Early Human Development 122 (2018) 22–31

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Kangaroo mother care and infant biopsychosocial outcomes in the first year: A meta-analysis

Emis Akbari[a,b,*], Noam Binnoon-Erez[c], Michelle Rodrigues[c], Alessandro Ricci[c], Juliane Schneider[d], Sheri Madigan[e,f], Jennifer Jenkins[c]

[a] School of Early Childhood, George Brown College, Toronto, Ontario, Canada
[b] Atkinson Centre for Society and Child Development, Toronto, Ontario, Canada
[c] Department of Applied Psychology and Human Development, University of Toronto, Toronto, Ontario, Canada
[d] Division of Neurology, The Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada
[e] Alberta Children's Hospital Research Institute, Calgary, Alberta, Canada
[f] Department of Psychology, University of Calgary, Calgary, Alberta, Canada

ABSTRACT

Aim: A systematic review and meta-analysis was conducted to examine the relationship between KMC and infant/toddler biopsychosocial outcomes.

Method: PubMed, MEDLINE (OvidSP), MEDLINE in Process (OvidSP), Embase (OvidSP), PsycINFO (OvidSP), and AMED (OvidSP) were searched. Observational studies and randomized control trials through October 2015 that investigated the association between KMC intervention and infant/toddler biopsychosocial outcomes were included. Studies with < 10 participants, those using skin-to-skin only during painful procedures or only on the day of birth, and those that did not report quantitative outcomes were excluded. Data were extracted by two coders and estimates were examined using random-effects.

Results: 3177 studies were screened with 13 meeting inclusion criteria and representing 5 child outcomes (cognitive, motor, self-regulation, socio-emotional and temperament). Among LBW/premature neonates, KMC compared to conventional care was associated with improved infant self-regulation. Moderated effects were identified for cognitive (duration of KMC) and motor development (duration of KMC, country-level mortality ratio, and infant gender).

Interpretations: KMC administered to vulnerable neonates during a sensitive period of brain development has a lasting impact on self-regulation skills later in infancy. Further research examining the longer-term effect of KMC on cognitive and motor development, socioemotional skills, and temperament is needed.

Substantial progress has been made globally in decreasing rates of infant and child mortality. Infectious diseases and perinatal complications remain the primary causes of deaths globally [1]. Infant deaths account for approximately 40% of the under-five, developing country mortality rate, with premature birth and/or low birth weight (LBW) being a leading cause of mortality in this age group [2]. Each year, > 20 million infants are born either premature or with LBW. Babies born with LBW have 20 times the mortality rate of their heavier counterparts, with a third dying within 12 h of birth [3]. Premature babies are more vulnerable because of their inability to regulate their body temperature, leading to cessation of feeding, and increased risk of developing infections [4]. Approximately 95% of premature births occur in developing countries [4]. Premature birth and/or LBW is a substantial health care burden with costs averaging just over $50,000 per infant [5].

Kangaroo mother care (KMC) was developed in 1978 in Bogotá, Colombia as a substitution for incubators for preterm and/or LBW infants [6]. This low cost intervention has now been adopted worldwide as a low cost alternative to the treatment of vulnerable infants. Often defined by four elements: skin-to-skin contact (SSC) between the newborn and caregiver (immediate, continuous, and sustained), exclusive breastfeeding, earlier release from hospital, and post-discharge follow-up, KMC has been shown to increase infant survival rates [6].

The physiological benefits of KMC are well established. Meta-analytic evidence has demonstrated that KMC lowers infant mortality rates, decreases the risk of sepsis infection, hypoglycemia, hyperthermia, and hospital re-admittance [6–10]. KMC also increases the rates of exclusive breastfeeding, lowers neonatal respiratory rate, increases oxygen

* Corresponding author at: School of Early Childhood, George Brown College, 99 Gerrard St. East, Toronto, Ontario M5B 2L4, Canada.
E-mail address: emis.akbari@georgebrown.ca (E. Akbari).

https://doi.org/10.1016/j.earlhumdev.2018.05.004
Received 9 March 2018; Received in revised form 12 April 2018; Accepted 9 May 2018

Table 1
Study characteristics of included studies.

Author	Year	Country	Participant sex (% male)	Child age at outcome (weeks)	Mean birth weight (grams)	Sample size	Comparison group	Outcome measure	Outcome assessment method	Maternal age	Maternal edu.
Bera et al.	2014	India	NR	52	1617.8	449	Conventional Care	Cog; Mot	1;1	NR	NR
Bigelow et al.	2012	Canada	47.5%	6.75	3647.1	80	Conventional Care	Cog; SR; SE	2; 2; 2	29.7	14.46
Charpack et al.	2001	Colombia	45.4%	39	1719.6	746	Conventional Care	Cog; Mot; SE	1; 1; 1	NR	NR
Feldman et al.	2002	Israel	51.37%	13	1270	146	Conventional Care	SR; Temp	2; 2	29.35	14.4
Feldman et al.	2003	Israel	54.3%	0	1231.0	70	Conventional Care	Cog; Temp	1; 2	29.13	14.71
Feldman et al.	2002	Israel	51.37%	13	1270	133	Conventional Care	Cog; Mot	1; 1	29.35	14.4
Mello et al.	2011	Brazil	38.1%	29.5	1463.1	42	Conventional Care	Cog; Mot	1; 1	NR	NR
Miles et al.	2006	UK	61.54%	52 (Cog, Mot, SE); 25.5 (SR), 17 (Temp)	1105.2	54 (Cog, Mot, SE outcomes) 62 (SR & Temp outcomes)	Conventional Care	Cog; Mot; SR; SE; Temp	1; 1; 2; 1; 2	30.42	12.74
Mitchell et al.	2013	USA	50%	1	1266.4	38	Conventional Care	SR	2	NR	NR
Neu et al.	2013	USA	49%	8	1948.1	53	Conventional Care	Cog; Mot; Temp	1; 1; 1	26.08	NR
Ohgi et al.	2002	Japan	41.5%	39	1842.3	53	Conventional Care	Cog; Mot; Temp	1; 1; 3	30.3	NR
Saeidi et al.	2014	Iran	35%	1	NR	48	Conventional Care	Temp	3	NR	NR
Tessier et al.	2003	Colombia	45.8%	52	1549.2	336	Conventional Care	Cog; Mot; SE	1; 1; 1	28.05	NR

Note: Cog = cognitive, Mot = motor, SR = self-regulation, SE = socio-emotional, Temp = temperament; NR = not reported by authors; Age at outcome presented as the mean age of infants (in weeks) at the time of outcome assessment. Characteristics based on whole sample (not KMC groups only).

saturation, and improves head growth [7,11,12]. The effects of KMC are most notably advantageous for LBW and/or preterm neonates [9]. What is less well understood are the effects of KMC on the biopsychosocial development of the neonates such as temperament, motor, cognitive, socio-emotional, and self-regulation outcomes. With the expansion of the use of KMC globally, especially in resource limited settings and with support from the World Health Organization [13] and UNICEF [14], it has become necessary to examine the longer-term benefits of KMC. To examine the non-physiological potential benefits of KMC, and the use of KMC as developmentally supportive care, this systematic review and meta-analysis examines both randomized control trials and observation studies (where the independent variable is not under the researcher's control) of KMC on infant biopsychosocial outcomes.

1. Methods

1.1. Search strategy

Searches were conducted in MEDLINE, Embase, PsycINFO, Cinahl and AMED (from database inception to October 2015) by a health sciences librarian. Both database specific subject headings and text word fields were searched for the concepts "kangaroo care" and "infants". Synonymous terms were first combined with the Boolean "OR". These two concepts were then combined with the Boolean "AND". In all databases, truncation symbols and adjacency operators were used in text word searches when appropriate, to capture variations in spelling and phrasing. No language or date restrictions were applied. See Appendix A for the sample MEDLINE strategy.

1.2. Study selection criteria

To meet inclusion criteria, titles and abstracts of studies were examined. Inclusion criteria included cross sectional or longitudinal KMC interventions that 1) contained a control group (sample did not have to be randomized), 2) examined biopsychosocial outcomes (i.e. cognitive, socio-emotional, motor development, self-regulation, and temperament) in infants and children, 4) had a study statistic that could be transformed into an effect size (e.g. correlations, means and standard deviations, odds ratios, sample size and *p*-values). Exclusive breast feeding was not an exclusion criterion. The following exclusion criteria were used in screening articles for the current meta-analysis: 1) article was not an original study/did not include primary data, 2) measured outcomes were unrelated to the purpose of the meta, 3) the full text of the article could not be found, 4) article in language other than English, 5) study contained < 10 participants, 6) study included non-human subjects, 7) no effect size measure was reported, 8) study included maternal/paternal outcomes only, 9) study included cost effectiveness outcomes only, 10) skin-to-kin only administered on day of birth or only during a painful procedure (i.e. not a full KMC intervention).

To guarantee independence of effect sizes, if there was more than one publication from the same study (i.e. same sample), we selected the study that contained the most psychometrically valid and/or relevant measure.

Following the aforementioned inclusion and exclusion criteria, we further excluded studies for one of the following reasons: 1) contacted authors for raw data and did not receive a response, 2) contacted authors but they no longer had available data, and 3) outcome measures were gathered only during mother-infant observation tasks and did not focus on the child's behaviour. If interactions included relevant child behaviour (i.e. still face paradigm), the study was included. Discrepancies between coders were discussed and consensus scores were used for data analysis.

1.3. Data extraction

To extract study and sample characteristics, two independent coders