

The subsequent newborn effects of stillbirth and abortion, a longitudinal study.

Berhanu Elfu Feleke (✉ elfufeleke@gmail.com)

Bahir Dar University <https://orcid.org/0000-0001-9251-3337>

Teferi Elfu Feleke

Wolkite University

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Abstract

Introduction This study was conducted to assess the effects of stillbirth and abortion on the health of the subsequent newborn.

Methods A prospective cohort study was implemented. The data were collected from January 2015 to August 2019. The study participants were selected using the simple random sampling technique. The data were collected using interviewing the pregnant mothers, reviewing medical charts, analyzing the blood samples from the newborn, and scheduled medical checkups. General linear model was used to assess the effects of stillbirth and abortion on the health of the newborn, Poisson regression was used to identify predictors of childhood infectious diseases episodes and Kaplan Meier survival curve were used to estimate time to childhood pneumonia and diarrhea.

Results 2872 infants were included giving for the response rate of 88.97%. Neonate born from mothers with a previous history of stillbirth or abortion had low birth weight, low serum iron, and zinc levels. High infection episodes of diarrhea and pneumonia were observed among infants born from a previous history of stillbirth and abortion mothers. The infection episodes during the childhood period were determined by serum zinc level [IRR 0.71; 95% CI: 0.61- 0.83], birth weight [IRR 0.86; 95% CI: 0.81 – 0.91], breastfeeding frequency [IRR 0.9; 95% CI: 0.87-0.93].

Conclusion The birth weight, serum iron and zinc levels of neonates born from the previous history of stillbirth and abortion were lower. The infection episodes of newborns born from mothers with previous history stillbirth or abortion were higher.

Introduction

The health of the newborn proximally affected by maternal bad obstetric histories like the previous history of stillbirths and abortion. Each year, 56 million abortion and 2.6 million stillbirths were reported [1, 2]. The world health organization report indicates that, in 2017, 4.1 million infants' death was recorded mostly from low – income countries [3].

Low birth weight means the birth of the newborn weighing less than 2.5 kg and affects more than 22.9 million newborns annually [4]. Preterm deliveries, intrauterine growth retardation, multiple pregnancies and disease conditions are some of the reasons for low birth weight delivery [5–7]. The health of low birth weight newborns can be complicated with hypothermia, infections, inadequate feeding, lung immaturity, nervous disorders, necrotizing enterocolitis, and sudden infant death syndrome [8–12].

Micronutrients are vitamins and minerals and they have numerous effects on the health of the newborn. The normal serum iron level for the newborn ranges from 100–250 micrograms/deciliter (mcg/dl) [13]. Iron deficiency anemia affects the development of multiple organs during the infancy periods and if not treated early, can cause permanent sequels [14, 15]. Zinc plays critical roles in fighting against infections

in the newborn and the normal reference range for the newborn ranges from 0.6–1.2 micrograms per milliliter (mcg/ml) [16].

Diarrheal diseases and pneumonia are the common infectious diseases observed during the infancy period. Each year, the diarrheal disease affects 1.7 billion children and kills 525 000 children [17]. Pneumonia is an inflammation of the lungs and responsible for the death of 808 694 children in 2017, that means 15% of all deaths were attributed by pneumonia [18].

The subsequent pregnancy effects of stillbirth and abortion on the birth weight, serum concentrations of iron, zinc as well as on the episodes of infectious diseases during the infancy were nor clearly known and this study was conducted,

To assess the effects of stillbirth and abortion on the birth weight of subsequent newborn
To estimate the effects of stillbirth and abortion on the newborn serum concentration of zinc and iron
To assess the effects of stillbirth and abortion on the episodes of infectious diseases during the infancy period.

Methods And Materials

A prospective cohort study was implemented among pregnant women with a bad history of obstetric outcomes and a good history of obstetric outcomes in the Mecha demographic surveillance and field research center catchment areas. Pregnant women with a previous history of stillbirth or abortion were labeled as bad obstetric history. The data were collected from January 2015 to August 2019. Pregnant women with bad obstetric history and without bad obstetric history from Mecha demographic surveillance and field research center catchment areas were followed from their pregnancy until 6 months post-partum. The source population of this study was all pregnant mothers. Pregnant mothers with incomplete medical records, unable to give consent, and out migrated from the study areas were excluded from the study. The sample size was calculated using Epi-info software version 7 with the assumption of 95% CI, 90% power, previous bad obstetric outcomes to good obstetric outcomes ratio of 1:2, a risk ratio of 1.2 and 10% none response rate. This gives 1076 pregnant mothers with a bad previous history of obstetric outcomes and 2152 pregnant women with no previous history of bad obstetric outcomes. The study participants were selected using the simple random sampling technique. The sampling frame was obtained from Mecha demographic surveillance and field research center database. The data were collected using interviewing the pregnant mothers, reviewing medical charts, analyzing the blood samples from the newborn, and scheduled medical checkups. Baseline data were collected using interview techniques, from each pregnant woman registered from the household registration system database of the research center. Then, update data were collected every week by assigning trained general practitioner from each post-partum mother using their ID numbers from the database of the research center as tracing mechanisms until the infant reach 6 months. Blood samples were obtained from the newborn and analyzed using an atomic absorption spectrophotometer for measuring the serum zinc and the serum iron level was measured using cobas6000 (Roche kits German) instruments (Set 2015; analytics 2014)

[19, 20]. Data were entered into the computer using the EPI-info software and transferred to STATA software version 14 for the analysis. Descriptive statistics were used to describe the profile of study participants, general linear model (GLM, multivariate) was used to assess the effects of stillbirth and abortion on the health of the newborn, Poisson regression was used to identify the predictors of childhood infectious diseases episodes and Kaplan Meier survival curves were used to estimate time to childhood pneumonia and diarrhea.

Ethical clearance was obtained from Bahir Dar University's ethical review board. Legal permissions were obtained from the Amhara national regional state health bureau ethical committee and Mecha district health office. Written informed consent was obtained from each study participant. The confidentiality of the data was respected at every step. Study participants the right to withdraw from the study at any point was respected. Infants with pneumonia or diarrhea were linked to the nearby health center curative unit immediately.

Results

Totally, 2872 infants were included giving for the response rate of 88.97%; 216 infants were excluded due to incomplete records, 113 study participants were excluded due to outmigration from the study areas, and 27 infants were excluded due to the consents. 15.53% of infants were from the urban areas. The recurrence rate of stillbirth was 3.67% (95% CI: 2.58–5.01) (Table 1).

Table 1
; Population profile of the study participants (n = 2872)

SN	Population profile		Frequency	Percentage
1.	Gestational age during delivery	≥ 37 weeks	549	19.12
		38–42 weeks	2310	80.43
		> 42 weeks	13	0.45
4.	Residence	Urban	446	15.53
		Rural	2426	84.47
6.	Maternal chronic illness	Present	454	15.81
		Absent	2418	84.19
8.	Previous pregnancy outcome	No history of abortion or stillbirth	1958	68.18
		Abortion	37	1.29
		Stillbirth	877	30.54
11.	Gravidity	2	102	3.55
		3	787	27.4
		4	1462	50.91
		5	509	17.72
		6	12	0.42

Table 2

The mean birth weight, serum iron level, and serum zinc levels of neonates born from 3 different groups of mothers (n = 2872)

Groups of mother	Birth weight in kilogram		Serum zinc level in mcg/ml		Serum iron level in mcg/dl	
	Mean	SD	Mean	SD	Mean	SD
No history of stillbirth or abortion	2.72	0.48	0.83	0.1	157.53	29.62
History of abortion	2.5	< 0.01	0.7	< 0.01	92.43	16.73
History of stillbirth	1.97	0.37	0.59	0.2	97.86	24.26

Neonate born from mothers with a previous history of abortion had significantly lower birth weight, serum zinc level, and serum iron level as compared to neonates born from mothers with no previous history of stillbirth or abortion (Table 2).

After adjusting for maternal chronic illnesses, maternal age, parity, gestational age, ante-partum hemorrhage, residence, previous history of stillbirth or abortion: the neonatal birth weight, serum iron level, and the serum zinc levels were determined by; previous history of abortion, previous history of stillbirth, gestational age during delivery, residence, maternal chronic illnesses, and maternal age (Table 3).

Table 3

Multivariate analysis for the determinants of birth weight, serum iron levels and serum zinc levels (n = 2872).

Dependent variable	Predictors	β	95% CI for β		p-value
			Lower Bound	Upper Bound	
Iron level in mcg/dl	Maternal chronic illnesses	-5.85	-8.64	-3.06	< 0.01
	Residence	5.71	2.36	9.07	< 0.01
	Gestational age during delivery	3.20	2.61	3.79	< 0.01
	Maternal age	-0.41	-0.68	-0.14	< 0.01
	No previous history of abortion or stillbirth	65.98	56.46	75.49	< 0.01
	Maternal history of abortion	38.93	-57.95	135.82	0.43
	Maternal history of stillbirth	Reference category			
Zinc level in mcg/ml	Ante-partum hemorrhage	-0.04	-0.02	-0.06	< 0.01
	Gestational age during delivery	0.01	0.01	0.02	< 0.01
	No previous history of abortion or stillbirth	0.22	0.17	0.27	< 0.01
	Maternal history of abortion	0.09	-0.41	0.59	0.72
	Maternal history of stillbirth	Reference category			
Birth weight	Ante-partum hemorrhage	-0.23	-0.17	-0.29	< 0.01
	Residence	-0.20	-0.25	-0.14	< 0.01
	Gestational age during delivery	0.06	0.05	0.07	< 0.01
	Maternal age	0.01	0.00	0.01	< 0.01
	No previous history of abortion or stillbirth	0.63	0.48	0.78	< 0.01
	Maternal history of abortion	0.30	-1.21	1.81	0.70

During the subsequent 6 months of life, 73% of infants born from mothers with a previous history of abortion had 4 episodes of infectious diseases, and 71% of infants born from mothers with previous history of stillbirth had 4 episodes of infectious diseases in the subsequent 6 months of life. After adjusting for gestational weeks during delivery, birth weight, serum iron and serum zinc level during delivery, breastfeeding, immunization for age, maternal history of stillbirth or abortion, residence, maternal chronic illnesses: the episodes of childhood infection were determined by maternal history of abortion or stillbirth, birth weight, breastfeeding, the serum zinc and iron level during the delivery (Table 4).

Table 4

Poisson regression outputs for the determinants of childhood infectious diseases (n = 2872).

Predictors	β	Sig.	IRR	95% IRR	
				Lower	Upper
No previous history of abortion or stillbirth	-0.14	< 0.01	0.87	0.80	0.95
Maternal history of abortion	0.19	0.04	1.21	1.01	1.45
Maternal history of stillbirth	Reference category				
Serum iron level during delivery	0.00	< 0.01	1.00	1.00	1.00
Serum zinc level during delivery	-0.34	< 0.01	0.71	0.61	0.83
Birth weight	-0.16	< 0.01	0.86	0.81	0.91
Breastfeeding	-0.10	< 0.01	0.90	0.87	0.93

Pneumonia and diarrhea were the most common complications of childhood infections occurred as a result of stillbirth and abortion. Among infants born from mothers with a previous history of abortion, 100% of the infants were attacked by diarrhea and 29% of them suffer from pneumonia in the subsequent 6 months. 94.3% of infants born from mothers with a previous history of stillbirth develop diarrhea in the subsequent 6 months. The median time of diarrhea among infants born from a previous history of abortion was 3 weeks and among infants born from previous history of stillbirth was 5 weeks. The median time diarrhea among infants born from mothers with no previous history of abortion or stillbirth was 15 weeks (Fig. 1 and Fig. 2).

Discussion

The serum iron levels of a neonate born from mothers with chronic illnesses were 5.85 mcg/dl lower than neonate born from mothers free from chronic illnesses. This finding agrees with research outputs from

Mexico [21]. This is due to the effects of maternal chronic diseases on fetal perfusions which finally decreases the amount of iron transferred from the mother to the fetus [22].

The serum iron levels of neonates born from urban mothers were 5.71 mcg/dl higher than the rural mothers. This is due to the reasons that low maternal and health service utilization of pregnant mothers in the rural areas which significantly decreases the iron concentration of the neonates [23].

Per a year increase in the age of the mother, the serum iron level of the neonate decreases by 0.41 mcg/dl. This finding agrees with finding from Israel [24]. This is due to the negative effects of old age pregnancy on the fetal hematopoiesis [25].

The serum iron levels of a neonate born from mothers with no history of stillbirth were 65.98 mcg/dl higher than neonates born from mothers with a history of stillbirth. This is due to the effects of stillbirth on the iron store of the mothers that affects the concentration for the infants [26].

Ante-partum hemorrhage decreases the serum zinc level of the neonate by 0.04 mcg/ml. This is the direct association between maternal zinc deficiency and low fetal zinc levels because Antepartum hemorrhage depletes the zinc concentration of the mothers [27, 28].

The serum zinc level of a neonate increase by 0.01 mcg/ml per one year increase in the gestational age. This finding was in line with the research results from China [29]. This is due to the reason that adequate amount of zinc will not be transferred during preterm delivery [30].

The serum zinc level of a neonate born from mothers with a history of stillbirth was 0.22 mcg/ml lower than neonate born from mothers with no history of stillbirth. This is due to the effects of stillbirth on the serum micronutrient levels of the mothers which finally decreases the transfer of zinc to the subsequent fetus [31].

Antepartum hemorrhage decreases the birth weight of a neonate by 0.23 kilogram. This finding agrees with finding from Pakistan [32]. This is due to the reason that bleeding during pregnancy decreases the transfer of the essential nutrient to the fetus [33].

The birth weight of a neonate born from urban mothers was 0.2 kg less than the rural residence. This finding agrees with findings from South Sudan [34]. This is due to the good social support of pregnant women during pregnancy in the rural areas [35].

A one-week increase in the gestational age increases the birth weight of a neonate by 0.06 kg. This finding agrees with USA finding [36]. This is due to the fact that preterm births did not get enough quantity of nutrients necessary to achieve the normal birth weight [37].

The birth weight increase by 0.01 kg per one year increase in the age of the mother. This finding disagree with a 2016 fining [38]. This is due to the reason that the awareness of mothers will be increased as their

age increases due to the repeated exposure which finally makes them to take enough quantity and quality of nutrient necessary for their fetus growth [6].

The birth weight of a neonate born from mothers with no history of stillbirth was 0.63 kg higher than neonate born from mother with a history of stillbirth. This finding agrees with research output from USA [39]. This is due to the high gravidity effects on the birth weight of the neonates, like the mother became anemic which decreases the fetal nutrition supply [40].

Infectious disease episodes were 14% lower for infants born from no history of stillbirth mothers as compared to infants born from mothers with a history of stillbirth. This is due to the effects of stillbirth on the immunity of subsequent infants [41].

An infant born from mothers with a history of abortion had 14% higher infection rate as compared to infants born from mothers with no history of abortion. Diarrheal diseases and pneumonia were the common infectious diseases observed among infants born from previous history of abortion. This is due to the effects of abortion on the immune status of the mother which makes poor transfer of passive immunity from the mother to the fetus [42].

Infectious disease episode decreases by 14% per one kilogram increase in the birth weight of the newborn. This finding agrees with findings from Benin [43]. This is due to reason that low birth weight has poor cellular and humoral immunity to protect themselves from the infections[44].

One unit increase in the breastfeeding frequency decreases the infectious disease episode by 10%. This finding was in line with previous research results [45–47]. This is due to the fact that breast milk is one form of immunity with no side effects and infants with complementary feedings had high rate of gastrointestinal and respiratory infections [48–50].

The main limitation of this study was failure to identify the long-term effects of stillbirth and abortion to the subsequent children.

Conclusion

Stillbirth and abortion significantly decreases the subsequent newborn weight, serum zinc level and serum iron level. Both abortion and stillbirths increase the number of infectious disease episodes to the subsequent newborn. The birth weight, breastfeeding frequency and the serum zinc levels determines the number of infectious disease episodes during the infancy periods. Diarrheal diseases and pneumonia were the most frequent complications of subsequent infants born from mothers with a history of abortion or stillbirth.

Abbreviations

B; Beta-coefficient

BDU; Bahir Dar University

C/S; Cesarean section

CI; Confidence interval

G/dl; Gram per deciliter

GEE; Generalized estimating equation

ml; Milliliter

SD; Standard deviation

SN; Serial number

USA; United State of America

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from Bahir Dar University's ethical review board. Legal permissions were obtained from the Amhara national regional state health bureau ethical committee and Mecha district health office. Written informed consent was obtained from each study participant. The confidentiality of the data was respected at every step. Study participants the right to withdraw from the study at any point was respected. Infants with pneumonia or diarrhea were linked to the nearby health center curative unit immediately.

Consent for publication

Not applicable

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declares that they have no competing interests

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Author contribution

BEF conceived the experiment; BEF and TEF performed the experiment, plan the data collection process, analyzed and interpreted the data. BEF and TEF wrote the manuscript and approved the final draft for publication.

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