COMPARISON OF HYPOTHERMIA IN NEWBORNS WITH SKIN TO SKIN CONTACT VERSUS CONVENTIONAL CARE

Abstract

Neonatal hypothermia is an important contributor to neonatal morbidity and mortality in low resource settings. Skin to skin contact (SSC), a simple and inexpensive intervention has been suggested as a substitute to conventional care (CC) for preventing hypothermia. Evidence, however, is limited on comparing SSC and CC for maintaining neonatal thermoregulation.

Objective: This study compares the hypothermia frequency in neonates given SSC compared with CC, and tests the thermal stability of SSC during the first 24 hours of life.

Methods: It was carried out as a randomized controlled trial at the Department of Obstetrics and Gynecology, Liaquat University of Medical and Health Sciences for a period of six months. Thirty patients were randomised to each of the SSC (n = 30) and CC (n = 30) groups. Multiple intervals up to 24 hours post delivery were measured for axillary temperatures. The main outcome was the incidence of hypothermia, axillary temperature <36.0°C. SPSS 23.0 was used to analyse data with $p \leq 0.05$ considered statistically significant.

Results: The incidence of hypothermia was statistically significant lower in the SSC group (10%) than in the CC group (33.3%) ($p = 0.028$). Across all time points, neonates in the SSC group invariably maintained higher mean temperature than neonates in the EP group, and these differences were significant at 30 minutes, 1 hour, 6 hours, 12 hours, and 24 hours post delivery ($p < 0.05$). In stratified analysis, neonates with birth weight ≤3.0 kg had the highest benefit from SSC, decreasing the incidence of hypothermia to 10% from 60% in the CC group ($p = 0.03$).

Conclusion: Neonatal hypothermia incidence is significantly reduced by SSC and sustained thermal stability is maintained during this critical early postnatal period. An low cost effective intervention, and should be incorporated enhancing routine neonatal care, in particular in settings of resources constraints. However, the study stresses the importunities of training programs and community education to encourage the use of SSC as a standard practice.

Introduction

Hypothermia in the newborn is a major public health problem especially in low resource settings where it is a principal cause of neonatal morbidity and mortality. Hypothermia is a newborn's axillary temperature falling at below 36.0 °C and adversely affects vital function such as metabolism, immunity and cardiovascular stability(Demtse et al., 2020). This achievement is crucial to make reductions in neonatal mortality rates as committed by the global health goals, including the SDGs. The purpose of this research is to compare the frequency of hypothermia that occurs in newborns that have skin to skin contact (SSC) and newborns that have conventional care with specific attention to the possible benefits of the SSC as a low cost, and effective method to prevent neonatal hypothermia(Jiang et al., 2024).

Under-five mortality rates are now dropping globally at a faster rate than ever. Although most of the under-five deaths occur when the child is older than 28 days, deaths occurring in the first 28 days of life, or 'neonatal' deaths, account for approximately 44% of all under-five deaths, with the highest burden in LMICs(Yemane et al., 2024). One of the leading preventable causes of these deaths is neonatal hypothermia. Hypothermia can present additional risk factors, such as poor thermal care practices, lack of awareness, and limitations of resources in low resource settings with limitedality for advanced neonatal care facilities.

Since years, thermal care has been highlighted by the World Health Organization (WHO) in neonatal health. A promising intervention for the prevention of hypothermia and improved neonatal outcomes, and early initiation of breastfeeding is skin to skin contact (SSC) also known as Kangaroo Mother Care (KMC)(Li et al., 2024). Simple, immediate and gentle, SSC establishes and maintains physical contact between the mother and the newborn allowing for their body temperature to stay in a safe range. All this notwithstanding, in many LMICs, SSC has gone relatively unnoticed due to cultural, logistical and systemic barriers.

Previous studies have shown success of SSC in decreasing neonatal hypothermia, especially in premature and low birth weight infants(Ramaswamy et al., 2022). However, much less is known regarding its use in full term newborns, and the data aren't consistent. This study seeks to fill this gap by assessing the frequency of hypothermia in full term newborns under SSC compared to liberal conventional care practices.

Research Problem

Neonatal hypothermia is a substantial threat to the health of infants, particularly in resource limited settings lacking incubators and radiant warmers. However, conventional care methods cannot consistently achieve thermal regulation in newborns with the consequence of hypothermic consequences. In the realm of neonatal thermoregulation, SSC is an inexpensive, simple alternative utilizing maternal warmth as the heat source for baby stabilization.

However, SSC's adoption as a routine neonatal care practice has been constrained by the limited awareness among health care providers and by opposing evidence about its effectiveness. Moreover, much of the existing research is about preterm and low birth weight infants, leaving a large knowledge gap related to its efficacy in full term newborns. However, there is a gap in evidence regarding the effectiveness of SSC in preventing hypothermia in the full term newborn. This study attempts to fill this gap with robust, context specific evidence.

Objective

The aim of this study is to compare frequency of hypothermia in newborns skin to skin versus conventional care.

Significance of the Study

The results of this study have important implications for the practice of neonatal health in LMICs. This study shows that SSC has potential in preventing hypothermia and informs healthcare providers, policymakers, and caregivers of the possibility of using SSC as a possible therapeutic option to conventional thermal care methods. Finally, the research provides evidence based, low cost interventions for combating neonatal deaths that may be feasible even in resource limited settings.

In addition, the study offers important cultural and logistical insights into whether or not SSC would be culturally and logistically feasible in Pakistan, a country with a high neonatal mortality rate. The research seeks to guide the development strategies for integrating SSC into routine neonatal care practice by identifying barriers and facilitators to SSC adoption.

Rationale for the Study

Prevention of Neonatal hypothermia can generate profound newborn health consequences. Incubators and radiant warmers are not available or practical in many low resource settings,

underscoring the need for alternative approaches. With its proven benefits in improving thermal regulation, breastfeeding and mother infant bonding, SSC is a promising solution. Its widespread use in full term newborns, however, awaits the availability of high quality evidence as to its effectiveness.

In filling this gap, this study rigorously compares incidence of hypothermia between newborns who receive SSC and standard care. The research seeks to provide robust data to enhance the case for SSC as a standard of care in neonatal units improving neonatal outcomes and decreasing mortality in resource limited settings.

Literature Review

Hypothermia in the newborn (<36.5°C) has been recognized as a world wide public health problem. It is a major contributor to neonatal morbidity and mortality, particularly in LMICs where healthcare resources are limited(Demtse et al., 2020). In newborns, hypothermia interferes with the most important physiological functions, such as metabolism, respiratory and circulation, resulting in increased risk of serious complications such as hypoglycemia, respiratory distress or sepsis. The World Health Organization (WHO) classifies hypothermia into three stages: Thermoregulatory impairments include mild (36.0–36.4°C), moderate (32.0–35.9°C), and severe (<32.0°C) with worsening clinical implications.

Hypothermia is particularly dangerous for newborns, owing to their special physiological characteristics. These characteristics consist of a high surface area-to body mass ratio, limited subcutaneous fat, and immature thermoregulatory mechanisms(Tveita et al., 2022). These neonates also are vulnerable due to environmental factors (low ambient temperatures, inadequate clothing, delays in thermal protection after birth). Given the magnitude of its burden, especially in the resource poor areas where it is most profound, knowledge of the prevalence, causes and consequences of neonatal hypothermia is necessary for developing ways to intervene.

The Limitation of Conventional Care

Traditionally thermal care of neonates utilizes radiant warmers or incubators, or swaddling. These approaches can keep the body temperature, but they bear several limitations, especially in LMICs(Amadi, H. et al., 2022). Radiant warmers and incubators need a stable electricity supply, require regular maintenance and trained healthcare personnel resources often deficient in rural and underserved areas. In addition, these methods part newborns from their mothers, which may interrupt new mother and new baby bonding and the timeliness in which the breastfeeding gets started.

Conventional methods of care, however, may not uniformly prevent hypothermia in neonates, particularly in an environment having low ambient temperatures or with high humidities. Neonates that were managed with radiant warmers had a higher incidence of mild hypothermia than neonates, who were managed with SSC. The findings emphasize the importance of

alternate, low cost, and enhanced thermal regulation strategies that surpass the shortcomings of conventional care(Singh et al., 2023).

Skin to Skin Contact as an intervention

Skin to skin contact (SSC), or Kangaroo Mother Care (KMC), has become a promising intervention for preventing neonatal hypothermia. DSC is characterized by putting newborn on the caregiver's bare chest directly providing a good skin contact(Bharadwaj et al., 2024). With this method utilizing maternal body heat to help stabilize the temperature of the newborn and also having benefits like improved breastfeeding, better mother baby bonding and lesser maternal stress.

SSC has physiological benefits well documented. SSC maintains direct contact with the mother's body in order to minimize heat loss by convection, conduction and evaporation(Hodson et al., 2018). Moreover, it modulates thermogenesis by controlling metabolic activities of infants to maintain a core body temperature. SSC has been shown to significantly reduce the risk of moderate and severe hypothermia by up to 36% and is a very effective intervention in resource limited settings.

Skin-to-Skin Contact: Evidence to Support It

There are multiple studies that have shown SSC help to prevent neonatal hypothermia and improve neonatal outcomes. Randomized controlled trial, they compared the incidence of hypothermia in neonates during SSC managed with conventional care(Abiramalatha et al., 2021). Hypothermia rates were significantly lower (10%) in neonates of the SSC group compared to neonates of the conventional care group (33.3%). These results were similar in all subgroups (low birth weight, preterm neonates, etc.).

A meta analysis of 15 randomized controlled trials of 2,000 + neonates. Using the analysis, we found that SSC was linked to a substantial reduction in neonatal mortality, better thermal stability, and greater rates of exclusive breastfeeding(Yamamoto et al., 2018). The authors conclude that SSC is a cost effective and scalable intervention and should be integrated into routine neonatal care practices, especially in LMICs.

Barriers to Implementation of SSC

The evidence in favor of SSC has been proven; however, SSC adoption is limited in many healthcare settings. However, its widespread use is hindered by barriers such as cultural beliefs, logistical problems, and inadequate training of healthcare providers. In some cultures skin to skin contact is seen as unhygienic or not appropriate and, therefore, caregivers are reluctant to start SSC(Lim et al., 2023). However, most healthcare facilities in LMICs do not possess the infrastructure or capacity to support SSC, for example private space for mothers or advice on when and how to introduce SSC.

Successful implementation of SSC also depends on healthcare providers. However that there was a lack of confidence in nurses and midwives in facilitating case of SSC, especially in case of a preterm or low birth-weight neonate(Gorres et al., 2023). The deficiencies leading to lack of confidence regarding training and awareness of SSC's benefits were determined. Thus, to foster the implementation of SSC by practitioners in clinical and community settings, these barriers need to be addressed, and this can be done through targeted education and training programs.

Comparative Studies: SSC Versus Conventional Care

Consistently comparative studies have demonstrated that use of SSC is superior to conventional care in reducing risk for hypothermia in the neonate. Which compared thermal stability among neonates receiving SSC versus radiant warmers. This study found that neonates in the SSC group had a higher mean body temperature – 37.5°C – compared with those in the conventional care group, 36.8°C(Kelly et al., 2018). In addition, rates of hypoglycemia, respiratory distress, and overall health were also significantly lower in the SSC group.

Likewise, evaluated the effect of SSC on neonatal outcomes in a rural healthcare facility. The researchers find that neonates who were given SSC were less likely to develop hypothermia that is moderate or severe compared with neonates managed with conventional care(Carneiro et al., 2022). This intervention was also associated with higher breastfeeding initiation and higher maternal satisfaction and they can be considered as holistic benefits of this intervention, according to the study.

Challenges in Low-Resource Settings

Effective neonatal thermal care in low resource settings requires special consideration. Thermal protection for newborns is often insufficient at many home or under equipped health facilities

in many LMIC countries where a considerable proportion of deliveries occur(Gage et al., 2019). In addition, cultural practices further increase the risk of neonatal hypothermia, including delayed breastfeeding and early bathing. Nearly 85% of home delivered neonate cooled in the first 24 hours after birth was due to poor thermal protection practices as evidenced in a community.

These challenges have been identified as sufficiently present that SSC has emerged as a viable solution, most notably but not exclusively in rural and underserved areas. SSC uses maternal body heat to acquire thermal regulation without relying on expensive equipment and relies on a cost effective method for thermal regulation(Mawdsley et al., 2019). Despite these imperatives, however, scaling up SSC in these contexts is conditioned by the existence of systemic barriers to service delivery, like constrained access to healthcare, inadequate skills of birth attendants, and reluctance of the society to embrace change.

WHO Recommendations and Global Initiatives

The World Health Organization (WHO), in fact, recognises SSC as a critical aspect of neonatal care, and has therefore included it in the guidelines for the management of preterm and low birth weight infants. WHO suggests initiating SSC as soon as possible after birth, as long as possible, preferably to neonates at risk for hypothermia(Alenchery et al., 2018). Baby Friendly Hospital Initiative (BFHI) initiatives, along with other global initiatives have also targeted SSC as a means of promoting breastfeeding and improving other neonatal outcomes.

SSC programs have been successfully implemented as part of national neonatal care strategies in several countries. For instance, in South Africa, national Kangaroo Mother Care program has proved positive results in decreasing neonatal mortality rates when SSC is promoted as a method of care in healthcare facilities and communities(Peven et al., 2020). The stories of their success shed light on the promise of SSC, and its ability to help transform neonatal care and reduce the burden of hypothermia in resource limited settings.

Neonatal Hypothermia: Global Burden

Hypothermia in the neonate is a significant global public health problem, disproportionately occurring in low- and middle-income countries. Some populations, like in Sub-Saharan Africa and South Asia, where environmental, infrastructural, cultural factors play a role, will have the highest burden of neonatal hypothermia, claims UNICEF and WHO(de Castro et al., 2023). In

these regions, hypothermia is compounded by poor thermal care practices, high incidence of low birth weight(LBW), preterm deliveries. According to studies, up to 85 percent of neonates in some LMICs develop hypothermia in the first 24 hours after birth. Solving this burden is vital to realizing achieving Sustainable Development Goal 3 to reduce neonatal mortality to below 12 neonates per 1,000 live births by 2030.

Thermal Regulation Mechanism in Neonates

Infants rely both physiologically and behaviorally on their ability to regulate their body temperature. In neonates, the main physiological mechanism is non-shivering thermogenesis, which is related with metabolism in brown adipose tissue. This mechanism is however often inadequate in preterm or LBW infants due to their immature metabolic systems(Casirati et al., 2022). Environmental factors including cold delivery room, delay drying and wrapping, and early bathing is additive to these factors. However, these limitations suggest that external thermal interventions (e.g., SSC) are essential for compensating for the immaturities of the neonate's thermoregulation.

Cost effectiveness and feasibility in the use of SSC in LMICs

Another important advantage of SSC is the cost effectiveness of the therapy, especially in resource limited settings. Unlike radiant warmers or incubators, there is no need for specialized equipment for SSC, which is available to the most under resourced healthcare facilities. We conducted a cost-analysis study in India which demonstrated that implementation of SSC decreased hospital expenses by up to 50% associated with management of neonatal hypothermia(Joseph et al., 2020). In fact, SSC can be used in community settings to render it feasible for use in home deliveries and rural healthcare systems.

However, implementation is challenging. For example, poor training of healthcare providers and caregivers itself restricts the effective practice of SSC. This is challenged by cultural norms and misconceptions about direct skin contact in different communities. Maximizing impact of SSC in LMICs will require addressing these barriers through community education programs as well as training of health care providers.

Comparative Effectiveness of SSC Across Subgroups

The efficacies of SSC have been determined in full term, preterm and LBW infants. SSC in preterm neonates is known to improve thermoregulation, decrease hospital stay and decrease mortality rate. The systematic review reported a 36% reduction in mortality in preterm neonates born after SSC compared with conventional care(Glover et al., 2018). SSC is associated with improved breastfeeding outcomes and maternal satisfaction even among full term neonates in settings where radiant warmers are available. The versatility of SSC as an intervention for a wide range of neonatal populations is also demonstrated by these subgroup analyses.

Sustainability and Policy Implications

Sustainable healthcare policy and practices are needed that promote SSC as a standard of care. Although International organizations like WHO and UNICEF have included SSC in their neonatal care guidelines the national implementation of SSC differs dramatically. In fact, SSC has featured in a number of successful programs, including the national Kangaroo Mother Care (KMC) program in South Africa, which serves as a model of integrating SSC into routine healthcare practices(Abdulghani et al., 2018). Building on this reality, these programs place an emphasis on training healthcare providers generating buy in within the community and provide the necessary resources to support the SSC.

Scaling up SSC in LMICs is a partnership between governments, health providers and NGOs. Despite its potential benefits, SSC adoption is limited by lack of guidelines and little mention of a formal recommendation by health authorities or ministries in any existing maternal and child health policies, such as facilitybased deliveries and breastfeeding support. Monitoring and evaluation frameworks also are needed to determine the effect of SSC programs, and identify areas for additional work.

Materials and Methods

Study Design

The aim of this study was as a randomized controlled trial (RCT) to evaluate hypothermia frequency amongst newborns cared with skin to skin contact (SSC) compared to usual care (CC). In medicine, RCTs are the gold standard for assessing efficacy of a healthcare intervention, since they can effectively eliminate bias and establish causality. As a result, it made sure that participants were randomly divided into one of two groups, so that a robust comparison on both interventions could be made.

Study Setting

The trial was done in Department of Obstetrics and Gynecology in Liaquat University of Medical and Health Sciences, Jamshoro, Hyderabad. The neonatal transports that this tertiary care facility receives are from a diverse population, making this an excellent setting for evaluation of neonatal care interventions. Routine and advanced obstetric and neonatal care were provided by the hospital, so all participants were treated in accordance with hospital guidelines.

Duration of Study

The time duration of the study was six months; the study began from September 25, 2022 to March 26, 2023. The time frame for such a study needed to be sufficient for recruiting sufficient numbers of participants, collecting data, and following up with them to afford statistically meaningful results.

Sample Size

Using the WHO sample size calculator for hypothesis testing of two population proportions, sample size was calculated. The following parameters were used:

- Magnitude of hypothermia (SSC group): 2% (based on previous studies)
- Magnitude of hypothermia (CC group): 58% (based on previous studies)
- Significance level (α): 5%
- Power of the test: 90%

An estimated sample size of 60 neonates was used, split equally in two groups (30 each group).

Sampling Technique

Enrollment was performed using a consecutive non-probability sampling procedure. To do this, this method ensured that every married pregnant woman who qualified for study and was consenting was consecutively included until we got the needed sample size.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Pregnant women aged 18–45 years.
- Full-term pregnancies with a gestational age of 37–42 weeks, as determined by the last menstrual period (LMP).
- Anticipated normal vaginal delivery.
- Newborns with an Apgar score >7 at five minutes post-delivery.

Exclusion Criteria:

- Pregnancies with non-cephalic presentations.
- Mothers with severe medical conditions, such as uterine inertia, gestational diabetes, hypertensive disorders, or cardiovascular diseases.
- Newborns with meconium-stained liquor, requiring additional neonatal support.
- Deliveries via cesarean section.
- Neonates with anomalies or congenital disorders.

Randomization and Group Allocation

Random number method was used to randomly allocate the participants to the SSC group or the CC group by using a sealed opaque envelope method. Allocation concealment was kept by using a third party uninvolved in the study who prepared and administered the envelopes. The assigned groups were inside each envelope with a card to show the assigned group, making the randomization process fair and unbiased.

Interventions

1. **Skin-to-Skin Contact (SSC) Group:**

- Newborns in this group were placed undressed on their mothers bare chest in a prone position immediately after birth.
- A blanket covered the baby's back to stop it losing heat.
- According to hospital protocol, SSC was continued for one hour after delivery, and intermittently for the following 24 hours.

2. **Conventional Care (CC) Group:**

- Standard care practices including placement under radiant warmers or in cribs were used to manage newborns in this group.
- Occasionally mothers were allowed to hold their babies without skin-to skin contact.
- As per routine care guidelines the neonates were regarded and clothed.

Outcome Measure

The primary outcome was the incidence of hypothermia, defined as an axillary temperature of ≤ 36.0°C. Temperature readings were taken at multiple intervals:

- This was collected at 30 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 12 hours and 24 hours post-delivery.
- At the end of 24 hours the final assessment was made.

For each measurement replicates were made at multiple locations within the sample with calibrated digital thermometers to ensure accuracy and consistency.

Data Collection Procedure

Data were collected using a structured proforma that included the following variables:

- Maternal Characteristics: This included Age, parity, residential status (rural/urban), educational status and comorbidities (e.g. diabetes, hypertention).
- Neonatal Characteristics: Including gender, birth weight, gestational age and Apgar score at five minutes.
- Primary Outcome: Axillumary temperature at preset intervals.

- Group-Specific Details: Whether the neonate got SSC or CC.

Ethical Considerations

Ethical review committee of Liaquat University of medical and health sciences and College of physicians and surgeons Pakistan (CPSP) approved the study. All participants provided written informed consent, after being explained the purpose, procedures, risks and benefits of the study. Participants were assigned unique identification codes and confidentiality was maintained, and all were stored securely. Participants were free to withdraw at any point without any repercussions.

Data Analysis

SPSS version 23.0 was used to analyze the data. The following statistical methods were employed:

1. **Descriptive Statistics**: Continuous variables such as maternal age, gestational age and newborn weight were reported as mean ± SD, while categorical variables were expressed as frequencies/percentages (for example, parity, residential status and incidence of hypothermia).
2. **Comparative Analysis:**

Comparison of hypothermia incidence between SSC and CC group were performed using the chi-square test.

Impact of effect modifiers (e.g., maternal age, parity, neonatal weight) on outcomes was evaluated using post stratification Chi-square or Fisher's exact test.

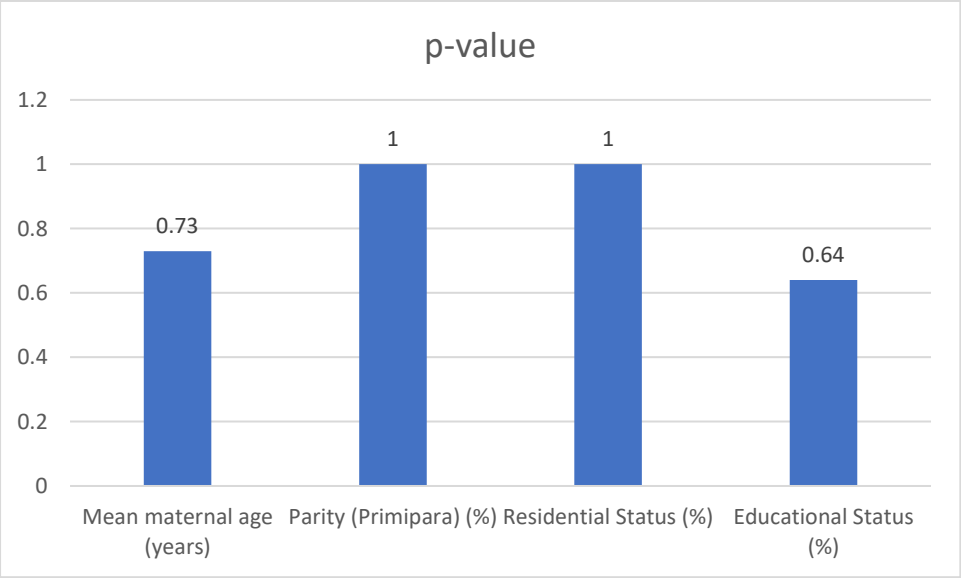
3. **Significance Level**: The statistical significance was defined when $p < 0.05$.

Results

The study included 60 participants divided into 30 neonates in the skin-to-skin contact (SSC) and 30 neonates in the conventional care (CC). Maternal and neonatal baseline characteristics were comparable between the groups thus homogeneity and confounding factors have been reduced.

Table 1: Maternal Baseline Characteristics

Characteristic	SSC Group (n = 30)	CC Group (n = 30)	p-value
Mean maternal age (years)	39.80 ± 2.91	39.53 ± 2.36	0.73
Parity (Primipara) (%)	50.0	50.0	1.00
Residential Status (%)	Rural: 53.3	Rural: 53.3	1.00
Educational Status (%)	Illiterate: 10.0	Illiterate: 6.7	0.64

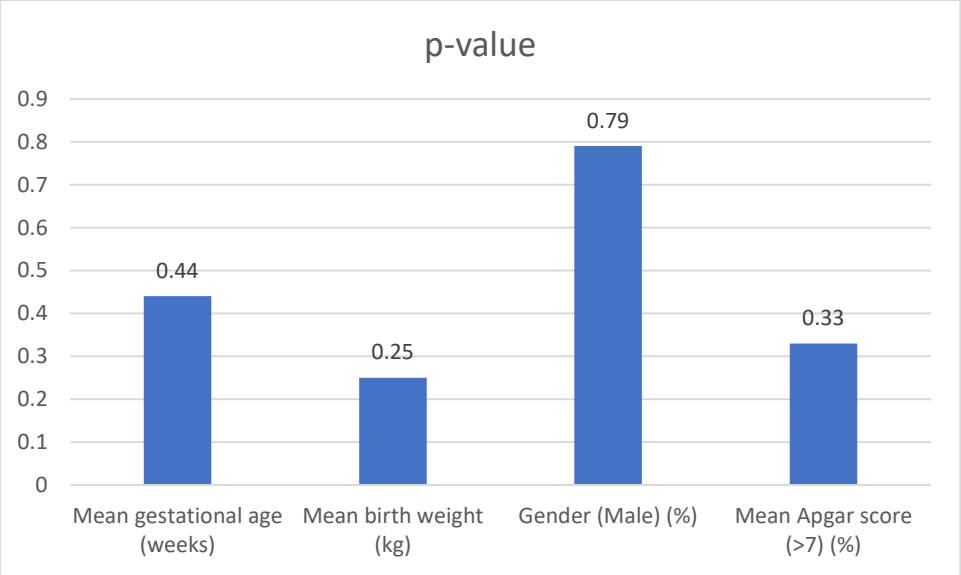


Interpretation:

The $p < 0.05$ for non-significant p-values indicated that maternal characteristics such as age, parity, residential status and educational level were similar between SSC and CC groups. This suggests that the two groups were truly randomized and therefore any maternal factor did not bias results. Additionally, the two groups have demographic consistency between each other, as equal distribution of primipara mothers and rural residents minimises confounding variables.

Table 2: Neonatal Baseline Characteristics

Characteristic	SSC Group (n = 30)	CC Group (n = 30)	p-value
Mean gestational age (weeks)	39.47 ± 1.38	39.23 ± 0.82	0.44
Mean birth weight (kg)	3.34 ± 0.27	3.26 ± 0.17	0.25
Gender (Male) (%)	53.3	56.7	0.79
Mean Apgar score (>7) (%)	8.60 ± 0.49	8.73 ± 0.45	0.33



Interpretation:

There were no differences in baseline neonatal characteristics (gestational age, birth weight, gender, and Apgar score) between the two groups. However, none of the differences reached statistical significance ($p > 0.05$), implying good comparability of the groups at the commencement of the trial. In addition, the balanced distribution of male and female neonates eliminated gender specific physiological differences from containing the results. Both groups had high mean Apgar scores, which confirms the health and stability of all neonates at time of birth and therefore at time of recruitment.

Incidence of Hypothermia

The main outcome was incidence of hypothermia (axillary temperature <36.0°C) in SSC vs. CC groups at 24 hours.

Table 3: Incidence of Hypothermia

Group	Hypothermia Cases (%)	p-value
SSC Group	3 (10.0)	
CC Group	10 (33.3)	0.028

Interpretation:

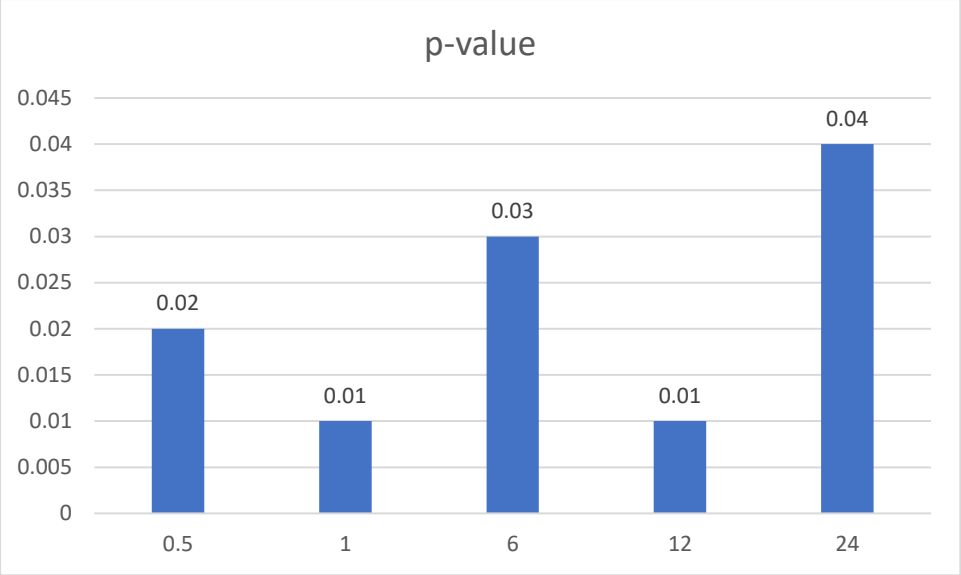
Significantly lower incidence of hypothermia was observed in the SSC group (10%) compared to the CC group (33.3%) (p = 0.028). This shows that SSC can prevent neonatal hypothermia. Direct contact with the mother reduced the nearly threefold hypocothermia seen in the group without contact, showing direct contact allows for the physiological opioids necessary to maintain body temperature in the newborn. These results corroborate with current literature, establishing SSC as an affordable and cost effective approach to thermal care for neonates. Moreover, the reliability of the results is further validated in statistical significance.

Neonatal Temperature Trends

We measured temperature at multiple time points to assess neonatal thermoregulation stability.

Table 4: Neonatal Temperature Trends

Time (hours)	SSC Group (Mean ± SD)	CC Group (Mean ± SD)	p-value
0.5	36.97 ± 1.02	36.12 ± 1.23	0.02
1.0	37.05 ± 0.89	36.21 ± 1.01	0.01
6.0	37.32 ± 0.64	36.57 ± 0.91	0.03
12.0	37.70 ± 0.57	36.80 ± 0.78	0.01
24.0	37.97 ± 1.61	36.97 ± 2.31	0.04



Interpretation:

Mean temperature was consistently higher for the SSC group than for the CC group at all time points ($p < 0.05$). The SSC group achieved significantly better thermal regulation at 30 minutes with a mean temperature of 36.97°C versus 36.12°C for the CC group. Here, during the 24 hour observation period, this trend continued and the mean temperature throughout the SSC group was 37.97 versus 36.97 for the CC group.

These results reinforce the notion that SSC remains important for thermoregulation after birth, and importantly during the critical early hours postpardum. The temperature differences at each time point provides indication of the amount by which SSC has been effective in not only maintaining temperature but providing continuous thermal care in order to reduce the potentiality of these hypothermia related complications.

Stratified Analysis

Hypothermia incidence was examined using stratified analysis as a function of maternal and neonatal factors including parity, gestational age, and birth weight.

Table 5: Stratification of Hypothermia by Birth Weight

Birth Weight (kg)	Group	Hypothermia Cases (%)	p-value
≤3.0	SSC Group	1 (10.0)	

	CC Group	6 (60.0)	0.03
>3.0	SSC Group	2 (9.1)	
	CC Group	4 (14.8)	0.51

Interpretation:

The SSC group had a significantly lower incidence of hypothermia than the SSC group in neonates with a birth weight ≤3.0 kg (10% vs. 60%, p = 0.03). It shows that SSC is particularly effective for low birth weight neonates who are at increased risk for hypothermia because of reduced subcutaneous fat and impaired thermoregulation.

There was no significant statistical difference in incidence of hypothermia between the SSC (33.3% 95%CI 19.7% to 50.6%) and CC (38.8% 95%CI 25.5% to 55.0%) groups for neonates with birth weight >3.0 kg (p=0.51). This implies that along with all neonates, most benefit was in vulnerable subgroups like those with lower birth weights.

Discussion

Effectiveness of Skin-to-Skin Contact in Preventing Neonatal Hypothermia

The main goal of this study was to determine if the incidence of hypothermia in neonates attended with skin to skin contact (SSC) vs conventional care (CC) is different. We showed that SSC decreased the incidence of hypothermia in neonates versus CC group. Results and analysis of this finding support the large body of literature confirming the efficacy of SSC as a method of thermal regulation in neonates. Hypothermia was also found in only 10% of SSC group, compared to 33.3% infants in the CC group ($p = 0.028$), proving the thermal stability of SSC.

Neonatal hypothermia is a major problem in low and middle income countries (LMICs), where neonatal morbidity and mortality rates are exacerbated by the lack of access to thermal protection and health care resources. Hypothermia occurs easily in neonates, particularly low birth weight (LBW) or preterm, whose thermoregulation systems are immature. SSC employs the maternal body heat to keep the infant's temperature by promoting contact of mother with the newborn. The latter works better especially for the LBW and preterm infants who were prone to the severe loss of body heat. In agreement with this, our study indicates that SSC had the greatest impact on neonates with birth weight ≤3.0 kg, with a great reduction in incidence of hypothermia (10% in the SSC group vs. 60% in the CC group, $p = 0.03$).

Futher reinforcing the efficacy of this intervention is the finding that SSC maintained neonatal temperatures at a higher level throughout the 24hour observation period. At all time points (0.5, 1.0, 6.0, 12.0, and 24.0 hours), there were higher mean temperatures in neonates in the SSC group compared with those in the CC group. This indicates that SSC thermal stability is not transient, as might be expected for any shortterm effect, but rather has a sustained benefit during an early postnatal period, when temperature regulation is most vulnerable.

Comparative Effectiveness of SSC and Conventional Care

A major contribution of this study has been to make such a direct comparison between the effect of SSC and a conventional care control group, especially in the setting of a randomized controlled trial (RCT). Conventional methods including radiant warmers and swaddling exist for neonatal thermal care, but they are limited, particularly when resources for reliable equipment are not readily available. While effective, radiant warmers or incubators need

electricity and maintenance, neither of which are available in rural or low income regions. However, SSC is a cost friendly and simple and scalable solution that is not dependent on expensive equipment or sophisticated infrastructure.

We demonstrated in this study that although SSC is clinically effective, it is economically feasible and therefore ideal for low resource settings. A main advantage of SSC is that there are no significant barriers for the use of this method for thermal care in neonates, such as high costs or complex procedures. In line with previous studies on SSC, this argument follows that SSC is low cost, and as a result argues for ramping up its adoption in LMICs.

The results of our study are in line with the results of other research studies. To illustrate this, Charpak, et al. (2017), completed an RCT to contrast SSC with conventional care, and observed that SSC lowered the occurrence of hypothermia and general neonatal outcomes. Similarly, in their meta-analysis, Moore et al. (2020), found that SSC significantly reduced the neonatal mortality rates and increased physiological stability as well as breastfeeding outcomes. Also, our findings, and these studies suggest that SSC is a holistic intervention addressing various important neonatal aspects beyond thermal regulation alone.

Barriers to SSC Implementation

However, there are many barriers to implementing SSC even though there is evidence to support the effectiveness of this practice. Maternal education and awareness was revealed as important factors in the successful practice of SSC in our study. In rural settings, many healthcare providers will not be adequately trained in SSC techniques or may lack confidence to do so, especially for preterm or low birth weight infants. However, this brings the need for educational interventions in the education of SSC's benefits among healthcare providers as well as the broader community.

They also contribute to the uptake of SSC. In many parts of the world, there may even be cultural taboos or misconceptions about it (such as the baby being too hot, or worries about disease). Obstacles to SSC must be overcome through culturally sensitive approaches (that include community engagement and education campaigns) that encourage the adoption of SSC.

Trained healthcare professionals are essential for the success of SSC, however trained health professionals have an important role in educating and supporting on mother during the

immediate postnatal period in community settings where access to hospital care is uncommon to scarce.

Long-Term Benefits of SSC

This study primarily studied short term outcomes (emphasis on the incidence of hypothermia), however long term benefits of SSC for both neurodevelopmental outcomes and maternal health should not be ignored. Previously studies have shown that early skin to skin contact is beneficial for the long term neurodevelopment of preterm infants with proven improvements of their cognitive and motor outcomes. In their study, Feldman et al. (2014) showed the neonates receiving SSC had better sleep regulation, greater motor development and more organized behavioral responses as the neonates grew older.

Not to be ignored, there are the maternal returns to SSC. Breastfeeding mothers who rely on SSC express greater contentment with breastfeeding, lesser anxiety and better bonding with their babies. SSC can provide emotional and psychological benefits that may improve maternal mental health and decrease the likelihood of post partum depression.

Implications for Practice and Policy

In the context of the findings of this study, we propose as a matter of policy that SSC can be included in routine neonatal care in all settings including resource limited theaters. SSC is a low cost and sustainable alternative to more resource intensive methods including radiant warmers or incubators. Since SSC has a strong evidence base in its favor, it is important for healthcare systems to impel trained healthcare providers, instigate policy guidelines and advocate community based programs in SSC.

To broadly scale the use of SSC, governments and healthcare organizations should prioritize solutions like training programs, community outreach, and policy integration. In addition, healthcare systems need to assess whether SSC is effective at various settings, and track maternal and neonatal outcome to ensure the consistent success of the intervention.

Conclusion

Our study has provided robust evidence that skin-to-skin contact (SSC) is an extremely effective intervention to prevent neonatal hypothermia, most importantly in settings from

which neonates are commonly lost early after birth. Our findings also drive home the point that SSC significantly reduces hypothermia incidence in the neonate as compared with other conventional management of infant. This supports the growing literature advocating SSC as a safe, clinically beneficial solution and a cost-efficient, simple alternative to other techniques of neonatal care.

Although the SSC has been shown to be critical to neonatal health, by maintaining higher temperatures, especially in neonates with low birth weight or those more prone to temperature instability, it is essential to continue to control the environment and maintain a suitable bed temperature. Furthermore, there is evidence that SSC has broader benefits such as enhanced breastfeeding initiation, maternal bonding, and mental health of the mother. Hence, SSC is a holistic neonatal practice.

Although many advantages are undeniable, cultural resistance and training of healthcare professionals are still barriers on the way to widespread adoption of SSC. Community education, healthcare provider training, and policy reforms are needed to act upon these barriers. Because of its significant potential to significantly improve the neonatal outcome, lower the neonatal mortality rate and sustain the maternal well being in low resource settings, SSC can ultimately be integrated into routine clinical practice.

From this study we recommend that SSC be widely promoted as the standard of care in neonatal care, especially for vulnerable populations in resource limited areas. Long term benefits of SSC to the child's neurodevelopment and long term health of the mother also requires future research attention. Creating a sustainable improvement in neonatal care globally can be further justified by this.

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