Abstract

**Background:** Implementation of recommended intrapartum care intervention varies across places due to contextual socio-cultural and behavioral determinants. Previous research has utilized several operationalizations to measure intrapartum intervention content and has failed to analyze provider and facility-related factors that influence intrapartum intervention content. So yet, no study has used intervention fidelity metrics to assess intrapartum care. Therefore, this study aimed at assessing institutional intrapartum care intervention fidelity & factors associated with it.

**Methods:** On randomly selected keabeles (study sites), a cross-sectional study design was used. All health posts and health extension workers within the specified area were included, as were 898 postnatal mothers within six months of delivery. Data was collected via an interview, self-administered questionnaires, and an observation checklist. To calculate the institutional delivery coverage and intrapartum care intervention fidelity, descriptive statistics were used. The weighted sum of all intrapartum care components and institutional delivery coverage were used to calculate intrapartum care intervention fidelity. The researchers utilized a multilevel linear regression analysis model to find characteristics linked to intrapartum care intervention fidelity.

**Results:** In this study, institutional delivery coverage was 60.9% (95% CI: 57.7 – 64.1) with intrapartum care intervention fidelity of 35.6% (95% CI: 31.3-35.9). Moreover, only 21 (2.3%) of mothers received all of the contents of intrapartum care intervention. Health posts' distance from mothers' home, unskilled birth attendant, poor relationship
between HEWs and HC staffs and low HEWs knowledge of danger signs were statistically significant barriers while HEWs as birth attendant were facilitators for Intrapartum care intervention fidelity.

**Conclusion:** This study investigated that intrapartum care intervention fidelity was low. This finding indicated that distance from health institution inhibit mothers to receive skilled intrapartum care interventions as recommended.

**Keywords**
Intrapartum care, fidelity, institutional delivery
Introduction

Intrapartum period is critical for the life of mothers and newborns as well as human capital for future generation which is associated with 904,000 (23%) of the global total of 4 million neonatal deaths.\(^1\)\(^2\) Maternal and newborn deaths during intrapartum period can be averted if quality intervention is applied. An intervention during intrapartum period is essential for the healthy start of life. Health facility delivery, cord care, thermal care, eye care, providers’ clean hand, clean surface and newborn feeding are some of the safe, effective and feasible evidence-based interventions recommended during intrapartum period.\(^7\) There has been a lot of issues researched on the effects of intrapartum care interventions on neonatal mortality reduction. According to synthesis result, births attended by skilled attendant (25%), basic emergency obstetric care (40%) and comprehensive emergency obstetric care (85%) can significantly reduce intrapartum neonatal mortality.\(^4\) Other study that pooled three cluster randomized community trial results from Bangladesh, India and Nepal found that appropriate use of delivery kit was associated with 48% neonatal mortality reduction: this study also indicated that clean delivery surface (31%) and clean cord cut (27%) were associated with significant neonatal mortality reduction.\(^5\) A systematic review indicated that attendants’ hand washing alone can reduce 19% of neonatal mortality, 30% of cord infection and 49% of neonatal tetanus. This study’s Delphi expert estimated that clean birth practice at home can significantly reduce 15% of neonatal sepsis and 30% of neonatal tetanus. Clean birth practice at facility would result in a significant reduction of 27% and 38% of neonatal sepsis and tetanus respectively.\(^6\) Other sub-Saharan study estimated that clean delivery practice at home, clinic or hospital resulted in a 61.2% neonatal mortality reduction. The combination of clean delivery practice, chlorhexidane application to cord and antibiotic administration at hospital reduced neonatal mortality by 88.4%.\(^7\) Delayed bathing (72 hours) significantly reduces 84% of neonatal mortality based on Bangladesh cross-sectional study.\(^8\) All studies reviewed here clearly indicate that intrapartum care interventions are evidenced to be effective in reducing neonatal mortality.

However, implementation of these recommended interventions varied spatially. This varying level of implementation is associated with contextual, socio-cultural and behavioral determinants.\(^6\)\(^7\) Previous research has utilized several operationalization to measure intrapartum intervention content and has failed to analyze provider and facility-related factors that influence intrapartum intervention content. So yet, no study has used intervention fidelity metrics to assess intrapartum care. Therefore, this study aimed at assessing intrapartum care intervention fidelity & factors associated with it. Intrapartum care intervention fidelity is defined as the degree to which an intrapartum intervention is implemented as recommended by EMOH.\(^18\)

Methods

The method was published in a prior work elsewhere.\(^19\) To make things apparent for readers, the next section describes the methods used in this paper.

Design

Community-based cross-sectional study was conducted to evaluate the implementation of intrapartum care intervention.

Setting

This research was carried out in South Wollo Zone, 400 kilometers north of Addis Ababa. North Shewa and Oromia Region border South Wollo on the south, East Gojjam on the west, South Gondar on the northwest, North Wollo on the north, and Afar Region on the northeast. There were 900 rural and 150 urban HEWs in the zone, with 499 HPs, 126 health centers, and 9 hospitals (including one referral). It has been suggested that clean delivery care be implemented throughout the spatial continuum of care (household - health post - health center to hospital levels). Mothers in labor are intended to be notified and linked to a primary health care facility by HDAs. HEWs are required to refer laboring mothers to primary health care facilities. They are also expected to provide safe and clean intrapartum care in the event of an unavoidable home birth. Skilled practitioners (nurses, midwives, health officers or physicians) at the HC and hospital level are expected to arrange ambulance services, accept delivery referrals, support HEWs and provide basic emergency obstetric care. To reduce neonatal mortality, family members, HDAs, HEWs, and skilled practitioners should all play a complementary role.\(^20\)

Participants

All postnatal mothers who have been expected to receive, all health posts and HEWs that have been providing intrapartum care intervention in South Wollo Zone were ineligible for this study. Kebele’s (one health post each) was chosen using computer generated random numbers. Then all postnatal mothers who had given birth within six months of the survey and lived in those selected kebeles were included.
Variables
The outcome of this study was intrapartum care intervention fidelity while the considered predictors include customer level (maternal age, educational status, occupation, paternal education, parity, gravidity, number of abortions and stillbirths) and provider level (supervision, feedback, technical assistance, HDAs support, distance between HP and farthest maternal home, relationship between HEWs and health center staffs, place of delivery, type of attendant, HEWs age, experience, and knowledge of danger sign).

Data source and measurement
This study utilized multiple data sources which includes postnatal mothers, HEWs and HPS. Intrapartum care intervention fidelity was measured by the composite index of institutional delivery coverage and intrapartum care intervention content. Data were collected by using interview and self-administered questionnaires and facility audit checklist. Postnatal mothers were interviewed at their home. Health facility audit was undertaken by principal investigator while self-administered questionnaire was responded by HEWs in their HP at working hours.

Bias
Different strategies were employed to reduce biases at different stages of the study. Accordingly, data collection tool was developed by reviewing the implementation guideline, HEWs training manual, lancet review, every newborn lancet series-2 & 3 and other relevant literatures.20–25 Facility audit checklist and HEWs questionnaire was mainly developed by reviewing the implementation guideline. The questionnaire was first developed in English then translated to Amharic for maternal interview. Mothers were interviewed at their home by 12th grade completed students who have been living in the same kebeles to reduce social desirability bias. Multiple multilevel linear regression model was used to control the possible confounding biases.

Study size
Using single population proportion formula in Epidemiological information (Epi info) version 7 statistical software and by considering 95% confidence level, 5% margin of error, 19% of births attended by trained professionals in Ethiopian study,14 design effect of 2 and 10% non-response rate, the calculated sample size was 521 mothers. However, because of the cluster nature of sampling, the study included all 898 mothers who could be serviced by the chosen health posts. Ten Kebeles and 16 HEWs working in those kebeles were included in this study.

Quantitative variables
Intrapartum care intervention contents include all practices of clean care (clean hands, clean genitalia, clean cord cut, clean cord tie, utilizing clean cloths/towel), thermal care, eye care, vitamin K supplementation and breast feeding. Therefore, content of intrapartum care that each mother received were weighted by dividing each received service by the recommended quantity of care. Accordingly, 14 recommended intrapartum contents were considered and weighted as \( \frac{1}{14} \) (content received). Intrapartum care intervention fidelity was calculated as \( \frac{\text{Institutional delivery coverage} \times \text{Intrapartum care content received}}{\text{Intrapartum care content received}} \). Thus the values of intrapartum care intervention fidelity ranges from 0 to 1 or 0 to 100%. Danger sign knowledge of HEWs was categorized as knowledgeable for those scored above the mean and non-knowledgeable for those scored below the mean score out of 21 questions.25,26

Statistical method
Descriptive statistics was employed to compute proportion and mean. Mean of intrapartum care intervention fidelity was computed to estimate the average amount of intrapartum care intervention that a mother received. Multilevel linear regression analysis with p value of \( \leq 0.05 \) and 95% confidence interval were used to identify factors influencing for intrapartum care intervention fidelity.

Results
Socio-demographic characteristics
The mean age of study participants were \( 31 \pm 7 \) years. 768 (85.91%) mothers were married, while 96 (10.94%) were separated. Concerning educational status, 638 (71.44%) of mothers did not attend formal education with 817 (92%) farmer in occupation. 617 (70.03%) study participants' partner did not attend formal education but 202 (22.93%) attended elementary (1–8 grade) school. Concerning partners occupation, 704 (80.09%) of them were farmers while 143 (16.27%) merchants. Only 180 (20.04%) of women walked less than 15 minutes from their home to the nearest HP while 333 (37.08%) of them walked more than 45 minutes.

Intrapartum care intervention
Coverage: 547 (60.9%, 95% CI: 57.7 – 64.1) of eligible mothers gave birth at health institutions. 53% of antenatal care attended women, 24.2% FANC attended women (≥ 4 visits), 49.2% women attended ANC at health center, 45.9% of referred and 59.2% of counseled for institutional delivery women were attended institutional delivery (Table 1).
Concerning the contents of intrapartum care intervention, only 21 (2.3%, 95% CI: 1.3 – 3.3%) of mothers received all the recommended contents. Using clean cord cut (92.8%) and cord tie (89.7%), cleaning the women genitalia and wrapping the newborn with clean towel (84.5% each) were the commonly practiced intrapartum care intervention contents by HEWs. On average an intrapartum mother received 34.8% (95% CI: 31.96 – 37.66), 70.69% (95% CI: 67.39 – 73.99), 54.53% (95% CI: 52.06 – 56.99) and 62.24% (95% CI: 52.26 – 72.23) of the recommended intrapartum intervention contents when gave birth at home, health post, health center and hospitals respectively (Table 2).

Intrapartum care intervention fidelity: An average intrapartum care intervention fidelity is 33.57% (95% CI: 31.29 – 35.86) meaning that on average a mother receives only 33.6% of the recommended intrapartum care intervention. Only 16 (1.8%) of mothers received intrapartum care interventions with full fidelity. The weighted average intrapartum intervention fidelity was 54.53% (95% CI: 52.06 – 56.99) in health center and 62.24% (95% CI: 52.26 – 72.23) in hospital deliveries.

Factors associated with intrapartum care intervention fidelity

In multilevel linear regression model, random intercept variance of 3.1% and ICC of 38.4% indicates that intrapartum care intervention fidelity varies across study sites. In this model, an average of one minute increase in walking distance from HP to farthest home resulted in a 5% decrease in intrapartum care intervention fidelity. Intrapartum care intervention fidelity was reduced by 21% and 27% when attended by TBA and family members than skilled attendants respectively. Intrapartum care intervention fidelity was increased by 14% when attended by HEWs than skilled attendants. Poor

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**Table 1. Institutional delivery with different maternal obstetrics characteristics in South Wollo Zone, Northeast Ethiopia.**

| Items                              | Responses | Place of delivery | Non-institutional | Institutional | Total |
|------------------------------------|-----------|------------------|-------------------|--------------|-------|
| Current pregnancy                  |           |                  |                   |              |       |
| Unwanted                           | 318 (37.7%) | 502 (59.5%)     | 820 (97.3%)       |              |       |
| Wanted                             | 9 (1.1%)  | 10 (1.2%)        | 19 (2.3%)         |              |       |
| Untimely                           | 2 (0.2%)  | 2 (0.2%)         | 4 (0.5%)          |              |       |
| Problem in previous pregnancy      |           |                  |                   |              |       |
| No                                 | 222 (24.7%)| 314 (35.0%)     | 536 (59.7%)       |              |       |
| Yes                                | 62 (6.9%) | 125 (13.9%)      | 187 (20.8%)       |              |       |
| First pregnancy                    | 67 (7.5%) | 108 (12.0%)      | 175 (19.5%)       |              |       |
| Antenatal care                     |           |                  |                   |              |       |
| Not received                       | 75 (8.4%) | 71 (7.9%)        | 146 (16.3%)       |              |       |
| By HEWs                            | 165 (18.4%)| 232 (25.8%)     | 397 (44.2%)       |              |       |
| By skilled provider                | 111 (12.4%)| 244 (27.2%)     | 355 (39.5%)       |              |       |
| ANC place                          |           |                  |                   |              |       |
| Health center                      | 161 (21.9%)| 361 (41.9%)     | 522 (71.1%)       |              |       |
| Home by HEWs                       | 30 (4.1%) | 13 (1.8%)        | 43 (5.9%)         |              |       |
| Private clinic                     | 1 (0.1%)  | 4 (0.5%)         | 5 (0.7%)          |              |       |
| Health post                        | 71 (9.7%) | 85 (11.6%)       | 156 (21.3%)       |              |       |
| Hospital                           | 3 (0.4%)  | 5 (0.7%)         | 8 (1.1%)          |              |       |
| ANC frequency                      |           |                  |                   |              |       |
| Once                               | 23 (3.1%) | 41 (5.5%)        | 64 (8.5%)         |              |       |
| Twice                              | 34 (4.5%) | 60 (8.0%)        | 94 (12.5%)        |              |       |
| Three times                        | 138 (18.4%)| 193 (25.7%)     | 331 (44.0%)       |              |       |
| Four times                         | 81 (10.8%)| 182 (24.2%)      | 263 (35.0%)       |              |       |
| Counseled for institutional delivery|         |                  |                   |              |       |
| No                                 | 35 (4.7%) | 31 (4.1%)        | 66 (8.8%)         |              |       |
| Yes                                | 241 (32.0%)| 445 (59.2%)     | 686 (91.2%)       |              |       |
| Referred for institutional delivery|         |                  |                   |              |       |
| No                                 | 146 (19.4%)| 131 (17.4%)     | 277 (36.8%)       |              |       |
| Yes                                | 130 (17.3%)| 345 (45.9%)     | 475 (63.2%)       |              |       |
| Expected date of delivery estimated|         |                  |                   |              |       |
| No                                 | 127 (16.9%)| 163 (21.7%)     | 290 (38.6%)       |              |       |
| Yes                                | 149 (19.8%)| 313 (41.6%)     | 462 (61.4%)       |              |       |
relationship between HEWs and HC staffs reduced intrapartum care intervention fidelity by 27% than good relationship. HEWs low knowledge of maternal and newborn danger signs reduced intrapartum care intervention fidelity by 40% (Table 3).

Discussion
This study was aimed at assessing intrapartum care intervention fidelity and its associated factors. Accordingly, average intrapartum care intervention fidelity was 33.6% with about 40% of mother gave birth outside the health facilities. Only 2.3% of mothers received all the recommended intervention contents. Distance between health post and furthest maternal home, delivery attended by traditional birth attendant and family member, poor relation between HEWs and health staffs and low level of HEWs knowledge of danger signs were statistically significant barriers whereas, delivery attended by HEWs was facilitator for intrapartum care fidelity in this study.

Table 2. Adherence to recommended intrapartum care intervention contents and procedures of birth attendants in South Wollo Zone, Northeast Ethiopia.

| Contents of safe & clean delivery care | Practice of Intrapartum care with place of delivery | Total (%) |
|---------------------------------------|-----------------------------------------------|----------|
|                                       | Home (%) | Health post (%) | Health center (%) | Hospital (%) |        |
| Clean hands                           | Yes      | 120 (47.2)       | 65 (67.0)         | 314 (62.2)   | 26 (61.9) | 525 (58.5) |
|                                       | No       | 134 (52.8)       | 32 (33.0)         | 191 (37.8)   | 16 (38.1) | 373 (41.5)  |
| Clean genitalia                       | Yes      | 68 (26.8)        | 82 (84.5)         | 327 (64.7)   | 31 (73.8) | 508 (56.6)  |
|                                       | No       | 186 (73.2)       | 15 (15.5)         | 178 (35.2)   | 11 (26.2) | 390 (43.4)  |
| Clean cord cut                        | Yes      | 111 (43.7)       | 90 (92.8)         | 334 (66.1)   | 31 (73.8) | 566 (63.0)  |
|                                       | No       | 143 (56.3)       | 7 (7.2)           | 171 (33.9)   | 11 (26.2) | 332 (37.0)  |
| Clean cord tie                        | Yes      | 121 (47.6)       | 87 (89.7)         | 319 (63.2)   | 31 (73.8) | 558 (62.1)  |
|                                       | No       | 133 (52.4)       | 10 (10.3)         | 186 (36.8)   | 11 (26.2) | 340 (37.9)  |
| Wrapping with clean towel             | Yes      | 89 (35.0)        | 82 (84.5)         | 313 (62.0)   | 31 (73.8) | 515 (57.3)  |
|                                       | No       | 165 (65.0)       | 15 (15.5)         | 192 (38.0)   | 11 (26.2) | 383 (42.7)  |
| Clean & dry the baby immediately      | Yes      | 145 (57.1)       | 85 (87.6)         | 340 (67.3)   | 30 (71.4) | 600 (66.8)  |
|                                       | No       | 109 (42.9)       | 12 (12.4)         | 165 (32.7)   | 12 (28.6) | 298 (33.2)  |
| Skin-to-skin contact                  | Yes      | 95 (37.4)        | 73 (75.3)         | 284 (56.2)   | 27 (64.3) | 479 (53.3)  |
|                                       | No       | 159 (62.6)       | 24 (24.7)         | 221 (43.8)   | 15 (35.7) | 419 (46.7)  |
| Delayed bathing (after 24 hours)      | Yes      | 4 (1.6)          | 31 (32.0)         | 78 (15.4)    | 18 (42.9) | 131 (14.6)  |
|                                       | No       | 250 (98.4)       | 66 (68.0)         | 427 (84.6)   | 24 (57.1) | 767 (85.4)  |
| TTC applied on eyes                   | Yes      | 30 (11.8)        | 51 (52.6)         | 179 (35.5)   | 27 (64.3) | 287 (32.0)  |
|                                       | No       | 224 (88.2)       | 46 (47.4)         | 326 (64.5)   | 15 (35.7) | 611 (68.0)  |
| Colostrum given to newborn            | Yes      | 126 (49.6)       | 78 (80.4)         | 310 (61.4)   | 29 (69.0) | 543 (60.5)  |
|                                       | No       | 128 (50.4)       | 19 (19.6)         | 195 (38.6)   | 13 (31.0) | 355 (39.5)  |
| Not taking pre-lacteal feeding        | Yes      | 103 (40.6)       | 70 (72.2)         | 299 (59.2)   | 29 (69.0) | 501 (55.8)  |
|                                       | No       | 151 (59.4)       | 27 (27.8)         | 206 (40.8)   | 13 (31.0) | 397 (44.2)  |
| Early initiation of breast feeding (within an hour) | Yes | 104 (40.9) | 77 (79.4) | 304 (60.2) | 23 (54.8) | 508 (56.6) |
|                                       | No       | 150 (59.1)       | 20 (20.6)         | 201 (39.8)   | 19 (45.2) | 390 (43.4)  |
| The newborn received BCG vaccine      | Yes      | 71 (28.0)        | 49 (50.5)         | 250 (49.5)   | 15 (35.7) | 385 (42.9)  |
|                                       | No       | 183 (72.0)       | 48 (49.5)         | 255 (50.5)   | 27 (64.3) | 513 (57.1)  |
| The newborn received Polio-0 vaccine  | Yes      | 51 (20.0)        | 40 (41.2)         | 204 (40.4)   | 18 (42.9) | 313 (34.9)  |
|                                       | No       | 203 (80.0)       | 57 (58.8)         | 301 (59.6)   | 24 (57.1) | 585 (65.1)  |
| Average score                         |          | 34.8%            | 70.7%             | 54.5%        | 62.2%     | 51%        |
Reception of all the recommended intrapartum care intervention in this study is consistent with Pakistan’s (2.9%)\(^1\) but lower than Ethiopian study (62%).\(^9\) The reason for the difference might be due to the difference in study setting (institution and community based). In this study, on average a woman receives 33.6% of the recommended intrapartum care interventions which is too low to result in an anticipated neonatal mortality reduction.

The weighted average intrapartum care intervention fidelity in non-institutionally delivered mother in this study (44.7%)\(^2\)–\(^3\) is greater than other studies in Ethiopian (2.9\(\text{–}40.7\%\)), Nepal’s (0.9\%)\(^4\) and Ghana’s (15.8\%).\(^2\)–\(^3\) In contrast, this finding is lower than other Ethiopian Awi (62.7\%)\(^5\) study.\(^3\) The difference might be due to measurement difference in that other studies used only three domains (cord care, thermal care, and neonatal feeding) while this study uses wider intrapartum care intervention contents as mentioned in method above. The other reason for the difference might be the recall period in that this study used six-months while others used one-year postnatal recall period.

In this study, increased average distance between HP and farthest mothers’ home decreased intrapartum care intervention fidelity which is consistent with other Ethiopian study.\(^3\)–\(^4\) This could be justified by those mothers who are far distant from health facility may not attend and get the recommended intrapartum care interventions which is too low to result in an anticipated neonatal mortality reduction.

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Intrapartum care intervention fidelity is lower when births are attended by unskilled attendants which might be justified by home deliveries attended by unskilled attendants is challenged by inappropriate delivery environment, insufficient supplies, inadequate training thereby dearth with the desired knowledge and skill about delivery care.\(^2\)

Intrapartum care intervention fidelity is higher when attended by HEWs than skilled attendants. This might be due to low work load in the curative service at health post and more time allocation to clinical activities by HEWs.\(^2\)–\(^4\)

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Poor relationship between HEWs and HC staffs (midwives and nurses) reduced intrapartum care intervention fidelity. HEWs and HC staffs are the immediate health care cadres in the client referral pathways. So, their respectful, open, effective and collaborative relationship across the service provision platform is integral to providing safe and high quality care.\(^1\)–\(^4\)

**Table 3. Factors associated with Intrapartum care intervention fidelity in South Wollo Zone, Northeast Ethiopia.**

| Factors/variables | Coefficient (95% CI) | P-value |
|-------------------|----------------------|---------|
| **Model-1 First level** | | |
| HP: Identity Var (_constant) | 0.031 (0.015 – 0.06) | | |
| Husband attended formal education | | |
| Yes | 1 | |
| No | -0.05 (-0.08 – -0.005) | 0.026 |
| Antenatal care frequency | 0.11 (0.03 – 0.19) | 0.006 |
| **Model-2 Combined** | | |
| Walking distance from health post | -0.05 (-0.07 – -0.03) | <0.001 |
| Type of attendant | | |
| Skilled | 1 | |
| TBA | -0.21 (-0.27 – -0.15) | <0.001 |
| Family/neighbor | -0.27 (-0.35 – -0.20) | <0.001 |
| Skilled | 1 | |
| HEWs | 0.14 (0.07 – 0.20) | <0.001 |
| HEWs relation with HC staffs | Good | 1 | |
| Poor | -0.27 (-0.34 – -0.19) | <0.001 |
| HEWs ability to diagnose danger signs | Knowledgeable | 1 | |
| Non-knowledgeable | -0.40 (-0.49 – -0.31) | <0.001 |
| Var (_constant) | 3.49e-23 (2.46e-36 – 4.94e-10) | |

**Note:** Effects of total number of pregnancies, husband’s educational status, ANC frequency, HDA support, HEWs incentive and HEWs cooperation by HC staffs were controlled.

**Abbreviations:** HEW: Health extension workers; EMOH: Ethiopian ministry of health; HDAs: Health development armies; HC: Health center; HPs: Health posts; UoG: University of Gondar; TBA: Traditional birth attendants.
HEWs’ knowledge to diagnose danger sign was another barrier for intrapartum care intervention fidelity. This finding implies that HEWs competency is directly related with the implementation of an intervention as planned. Considering provider level factors and multilevel nature of the analysis is the strength of this study while recall bias might be inevitable to the finding.

Conclusion
In summary, this study investigated that intrapartum care intervention fidelity is low. Moreover, far distance of HP from maternal home, births attended by unskilled attendants, poor relationship between HEWs & HC staffs and HEWs competency were found to be statistically significant barriers while HEWs birth attendant is facilitator for intrapartum care intervention fidelity. This finding implies that distance from health institution inhibit mothers to attend and receive skilled intrapartum care interventions as recommended.

Ethics approval
This study has granted an ethical clearance from institutional review board of University of Gondar numbered O/V/P/ RCS/05/810/2018 and Amhara public health research institute numbered -@¼M¼t&¼>¼Ä 03/938/10. Moreover, support letter was received from South Wollo administrative zone. Besides, written informed consent was secured from study participants (mothers and health extension workers).

Data availability
This study's data is accessible from the corresponding author. It can be provided upon request because this is a PhD big data research containing sensitive personal information and more subsequent activities are continued.

Author contributions
AM, the corresponding author, contributes to conceptualization, designing and conducting the study, data curation and analysis, validation, visualization and writing this paper. AG, SM, KA and ZT contributes to supervising the overall research process.

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