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Comparing long-term educational effects of two early childhood health interventions[☆]

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ABSTRACT

We compare the educational effects of two medical protocols that mitigate long-term consequences of prematurity or low birth weight. The two protocols are Traditional Care (TC), which uses incubators, and Kangaroo Mother Care (KMC) which replaces incubators for 24-hour skin-to-skin contact between newborns and caregivers. We concentrate on educational outcomes addressing contradictory results in previous contributions. We use a randomized controlled trial implemented in 1993 that randomly assigned children to either TC or KMC. OLS results suggest that KMC children spent more time in preschool, had fewer temporary school absences, and showed lower math test scores. Both groups observed similar effects on high-school graduation and language test scores. We correct for attrition, small sample, and multiple outcomes. Effects on preschool attendance and school absenteeism are robust, particularly for more vulnerable infants (birth weight $\leq 1,800$ g). The other effects lose statistical significance due to multiple outcome testing or attrition corrections.

1. Introduction

Low weight and premature birth affect many newborns in developing and developed countries across the world (WHO, 2012). In 2010, about 14.9 million babies were born before 37 weeks of gestation, which accounted for 11% of all live births worldwide. The problem is also growing across several regions of the world (Blencowe et al., 2012, 2019). Moreover, low weight and premature

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birth are the main reasons for survivors' long-term loss of human potential in developed and developing countries. Both factors have repercussions during infancy, as reflected in mortality, motor, physical or mental development (Behrman and Rosenzweig, 2004; Datar and Jacknowitz, 2009; Oza et al., 2015; Royer, 2009; Torche and Echevarria, 2011). They are also responsible for low IQ, learning, educational attainment, and permanent income (Bharadwaj et al., 2018; Black et al., 2007; Newcombe et al., 2007; Royer, 2009). Although some research has addressed the magnitude of this effect (Almond et al., 2005), recent extensive reviews of the literature that concentrate on studies that use methods to unveil causality have shown that, indeed, individual consequences of low birth weight can be relevant (Currie, 2011; Almond and Currie, 2011).

This paper aims to study the differential causal effects of the two main accepted protocols to prevent the adverse consequences of low birth weight or prematurity. These two protocols are the traditional care procedure (TC) that involves the use of a Newborn Intensive Care Unit (NICU) and its main alternative known as the Kangaroo Mother Care (KMC), which limits the use of NICUs. In the TC, babies spend considerable time in NICUs since they must be placed in incubators until they attain specific growth, weight, and other development goals. When they are in NICUs, babies are subject to essential restrictions regarding access to their parents or caregivers. Moreover, the experience of the physical environment of NICUs may entail sizable pecuniary costs to newborns and their families associated with noise and lighting (White, 2011). Additionally, NICUs require sophisticated, expensive technology that is not easily available in many places in the world and that depends on electricity, which is also unavailable in certain places (Martinez et al., 2012). Alternatives may reduce some of the costs for families and newborns and be more cost-effective and easier to implement in places where NICUs are still unavailable. The main alternative to the TC is known as the Kangaroo Mother Care (KMC) and was developed in Colombia in the late 1970s. KMC is based on permanent skin-to-skin contact, decreasing the period of early separation between the mother and the baby, thus reducing cross-infection caused by incubator sharing.

Two different issues must be considered in regards to the effects of the protocols used to protect newborns from the consequences of prematurity and low birth weight. First, whether existing programs protect newborns from the consequences of prematurity and low birth weight (in the short and long term). Second, the relative effectiveness of the alternatives to prevent those consequences. Answering the two questions entails different methodological challenges; the first one implies comparing non-treated newborns with those treated by some alternatives, and the second one implies comparing the treated newborns and those who received different treatments. The literature has partially addressed both issues. First, it is already clear that both treatments are safe; in particular, both prevent high mortality rates associated with prematurity and low birth weight (Charpak et al., 2005; Conde-Agudelo and Díaz-Rossello, 2016). As a result, KMC has been included in the main packages of newborn health care that all countries must offer (Bhutta et al., 2014; Moxon et al., 2015; Almond et al., 2005). Second, comparisons among the newborns that received the two alternative treatments, performed over the first two years after birth, have shown health-related advantages of KMC when compared with TC. One year after childbirth, evaluations show that the KMC method promotes breastfeeding and shortens the neonatal hospital stay without compromising survival, growth, or development. Moreover, some evidence suggests that KMC may be less costly and more efficient than TC (Castillo et al., 2013; Lowson et al., 2015; Quintero-Romero and Cattaneo, 2000).

Long-term consequences of these procedures have been examined to a lesser extent, however. Moreover, the conclusions of said analyses seem contradictory. Regarding the first issue, Bharadwaj et al. (2013) show that children born with low weight but who receive improved early life health care exhibit lower mortality and have higher long-run (at age 8–9) academic achievement. Regarding the second issue (the comparison of alternatives), Schneider et al. (2012) find that KMC positively influenced premature brain networks and synaptic efficacy up to adolescence, as compared with TC. Charpak et al. (2017) show that KMC had significant, long-lasting social and behavioral protective effects 20 years after the intervention. Still, the results of TC-treated participants in standardized exams were superior to those of the KMC-treated ones.

If KMC tends to display better behavioral and developmental results than TC, why do KMC-treated participants have lower academic achievement than the TC-treated ones? The objective of this paper is to reconsider the differential effect of KMC and TC on academic achievement results using data from a long-run follow-up performed between 2012 and 2014 (an enlarged sample compared to the one used in Charpak et al. 2017), with a focus on the statistical challenges of RCTs and heterogeneous effects. Addressing statistical challenges may help reconcile health and academic achievement differences among KMC- and TC-treated newborns. Charpak et al. (2017) only reported mean comparisons leaving aside issues that arise in RCTs, which may affect the statistical significance of its results. We account for three common problems in RCTs: attrition in the 20 years between the experiment and the follow-up, a small sample, and the artificial increase in the likelihood of false discoveries due to multiple hypothesis tests. We use the methodologies of Romano and Wolf (2005), List et al. (2019), Heckman et al. (2010) and Bharadwaj et al. (2013) to further test the differences in the results of the two treatments in educational outcomes. Further, we consider two reasons for attrition: the traditional non-response in long-term program evaluations and the possibility of not observing long-term outcomes for participants who passed away between the intervention and the follow-up. In addition to using more robust methodologies, we also employ a larger database where we can observe the results in standardized high school exit exams for more students than in Charpak et al. (2017).

An additional problem we consider is the heterogeneity of the differential effects of KMC and TC along the birth-weight margin. The rationale for this heterogeneity stems from the previous evidence that indicates that KMC is particularly effective in preventing child mortality among newborns with the lowest birth weight (Tessier et al., 1998). If this is the case, the average results in which TC-treated individuals outperform the KMC-treated ones may be explained by an over-representation of low-birth-weight individuals in the KMC group. We test whether there are differences in the program's effect according to the weight of premature newborns.

Our results suggest that, after addressing the methodological challenges of the analysis of RCTs, the effect of KMC-treated participants on preschool attendance and temporary school absence are superior to those of TC-treated. The effects on preschool attendance are superior, particularly for participants with lower birth weight (≤ 1800 g). All the other effects are not robust. We show