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REVIEW ARTICLE

Effect of Kangaroo Mother Care on Successful Breastfeeding: A Systematic Review and Meta-Analysis of Randomised Controlled Trials

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ARTICLE HISTORY

Received: June 19, 2018
Revised: September 15, 2018
Accepted: September 18, 2018

DOI:
10.2174/1574887113666180924165844

Abstract: ***Background & Aims*:** Evaluating the effect of Kangaroo Mother Care (KMC) on breastfeeding success shows conflicting results. Regarding the importance of breastfeeding and uncertainties about its effect, this study intended to conduct a systematic review and meta-analysis of randomised controlled trials on the effect of KMC on success of breastfeeding.

***Methods*:** In this systematic review and meta-analysis study, required data were collected by searching the following keywords: breastfeeding, Breast-Feeding, "skin-to-skin", "Kangaroo Mother Care", randomized clinical trial. The following databases were searched: Google Scholar, PubMed, EMBASE, Scopus, and Cochrane Central Register of Controlled Trials. Two authors independently extracted the data. To estimate the Breast-Feeding outcome variables, CMA2 software was used. The risk of bias of studies was assessed with the criteria developed in the Cochrane Handbook.

***Results*:** Twenty articles were included. In the KMC and CNC groups, 1,432 and 1,410 neonates were examined. Breastfeeding success rate was higher in the KMC group within different time slots, however this difference was not statistically significant (RR=1.11(95CI, 0.93-1.34) and RR=1.13(95%CI, 0.92-1.34) based on the time slot and birth weight, respectively). The inter-groups differences in the mean scores of Infant Breast-Feeding Assessment Tool (IBFAT) were statistically significant (P<0.05). Breastfeeding was initiated very sooner in the KMC group, suggesting a statistically significant inter-groups difference -0.72(95%CI, from -0.92 to -0.53) (P<0.05). Majority of the studies had a high risk of bias.

***Conclusion*:** Findings indicated a superiority of KMC over CNC in terms of breastfeeding success. Assessment of the complications and costs of KMC implementation is recommended.

Keywords: Breastfeeding, conventional neonatal care, kangaroo mother care, randomized clinical trial, skin-to-skin, systematic review.

1. INTRODUCTION

Breast milk is a complex biological liquid and an ideal food for neonates [1]. Therefore, exclusive breastfeeding is recommended for the first six-month of life, along with complementary foods up to two years of age [2]. Despite this, recent reduction in the prevalence of breastfeeding has become a major public health issue [3]. Since 2007, the World Health Organization (WHO), along with UNICEF has come up with the slogan of the World Breastfeeding Week, focusing on the importance of initiating breastfeeding within the early hours of life. They emphasize that if all mothers have skin-to-skin contact with their neonates within the first hours of life and breastfeed them for six months, more than one million neonates will be survived, worldwide [4, 5].

Among the most important factors in breastfeeding is midwifery care and interventions, including mother-neonate separation immediately after birth, which can exert adverse impacts on breastfeeding success rate [6]. To alleviate this problem, Kangaroo Mother Care (KMC) technique has been proposed by WHO. It is a type of neonatal care practice, in which the neonate is carried while having a skin-to-skin contact with the mother [7].

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Table 1. Inclusion and excluded criteria for selection of studies.

inclusion Criteria (PICOTS)	Excluded Criteria
Population: mother and baby pairs	Articles published in non-English language
Intervention: Kangaroo Mother Care (skin-to-skin contact)	community-based articles
Comparison: Conventional Neonatal Care (CNC)	Pilots study articles
Outcome: Primary: exclusive or partial breastfeeding (%) Secondary: Infant Breast-Feeding Assessment Tool (IBFAT) score and mean time to first breast feed (min).	Articles with less than 10 sample size
Time: 0 day to 18 month after intervention	Articles published earlier than 1January 2000
Study design: randomized controlled trial studies	Specific kind of articles (conference presentations, case reports and qualitative studies)

Research findings about the effect of KMC on breast-feeding success imply several confusions. Regarding the importance of breastfeeding and uncertainties concerning its effect, systematic review of research findings can point to conclusions that are more definitive. Therefore, this study intended to conduct a systematic review and meta-analysis of previous clinical trials on the effect of KMC on breastfeeding success rate compared to the Conventional Neonatal Care (CNC).

2. METHODS AND MATERIALS

This systematic review and Meta-Analysis study was conducted using the approach of systematic review adopted from the book entitled "A Systematic Review to Support Evidence-Based Medicine" [8] as well as in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [9-11].

2.1. Eligibility Criteria

The inclusion and exclusion criteria are summarized in Table **1**.

2.2. Information Sources and Search Strategy

Articles were collected through searching the following keywords; breastfeeding, Breast-Feeding, "skin-to-skin", "Kangaroo Mother Care", randomized clinical trial. The following databases were searched: Google Scholar, PubMed, EMBASE, Scopus, and Cochrane Central Register of Controlled Trials. Some of the relevant journals and websites were searched manually. Reference lists of the selected articles were also checked. We also conducted the gray literature and did expert contact.

2.3. Review Process

In the first phase of the review process, two extraction tables (one for characteristics of participant and one for Breastfeeding outcome variables) were designed in which the following items were included:

2.3.1. Characteristics of Participant

The variables were: first author's name, year of publication, country, sample size, Gestational Age (week), Birth Weight(gr), Delivery type (% of cesarean), KMC Duration per day (hours), KMC initiation time.

2.3.2. Breast-Feeding Outcome Variables

The variables were: first author's name, year of publication, exclusive or partial breastfeeding (%), Infant Breast-Feeding Assessment Tool (IBFAT) score and mean time to initiate first breastfeed (min).

The validity of the data extraction table was improved by obstetricians and midwifery experts. Also a pilot study was conducted for improvement of the extraction table. Two authors who had enough knowledge about subject independently extracted the data.

2.4. Assessment of Risk of Bias

The risk of biasness in the included studies was assessed by two reviewers with the criteria developed by the Cochrane Handbook [12]. This tool included six factors of risk of bias: Sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and other sources of bias. The result of risk of bias assessment with this tool included: low risk of bias, high risk of bias and unclear or unknown. Controversies between these two reviewers were referred to a third author.

2.5. Data Analysis

To estimate the Breast-Feeding outcome variables, CMA2 (Comprehensive Meta-Analysis) (Englewood, NJ, USA) software was applied. For reporting the results, forest plot was used. The sample size is shown in the forest plot by the size of each square. Confidence Interval (CI) is shown by lines on each side of the square. Breast-Feeding outcome variables were calculated based on the fixed effect model with 95% CI. Heterogeneity of the study's results was assessed by I^2 ($I^2 \geq 50\%$ indicate Heterogeneity). Funnel plot was used to evaluate the possibility of publication bias.

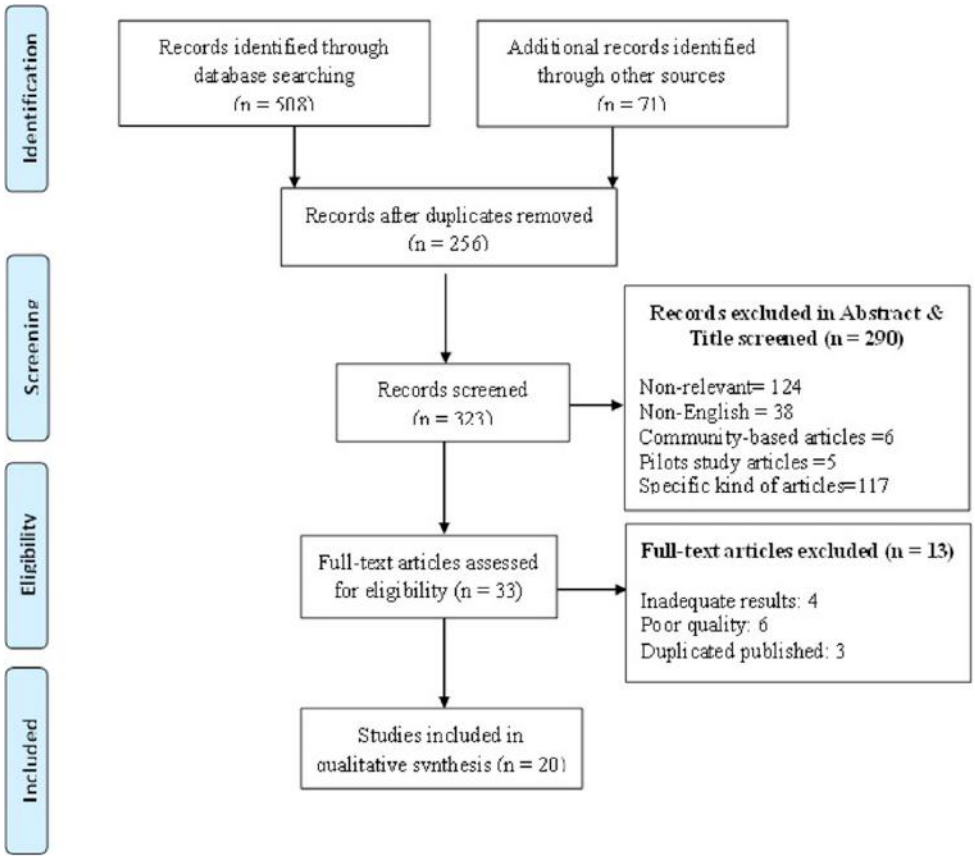

Fig. (1). Search and inclusion process.

3. RESULTS

Out of 579 articles, finally, 20 articles were completely related to the study aim and included in the analysis (Fig. **1**).

As seen in Fig. (**1**), 323 articles excluded due to database duplication. In the next phase, abstracts and titles were reviewed and 290 articles were excluded and in full texts review phase, 13 further articles excluded.

Participants/studies characteristics and breastfeeding variables are presented in Tables **2** and **3**, respectively. Studies reviewed by this study had been conducted in 12 countries, mainly in India and the United States of America. In the KMC and CNC groups, 1,432 (71.6 person/per study, on average) and 1,410 (70.5 person/per study, on average) individuals were examined. The average gestational age of all participants was 34.8 weeks. The mean birth weight was 2,312±927.4gr and 2,300.1±892.6gr in the KMC and CNC groups, respectively. Almost 48.1% of deliveries were done through cesarean. The mean length of KMC was nearly 3.5 hours per day (Since the total duration of the interventions was not mentioned in the majority of studies, the calculation of the total duration of KMC was not possible). In 11 studies, KMC was initiated immediately after birth. Other studies did not either indicate the KMC initiation time or initiate immediately after birth.

Breastfeeding success rates in the KMC group at discharge (T1), from discharge to the third month (T2), between the third and sixth months (T3), after the sixth month (T4), and in total were 89%, 64%, 49%, 31%, and 69%, respectively (Appendix I). Breastfeeding success rates in the CNC group at discharge, from discharge to the third month, between the third and sixth months, after the sixth month, and in total were 84%, 63%, 45%, 30%, and 63%, respectively (Appendix II). In the KMC group, breastfeeding success rates in the very low (1001-1500g; W1), low (1501-2500g; W2), and normal (more than 2501g; W3) birth weight neonates, and in total were 67%, 66%, 77%, and 70%, respectively (Appendix III). In the CNC group, breastfeeding success rates in the very low, low, and normal birth weight neonates and in total were 60%, 61%, 67%, and 63%, respectively (Appendix IV).

In total, the difference in risk ratio for breastfeeding success was 1.11(95CI, 0.93-1.34) and 1.13(95%CI, 0.92-1.34), based on the time slot and birth weight, respectively (Figs. **2** and **3**).

Results from heterogeneity measurement and inter-groups difference in risk ratio for breastfeeding success rate are summarized in Table **4**, based on the time slot and birth weight. Based on the time slot, the least difference was observed after the sixth month. In terms of the birth weight, the least difference was observed among the low birth weight group (1,501<W2<2,500). Heterogeneity measurement results indicated very low heterogeneity, which is due to great consistency between study results. The inter-groups differences in terms of the time slot and birth weight were not significant ($p<0.05$).

IBFAT was used only in three studies. According to the results, difference in the mean IBFAT scores was

Table 2. Characteristics of the participants/ included studies.

Author : Year	Country	Participants (N)		Gestational Age (Week)		Birth Weight(gm)		Delivery Type (% of Cesarean)	KMC Duration Per Day (Hours)	KMC start
		KMC	CNC	KMC	CNC	KMC	CNC			
1. Roberts *et al*. 2000 [13]	Australia	16	14	31.7	31.2	1562	1481	77	1.6	-
2. Carfoot *et al*. 2005[14]	UK	102	102	>38	>38	-	-	28	-	immediately
3. Morelius *et al*. 2015[15]	Sweden	18	19	32-35	32-35	2468	2512	-	19.6 h	immediately
4. Charpak *et al*. 2001[16]	France	382	364	≤32:36 ≥32:64	≤32:30 ≥32:70	1705	1735	68	24 hours/day	-
5. Thukral *et al*. 2012[17]	India	20	21	38	38	2841	2755	0	2 h	immediately
6. Roberts *et al*. 2000 [13]	Iran	47	45	38.2	38.3	3121.7	3237.5	0	2h	immediately
7. Carfoot *et al*. 2005[14]	India	30	30	35.4	35.9	1815.5	1859	-	8 h	immediately
8. Morelius *et al*. 2015[15]	India	50	50	35.4	35	1690	1690	-	6h	-
9. Charpak *et al*. 2001[16]	Pakistan	80	80	38.9	38.9	3058	3036	0	-	-
10. Thukral *et al*. 2012[17]	India	122	118	27.1	27.8	3004.7	2994.3	-	2 h	immediately
11. Aghdas *et al*. 2014[18]	India	68	68	30.8	30.7	1170	1198	86.5	8 h	-
12. Ghavane *et al*. 2012[19]	India	14	14	30.4	30.9	1219	1270.9	46.4	4h	-
13. Gathwala *et al*. 2010[20]	Madagascar	29	26	36.8	36	2082.2	2074.3	25.3	-	immediately
14. Mahmood *et al*. 2011[21]	Spain	118	120	38.9	39.1	3166.2	3300.1	-	2h	immediately
15. Srivastava *et al*. 2014[22]	US	10	10	39.8	39.7	3734	3341	-	2h	immediately
16. Ghavane *et al*. 2012[23]	Malaysia	64	62	31	30.4	1198	1206	67.5	1h	immediately
17. Ramanathan *et al*. 2001[24]	Italy	17	17	38.6	38.6	3409	3305	100	2h	Not immediately
18. Nagai *et al*. 2011[25]	UK	182	187	39.2	39.1	3469	3469	100	1h	during the first 48 hours
19. Gabriel *et al*. 2010[26]	US	27	33	26.6	27.2	906	939	-	8h	-
20. Moore and Anderson 2007 [27]	US	36	30	-	-	-	-	27.5	-	immediately

KMC: Kangaroo Mother Care
CNC: Conventional Neonatal Care

Table 3. Breast-Feeding outcome variables data.

Author : Year	Exclusive or Partial Succesful Breastfeeding (%)		IBFAT		Mean Time to First Breast Feed (min)	
	KMC	CNC	KMC	CNC	KMC	CNC
1. Roberts *et al*. 2000 [13]	Discharge:62.5 6 w:56.2 3 m:43.7 6 m:25	Discharge:78.5 6 w:42.8 3 m:28.5 6 m:28.5	-	-	-	-
2. Carfoot *et al*. 2005[14]	Discharge:91 4m:43	Discharge:83 4m:40	-	-	46±22.2	45±22.8
3. Morelius *et al*. 2015[15]	Discharge:100 1m:94.4 4m:76.5	Discharge:84.2 1m:73.7 4m:53.3	-	-	-	-
4. Charpak *et al*. 2001[16]	Discharge:98 3 m: 81.7 6 m: 51.6 9 m: 36.3 12m:19.7	Discharge:93.3 3 m:75.3 6 m:48.2 9 m:34.8 12m:22.2	-	-	-	-
5. Thukral *et al*. 2012[17]	48 h: 95 6 w: 90	48 h: 38.1 6 w: 28.6	-	-	-	-
6. Aghdas *et al*. 2014[18]	56.6	35.6	-	-	21.9±9.1	66.5±20.7
7. Ghavane *et al*. 2012[19]	42 w: 83.3	42 w: 66.7	-	-	-	-
8. Gathwala *et al*. 2010[20]	3 m: 88	3 m: 72	-	-	-	-
9. Mahmood *et al*. 2011[21]	1m: 58.8	1m: 32.5	-	-	40.6±10.5	101.8±67.9
10. Srivastava *et al*. 2014[22]	4 or 5 days: 86.1 6 w: 85.2	4 or 5 days: 66.9 6 w: 63.6	9.55±1.14	6.71±1.89	-	-
11. Ghavane *et al*. 2012[23]	85.9	87	-	-	-	-
12. Ramanathan *et al*. 2001[24]	6 w: 85.7	6 w:42.8	-	-	-	-
13. Nagai *et al*. 2011[25]	6 m: 41.4	6 m: 15.4	-	-	-	-
14. Gabriel *et al*. 2010[26]	Discharge: 99.2 1 m: 91.5	Discharge: 95.8 1 m: 90.3	-	-	-	-
15. Moore and Anderson 2007 [27]	-	-	8.7±2.1	6.3±2.5	-	-
16. Boo and Jamli 2007[28]	discharge: 29.7	discharge: 14.5	-	-	-	-
17. Gouchon *et al*. 2010[29]	Discharge:76.4 3 m:64.7	Discharge:64.7 3 m:47	9.2 ±3.8	8.2 ± 3.2	22 ± 8	43 ± 67
18. Gregson *et al*. 2016[30]	48 hours: 88 10 days: 69 6 w: 53	48 hours: 83 10 days: 69 6 w: 46	-	-	-	-
19. Rojas *et al*. 2003[31]	Discharge:60	Discharge:35	-	-	-	-
20.Hake-Brooks and Anderson 2008[32]	Discharge:83.3 6 w:63.6 3 m: 47.2 6 m: 33.3 12m:13.9 18 m:11.1	Discharge:70 6 w:50 3 m: 40 6 m: 10 12m:6.9 18 m:6.9	-	-	-	-

KMC: Kangaroo Mother Care
CNC: Conventional Neonatal Care
W: weeks
M: Month
IBFAT: Breast-Feeding Assessment Tool

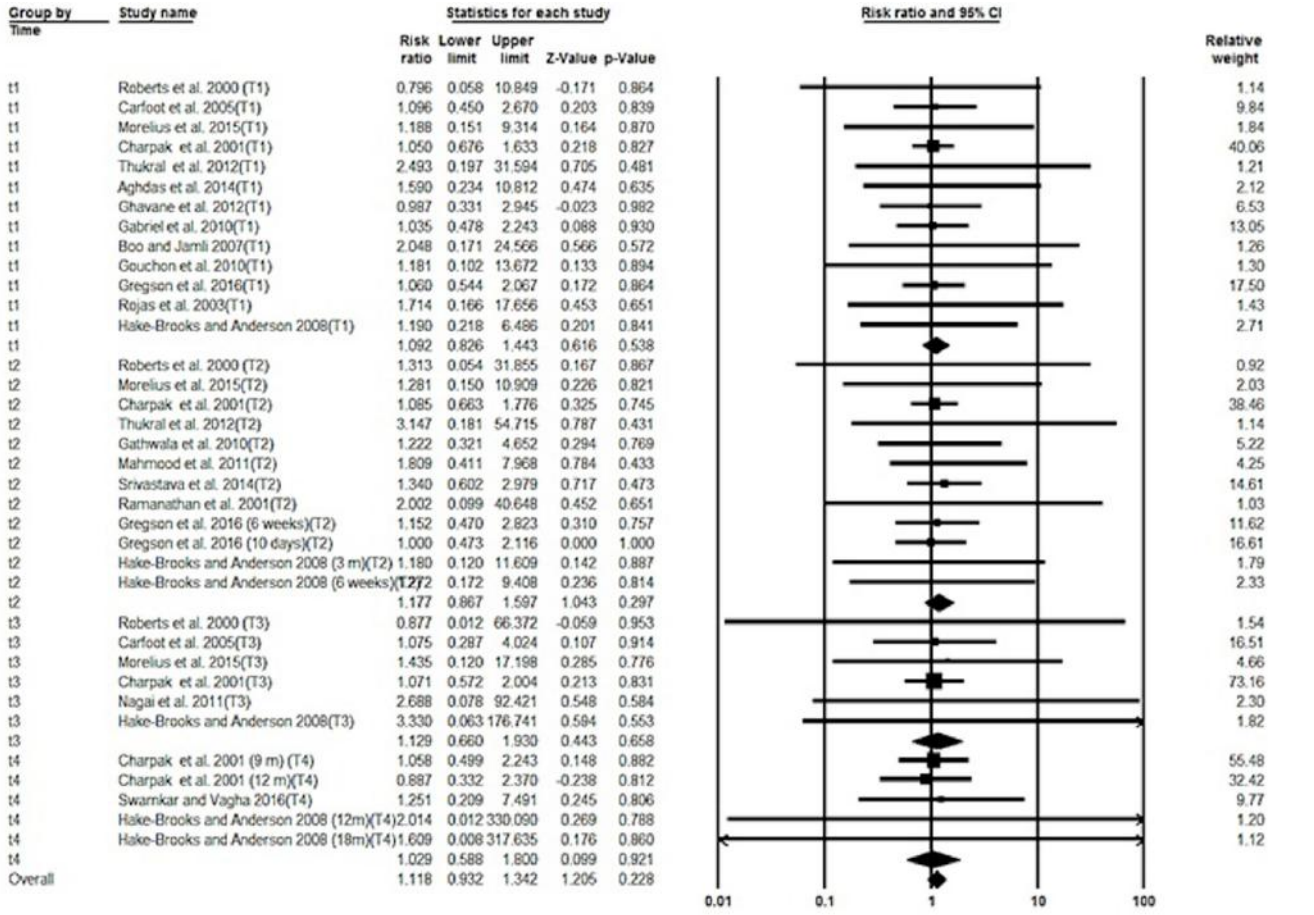

Fig. (2). Difference between Kangaroo Mother Care (KMC) and Conventional Neonatal Care (CNC) in risk ratio for breastfeeding success based on time slot.

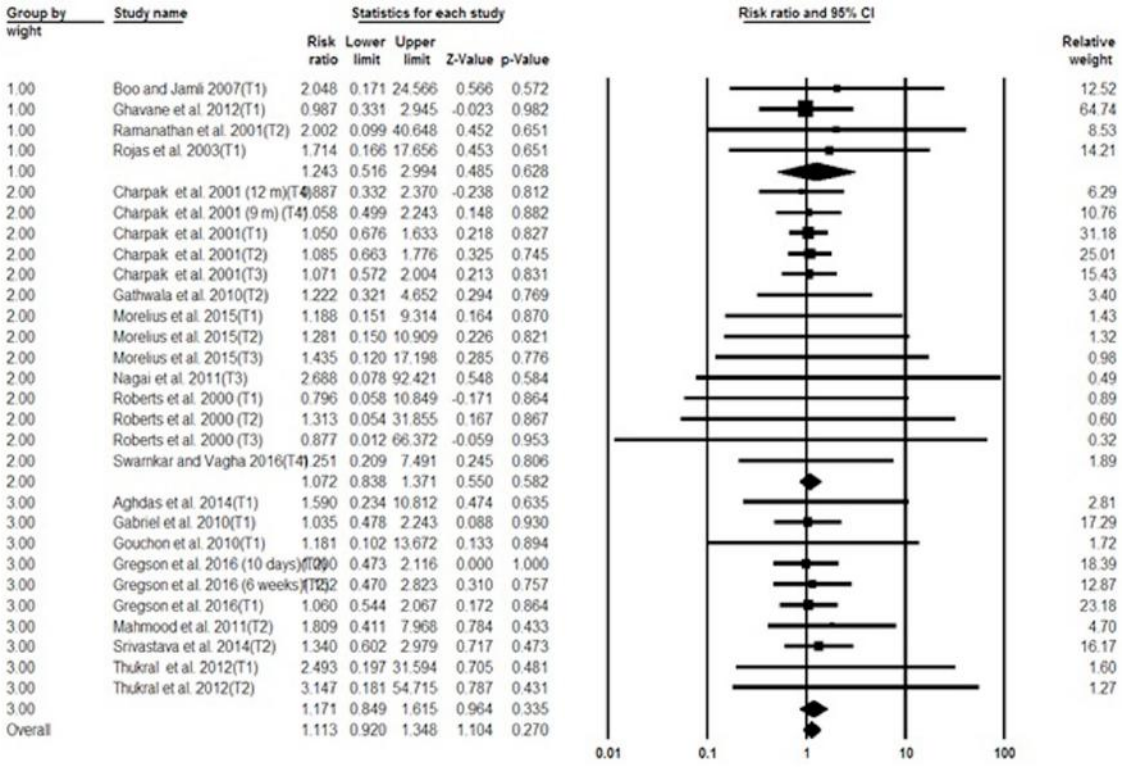

Fig. (3). Difference between Kangaroo Mother Care (KMC) and Conventional Neonatal Care (CNC) in risk ratio for breastfeeding success based on birth weight.

Table 4. Results of heterogeneity tests and Risk Ratio between Kangaroo Mother Care (KMC) and Conventional Neonatal Care (CNC).

Variables	Levels of Variable	Risk Ratio [Lower Limit-Upper Limit 95% CI]	Heterogeneity			
			df	Q	I^2	P-value
Time	T1< Discharge	1.09[0.88-1.44]	12	0.79	0	1
	Discharge <T2<3 m	1.77[0.88-1.59]	11	1.2	0	1
	3m<T3<6m	1.12[0.66-1.93]	5	0.55	0	0.99
	T4M>6m	1.02 [0.58-1.80]	4	0.24	0	0.99
	overall	1.11[0.93-1.34]	35	3.78	0	1
weight	1001<W1<1500	1.24[0.51-2.99]	3	0.48	0	0.92
	1501<W2<2500	1.07[0.83-1.37]	13	0.64	0	1
	W3>2501	1.17[0.84--1.61]	9	0.68	0	0.99
	overall	1.11[0.92-1.34]	27	3.08	0	1

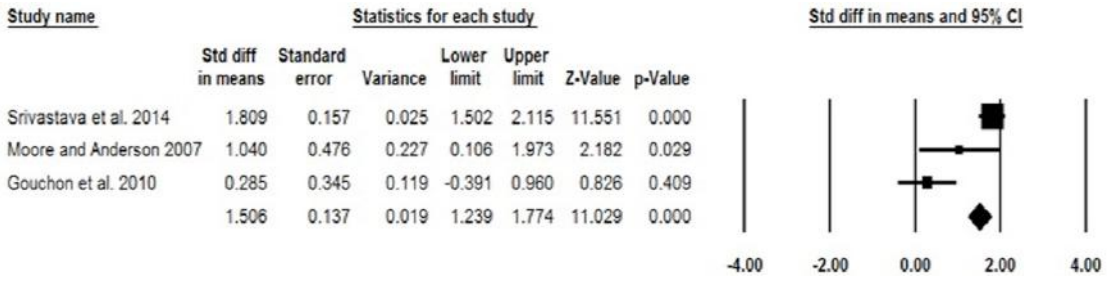

Fig. (4). difference Between Kangaroo Mother Care (KMC) and Conventional Neonatal Care (CNC) in risk ratio for breastfeeding success based on Infant Breast-Feeding Assessment Tool (IBFAT).

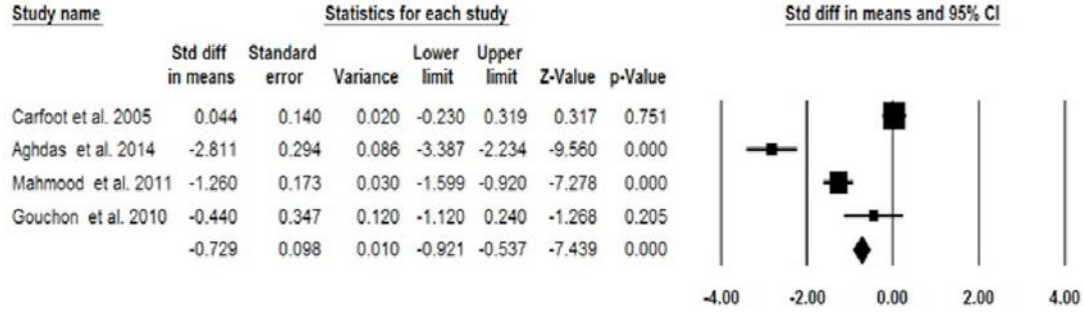

Fig. (5). difference Between Kangaroo Mother Care (KMC) and Conventional Neonatal Care (CNC) in risk ratio for breastfeeding success based on initiation time of breastfeeding.

1.50(95%CI, 1.23-1.77). This difference was statistically significant ($p<0.05$; Fig. **4**).

Four studies have indicated the initiation time of breastfeeding. According to the results, breastfeeding was initiated very sooner in the KMC group, suggesting a significant difference -0.72(95%CI, -0.92 to -0.53) ($p<0.05$; Fig. **5**).

Funnel plot was used to evaluate the possibility of publication bias in this study (Fig. **6**). The result of funnel plot shows that there was the possibility of publication bias.

Result of the risk of bias assessment showed that the majority of studies had a high risk of bias (Appendix V), In that, six, six, and eight studies had low, uncertain, and high risk of bias, respectively. Blinding was carried out only in one study, and randomization was done appropriately in 14 studies.

4. DISCUSSION

Results showed that although breastfeeding success rate was higher in the KMC group within different time slots; however this difference was not statistically significant. Totally, the inter-groups difference in risk ratio for breastfeeding success was 1.11(95CI, 0.93-1.34) and 1.13(95%CI,

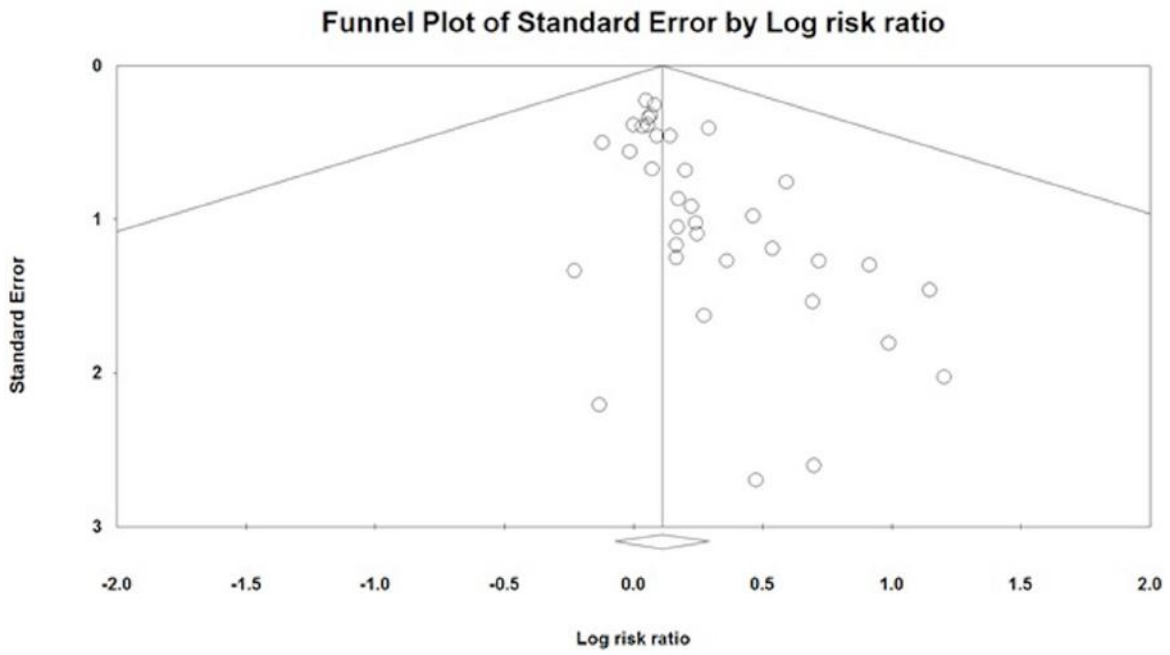

Fig. (6). Funnel plot to evaluate the possibility of publication bias.

0.92-1.34) based on the time slot and birth weight, respectively. The inter-groups difference in the mean IBFAT scores was 1.50(95%CI, 1.23-1.77), which was statistically significant. According to the results, breastfeeding was initiated very sooner in the KMC group, suggesting a statistically significant inter-groups difference -0.72(95%CI, from -0.92 to -0.53).

Results indicated that KMC did not have a significant impact on the breastfeeding success rate. This finding is consistent with the review study by Conde-Agudelo *et al*. (2011), through which the results of eight clinical trials have been investigated [33]. Findings of the present study on the effect of KMC on breastfeeding success confirmed the findings of Carfoot *et al*., who investigated seven clinical trials published before 2000 [34]. Although, evidence suggests that KMC increases the chance of breastfeeding success, this effect is not significant. In contrast, Lawn *et al*. have shown that KMC has a significant impact on the reduction of neonatal mortality rate [35]. Conde-Aguedo *et al*. also showed that KMC has a significant effect on the reduction of mortality, infection, as well as hypothermia rates, and the length of hospital stay [33]. Many other clinical trials have also shown that KMC has a significant impact on the reduction of neonatal complications and the length of recovery [15, 19, 31, 36-41]. Results of some clinical trials also revealed a positive effect of KMC on parents [13, 15, 37, 42, 44]. Sharma *et al*. [45] and Vahidi *et al*. [46] have shown that KMC is more cost-effective than CNC. In conclusion, KMC has a positive effect on the majority of neonatal and parental health indicators, and is a part of hospitals' child-friendly programs and of the interest of their medical staff [47, 48]. As a result, the implementation of KMC regarding its complications and costs compared to conventional methods can be considered by healthcare policymakers and providers in every country.

In this study, although KMC had no significant impact on breastfeeding success rate, it was significantly more effective than CNC according to IBFAT. It is an effective breastfeeding measurement tool, which evaluates breastfeeding behavior in the newborn in four aspects: infant state of arousal or readiness to feed, rooting reflex, latch-on, and suckling pattern [49]. Bramson *et al*. also used IBFAT and achieved similar results [50]. Regarding the few studies conducted using IBFAT, the use of this tool is recommended in future studies.

According to the results of the present study, breastfeeding was initiated significantly sooner in the KMC group. Karimi *et al*. [51] and Khadivzadeh *et al*. [52] have shown that KMC has a positive effect on early breastfeeding initiation. In contrast to the results of the present study, Keshavarz and Bolbolhaghighi (2007) in a clinical trial in Iran have shown that there is a significant difference in terms of breastfeeding initiation time [53].

Generally, the present study has addressed the effect of KMC on breastfeeding more exclusively and systematically. There were some limitations in the present study, specifically incomplete reported data, which imposed a limitation to some subgroup analyses (type of delivery, duration of KMC, and KMC initiation time). According to the results, the probability of publication bias in references was relatively high, which had to be considered in data interpretation and usage. All included articles for analysis have low sample size, which may suffer from small study effect. In this regard, readers of this article should be careful about interpreting the results.

CONCLUSION

Findings indicated superiority of KMC over CNC in terms of breastfeeding success rate. Existing evidence indicates positive effects and high cost-effectiveness of KMC. Performing more investigations into the complications and costs of KMC implementation under local conditions of each region, and comparing them with conventional methods can

be considered by healthcare managers, policymakers, and providers in every country.

LIST OF ABBREVIATIONS

CNC = Conventional Neonatal Care

IBFAT = Infant Breast-Feeding Assessment Tool

KMC = Kangaroo Mother Care

WHO = World health organization

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

SUPPLEMENTARY MATERIAL

Appendix I: Breastfeeding success rates in the Kangaroo Mother Care (KMC) group based on time slot.

Appendix II: Breastfeeding success rates in the Conventional Neonatal Care (CNC) group based on time slot.

Appendix III: Breastfeeding success rates in the Kangaroo Mother Care (KMC) group based on birth weight.

Appendix IV: Breastfeeding success rates in the Conventional Neonatal Care (CNC) group based on birth weight.

Appendix V: Result from the risk of bias assessment.

Supplementary material is available on the publisher's website along with the published article.

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