Feasibility of the use of Kangaroo mother care in the transfer of preterm and low-birth-weight infants: a two-arm nonrandomized controlled cluster feasibility study of neonatal transport in Cape Coast, Ghana.

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BMC Pediatrics

RESEARCH **Open Access**

Feasibility of the use of Kangaroo mother care in the transfer of preterm and low-birth-weight infants: a two-arm nonrandomized controlled cluster feasibility study of neonatal transport in Cape Coast, Ghana

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Abstract

Background Despite progress made towards SDG 3, sub-Saharan Africa lags behind the rest of the world, accounting for over 50% of global neonatal deaths.

The increased number of hospital births in the region has not reciprocated the reduction in neonatal mortality rates. Sick newborns face uncertain journeys from peripheral facilities to specialized centres arriving in suboptimal conditions, which impacts their outcomes, due partly to the scarcity of dedicated neonatal transport services.

Methods This was a 2-arm nonrandomized controlled cluster study of preterm and low-birth-weight neonates transferred from eight peripheral sites to a tertiary neonatal unit via conventional methods or the KMC (August 2022–April 2023).

Results A total of 77 (mother-baby pairs) were recruited, 34 in the KMC group and 43 in the conventional arm. Most (60%) were transported by taxis/private cars. Overall mortality was 20.8%. No untoward event was recorded for neonates transported by KMC, with marginally better temperatures on arrival. Although the observed differences were not statistically significant given that this was not the primary aim, the findings add to evidence that KMC transport may not be more life-threatening than the current practice of transporting newborns in the caregiver's arms. KMC transport has the added advantage of ensuring non-separation of the small and sick child from its mother from birth and improved temperatures upon arrival.

Conclusion KMC transport for preterm and Low birth weight infants using available transport in Sub-Saharan Africa is feasible. Local large-scale randomized trials are needed to gather more evidence for policy direction needed to inform a scale-up of this low-cost intervention.

Trial registration ISRCTN98748162. Retrospectively registered 02.09.2024.

Keywords Kangaroo mother care, Prematurity, Low birth weight, Neonatal transport, Low- to middle-income countries, Sub-Saharan Africa

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Background

Progress towards reducing newborn mortality worldwide has stagnated compared with reductions in maternal and under-five childhood mortality over the past three decades [1]. The United Nations Sustainable Development Goals (SDGs) target 3.2 is laudable for all countries to reduce neonatal mortality to at least 12 per 1,000 live births and under-five mortality to 25 per 1,000 live births by 2030 [2]. Despite the worldwide adoption and progress made towards SDG 3, sub-Saharan African (SSA) countries, with some of the weakest health infrastructure in the world, continue to fall behind most of the world. In 2022, approximately half (47%) of all deaths in children under 5 years of age occurred in the newborn period, with SSA accounting for 57% of these deaths but only 30% of global live births [3]. Current projections estimate that sixty-three countries, almost three-quarters of which are in SSA, will miss the SDG 3,2 target by 2030 unless they double or triple their current progress [4].

Ghana has a population of 30.8 million, with a rapidly urbanizing and youthful population: 35% are children (0–14 years), and 38% are young people (15–35 years) [5]. Ghana's commitment to accelerating its efforts towards achieving the SDG NMR target has inspired its subscription and commitment to several global standards, including the Global "Newborn Action Plan" in 2014, "Every Woman Every Child" in 2015, the Ghana National Newborn Care Strategy and Action Plan, 2019–2023, "WHO standards of care for small and sick newborns" and the "Global Initiative for Quality of Care for Maternal and Newborn Health" [6–8]. Consequently, coverage of maternal and newborn health services has improved in Ghana over the last decade, but progress towards the SDG NMR target remains slow, and neonatal mortality remains an important public health challenge in the country. The neonatal mortality rate in Ghana decreased from 29 per 1000 live births in 2014 to 17 per 1000 live births in 2022 [9]. Eighty-six per cent of live births and stillbirths took place in a health facility in Ghana according to the 2023 GDHS, with 88 per cent of live births and stillbirths assisted by a skilled provider, up from 76 per cent in 2014 [9].

Specialized neonatal services remain a major challenge in many LMICs, including Ghana, with the few existing services concentrated in urban areas. Owing to this poverty of neonatal critical care services, critically ill neonates are transferred frequently over vast distances, mostly in the arms of caregivers [10]. Consequently, transferred neonates face an uncertain journey in many LMICs, with numerous studies describing higher rates of adverse outcomes and increased mortality [11–13]. The admission temperature of newborn babies during all gestations is a strong predictor of morbidity and mortality, especially for preterm and very small babies [14, 15]. Hypothermia is associated with increased mortality and morbidity in newborns [16], and admission temperature is inversely related to in-hospital mortality [17]. For every degree below 36.5^0 C, the mortality risk increases by up to 28% in low-birth-weight newborns [18]. A dedicated and specialized neonatal transport service involving the use of ambulances and transport incubators is beneficial for thermoregulation and maintenance of physiological stability in transported neonates but cost-intensive and unavailable in many developing countries [19, 20]. Incubator transport is moreover not without risks. Studies have documented an increased risk of intraventricular haemorrhage (IVH) caused by mechanical effects such as shaking or vibration of the head, instability of temperature and blood pressure [21] and eminently the lack of practice of Family-centred care (FCC), including skin-to-skin care which aims to overcome the negative effects of separating the parents and their infant [22–24].

Kangaroo mother care(KMC) is a method of care in which the infant is carried in a skin-to-skin position with the mother/caregiver. It was developed out of necessity in Bogota, Colombia in 1979 and used as a substitute for incubators for preterm neonates to address the shortage of caregivers and the lack of resources. Initially designed as an early, prolonged, and continuous skin-to-skin contact between the mother and the low birth weight (LBW) newborn infant until 40 weeks postnatal age [25] , it has evolved into its present state as a form of parental caregiving where the LBW neonate is intermittently nursed skin to skin in a vertical position between the mother's breast or against the father's chest for a nonspecific period [26].

Several hospital-based and community studies on KMC have demonstrated its many benefits, including strengthening the mother-baby bond, promoting breastfeeding, preventing hypothermia, reducing nosocomial infection, and increasing early discharge from the hospital [27–29].Studies on the physiological outcomes of newborns undergoing KMC have shown beneficial outcomes including efficient gas exchange [30], stable respiratory functions and pulse oxygenation [31, 32].

The use of KMC within neonatal units is well documented and until recently has been reserved for stable preterm and LBW neonates. However, a recent release of new landmark guidelines by the WHO recommended KMC as the essential standard of care, starting immediately after birth for both well and sick, preterm and LBW infants. It further provides guidance for a global scale-up of KMC within health facilities and at home, starting right after birth for at least 8 h a day [33]. Implementing

KMC into neonatal transport offers the opportunity to overcome the severe limitations associated with incubator transfer in many developing countries.

Previous studies in higher-income countries on neonatal transport using skin-to-skin care/KMC reported it to be safe, cost-effective and a low-stress alternative to incubator during ground ambulance transport with no recorded adverse events [21, 34]. Inter and intra-hospital transport studies from the Philippines using KMC have reported no significant differences in the heart rate, respiratory rate, temperature, oxygen saturation, and blood glucose levels among preterm neonates [20]. with one study reporting a 93.7% reduction in risk of hypothermia [35].

To date, studies on KMC transport from Sub-Saharan Africa are lacking with no policy directive encouraging its implementation. Newborn transport in the region is mostly self-conducted with minimum care during the process. Exploring the safe use of KMC in the transfer of these neonates might help reduce the burden of neonatal mortality and morbidity in the region.

This study examined the feasibility of employing KMC in the transport of preterm and LBW neonates requiring specialized care in Cape Coast, Ghana.

Methods

This was a 2-arm nonrandomized controlled cluster study.

AIMS

1. To assess the feasibility of employing KMC in the transport of preterm and low-birth-weight neonates.
2. To assess the feasibility of conducting a future larger randomised controlled trial on the use of KMC in the transport of preterm and Low-Birth weight neonates in Ghana.
3. To compare the outcomes of neonates transported by KMC and current existing conventional methods of transport of preterm and Low-birth weight neonates.

Study setting

Country context

Ghana is a low- to middle-income country situated along the Gulf of Guinea in West Africa. It has a total population of approximately 31 million [9]. At the time of this study, sixteen administrative regions were implemented in the country. The country operates a universal national health insurance scheme (NHIS) that provides free health care to subscribed members. The scheme does not attempt to treat all the diseases suffered by insured members. However, common diseases such as malaria, upper respiratory tract infections, diarrheal diseases, and emergency medical care, such as road traffic accidents, are covered. Under the free NHIS, pregnant women and vulnerable populations, including elderly individuals (defined as individuals over 70) and children under 18, are exempt from the NHIS premium payment [36, 37]. The country has a national ambulance service that serves to provide prehospital emergency medical care as well as for transport. As of 2020, the country, with 275 constituencies and 8,847 healthcare facilities, had 362 functioning ambulances and 180 ambulance service stations [38]. Despite the sustained growth of ambulance services over the years, coverage has remained low, even in the main capital, Accra, which has an ambulance-to-population ratio of approximately 1:250,000—a ratio that is 5–10 times below expert-recommended ratios for lower-income countries [5, 39]. Public utilization also remains low, with the current norm to transport the injured or ill to the hospital being the use of private vehicles and taxis because of the belief that taxis are faster than ambulances [5]. Health service delivery in Ghana is decentralized with curative services delivered at the regional level by regional hospitals and district level, by district hospitals. At the subdistrict level, both preventive and curative services are provided by the health centres, as well as outreach services to the communities. Health centres are traditionally the first point of contact between the formal health delivery system and the patients and serve a population of approximately 20,000. They provide basic curative and preventive services, as well as reproductive health services. District hospitals are the first referral hospitals with about 50 to 60 beds and serve an average population of 100,000 to 200,000 people in a clearly defined geographical area. Regional hospitals form the secondary level of health care for their locations and Teaching hospitals are centres of excellence for the provision of complex health care [40].

Study area

The study was conducted in Cape Coast, which is the regional capital of the Central Region of Ghana. The Cape Coast metropolis is located 163 km west of the capital of Ghana, covers an estimated land area of 122 square kilometres and is considered the smallest metropolis in Ghana. It is located at longitude 1° 15'W and latitude 5°06'N. Cape Coast is the former capital city of Ghana (Gold Coast) and is considered one of the oldest districts in the country. Owing to the growing population, its status increased to metropolitan in 2007. It is bounded south by the Gulf of Guinea, east by the Abura Asebu Kwamankese District, west by Komenda Edina Eguafo Abrem Municipal, and north by the Twifo Hemang Lower Denkyira District. The population of the metropolis according to the 2021 population and housing census was 189,925, with 92,790 males and 97,135 females. As a Metropolitan District, Cape Coast has health facilities at various levels of care, with the Cape Coast Teaching Hospital (CCTH) where this study was conducted being its tertiary referral centre.

CCTH is a 400-bed capacity hospital that serves as the teaching hospital of the University of Cape Coast, School of Medical Sciences (UCC-SMS), and as the main referral hospital for the central region and parts of western regions of Ghana. The hospital oversees approximately 2800 births per year. At the time of this research, the neonatal unit could provide continuous positive airway pressure (CPAP) ventilation support, oxygen, incubator care radiant warmers (although often shared), and phototherapy. KMC is routinely used in CCTH for the care of stable newborns who are being prepared for discharge, and nurses in the unit have regular in-service training on the KMC to improve practice.

Site selection

Four (4) primary care/maternity units with the highest referral/transfer to the neonatal unit of the CCTH were initially recruited following a review of the admission–discharge records over the past 2 years and a 2-month piloting of a designed proforma. Two of these sites were designated intervention sites, and the other two were designated control sites, with consideration given to the optimal balance for socioeconomic status, the size of the maternity unit, the ethnic mix, and the distance from the neonatal unit in CCTH. Two (2) additional maternity units were added to each arm of the study, 6 months into the study, to compensate for participant losses, particularly due to the institution of new policies directed by the Ministry of Health.

Participant recruitment

The intervention sites had posters displayed in the antenatal units, delivery suites and children's ward providing information about the study during the sensitization and training period. Potentially eligible participants were approached at their earliest antenatal appointment (using known risk factors for preterm delivery) or at an appropriately chosen time postnatally when the mother or the appropriate caregiver could give consent to the trained midwives/health care workers.

The decision to approach eligible women/families was made in liaison with the midwife/health care worker taking cognisance of the mother's health and mental state to minimize obtaining consent during a period of vulnerability.

The midwife/health care worker provided the mother/caregiver with comprehensive information about the study in the local language, and opportunities were given for the mother/caregiver to ask any questions about the study. Mothers/caregivers were reminded that they retained the right to not participate in the study and to withdraw consent or participate at any time without any form of impact on the care of themselves or their babies.

The midwives/health workers were trained in all the study procedures. A screening form was completed to record the number of mothers/caregivers approached about the study, eligibility, and at what stage women declined to participate.

All staff involved in the study and data collection were trained to collect and record physiologic parameters and outcome measures accurately. All staff involved reported and recorded information on adverse events during the transport process and before and after transport stabilization at the intervention sites.

The adverse events expected in this trial included the possibility of a neonate not tolerating the KMC resulting in difficulty breathing. However, previous studies on KMC in stable babies have reported no such adverse effects, but guidelines for dealing with such effects are part of health workers' training (Appendix 1).

Written consent was obtained from all participants who met the criteria for inclusion in the study.

Inclusion criteria

- Newborns < 2500 g and/or 28–37 weeks gestation at birth.
- Newborns less than 28 days old.
- Apgar score of at least 5 in the first and fifth minutes of life.
- Not requiring any ventilatory support, intravenous fluids, or vasopressors.
- Participants who provided informed consent were included in the study.
- Fathers or family members were willing to participate in situations where the mother was medically unwell for the transfer.

Exclusion criteria

- Apgar score of less than 5 at 10 min of age.
- Term neonates or neonates > 28 days of age.
- Preterm/LBW infants require prolonged resuscitation and oxygen therapy after 4 h of life.
- Newborns with major congenital malformations.
- Hypoxic ischaemic encephalopathy/prenatal asphyxia.
- Mothers with postnatal complications who were unable to give consent and had no dedicated family member to consent for inclusion in the study.

This list was not considered all-inclusive. If the midwife/health worker considered that the mother had other serious complications that would affect her suitability to participate in the transfer and that there was no guardian/relative to consent for the study, the midwife could use her discretion to exclude the mother from the study, noting on the recruitment form the reason for exclusion.

Mothers ($n = 0$) withdrawn on clinical grounds by the study team could still complete follow-up if they were willing, with these data contributing to questions about the acceptability of the intervention.

Procedures

Stabilization

All neonates enrolled in the study had a period of initial stabilization before transfer, during which they received conventional care.

Conventional care (control group and KMC group)

Conventional care for neonates starts in the delivery room, where the nurse/midwife receives the neonate after delivery, quickly dries and wraps in a towel and provides the necessary resuscitation as prescribed by the Helping Babies Breathe algorithm. A physical examination to check for any anatomical anomalies was performed by the receiving health worker, and the babies were given vitamin K injections intramuscularly and tetracycline ophthalmic ointment. Vital signs (temperature, heart rate, respiratory rate, and oxygen saturation) were checked by the nurse, who fed either at the breast or expressed breastmilk via a cup or nasogastric tube. Participants recruited from control sites received conventional care, and their babies were transferred to CCTH via the current established mode of transfer.

Kangaroo mother care group (Intervention group)

Neonates at the intervention sites received the same initial stabilization and conventional care as neonates at the control sites. The participants (mother–baby pairs), who were identified by trained health workers at the intervention sites for transfer and who provided consent for participation in the study, were taught the appropriate procedure for KMC, and the babies were transferred to the special care baby unit (CCTH) with the intervention. The intervention sites assessed women's or caregivers' confidence and competence in using KMC, and any identified issues improved before the transfer.

Components of the study intervention

Intervention site midwives/health workers following recruitment into the study provided conventional care as described above. Initial observations (heart rate, respiratory rate, oxygen saturation and blood glucose) were obtained and recorded. Neonates with low blood sugar levels (< 2.6 mmol/L) were given milk, and their blood sugar levels were rechecked for normality before transfer.

The neonate wearing a hat and diaper would be transferred gently and placed upright against the caregiver's (mother, father, or relative) bare chest. The neonate's head was turned to one side in a slightly extended position with the hips flexed and abducted. The arms were flexed, and the neonate was secured via a fabric (KMC sling or the mother's usual cover cloth). The fabric was wrapped around the caregiver and infant in a sling-like fashion such that it covered the whole body of the infant securely. It was then tied in a firm knot on the side of the mother. An additional blanket or cloth was placed over the mother and infant during transport to provide warmth.

The participants were accompanied by a nurse or trained health worker if the facility was adequately staffed to provide such support; otherwise, the caregiver was instructed to place his/her hands to support the back and neck of the neonate and monitor respiration. Caregiver–neonate pairs were transported in the available mode of transport, and neonates were kept in the kangaroo position on the chest of the caregivers during the entire transport process.

Monitoring

Measurements of heart rate, respiratory rate, temperature, and oxygen saturation were performed before transfer with kangaroo care transport or usual transport and then checked every 30 min during transport if accompanied by a health worker and immediately upon arrival at the CCTH.

Heart rate and oxygen saturation were monitored by pulse oximetry, and the respiratory rate was obtained by counting the rate per minute.

Capillary blood glucose was obtained before transport and upon arrival at the CCTH.

Data analysis

For a feasibility study, the analyses utilized were descriptive statistics such as percentages, proportions, frequencies, means and standard deviations (SDs). Given our aims and that the numbers in this feasibility study were too small for reliable inferences, between-group comparisons of outcomes were not appropriate. This manuscript adhered to CONSORT reporting guidelines [41, 42].

Sample size

A formal power calculation hinged on detecting evidence for effectiveness was not performed because the study was a feasibility trial. Based on a recent review of admissions to the neonatal unit at CCTH [43], 60 participants in the intervention arm were compared with the same number from the control sites. This was a pragmatic selection of sample size to allow us to identify evidence of feasibility, desirability, and recruitment rates and any problems with the intervention or research methods.

Outcome measures

Outcome measures were the survival and live discharge of preterm and low birthweight neonates. thermal stability (hypothermia), glucose control (hypoglycaemia),

and oxygen saturation (hypoxia).

Feasibility

Feasibility will be assessed by collecting data on the following:

- Recruitment and adherence rates.
- Time required to recruit to target sample size.
- Cost involved in conducting the study.

Study period

The study period was from 1st August 2022 to 30th July 2023.

Results

Initially, 120 mothers were approached and consented to the study from 4 cluster sites. A new Ministry of Health policy implemented during the study resulted in the loss of participants and inadvertent prolongation of the study. Four new sites were subsequently recruited, with 2 new sites added to each arm. The numbers in each arm and the reasons are summarized in Fig. 1.

A total of seventy-seven participants (mother-baby pairs) recruited into the study were included in the final analysis: thirty-four in the KMC arm and forty-three in the conventional arm.

For both the conventional and KMC arms of the study, we aimed to recruit 60 mother–baby pairs each. The age and sex distributions of those recruited in both arms were similar, although there were marginally more males than females. In total, 60 women in each group were

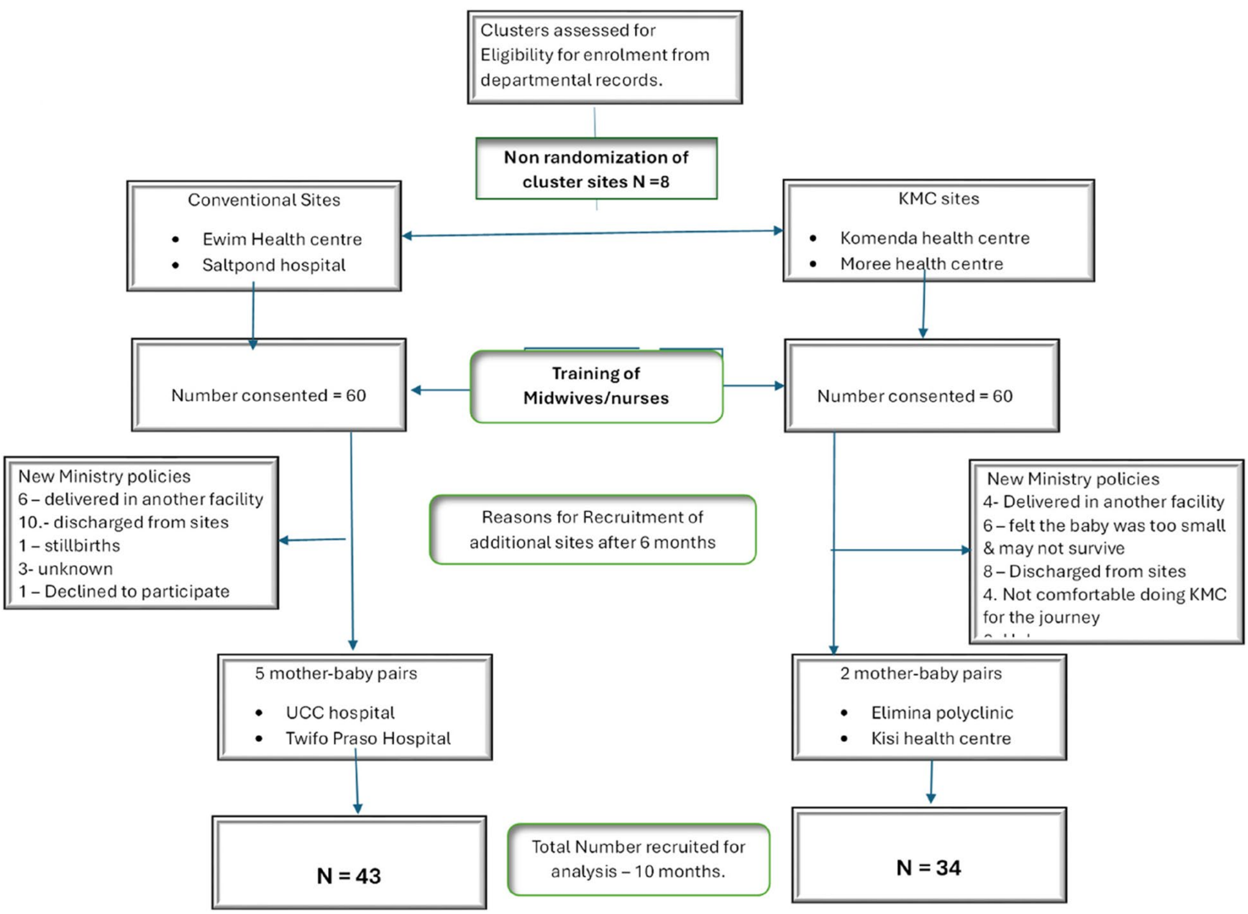

Fig. 1 Flowchart of the participant recruitment and randomization strategy

approached and consented to the study. However, after 6 months, 21 participants in the conventional arm and 28 in the KMC were lost for the reasons stated in Fig. 2. This necessitated the addition of 4 new sites, and recruitment of 7 additional mother baby pairs. Overall, 77 out of the 130 eligible mothers who consented eventually participated in the study, resulting in a yield of 59%. The nature of the study meant that following the transfer, no further interventions were required other than a follow-up to discharge and therefore an attrition of zero.

Background characteristics of the participating mothers (Table 1)

Most of the participant mothers were aged 20–32 years, with a median age of 24.4 years. In terms of marital status, 37.7% were single, 16.9% were cohabiting, and 45.5% were married. In terms of education, 22.1% had primary education, 45.5% had junior secondary school (JSS) education, and 16.9% had senior secondary school (SSS) education. The majority (42.6%) were unemployed, followed by skilled/manual workers (20.8%) and then those in sales and services (19.5%).

Comparison of characteristics between KMC-transport and conventional- care transport groups (Table 2)

Thirty-five (45.5%) of the babies were female, with 42 (54.5%) being male. The mode of delivery was mostly spontaneous vaginal delivery (92.3%), with equal numbers of babies who were resuscitated and not resuscitated. The gestational age of recruited neonates ranged from less than 28 weeks to 37 weeks with the majority between 28 and 32 weeks. The majority 58.4% of the transported neonates weighed less than 1.5 kg with 41.6% being above 1.6 kg.

Transport modalities and neonatal outcomes (Table 3)

Forty-three neonates were transported by existing conventional methods, with thirty-four being transported by KMC. Most of the babies were transported by taxis or private cars (60%), and 37% were transported by ambulances. The overall mortality rate was 20.8%, with high

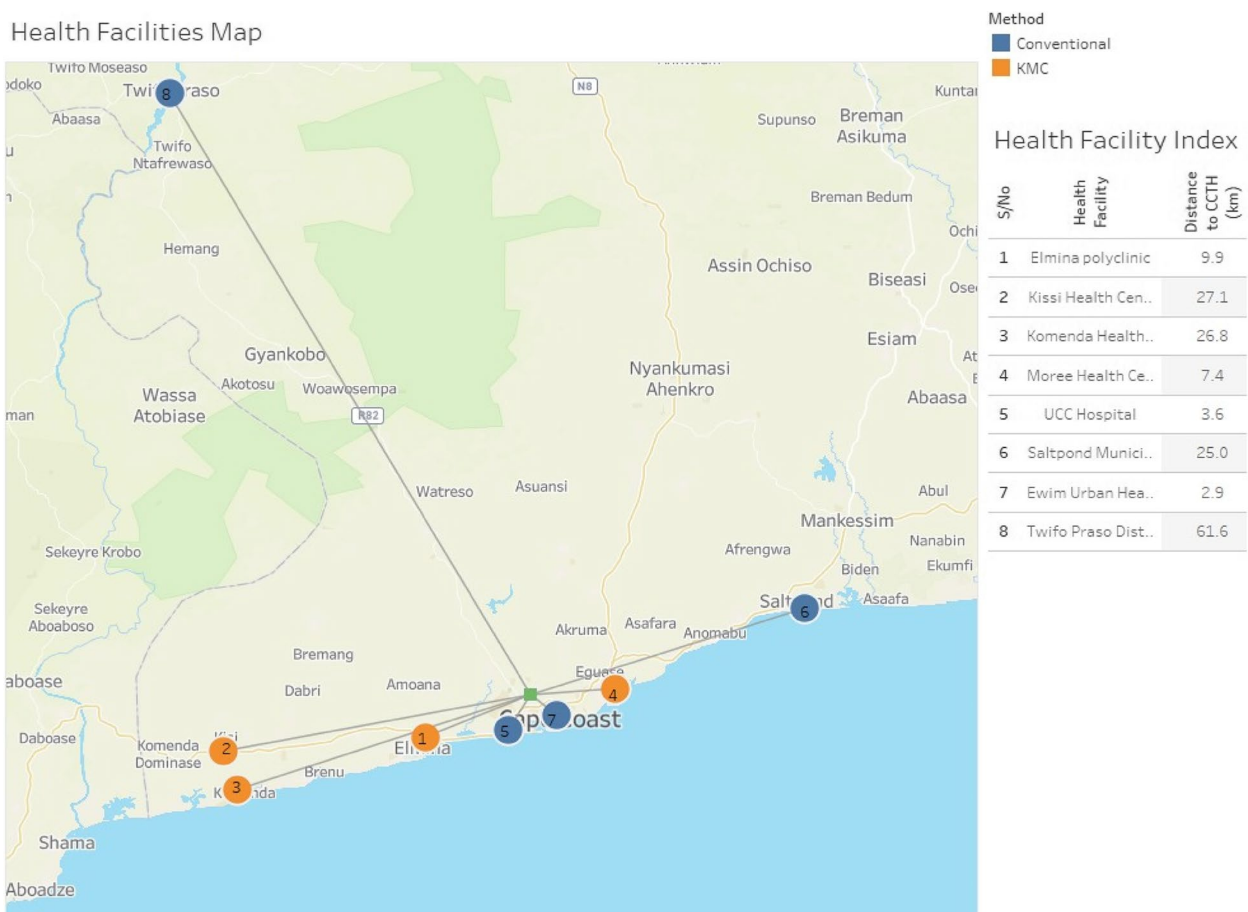

Fig. 2 Map showing the distribution of cluster sites

Table 1 Background characteristics of the participant mothers

Variable	Conventional	KMC	(Number (%)
Age in years(m ± sd)	25 ± 5.66	27.23 ± 7.58	Total
Marital status			
Cohabiting	10(13.0)	3(3.9)	13(16.9)
Married	19(24.7)	16(20.8)	35(45.5)
Single	14(18.2)	15(19.5)	29(37.7)
Education			
None	2(2.6)	1(1.3)	3(3.9)
Primary	11(14.3)	6(7.8)	17(22.1)
Jss	20(26.0)	15(19.5)	35(45.5)
Sss	6(7.8)	7(9.1)	13((16.9)
Tertiary	4(5.2)	5(6.5)	9(11.7)
Occupation			
Farming	1(1.3)	1(1.3)	2(2.6)
Professional/managerial	3(3.9)	3(3.9)	6(7.8)
Sales & services	8(10.4)	7(9.1)	15(19.5)
Skilled/manual	6(7.8)	10(13.0)	16(20.8)
Student	1(1.3)	2(2.6)	3(3.9)
Unemployed	24(31.2)	9(11.7)	33(42.6)
Unskilled/manual	0(0.0)	2(2.6)	2(2.6)
Household fuel			
Charcoal	23(29.9)	14(18.2)	37(48.1)
Firewood	3(3.9)	2(2.6)	5(6.5)
LPG/biogas	17(22.1)	18(23.4)	35(45.5)

Table 2 Delivery characteristics of neonates

Variable	Conventional	KMC	Discharged	Died
Normal Vaginal Delivery	41	30		
Number resuscitated	19	20		
Gender				
Female	20	15	30	5
Male	23	19	31	11
Gestational age				
< 28 weeks	2	5	4	3
28–32 wks	30	21	43	8
33–34 weeks	8	6	10	4
35–37 wks	3	2	4	1
Attendant at Delivery				
Midwife	36	30	51	15
Doctor	1	3	3	1
TBA	5	1	6	0
None	1	0	1	0
Birth weight(kg)				
< 1	6	4	4	6
1–1.5	22	13	30	5
1.6–2.5	15	17	27	5

mortality rates of 43 (11)−25.5% in the conventional group compared with 34 (5)−14.7% in the KMC group. No deterioration or untoward events were recorded for any of the babies transported by the KMC. There was no difference in blood glucose or oxygen saturation on arrival between the two arms, but marginally better temperatures were observed for the KMC group (Table 3).

Cost of KMC-transport (Table 4)

Exchange rate US$/GHS (1US$ = 14.5 GHS)

The cost involved in the process included the cost of a three-day training course for the midwives and nurses before the start of data recruitment, supervisory sessions during the study period and the cost of mobile telephone call credits for the recruitment team. The KMC cloth was the normal cover cloth used by the mothers, and vital sign monitoring equipment was hospital-acquired. No payments were made to participating mothers. Aside from the telephone credit costs, the other costs were fixed or semifixed costs, which did not increase linearly with increasing patient numbers.

Discussion

This study sought to answer the question of the feasibility of employing KMC in neonatal transport in Ghana, a sub-Saharan African country. Neonatal transport from peripheral birthing centres to the few specialized centres in many Sub-Saharan African countries is poorly organized with many transported neonates arriving in suboptimal conditions [11]. Despite the implementation of KMC in many neonatal units in the region with promising outcomes for preterm and LBW neonates, there are no documented studies from the region on KMC transport as an alternative to the current practice of transporting newborns in the arms of caregivers.

Results of a descriptive study by Sontheimer et al., Germany [21], and an RCT by Renelyn et al. in the Philippines [20] Showed that stable preterm can be transported over short and long distances by KMC without compromising their physiological status. Our study confirms this finding. Neonates in the KMC transport group remained stable with no difference in blood glucose or oxygen saturation on arrival, but marginally better temperatures compared to the neonates in the conventional group.

In our study, all neonates in the KMC group arrived at CCTH secured in the KMC positions with no adverse events recorded indicating that it is possible for KMC to the employed in the transport of stable neonates. This is in line with previous studies by Hennequin et al. (2018) in Brussels [34], Sontheimer et al. in Germany [21] Johannes van den Berg et al. in Sweden [44] and Renelyn et al. in

Table 3 Transport modalities and outcomes between KMC-transport and convention-care transport groups

Variable	Conventional	KMC	Discharged	Died
Indication for Referral				
Facility Not Equipped	40	30	56	14
No Oxygen	1	0	0	1
Other	2	3	5	1
Mode of Transport				
Ambulance	14	13	21	6
Taxi	22	20	36	6
Private Car	5	1	4	2
Foot	2	0	0	2
Did Mother accompany?				
No	20	7	19	8
Yes	23	27	42	8
Temperature on arrival (m ± sd)	35.4 ± 1.1	36.33 ± 0.6	35.9 ± 0.9	35.5 ± 1.2
Blood glucose (m ± sd)	4.45 ± 3.6	4.30 ± 2.3	4.2 ± 2.2	5.4 ± 5.2
Length of stay (m ± sd)	12 ± 8.3	13.8 ± 10.6	14.7 ± 9.3	5.8 ± 5.6
Transfer Sites (Distance-km)				
1. Elmina Polyclinic (9.9)	x	1	1	0
2. Kissi Health Centre (27.1)	x	1	1	0
3. Komenda health centre (26.8)	x	19	16	3
4. Moree Health Centre (7.4)	x	13	11	2
5. UCC Hospital (3.6)	3	x	2	1
6. Saltpond municipal Hosp (25.0)	20	x	15	5
7. Ewim Health Centre (2.9)	18	x	14	4
8. Twifo Praso (61.6)	2	x	1	1

Table 4 Cost associated with KMC-Transport

Item	Cost (GHS)	$ (equivalent)
3-day training session @ 500 GHS per day	1500	103.4
Telephone credit per month. 100 GHS per site	1000	69
Honoraria to the recruiting team. 200 GHS per site per month	8000	551.7
Cost per patient	136	9.4

the Philippines [20]. Our study confirms that KMC transport is feasible in newborns weighing less than 1 kg in contrast to studies by Gerlie et al. [35] and Renelyn et al. [20] which had the neonates in the KMC group being less than 2.2 Kg but above 1 kg. The transfers in our study were all land transports over distances of 7.4 to 27.1 km for the KMC group using public transport (private cars and taxis). This is in line with the study by Gerlie et al. in the Philippines [35] and supports the feasibility of KMC transport in resource-constrained settings using available transport where ambulance transport is limited.

Limitations

KMC transport in this study was at a low cost but would ideally be comparable if studies on incubator transport from this study and the region were available for compatibility. The patient care and journey for transferred neonates in CCTH, even though was out of the scope of this study can have an impact on mortalities between the two groups and needs to be explored in a larger study. Furthermore, differences in travel distances and missing data on accurate travel times between the two groups were a potential source of bias which could directly affect the outcomes. However, none of the transfers had an accompanying nurse/midwife and ambulance transfers were performed with paramedics who did not perform any monitoring or provide care during the transfer. The observed differences could not have been attributable to differential care during the transport process.

The strength of our study is in its application of KMC practice in neonatal transport in Sub-Saharan Africa using available land transport(taxis and private cars) with babies arriving at the referral centre not worse off physiologically compared to the current practice of wrapping them in a cloth and carrying them in the caregivers' arms. The low cost of transport, improved temperatures on arrival and an increased number of mothers accompanying the KMC-transported neonates providing continuous care compared to conventional care provide further strength in the feasibility and practicality of employing KMC in the transport of preterm and LBW neonates to improve outcomes.

Potential impact of missing data on the study findings

Six consented participants in the KMC arm of the study declined to participate because of parental concerns that the newborns were too small to be successfully transferred with KMC. Parental concerns about the poor survival of preterm neonates constitute a widely held local belief that often results in increased anxiety and delayed emotional attachment with preterm newborns. This local belief is deeply rooted in the rather stark neonatal mortality rates in Ghana, a situation that has continued to improve in the last two decades. These neonates were transferred to the CCTH by conventional means, 4 of whom were successfully discharged home and 2 of whom died. Adjusting for this lost group increased the total number of participants in the KMC from 34 to 40 compared with 43 in the conventional arm. The overall mortality in the KMC arm was adjusted from 14.7 to 17.5%, compared to 25.5% in the conventional group.

Conclusion

KMC transport from studies in other regions has been shown to provide physiological stability and no evidence of harm in transported neonates. This feasibility study from Ghana, a Sub-Saharan African country provides strength to employing this low-cost intervention which has the potential to improve continuous parental care and satisfaction as well as outcomes in transported preterm and LBW in the Sub region. The recent WHO recommendation for KMC to be adopted as the essential standard of care starting immediately after birth for all babies born early (before 37 weeks of pregnancy) or LBW should further empower local studies on KMC transport through larger clinical trials. This will inform clinical guidelines and policy development, as well as a scale-up in the implementation of KMC in the neonatal units and KMC transport in the Subregion.

Recommendation

A pragmatic trial focusing on the coordinated transfer of preterm and LBW newborns from peripheral birth centres to tertiary centres via KMC is urgently needed to assess the impact of such a low-cost but effective intervention on neonatal mortality in Sub-Saharan Africa.

Abbreviations

KMC	Kangaroo Mother Care
SSA	Sub-Saharan Africa
LBW	Low birth weight
LMIC	Low-middle-Income countries

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-024-05340-7.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

Mr. Prince Arkoh: School of Medical Sciences, University of Cape Coast, Cape Coast Ghana for his assistance with data analysis.Ms. Patricia Appiah of the Special Care Baby Unit, Cape Coast Teaching Hospital.

Authors' contributions

EO: Conceptualization, Methodology, Resources, Investigation, Data curation, Formal analysis, writing, original draft. F F: Conceptualization, methodology, data curation, formal analysis, review, editing and supervision. HK: Data collection, methodology, project administration. ED: Methodology, review, editing and supervision. HS: Conceptualization, Methodology, Formal Analysis, review & editing. Supervision.

Funding

No external funding was received for the project.

Data availability

The anonymised data collected are available as open data via the Open Science Framework repository: https://doi.org/10.17605/OSF.IO/P9HVK.

Declarations

Ethics approval and consent to participate

Ethical approval was received before starting any data collection from the Cape Coast Teaching Hospital Ethical Review Committee (CCTHERC) with approval number CCTHERC/EC/2021 (053) on 30th July 2021. All patients received treatment as per standard Institutional policies. We confirm that all methods were carried out per relevant guidelines and regulations. Informed consent for participation in the study was obtained from the parents and /or their legal guardians.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 13 September 2024 Accepted: 16 December 2024
Published online: 28 December 2024

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