



Determinants of Neonatal Hypothermia Among Babies Born in Public Hospitals of West Shewa Zone of Oromia Regional State, Ethiopia: Unmatched Case–Control Study

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Background: Neonatal hypothermia is one of the contributors to neonatal morbidity and mortality in Ethiopia. Even though the Oromia regional state is one of the regions with the highest neonatal-mortality rate in Ethiopia, only limited progress has been made towards understanding the determinant factors the causes of mortality such as neonatal hypothermia.

Purpose: The study aims to identify determinants of hypothermia among newborns born in public health institutions.

Methods: A hospital-based unmatched case–control study design was employed with a total of 226 (113 cases and 113 controls) babies born in public health facilities West Shewa Oromia region, 2019. The study participants were selected using systematic random sampling. Cases were babies with a temperature $<36.5^{\circ}\text{C}$ and controls were babies with temperature $\geq 36.5^{\circ}\text{C}$ measured at the axilla site using a digital thermometer at the first hour after delivery. The data were collected by interview and checklist using the CS-Entry and exported to SPSS version-23 for analysis. The data were collected from both the babies and their mothers. Binary and multiple logistic regressions were conducted to identify the determinants of hypothermia.

Results: A total of 226 babies are participating in the study. Neonates who had not started early breastfeeding [AOR= 2.2, 95% CI (1.3, 4.1)], who had not skin-to-skin contact [AOR= 2.8, 95% CI (1.3, 6.6)] and babies with birth weight less than 2500 g [AOR=2.6, 95% CI (1.3, 5.2)] are found to be at higher risk of hypothermia.

Conclusion and Recommendation: This study has found out that low birth weight babies and those who do not initiate breastfeeding and skin-to-skin contact at higher risk of hypothermia. These risk factors are previously identified by different studies; therefore, birth attendants should give due emphases to the immediate newborn cares in order to prevent neonatal hypothermia.

Keywords: hypothermia, neonates, determinants, Ethiopia

Background

The proposed Sustainable Development Goals (SDG) target for child mortality aims to end, by 2030, preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 deaths per 1000 live births.¹ But, in 2019 alone, globally estimated 4.01 million children died, mostly from preventable causes. About half of global child mortality is shared

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by Sub-Saharan Africa countries, while only 23,551 deaths in North America, 33,517 deaths in Europe and 96,426 deaths are reported from Asian countries.² Newborn deaths account for 45% of under-five deaths.³ Hypothermia among newborns is considered an important contributor to neonatal morbidity and mortality in low-resource settings.⁴

Maintaining a normal body temperature is a critical function of newborn survival. An abnormally low temperature (hypothermia) in neonates occurs when the temperature drops below 36.5°C.⁵ Newborns undergo environmental interferences during their adaptation to the extra-uterine life, due to their systemic immaturity. The loss of heat in newborns takes place fast as it can decrease from 2°C to 3°C in the first half-hour of life, since heat production is not greater than the heat lost by convection, evaporation, and radiation, newborns are at risk of hypothermia.^{3,5} Although hypothermia is rarely a direct cause of death, it contributes to neonatal mortality, mostly as a comorbidity of severe neonatal infections, preterm birth, and asphyxia.^{4,6–8} Cold stress effects oxygenation by increasing pulmonary artery resistance and reducing surfactant production. Poor perfusion causes an increase in anaerobic metabolism causing worsening acidosis. There is extra utilization of glucose because of the increased metabolism, which can lead to hypoglycemia.^{3,5}

In Ethiopia the prevalence of hypothermia is high and it ranges from 50.0% to 70.0%.^{9–13} Factors associated with hypothermia were various according to different studies from abroad and Ethiopia. Newborn factors like birth weight,^{14,15} pre-term,¹⁶ breastfeeding initiation, low Appearance, Pulse, Grimace, Activity, and Respiration (APGAR) score, multiple pregnancy,¹⁷ neonatal abnormality, skin-to-skin contact and bathing within 24 hrs.¹⁸ Behavioral factors like inappropriate thermal resuscitation appliance and clothing,^{6,19} no wearing cap and no warm intra-facility transportation¹⁰ are among the commonest factors associated with newborn hypothermia.

The trend of neonatal mortality was showing good progress. The 2005 Ethiopian demographic, health survey (EDHS) with Neonatal mortality rate (NMR) of 39, 2011 EDHS with NMR of 37 to NMR of 29 in the 2016 EDHS.²⁰ But the 2019 mini EDHS shows that the national NMR becomes 30. This shows that further actions should be taken to improve neonatal survival in Ethiopia.²¹ The NMR of Oromiya regional state was 37, which is higher than the national NMR of 29.²⁰

The ministry of health (Ethiopia) sets a standard routine care to prevent neonatal hypothermia in all health facilities in the country. The ministry recommends health professionals to warm the delivery room, organize newborn corner with adequate heat source before delivery and at birth: deliver the baby on mother's abdomen, dry the baby thoroughly immediately after birth and remove wet clothes, use cap to prevent significant heat loss through the scalp, keep the new-born in skin-to-skin contact with the mother, keep the new-born under preheated radiant warmer – if the need for resuscitation, cover weighing scales with a warm towel and initiate early breastfeeding.²² Hence, hypothermia among newborns is presumed to be an important contributor to neonatal morbidity and mortality; determinant factors of hypothermia in the region need further study. Therefore, this study is aimed to identify determinant factors of hypothermia among babies born in public health facilities in the West Shewa zone of Oromia regional state, Ethiopia.

Methods

Study Area and Design

A hospital-based unmatched case-control study design was employed among newborns at public hospitals in West Shewa zone of Oromia regional state, Ethiopia. West Shewa zone is located 114 km away from the country's capital city Addis Ababa. The data were collected from August 01 to December 30, 2019. There are eight hospitals in the study area providing delivery and other maternal and child health services.

Source of Population and Study Population

Five public hospitals were involved in the study, namely, Ambo general hospital, Ambo University referral hospital, Gedo Hospital, Guder Hospital and Ginde-beret Hospital. The source populations were all newborns and their mothers at public hospitals in West Shewa Zone during the study period. Newborns with serious medical problems and those who were transferred to the neonatal intensive care unit before the first hour were excluded. Also, Newborns with multiple births were excluded as the weight of the neonates and their respective temperatures differ. Cases were newly diagnosed neonates with hypothermia (< 36.5°C) measured at the first hour after delivery and Controls were neonates without hypothermia or $\geq 36.5^{\circ}\text{C}$ at the first hour after delivery. Axillary

temperature of newborns was measured by data collectors at the first hour after delivery for 3 min of duration by using a digital thermometer to identify cases and controls, which measures the surface temperature at the site of axilla according to the World health organization (WHO) recommendation.³

Sample Size and Sampling Procedures

The sample size of the study was calculated using Epi-info software version 7.1.1 with the following parameters for unmatched case-control study; significance 95%, power 90%, odds ratio 3.4, the proportion of controls with exposure 11.4%, and proportion of cases with exposure 30.7% from previous studies conducted in Tigray region, Ethiopia,¹⁸ case to control ratio 1:1 and we got 102 cases and 102 controls. After assuming a 10% non-response rate, the total sample size yields 113 cases and 113 controls with an overall sample size of 226. The sample size was distributed proportionally to the five hospitals. All neonates who fulfill the case definition of neonates with hypothermia ($<36.5^{\circ}\text{C}$) measured at the first hour after deliveries were included in this study until the required sample size was obtained. Among neonates without hypothermia or $\geq 36.5^{\circ}\text{C}$ at the first hour after delivery, the required numbers of controls were selected using a systematic random sampling technique. The sampling interval to select the controls was determined with a calculated K-value (i.e. a K-value was calculated by dividing the number of births in the selected hospitals, 3 months prior to data collection by the sample size required from each selected hospital). The first control was selected by lottery method from the babies born on the first day of the data collection. The rest of the study participants were selected consecutively using the K-value until the desired sample size was reached.

Data Collection Tool, Quality Control and Measurements

A structured, interviewer administered questionnaire, checklist and temperature measurements were used to collect data from both the cases and the controls. The interview questionnaire was prepared in English and translated into local language, fan-Oromo by language experts, and then translated back to English by a third person to check for consistency. The tool was adapted from previous literature in different parts of the world and modified according to the local context. The interview questionnaire

addresses the information from the mothers regarding socio-demographic, past and current obstetric history. The checklist was used to collect secondary data from the study participants' medical card to collect information regarding the mode of delivery summary and immediate newborn cares given. A digital thermometer measurement was used to measure the neonate's temperature. The questionnaire template was coded by using open source software for Computer Assisted Personal Interviewing using census and survey processing system (CS-Pro) version 7.1 and deployed to Census and survey entry (CS-Entry) android application.

Five nurses from working in other facilities from the selected hospitals were recruited as data collectors and two assistant professors with a background of health professionals were hired as supervisors. In addition, the data collectors were trained for 2 days on the techniques of data collection and the purpose of the study for study participants before the start of data collection. A pre-test was done on 5% of the total study participant in Innchin hospital; a hospital found in the West Shewa Oromia region, which was not included in the actual study, and necessary adjustments were made.

Data Processing and Analysis

The data were collected and entered using the CS-Entry for the android version and exported to SPSS version 23 for analysis. Bivariate and multivariable logistic regressions were done to identify determinants of hypothermia. Those variables which were found to be significant with a p-value less than 0.05 during bivariate binary regression were included in the multivariate binary regression. Multicollinearity was diagnosed using the variance inflation factor. Finally, significant variables at P-value <0.05 were considered as statistically significant in multivariable logistic regression and presented with an odd ratio and 95% confidence interval (CI).

Ethical Clearance

Ethical clearance was obtained from the institutional review board (IRB) of Ambo University, West Shewa health bureau and respective hospitals. The ethics committee also approves to collect data from the newborns. The purpose of the study was explained to all study participants (mothers) about the information needed from the mother and her newborn and written consent was taken to collect data and communicate the findings through publication. They were also informed that all of their

Table 1 Socio-Demographic Characteristics of Mothers in West Shewa Oromia, Ethiopia

Characteristics	Cases Number (%)	Control Number (%)	Total Number (%)	P-value
Age category				
Younger than 20	17 (15.0)	16 (14.2)	33 (14.6)	0.054
20–29	70 (62.7)	72 (63.8)	142 (62.9)	
30–39	21 (18.6)	22 (19.5)	43 (19.0)	
40 and above	5(3.7)	3(2.6)	8(3.5)	
Mother education				
No formal education	35 (31.0)	42 (37.2)	77 (34.1)	0.299
Primary education (1–8)	36 (31.9)	26 (23.0)	62 (27.4)	
Secondary education (9–12)	21 (18.6)	17 (15.0)	38 (16.8)	
Collage and above	21 (18.6)	28 (24.8)	49 (21.7)	
Occupation mother				
Government employee	13 (11.5)	19 (16.8)	32 (14.2)	0.838
Private employee	9 (8.0)	8 (7.1)	17 (7.5)	
Farmer	35 (31.0)	34 (30.1)	69 (30.5)	
Merchant	14 (12.4)	10 (8.8)	24 (10.6)	
House wife	39 (34.5)	40 (35.4)	79 (35.0)	
Other	3 (2.7)	2 (1.8)	5 (2.2)	
Residence				
Rural	62 (54.9)	61 (54.0)	123 (54.4)	0.894
Urban	51 (45.1)	52 (46.0)	103 (45.6)	
Monthly income				
Less than 1000 ETB	47 (41.6)	34 (30.1)	81 (35.8)	0.063
1000–2500 ETB	22 (19.5)	38 (33.6)	60 (26.5)	
2501–5000 ETB	31 (27.4)	25 (22.1)	56 (24.8)	
More than 5000 ETB	13 (11.5)	16 (14.2)	29 (12.8)	

responses are confidential and anonymous, and they have all the right not to be involved in the study or not to answer any of the questions. This study was conducted in accordance with the Declaration of Helsinki.

Results

Socio-Demographic Characteristics of Mothers

In this study, a total of 113 hypothermic (cases) and 133 norm-thermic (control) were with their index mothers were

included, making a response rate of 100%. The mean (\pm standard deviation) age of mothers was 26.7 ± 5 years' ranges from 17 to 43 years. The majority of the mothers were from the rural districts of West Shewa, Oromia region. The mean (\pm standard deviation) of monthly income was 2775 ± 3173 Ethiopian Birr (ETB) (Table 1).

Obstetric History of Mothers

The majority of the mothers were multiparous (had more than one child) 201 (88.9%); 102 (90.3%) cases and 99

Table 2 Obstetric History and Practice of Mothers in West Shewa Oromia, Ethiopia

Characteristics	Cases Number (%)	Control Number (%)	Total Number (%)	P-value
Number of Children				
Prim-parous	11 (9.7)	14 (12.4)	25 (11.1)	0.525
Multiparous	102 (90.3)	99 (87.6)	201 (88.9)	
Birth interval				
≤ 2 years	64 (56.6)	56 (49.6)	120 (53.1)	0.286
> 2 years	49 (43.4)	57 (50.4)	106 (46.9)	
ANC				
Yes	99 (87.6)	101 (89.4)	200 (88.5)	0.677
No	14 (12.4)	12 (10.6)	26 (11.5)	
History of obstetric complication				
Yes	6 (5.3)	17 (15.0)	23 (13.3)	0.472
No	107 (94.7)	96 (85.0)	203 (86.7)	
Labor onset				
Spontaneous	100 (88.5)	98 (86.7)	198 (87.6)	0.686
Induced	13 (11.5)	15 (13.3)	28 (12.4)	
Mode of delivery				
SVD	72 (63.7)	72 (67.3)	169 (74.8)	0.751
Assisted vaginal delivery	27 (23.9)	23 (20.4)	8 (20.7)	
Cesarean section	14 (12.4)	35 (12.4)	49 (21.7)	

(87.6%) of controls. Among the total of mothers, 200 (88.5%) had ANC and 203 (86.7%) had no any history of complication during pregnancy. Regarding labor and delivery process, 198 (87.6%) of the mothers labor starts spontaneously and 169 (74.8%) of the mothers delivered through spontaneous vaginal delivery (SVD) (Table 2).

Neonate and Immediate Newborn Care-Related Characteristics

Among the total of newborns in this study; 155 (68.6%) were males and the majority of them were term babies 200 (88.5%), normal birth weight 194 (85.8%), had skin-to-skin contact with their mothers 193 (85.4%) and 117 (82.4%) were HIV negatives. Regarding the timing of breastfeeding initiated, 36 (31.9%) from cases and 61 (54.0%) of controls were breastfeed within 1 hour after delivery. A total of study participants 129 (57.1%); 45 (38.9%) cases and 51 (45.1%) had APGAR

scores above seven at 5 minutes (Table 3). The mean temperature of the cases was 35.1°C with a standard deviation (SD) of 1.1°C and the mean temperature of controls was 37.5°C with SD 0.6°C. Hypothermia classified as mild hypothermia (36.0–36.5°C), moderate hypothermia (32.0–35.9°C) and severe hypothermia (less than 32°C) according to the WHO classification.³ In this study, from the hypothermic babies, 37 (32.7%) were mild hypothermia, 75 (66.4%) were moderate hypothermia and only 1 (0.9%) were under the classification of severe hypothermia.

Determinants of Neonatal Hypothermia

The independent predictors of hypothermia with a P-value less than 0.05 among neonates were breastfeeding, skin-to-skin contact, gestational age, birth weight and respiratory distress. In the multivariable binary logistic regression analysis, only three variables had shown an overall

Table 3 Neonate and Immediate Newborn Cares-Related Characteristics in West Shewa Oromia, Ethiopia

Characteristics	Cases Number (%)	Control Number (%)	Total Number (%)	P-value
Sex				
Male	69 (61.1)	86 (76.1)	155 (68.6)	0.011
Female	44 (38.9)	27 (23.9)	71 (31.4)	
Gestational age				
< 37 Weeks	8 (7.1)	18 (15.9)	26 (11.5)	0.037
≥ 37 Weeks	105 (92.9)	95 (84.1)	200 (88.5)	
Birth weight				
Low birth weight	22 (19.5)	10 (8.8)	32 (14.2)	0.022
Normal birth weight	91 (80.5)	103 (91.2)	194 (85.8)	
Respiratory distress				
Present	62 (54.9)	44 (38.9)	130 (57.5)	0.016
Absent	51 (45.1)	69 (61.1)	96 (42.5)	
APGAR at 5 min				
<7	68 (60.2)	62 (54.9)	97 (42.9)	0.419
≥ 7	45 (39.8)	51 (45.1)	129 (57.1)	
Breastfeeding				
Yes	36 (31.9)	61 (54.0)	130 (57.5)	0.001
No	77 (68.1)	52 (46.0)	96 (42.5)	
Skin-to-skin contact				
Yes	89 (78.8)	104 (92.0)	193 (85.4)	0.005
No	24 (21.2)	9 (8.0)	33 (14.6)	
HIV status				
Positive	7 (10.1)	15 (20.5)	22 (15.5)	0.045
Negative	62 (89.9)	55 (75.3)	117 (82.4)	

significant effect on the risk of neonatal hypothermia at the 5% level of significance. Neonates who had not started breastfeeding within 1 hour after delivery are about 2.2 times at risk of hypothermia than their counterparts [AOR= 2.2, 95% CI (1.3,4.1)]. Neonates who had not skin-to-skin contact with their mothers are about three times at higher risk to develop hypothermia than those neonates who had skin-to-skin contact with their mothers [AOR= 2.8, 95% CI (1.3,6.6)]. Finally, neonates with birth weight less than 2500 g are 2.6 times at higher risk of hypothermia than their counterparts [AOR=2.6, 95% CI (1.3,5.2)] (Table 4).

Discussion

In this study, we have tried to identify determinants of neonatal hypothermia and we also found similar risk factors previously indicated by different scholars. Breastfeeding initiation within 1 hour, skin-to-skin contact, and low birth weight are found to be one of the determinant factors of hypothermia. Newborns that did not start breastfeeding within 1 hour are about two times more likely to develop hypothermia. This is similar to studies conducted in, Nepal,⁸ Zambia,²³ and studies from Ethiopia' Addis Ababa,⁹ Tigray region,¹⁸ Amhara region²⁴ and, Gondar, Northern Ethiopia.¹¹ This may be due to

Table 4 Determinates of Hypothermia Among Neonates at NICU in West Shewa Oromia, Ethiopia

Characteristics	Cases Number (%)	Control Number (%)	COR (95% CI)	AOR (95% CI)
Breastfeeding with in 1hr				
Yes	36 (31.9)	61 (54.0)	1	1
No	77 (68.1)	52 (46.0)	2.3 (1.3,4.2)	2.2 (1.3,4.1)*
Skin-to-skin contact				
Yes	89 (78.8)	104 (92.0)	1	1
No	24 (21.2)	9 (8.0)	3.1 (1.3,6.9)	2.8 (1.3,6.6)*
Gestational Age				
< 37 Weeks	8 (7.1)	18 (15.9)	1	1
≥ 37 Weeks	105 (92.9)	95 (84.1)	2.4 (1.1,5.8)	2.1 (0.8,5.3)
Birth weight				
< 2500 g	22 (19.5)	10 (8.8)	2.4 (1.2,5.9)	2.6 (1.3,5.2)*
≥ 2500 g	91 (80.5)	103 (91.2)		1
Respiratory distress				
Present	62 (54.9)	44 (38.9)	1.9 (1.1,3.2)	1.5 (0.9,2.8)
Absent	51 (45.1)	69 (61.1)	1	1

Note: *P-value less than 0.05.

early initiation of breastfeeding facilitated skin-to-skin contact immediately, prevent exposing the baby to the environment, increase follow up care to mothers for their child and breast milk is the source of energy or calories to produce heat for thermoregulation and they have no adequate adipose tissue for glucose breakdown which results in hypothermia.

Skin-to-skin contact had a significant association with neonatal hypothermia in this study. This is found to be similar to, the risk of developing hypothermia among newborns who do not have skin-to-skin contacts is from 2 to 5 times than their counterparts according to studies conducted in Iran,²⁵ Zambia²² and, studies from Ethiopia; Addis Ababa⁹ Gondar,¹¹ Harar city, Eastern Ethiopia,¹⁰ Southern Ethiopia,¹³ and Tigray.¹⁸ The possible reason could be in the temperature of the fetus in the uterus is consistent with the maternal temperature; Newborns who had skin-to-skin contact immediately after delivery with their mother gain heat through conduction which is consistent with their temperature in the womb during exposure of the newborn to the extrauterine environment. Skin-to-skin contact is more effective than incubator care for re-warming the newborn. It may also be due to the maternal chest and abdominal movement that stimulates

the newborn for enhanced breathing which improves heat generation through oxidative phosphorylation. The WHO and American pediatric association recommends that newborns without complications should be kept in skin-to-skin contact with their mothers during the first hour after birth to prevent hypothermia and promote breastfeeding.^{3,5,15}

This study also found out that low birth weight newborns are 2.6 times at higher risk of developing hypothermia than normal weight babies. This is also supported by the findings from studies conducted in Lebanon¹⁵ Nepal⁸, Nigeria,²⁶ and studies from Ethiopia; Tigray,¹⁸ and Gondar.¹¹ It is also a consistent finding with a global hypothermia systematic review.⁶ The main reason that low birth weights are at greater risk of hypothermia is due to their higher surface area to weight, their decreased subcutaneous fat with its less isolative capacity, and less developed stores of brown adipose tissue.⁵

Limitation of the Study

Finally, we would like to inform our readers that this study was conducted among babies born in public hospitals; therefore, the result does not represent the general community as the samples were specific to women delivered in

public health facilities. Furthermore, due to Health care access bias: as the women in health facilities are more likely to have better information than those who do not receive health care, our study may miss some determinant factors that may affect the occurrence of the outcome variable. There is also a chance of Mis-classification bias: as the temperature was measured once and the cut point was small, this could affect the classification and the overall result. Therefore, we recommend our readers to consider these limitations while reading, interpreting the findings and also while considering to cite this study.

Conclusion and Recommendations

The finding of this study showed that initiation of breastfeeding within 1 hour, newborn skin-to-skin contact with their mother, and low birth weight are found to be determinant factors of neonatal hypothermia among newborns in public health hospitals of West Shewa, Oromia regional state. Therefore, this study strengthens this evidence regarding the determinants of hypothermia and the situations in the study are is not different. Following the recommendations of WHO and national guidelines, to initiate breastfeeding immediately and skin-to-skin contact is crucial and immediate newborn. Low birth weight babies are at risk of developing hypothermia than other babies. Therefore, due attention should be given for low birth weights and other hypothermic prevention plans and cares should be given to those newborns.

Abbreviations

AOR, adjusted odds ratio; APGAR, Appearance, Pulse, Grimace, Activity, and Respiration; COR, crude odds ratio; CI, confidence interval; CSPRO, census and survey processing system; CS-Entry, census and survey entry; EDHS, Ethiopian Demographic Health Survey; ETB, Ethiopian birr; NMR, neonatal mortality rate; SD, standard deviation; VIF, variance inflation factors; WHO, World Health Organization.

Data Sharing Statement

Full data for this research are available through the corresponding author upon request.

Ethics Approval and Consent for Publication

Ethical clearance was obtained from the institutional review board (IRB) of Ambo University West Shewa health bureau and respective hospitals. The ethics committee also approves to collect data from the newborns. The

purpose of the study was explained to all study participants (mothers) about the information needed from the mother and her newborn, and written consent was taken to collect data and communicate the findings through publication. They were also informed that all of their responses are confidential and anonymous, and they have all the right not to be involved in the study or not to answer any of the questions. This study was conducted in accordance with the Declaration of Helsinki.

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Author Contributions

All authors (BS, DB, KS and GA) made a significant contribution to the conception, study design, execution, acquisition of data, analysis and interpretation; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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