

Kangaroo Mother Care for Preterm Infants and Child Development – Evidence from São Paulo, Brazil

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Abstract

Background An estimated 15 million children are born prematurely each year globally, resulting in a high burden of under-five mortality and neurodevelopmental disability. Kangaroo Mother Care (KMC) is recognized as key intervention to support the development of preterm infants. Even though the benefits of KMC have been well documented in randomized controlled trials, evidence on the impact of KMC in routine care settings remains limited.

Methods This paper examines the associations between maternal Kangaroo Mother Care efforts and child development among preterm infants born at the University Hospital of São Paulo, Brazil. Primary study outcomes were physical development (HAZ) and cognitive development at age 3. **Results** Practicing Kangaroo Mother Care was positively associated with physical development (+0.91 SD, 95% confidence intervals [0.126, 1.695]), and cognition (+0.37 SD, [0.034, 0.806]) of preterm children at age 3. **Conclusion** The results presented suggest that KMC has a large potential to improve children's cognitive and physical development. New programs to increase KMC uptake in the setting studied may be beneficial for both mothers and their preterm children.

Background

Globally, an estimated 15 million children are born prematurely each year (1, 2). Preterm birth complications are a leading cause of under-five mortality, causing more than one million deaths per year (3). In addition to the much higher mortality risk, children born preterm face higher rates of neurodevelopmental disability as well as delays in their physical and cognitive abilities more generally (4-9).

A growing literature has highlighted that early intervention programs for preterm infants can positively influence developmental outcomes with cognitive benefits that persist (10). Kangaroo Mother Care (KMC) is increasingly recognized as one of the most effective interventions in this area (11). The key element of KMC is extensive skin-to-skin contact between mothers or other caregivers including fathers and their infants during the postnatal period at the hospital. Ideally, these activities are then continued at home until the child gains normal weight. Skin-to-skin contact has been shown to increase attachment, enhance mothers' ability to breastfeed, and stimulate the child (12, 13). Several recent studies have underscored the effectiveness and cost-effectiveness of KMC in particular for reducing infant mortality among preterm and low birth weight children, but also for

reducing the likelihood of severe illness and infections, and for reducing average length of stay at the hospital (14-18).

Despite the presumably large benefits of KMC, limited evidence exists on the use and impact of KMC in routine care settings. This paper aims to address this gap by using newly collected data on infant health and child development within a cohort of children born at the University Hospital of São Paulo between 2012 and 2014. As part of the cohort study, mothers of preterm infants were asked to report on their KMC activities after birth. Children's cognitive and physical development was then assessed through a home-based assessment by trained staff at age 3.

Methods

Study Procedures

The study was designed as an observational prospective cohort study conducted in São Paulo Municipality, Brazil. The São Paulo Western region cohort includes all children born to local residents at the University Hospital of São Paulo between April 1, 2012, and March 31, 2014. These children were revisited and re-assessed as part of a 3-year follow-up conducted between June 2015 and March 2018. Our study was restricted to children born prematurely during this period (born before 37 weeks of gestation). Data on birth outcomes including gestational length were directly extracted from the University Hospital's electronic records. Gestational age of all children was assessed by the health worker using the Capurro method. Data on KMC and development at age 3 were collected through interviews during the home visit by trained data collectors. Records with missing information on KMC engagement were excluded from the study.

Exposure and Outcome Variables

The main exposure variable of interest in our subsample was practice of KMC as reported by the caregivers. As part of their interview, caregivers reported whether they engaged in KMC, as well as the number of times per week it was practiced. The primary outcomes for this study were children's cognitive and physical development at 3 years of age. Cognitive

development was measured through direct observation using the PRIDI scale. The PRIDI scale has been used widely in Latin America to assess children's developmental outcomes (19), and measures development in the cognition, language and communication, socio-emotional, and motor domains (20). For physical development, height and weight were measured as children's homes. Height-for-age z-scores (HAZ) were computed using the World Health Organization (WHO) Anthro software (21). Stunting was defined as $HAZ < -2$.

Statistical Analysis

Data analysis was completed in three steps. First, we used descriptive statistics to characterize the study population. Socio-demographic and clinical data included child's age and weight at birth, caregiver's age at delivery, caregiver's education level, caregiver's marital status as well as family receipt of social transfers (bolsa familia). Second, we estimated unconditional associations between KMC practicing and cognitive and physical development. Third, we estimated multivariable linear regression adjusting the estimated associations for caregiver's age (indicators for ages ≤ 20 and for ages ≥ 35), childbirth weight (categorized into $< 1500g$, $1500-1999g$, $2000-2499g$ and $\geq 2500g$), child's sex, caregiver's schooling, caregiver's higher schooling, receipt of social support, caregiver's marital status, and wealth index. Finally, we stratified the HAZ with the child's weight at birth ($< 2500g$ and $\geq 2500g$) and caregiver's education level (basic education or less and secondary education or higher). Data analysis was performed using STATA 15.0 for Windows (STATA Corporation, College Station, TX) (22).

Results

Out of the 3620 children assessed at age three, 254 (7%) were born prematurely. From this subsample of premature children, KMC practice information was available for 139 children. **Table 1** summarizes caregivers'-children's socio-demographic characteristics by KMC status. 23% of mothers were under age 20 at the time of birth, and 10% of mothers were 35 or older. 7.9% of children born before week 37 of gestation had a birthweight of below 1500 grams, while 54.7% of children had a birthweight in the normal range (≥ 2500

grams). 51.8% of children were female, and 25.9% of families received social transfers (bolsa familia). On average, mothers practicing KMC were slightly younger, and had infants with substantially lower weight at birth. Differences in social transfer receipt were small.

Table 1. Maternal and Child Socio-demographic Characteristics

	NO KMC (N=113)		KMC (N=26)		TOTAL	
	N	%	N	%	N	%
Age of mother at birth						
Below 20	24	21.2	8	30.8	32	23
Between 20 - 34	77	68.1	16	61.5	93	66.9
Above 34	12	10.6	2	7.7	14	10.1
Child's weight at birth (grams)						
Under 1500g	2	1.8	9	34.6	11	7.9
Between 1500 - 1999	8	7.1	7	26.9	15	10.8
Between 2000 - 2499	31	27.4	6	23.1	37	26.6
2500 and Above	72	63.7	4	15.4	76	54.7
Child sex						
male	57	50.4	10	38.5	67	48.2
female	56	49.6	16	61.5	72	51.8
Social Support (Bolsa Familia)						
No	82	72.6	18	69.2	100	71.9
Yes	29	25.7	7	26.9	36	25.9

Abbreviations: KMC, Kangaroo Mother Care; g, weight in grams.

Fig.1 shows estimated kernel densities for height for age z-scores at age 3 by KMC group. Despite the large negative weight differential at birth, mean HAZ was substantially higher

in the KMC group at age 3 (-0.17 vs. -0.96 in the no KMC group), with a pronounced shift of the entire height distribution to the right.

Fig. 1 Density plots HAZ by KMC Group

Figure 2 shows estimated kernel densities for PRIDI z-scores. Once again, mean scores were substantially higher for the KMC group (0.50 vs. -0.09 in the no KMC group), with particularly large differences in the left tail of the distribution (z-scores < -2).

Fig. 2. Density plots of PS for PRIDI z-score by KMC

Table 2 shows crude and adjusted association between HAZ, stunting, PRIDI and KMC exposure. In unadjusted models, practicing KMC was associated with a 0.79 SD increase in HAZ (95% CI [0.22 - 1.36]), a 29 percentage point reduction in stunting (-0.41, -0.17) and a 0.59 SD increase in PRIDI scores (0.11 - 1.07). After adjusting for covariates, estimated associations were 0.91 SD for HAZ (0.13, 1.70), -25 percentage points for stunting (-0.44, -0.05), and 0.39 SD for PRIDI (-0.03, 0.81, p-value = 0.07).

le 2. Crude and adjusted associations between practicing KMC and child outcomes.

Outcome Variables ^a	HAZ (n=131)	Stunting (n=131)	PRIDI (n=115)
Crude Estimates			
β	0.787***	-0.290***	0.586**
	(0.220, 1.355)	(-0.410, -0.170)	(0.105, 1.067)
Adjusted Estimates	(n=128)	(n=128)	(n=113)
β	0.910**	-0.245**	0.386*
	(0.126, 1.695)	(-0.444, -0.0469)	(-0.0337, 0.806)

Abbreviations: KMC, Kangaroo Mother care, HAZ, height-for-age z-scores, PRIDI (acronym in Spanish), Regional Project on Child Development Indicators.

The second column represents the results of linear regression model, with 95% confidence intervals. The estimates are adjusted for the full list of all covariates in table 1. These included maternal age, child's sex, birth weight at birth, age at assessment, gender, caregivers' education, marital status, bolsa familia receipt, and household's assets.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 shows results from the stratified analysis. When we stratified the sample by caregiver education, positive associations between KMC and HAZ were primarily found for mothers with limited education. When we stratified the sample by birth weight, protective effects of similar magnitudes were found for children with birth weight above and below 2500 grams, but neither effect was statistically significant due to the relatively large standard errors.

3. Stratified Association between Practicing KMC and HAZ

Outcome variable: Height-for-age z-scores				
	Sample			
n=139)	Basic education or less	Secondary education or higher	Birth weight <2500g	Birth weight >= 2500g
	1.022**	0.169	0.586	0.798
	(0.003, 2.04)	(-1.37, 1.71)	(-1.15, 2.32)	(-0.16, 1.76)
Observations	58	70	60	68

All models adjust for the full set of covariates in Table 1. Coefficients displayed based on linear regressions, with 95% confidence intervals in parentheses

0.01, ** p<0.05, * p<0.1

Discussion

In this paper we used a novel data set from São Paulo Brazil to estimate the empirical associations between Kangaroo Mother Care (KMC) and child development among children born prematurely. Consistent with other studies of preterm (23-25) or low birth weight infants (26), our results suggest that practicing KMC may have large protective effects on children born prematurely, both in terms of their cognitive and in terms of their physical development.

A large literature has documented the high risk faced by preterm infants with respect to their cognitive development (27-29). These risks are well visible in the data presented in this study, with an average HAZ of -0.8 at age 3 among preterm children in the sample. Rather remarkably, these risks seem however almost exclusively restricted to children not benefitting from KMC, with an average HAZ of close to zero among children benefitting

from KMC, and an average HAZ of -1.0 among children not benefitting from KMC. These differences observed at age three are not definitely not due to initial advantages of children in the KMC group: the median gestational length in the KMC group was 33 weeks, compared to a gestational length of 36 weeks in the group of children without KMC. Children benefitting from KMC do not only seem to be able to close this initial gap, but also appear to be substantially better developed at age 3. From a behavioral perspective, it is of course possible that mothers practicing KMC may on average be more engaged with children more generally than mothers opting against it. We controlled for several potential factors in our empirical models, but cannot fully rule out residual confounding in our analysis. Given the rather large associations observed in fully adjusted models, it seems however unlikely that residual confounding would fully explain the observed patterns (30).

Several limitations of this study should be noted. First, the overall sample size was small, limiting statistical power of the study. Second, we have only limited information on the daily KMC efforts made by mothers. Additionally, we have only information about the KMC during the hospital stay, and are not able to assess the extent to which KMC was practiced at home. Our results indicate that even smaller doses during the first days of life may be highly beneficial. Our study does not allow us to directly understand the KMC mechanism, but the main links highlighted in the literature (12-17) such as bonding, breastfeeding, stimulation, are likely to apply in this setting as well. Further research will be needed to confirm the results of this study, and to identify optimal and minimal dosing of KMC.

Despite the presumably large benefits of KMC and the official hospital commitment to this program, our findings revealed that only about 20% of the women with preterm infants practiced KMC in the 2012-2014 period. Low uptake of KMC may be related to stress and stigma associated with having a preterm child (31), but may also reflect lack of knowledge about KMC by families and healthcare workers and local cultural practice (31, 32). Further research will be needed to better understand the main barriers in this setting as well as to identify the most effective ways to support mothers and their infant children during the post-natal period more generally.

Conclusions

The results presented in this paper suggest that KMC has large potential to improve children's cognitive and physical development. Getting more mothers engaged in this practice may have major benefits for both mothers and preterm infants in the long run.

Declarations

Abbreviation: KMC: Kangaroo Mother Care; HAZ; Height-for-age z-scores; PRIDI: The Regional Project on Child Development Indicators; SD: standard deviation;

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Author's Contributions:

AB and GF designed the study and contributed to data collection. GF and SO ensured completeness and accuracy of the data presented. The primary author, SO conducted the analysis with guidance of GF and the writing of this manuscript. All authors AB, GF and SO reviewed the manuscript and approved of the draft.

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Availability of data and materials

The datasets used in analysis during the current study are available from the corresponding author on request.

Ethical approval and consent to participate:

Ethics approvals were obtained from the University Hospital of São Paulo. Written consent was obtained from all participants. For mothers under the age 18, consent was obtained from a parent or legal representatives.

Consent for publication:

Not applicable.

Competing Interest

The authors declare that they have no competing interests.

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Figures

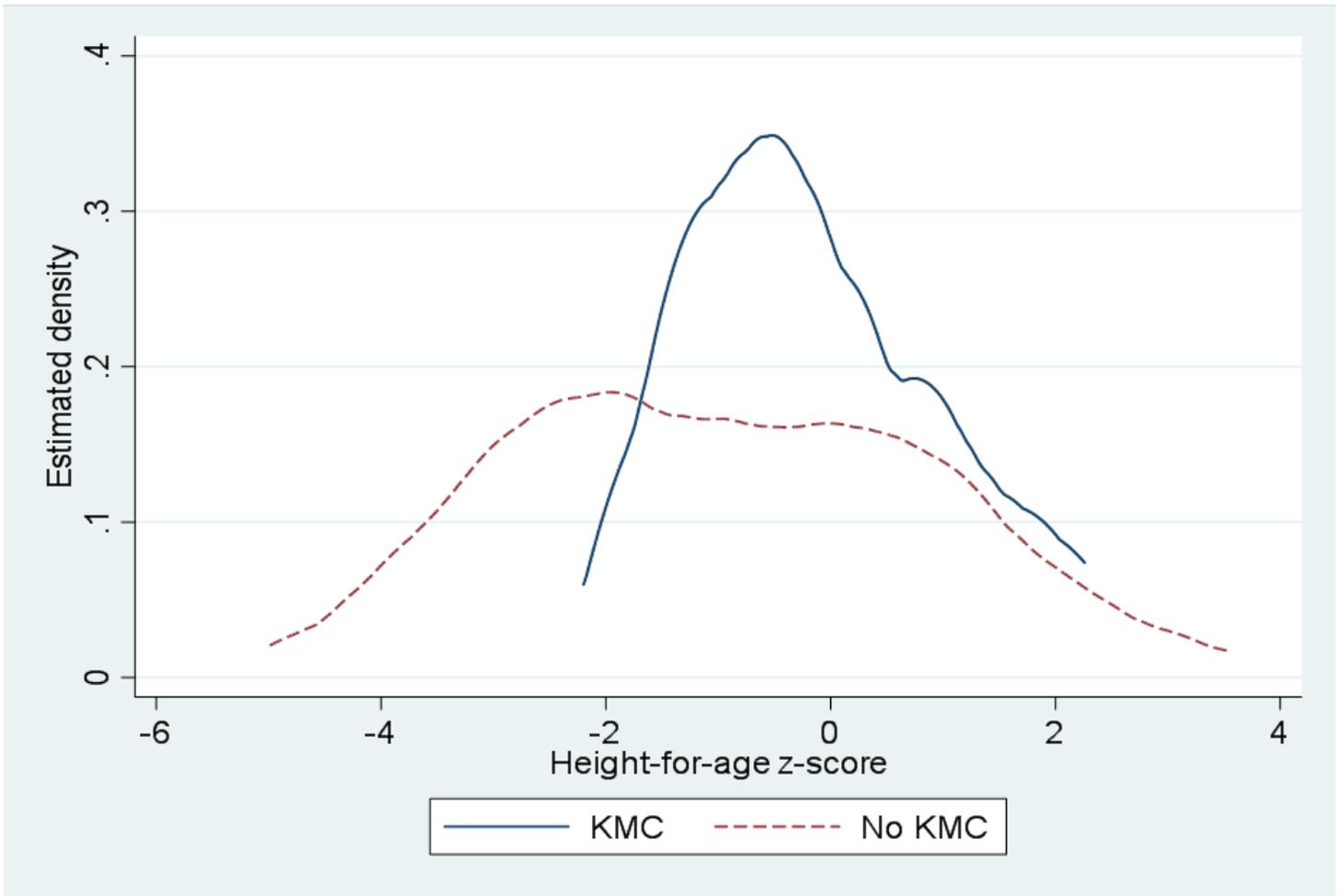


Figure 1

Density plots HAZ by KMC Group

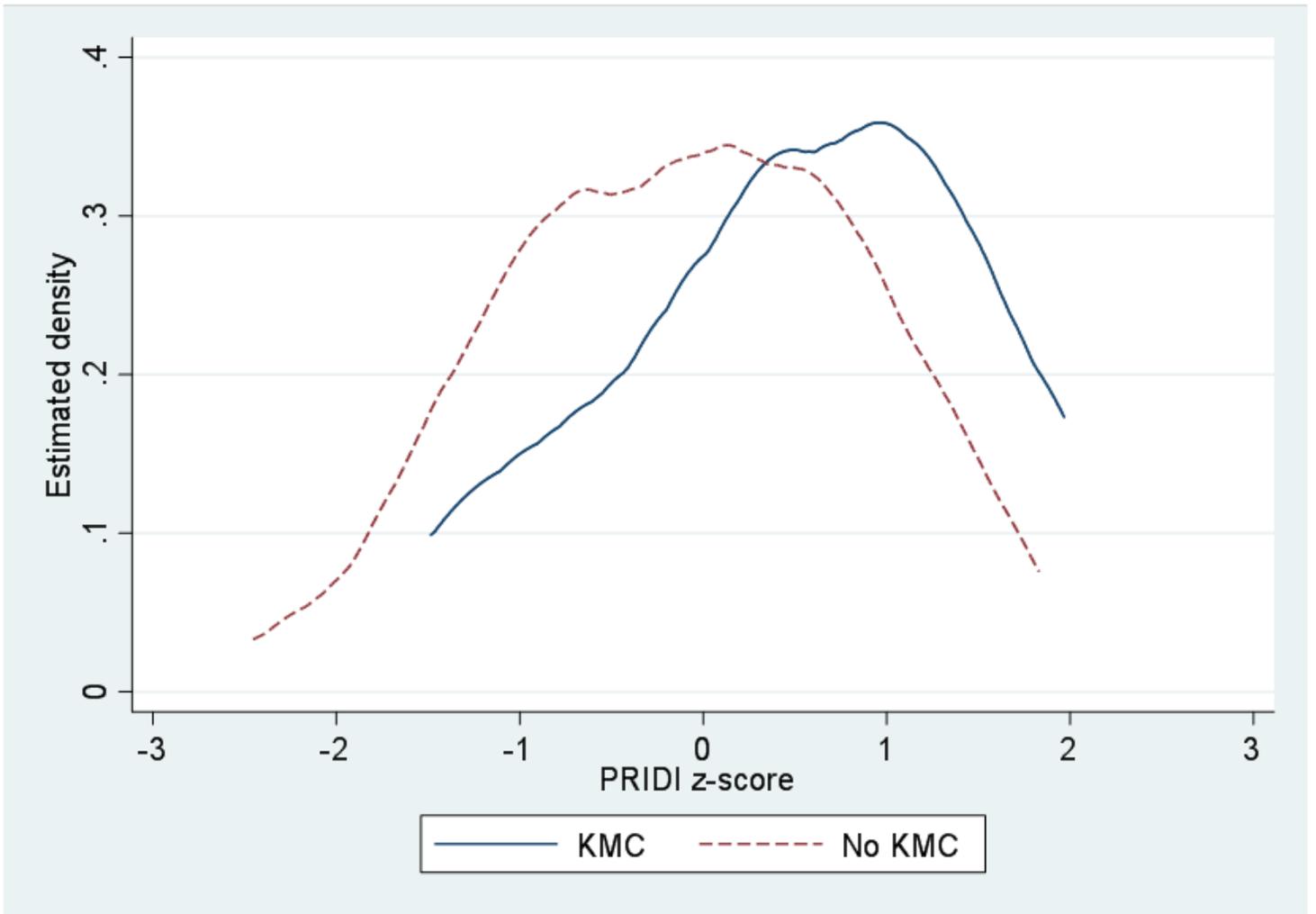


Figure 2

Density plots of PS for PRIDI z-score by KMC

Supplementary Files

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- [KMCSTROBEchecklist.docx](#)