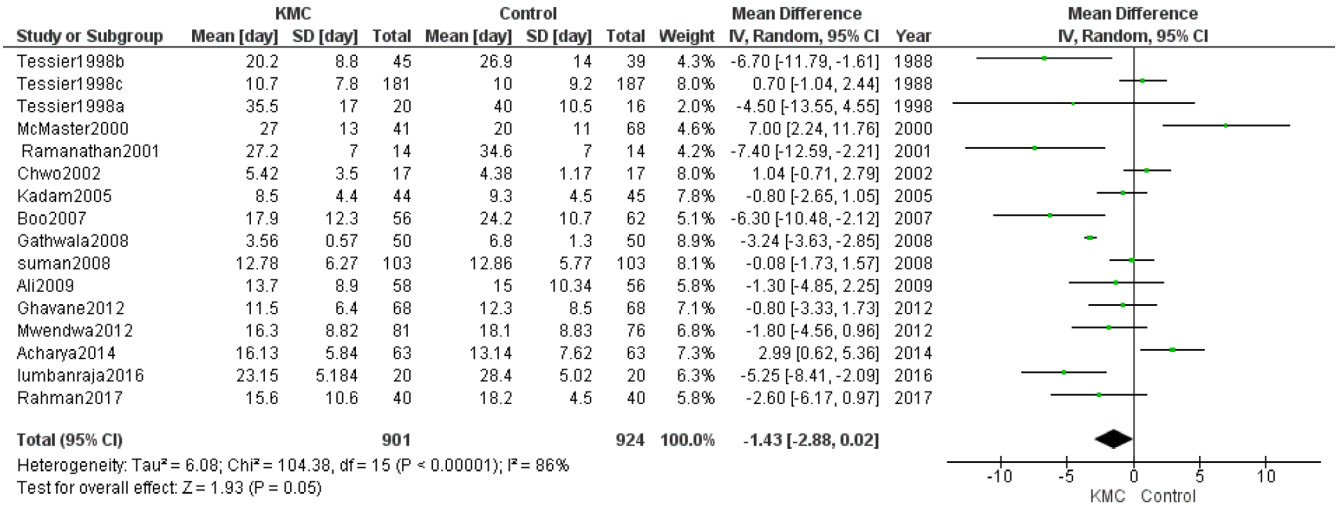

Fig. 4. A forest plot illustrating the length of hospital stay after the application of kangaroo mother care (KMC) compared to controls in preterm neonates

a continuous technique for assessing the length of hospital stay. The I^2 index ranged from 0% to 100%. The heterogeneity scale was 4-point – 0%, 25%, 50%, and 75% – indicating no, low, moderate, and high heterogeneity, respectively. If the I^2 value was 50% or higher, the random effect was taken into account, whereas the possibility of using a fixed influence increased in cases where I^2 was less than 50%. However, other parameters that indicate a high similarity between included studies should be checked to ensure the usefulness of this model. The risk of publication bias was assessed using Begg's test in addition to visual evaluation of funnel plots. The p-values for the rank correlation and regression tests were generated using Jamovi v. 2.2.5 software (https://www.jamovi.org/download.html). Subgroup analysis was conducted to obtain more specific results for articles with 1 or more outcomes and a high similarity between the included articles. The statistical analysis was carried out using two-tailed p-values with Reviewer Manager v. 5.4.1 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark).

Results

Among the 1107 unique reports, the current meta-analysis included 24 studies published between 1988 and 2021 (Table 2).[7–30] The studies chosen for this meta-analysis included 19,980 participants in total, of which 10,354 received KMC and 9626 were controls. The number of subjects included in each study ranged from 28 to 8282.

All studies evaluated the effect of KMC in preterm and LBW neonates on mortality and length of hospital stay. A total of 14 research studies compared data stratified by mortality rate (Fig. 2,3), and also in 14 studies, the data were stratified by length of hospital stay (Fig. 4). As shown in Fig. 2–4, when compared to the control group, the use of KMC in preterm LBW neonates resulted in significantly lower mortality (OR: 0.65, 95% CI: 0.44–0.97), $p < 0.05$) in the short term (within 2 months, $I^2 = 71\%$) and long term (3–12 months, $I^2 = 0\%$, OR: 0.72, 95% CI: 0.59–0.87, $p < 0.001$), but had no significant impact on the length of hospital stay (OR: –1.43, 95% CI: –2.88–0.02, $p = 0.05$, $I^2 = 86\%$).

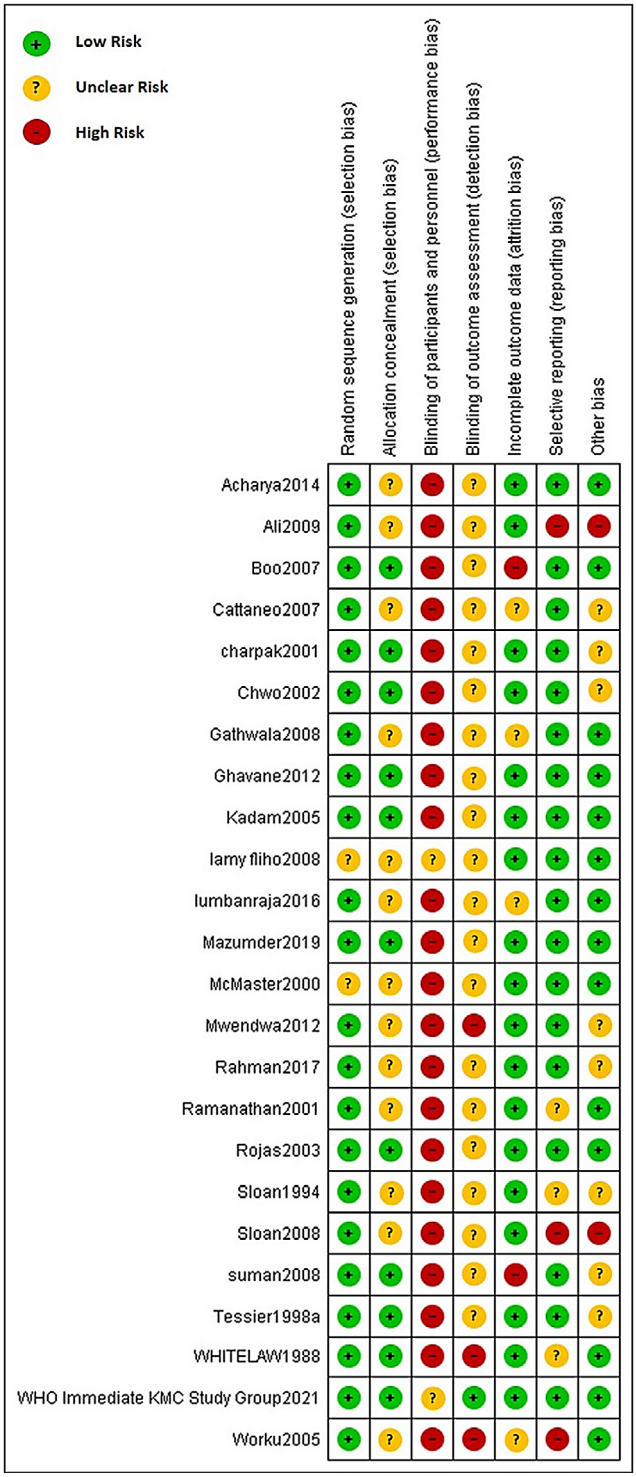

Fig. 5. Risk of bias summary

Included studies did not report findings related to ethnicity and gender, hence these factors were not included in the current meta-analysis. Figure 5 depicts the possibility of bias in the included studies. We concluded that no study adequately covered all 7 domains. There was a wide range in quality between methods employed in the included studies. Insufficient methodological tools were found In a study carried out by Lamy Filho et al.[23] Bias was a problem in 2 studies because of the selective reporting of outcomes.[16,29] We were unable to indentify clear findings in the vast majority of categories listed in the Methods section in the study by Ali et al., such as the severity of disease, sepsis, diarrhea (which can lead to pneumonia), aspiration (which can cause pneumonia), increase in body weight, and the feelings of the mother.[16] Primary outcomes such as neonatal mortality, weight, length, and head circumference at discharge and follow-up were also provided in that study; however, they were not sufficiently recorded. Some secondary outcomes specified in the Methods section of the remaining 3 trials were either not published[10] or were mentioned but not adequately described.[7,28] Block randomization was utilized in 1 study.[16] Using block randomization in an unblinded trial makes it possible to forecast future assignments if the assignments are provided to participants after they have been recruited. This is especially true when blocks are of a set size.

Publication bias assessment

Publication bias was assessed for mortality and length of hospital stay. Regarding the length of hospital stay (Begg's $p = 0.09$), publication bias was evident as the p-value was low compared to the other groups. Funnel plots showed evidence of bias for both length of hospital stay and mortality at 2 months (Fig. 6B,C). On the other hand, no evidence of publication bias was noted for mortality during the first 2 months using the Begg's test ($p = 0.72$). Similarly, no evidence of publication bias was found for mortality at 12 months (Begg's $p = 0.77$) as seen on visual inspection of the funnel plot (Fig. 6B)

Discussion

Our meta-analysis involved 24 studies with 19,980 participants consisting of 10,354 patients receiving KMC and 9626 as controls.[7–30] When compared to the control group, the application of KMC resulted in considerably lower mortality ($p < 0.05$ and $p < 0.001$ at 2 months and after 12 months, respectively). However, because some of the included studies had small sample sizes (7 studies had a sample size of less than 100 subjects), careful analysis of the results is required, and the need for future trials to confirm these findings and assess the impact of KMC is obvious.

The primary goal of the current study was to evaluate the impact of KMC in preterm and LBW neonates on mortality during the first 2 months and long-term mortality (3–12 months) as well as the length of hospital stay.

In 8 studies reporting on mortality during the first 2 months of the neonate's life, a significant ($p < 0.05$) decrease in mortality in the KMC group (OR: 0.65, 95 % CI: 0.44–0.97, $I^2 = 71\%$) was recorded. In 7 studies reporting on mortality between 3 and 12 months of life, a greater

Table 2. Characteristics of the studies selected for the meta-analysis

Study and reference	Year	Country	Total	KMC	Control	Weight
Whitelaw et al. [7]	1988	UK	71	35	36	<1500
Tessier et al. [8]	1998	Colombia	488	246	242	all infants
McMaster et al. [9]	2000	Papua New Guinea	109	41	68	<1500
Ramanathan et al. [10]	2001	India	28	14	14	<1500
Chwo et al. [11]	2002	Taiwan	34	17	17	all infants
Kadam et al. [12]	2005	India	89	44	45	<1800
Boo et al. [13]	2007	Malaysia	118	56	62	<1501
Gathwala et al. [14]	2008	India	100	50	50	≤1800
Suman et al. [15]	2008	India	206	103	103	<2000
Ali et al. [16]	2009	India	114	58	56	≤1800
Ghavane et al. [17]	2012	India	136	68	68	<1500
Mwendwa et al. [18]	2012	Kenya	157	81	76	≤1750
Acharya et al. [19]	2014	Nepal	126	63	63	<2000
Lumbanraja et al. [20]	2016	Indonesia	40	20	20	<2500
Rahman et al. [21]	2017	Bangladesh	80	40	40	<1800
Rojas et al. [22]	2003	USA	60	33	27	≤1500
Lamy Filho et al. [23]	2008	Brazil	987	619	368	<1750
Sloan et al. [24]	2008	Ecuador	4166	2045	2121	all infants
Mazumder et al. [25]	2019	India	8282	4423	3859	1500–2250
WHO Immediate KMC Study Group [26]	2021	Ghana, India, Malawi, Nigeria, Tanzania	3211	1609	1602	<1800
Cattaneo et al. [27]	1998	Ethiopia, Indonesia, Mexico	285	149	136	<2000
Charpak et al. [30]	2001	Colombia	695	350	345	<2000
Worku et al. [29]	2005	Ethiopia	123	62	61	<2000
Sloan et al. [28]	1994	Bangladesh	275	128	147	<2000
Total			19,980	10,354	9626	–

KMC – kangaroo mother care.

reduction in mortality ($p < 0.001$) was seen in the KMC group compared to controls (OR: 0.72, 95% CI: 0.59–0.87, $I^2 = 0\%$, Fig. 2,3). Regarding the length of hospital stay, there was no significant difference ($p = 0.05$) between both groups of neonates (OR: –1.43, 95% CI: –2.88–0.02, $I^2 = 86\%$; Fig. 4). Although the current meta-analysis found no significant impact of KMC on the length of hospital stay, additional studies are needed to more accurately evaluate this factor. No significant variations in death rates were found in regard to the region of the world, country and level of economic development. The reduction in newborn mortality rate was found to be a result of KMC use.

A modest reduction in neonatal morbidity, improved quality of mother-to-child bonding, and shorter hospital stay with lower expenses are all reasons for the use of KMC in LBW children. If a newborn care facility is unavailable, some researchers believe that KMC is the best alternative, and in overpopulated nurseries, the use of KMC could free up incubators for sicker infants.[31]

Six studies tested the impact of KMC on the length of hospital stay (n = 512) in LBW (<1501 g) neonates and found no significant difference ($p > 0.05$) between the KMC and the control group. This non-significant impact could be due to the high heterogeneity of the studies ($I^2 = 86\%$). The KMC group had a longer hospital stay according to Acharya et al.[19] However, this could have been a result of the discharge criteria used in that study (weight >1600 g), as well as the fact that babies in the control group weighed more than those in the intervention group. Studies with longer follow-up periods reported more significant findings reflecting the positive impact of using KMC. The KMC employed for more than 6 h had no significant impact on the clinical status of included subjects. In addition, KMC was linked to a statistically non-significant decrease in the probability of apnea compared to standard treatment. The number of subjects per study had a great impact on the conclusion of 2 studies included in our review,[25,26] and had more than a 50% impact on KMC use on mortality during the 1st month after birth. Heterogeneity ($I^2 = 0$) was absent when evaluating the impact of KMC compared to the control group on mortality during the 1st year after birth.

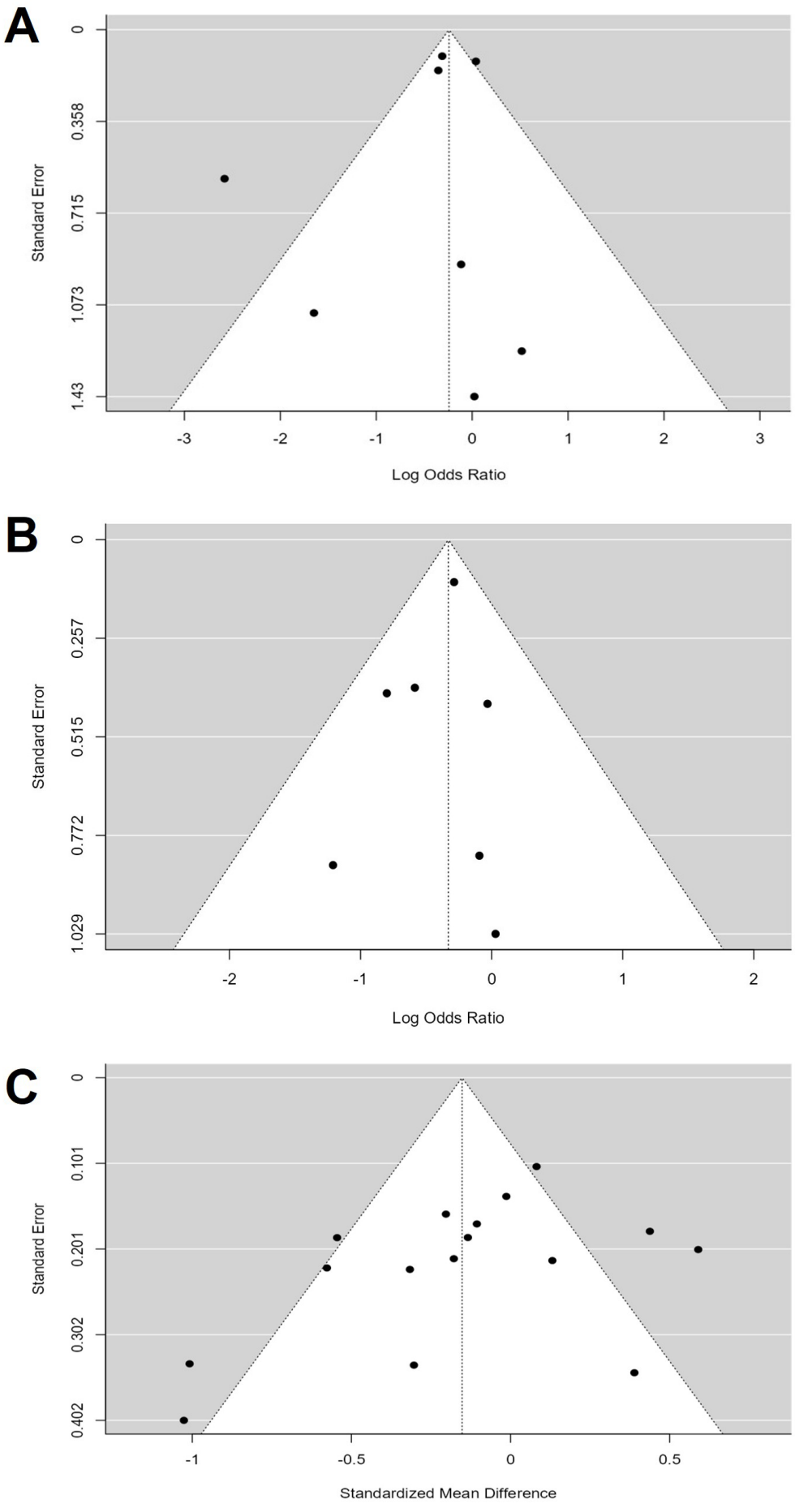

Fig. 6. Funnel plot showing the publication bias of the included studies for mortality during the first 2 months (A), 1st year (B) as well as for the length of hospital stay (C)

Finally, the KMC technique has been shown to have a beneficial impact on preterm/LBW neonates regarding clinical outcomes such as mortality rates, which were significantly lower than when conventional care technique was employed. However, no positive impact of KMC was observed on the length of hospitalization in preterm/LBW neonates.

Limitations

One of the drawbacks of the present study was that there were many biases as numerous papers were eliminated from the current meta-analysis because they did not match the inclusion criteria. Furthermore, there was some skepticism about how to include ethnicity, economical level and gender of the neonates into this study. Because only data from prior studies were used, the analysis may have been skewed because of missing information. The meta-analysis included 24 studies, 7 of which were small (under 100 participants). The incomplete presentation of finding in the included articles could be the source of bias in studies include in the present meta-analysis. In addition, the participants' weight varied among different studies.

Conclusions

This meta-analysis showed that the KMC technique has been proven to have a beneficial impact on preterm/LBW neonates regarding clinical outcomes such as mortality rates, which were significantly lower than in neonates receiving conventional care. However, no positive impact of KMC was noted on the length of hospitalization. Additionally, our meta-analysis was unable to demonstrate a connection between the results of analyzed studies and population characteristics such as economic level of the country of residence, ethnicity and gender. Because of the small sample size in some of the studies, additional investigations are needed to validate these findings and increase confidence in the effects of KMC.

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