**S1 File Table 1:** Estimation of the sample size required for identifying predictors of MHSU.(For all calculations, power was set at 80%, level of significance at 5%, and the ratio of unexposed-to-exposed at 1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | | **Maternal health service utilization rate (%)** | **AOR** | **Sample size in each category** | **Total sample size adjusted for NRR** |
| Knowledge about pregnancy complications [1](#_ENREF_1) | Yes | 16.6 | 1.97 | 477 | 954 |
| No | 6.3 |  | 477 |  |
| Illness experience [2](#_ENREF_2) | Yes | 15.4 | 1.87 | 423 | 846 |
| No | 9.1 |  | 423 |  |
| Gave birth at HF [1](#_ENREF_1) | Yes | 14.6 | 2.19 | 283 | 566 |
| No | 8.0 |  | 283 |  |
| Husbands who attend ANC with their spouse [3](#_ENREF_3) | Yes | 84.4 | **1.73** | **552** | **1,140** |
| No | 84.5 |  | **552** |  |
| The educational level of the husband [1](#_ENREF_1) | Unable to read and write | 3.2 |  | 235 | 470 |
| Secondary school and above | 8.6 | 3.38 | 235 |  |
| The educational level of the husband [1](#_ENREF_1) | Unable to read and write | 38.7 |  | 29 | 58 |
| Secondary school and above | 11.1 | 5.68 | 29 |  |

**Note**: AOR = Adjusted odds ratio, NNR = Non-response rate

**S1 File Table 2:** Description of study variables

|  |  |
| --- | --- |
| Study variables | Description |
| ANC utilization | was measured as a proportion of women who utilized ANC from skilled providers (HEWs, midwives, nurses, health officers, and doctors) at least once during their last pregnancy using a woman's self-report [4](#_ENREF_4), [5](#_ENREF_5). |
| Institutional delivery utilization | was measured as the proportion of women who utilized institutions (governmental health centers or hospitals, and/or private hospitals or clinics) for delivery in their last pregnancy using a woman’s self-report [4-6](#_ENREF_4). |
| PNC utilization | was measured as the proportion of women who utilized a PNC visit within 42 days after giving birth at least once using a woman’s self-report [4](#_ENREF_4), [5](#_ENREF_5). |
| **Individual-level variables** | |
| Maternal knowledge regarding ODS | were measured using the 30 questions during three phases namely antepartum (9 questions), intra-partum (12 questions), and postpartum (9 questions). The correct answers were assigned a score of 1, while incorrect answers were assigned a score of 0. Lastly, the total knowledge scores range from 0 to 30. The study respondents who spontaneously mention at least 3 ODS during each phase were classified as having “good knowledge” and those who were able to spontaneously mention 2 or fewer ODS have “poor knowledge” [7](#_ENREF_7" \o "Pervin, 2018 #48). |
| Spontaneous knowledge | is defined as the knowledge of study participants who can name or call an ODS without being read the name of that sign by data collectors. Merely true ODS spontaneously mentioned by study participants were recorded during the interview [8](#_ENREF_8" \o "Hailu, 2014 #50). |
| BPCR practice | was measured using 5 components of the question as to whether or not the woman planned for her most recent pregnancy such as identified a closer proper HF for childbirth, founded and communicated an SBA, saved money, a material resource for childbirth, and other associated costs, prepared or arranged transportation to a proper HF in case of childbirth and obstetric emergency and identified and fixed the compatible blood group givers in case of blood requirements. If a woman prearranged at least two components out of 5, she was considered as having “well prepared” and otherwise considered “poorly prepared” [9](#_ENREF_9), [10](#_ENREF_10) |
| Distance from the HF | is considered as close to HF if a woman is reported to travel less than 5 km or walking hours less than 30 minutes by foot to reach the nearest [11](#_ENREF_11), [12](#_ENREF_12). |
| Use of mass media | isgenerated by combining whether a study participant listens to the radio, watches television, and reads the newspaper and categorized as “yes” if the respondent is exposed to at least 1 of the 3 media and “no” otherwise [13](#_ENREF_13), [14](#_ENREF_14). |
| Family size | is defined as a total number of individuals existing in the household and is categorized as small when it is < 5, and large (> 5) [4](#_ENREF_4). |
| Women’s knowledge regarding ANC | was measured using the 8 knowledge questions. The correct answer was assigned 1 score, while the incorrect answer was assigned 0 scores. Hence, the total expected knowledge score ranged from 0 to 8. Hence, the increased total sum of the score was considered as increased knowledge of ANC on the scale [15](#_ENREF_15). |
| Women’s knowledge towards institutional delivery | was assessed using the 7 knowledge questions. The responding, ranking and scoring systems was the same as the ANC as described above [15](#_ENREF_15). |
| Women’s knowledge about the PNC | Was measured using the 7 knowledge questions. The responding, ranking and scoring systems was the same as the ANC as described above [15](#_ENREF_15), [16](#_ENREF_16). |
| Women’s attitudes regarding ANC | were assessed using the 9 attitude questions. Each attitude question was measured using 5 points Likert scale from strongly disagree (1) to strongly agree (5). The total expected attitude score was ranged from 9 to 45. Then, the value of each item scored on the Likert scale by respondents was summed and the value was considered as discrete scale data. Hence, the increased total sum of the score was considered as an increased positive attitude on the scale [15](#_ENREF_15). |
| Women’s attitudes about institutional delivery | were measured using the 11 attitude questions. The responding, ranking, and scoring systems was the same as the ANC as described above [15](#_ENREF_15). |
| Women’s attitudes towards PNC | were assessed using the 8 attitude questions. The responding, ranking, and scoring systems was the same as the ANC as described above [15](#_ENREF_15), [16](#_ENREF_16). |
| Formal education | is the education extending from primary to secondary and higher education and requires an organized and careful purpose that concretizes itself in an official curriculum, applied with a defined calendar and timetable [17](#_ENREF_17). |
| Women’s autonomy | a woman is considered autonomous if a woman can decide when and where to use MHS or on the health care spending by herself alone or with her husband together and a non-autonomous otherwise using a woman’s self-report [18](#_ENREF_18). |
| Perceived quality of MHS | is defined as the mother’s opinion regarding the overall image or quality of the MHS concerning its purpose of utilization as against its options using a woman’s self-report [17](#_ENREF_17). |
| The perceived quality of ANC | was assessed using the 23 perception questions. Items of perception was measured using 5 points Likert scale (strongly disagree = 1 through strongly agree = 5). Then, the value of each item scored on the Likert scale by respondents was summed and the value was considered as discrete scale data. Hence, the increased total sum of the score was considered as increased perceived quality of ANC on the scale [19](#_ENREF_19" \o "Jallow, 2012 #78). |
| The perceived quality of institutional delivery care | was assessed using the 8 perception questions. Each item was measured using 5 points Likert scale from strongly disagree (1) to strongly agree (5). The total score was ranged from 8 to 40. The responding, ranking, and scoring systems was the same as the ANC as described above [20](#_ENREF_20). |
| The perceived quality of PNC | was assessed using the 23 perception questions. Each question was measured using 5 points Likert scale from 1 “very poor” to 5 “very good”. The overall expected score was extended from 23 – 115. The responding, ranking, and scoring systems was the same as the ANC as described above [21](#_ENREF_21" \o "Wickramasinghe, 2019 #82). |
| **Community-level variables** | |
| Place of residence | categorized as urban and rural |
| Community-level women's literacy | the aggregate value of community-level women's literacy was generated by the percentage of women population in the cluster that had at least a primary level of literacy derived from the individual participants’ data.Categorized asa **“**high” concentration of literate women in the Kebeles if the percentage of women who were at least primary level of education >50% and “low” otherwise [6](#_ENREF_6), [22](#_ENREF_22). |
| Community-level poverty | the aggregate value of community-level poverty was generated by the percentage of households in the cluster in the poorest and poorer quintile derived from the individual participants’ data.Categorized asa **"**high” concentration of poverty in the Kebeles if the percentage of households in the poorest and poorer quintile >50% and “low” otherwise[6](#_ENREF_6), [22](#_ENREF_22), [23](#_ENREF_23). |
| Community-level social media use | the aggregate value of community-level social media use was generated by a percentage of study participants who listens to the radio, watches television and reads the newspaper in cluster derived from the individual participants’ data.Categorized as **“**high” concentration of social media use in the Kebeles if the proportion of a study participant who uses at least one social media >50% and “low” otherwise[6](#_ENREF_6), [24](#_ENREF_24). |
| Distance from nearest HF | was considered as “close” to HF if a woman reported a walking hour of less than 30 minutes by foot to reach the nearest HFs and “far” otherwise [12](#_ENREF_12). The aggregate value of community-level distance was generated by the percentage of a study participant walking hours to the nearest HF in a cluster derived from the individual participants’ data.Categorized as **“**not big problem” in the Kebeles if>50% of study participants reported as “close” and “a big problem” otherwise [12](#_ENREF_12), [25](#_ENREF_25), [26](#_ENREF_26). |

**Wealth index analysis method**

The multiple response variables were categorized into binary responses (yes/no) and “I don’t know” responses often coded as 999 to zero (Table 3). Similarly, the "I don't know" response and any missing value are often coded as 999 to zero for the continuous variables [27](#_ENREF_27). The predictors that can differentiate between comparatively "poor" and "rich" households were selected using simple frequency analysis. Thus, our PCA didn’t comprise any assets or variables that were possessed by less than 5% or more than 95% of the individuals in the sample [12](#_ENREF_12), [27](#_ENREF_27). Finally, the component factors or wealth index scores were ranked into 5 classes such as lowest, second-lowest, middle, second-highest, and highest [4](#_ENREF_4), [28](#_ENREF_28). The PCA was carried out for the computation of the wealth index [27](#_ENREF_27), [28](#_ENREF_28). All the basic assumptions of PCA were checked before ranking the components' factor scores into wealth quintiles. We removed the variables from PCA that didn’t satisfy the assumptions such as the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy less than 0.5, commonalities less than 0.5, and variables that contain the complex structure (high loading correlation >0.4 on greater than one component) [28](#_ENREF_28), [29](#_ENREF_29).

**S1 File Table 3:** Some of variables and given values to facilitate the computation of wealth index

|  |  |  |
| --- | --- | --- |
| S.no | Variables | Given values |
| 1 | Main source of drinking water | Improved: Piped water, tube well or borehole, protected well, protected spring = 1  Unimproved: Unprotected well, Surface water (river and dam), Unprotected spring, Lake/pond/stream/canal = 0 |
| 2 | Main source of water used for other purposes such as cooking and hand washing | Improved: Piped water, tube well or borehole, protected well, protected spring = 1  Unimproved: Unprotected well, Unprotected spring, Lake/pond/stream/canal, Surface water (River/dam) = 0 |
| 3 | Where is that water source located? | In own dwelling or yard/plot = 1  Elsewhere = 0 |
| 4 | Type of toilet facilities | Improved: comprise any non-shared toilet of the subsequent kinds: pour/flush toilets to septic tanks, piped sewer systems, and pit latrines; pit latrines with slabs; ventilated improved pit (VIP) latrines; and composting toilets = 1  Unimproved: Pit latrine without slab/open pit, bucket toilet and hanging toilet = 0 |
| 5 | Where is this toilet facility located? | In own dwelling or yard/plot = 1  Elsewhere = 0 |
| 6 | Type of fuel the household mainly use for cooking | Clean fuels include electricity, liquefied petroleum gas (LPG), natural gas, kerosene, and biogas = 1  Solid fuels include coal, charcoal, wood, straw/shrub/grass, agricultural crops, and animal dung = 0 |
| 7 | Where is the cooking usually done? | In the house and outdoors = 0  In a separate building = 1 |
| 8 | Who is the owner of the house? | Me = 1  Rental, family, and relative = 0 |
| 9 | Main material of the roof of the house | Natural roofing (no roof, mud, and sod) = 0  Rudimentary and finished roofing = 1 |
| 10 | Main material of the floor of the house | Natural floor (Earth/sand, dung) = 0  Rudimentary and finished floor = 1 |
| 11 | Main material of the wall of the house | Natural walls (no walls, cane/palm/trunks/bamboo/ree, dirt) = 0  Rudimentary and finished wall = 1 |
| 12 | All other categorical variables were considered as yes and no form | Yes = 1 and no =0 |
| 13 | All continuous variables were treated as continuous |  |
| 14 | “I don’t know” response often coded as 999 for categorical variables | 999 = 0 |
| 15 | “I don’t know” response and any missing value often coded as 999 to zero | 999 and missing value = 0 |

**S1 File Table 4:** Reproductive health and obstetrics characteristics of the study participants in the Northern Zone of Sidama region, Ethiopia, 2022 (N=1,130)

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Categories | Number | Percent |
| Age at first marriage | 18.41 + 2.33 | | |
| Age at first pregnancy | 19.70 + 2.45 | | |
| Total number of gravidities | 1 | 162 | 14.4 |
|  | 2-4 | 737 | 65.2 |
|  | >5 | 231 | 20.4 |
| Previous history of abortions | No | 910 | 80.5 |
|  | Yes | 220 | 19.5 |
| Number of abortions | No | 910 | 80.5 |
|  | 1 | 203 | 18.0 |
|  | >2 | 17 | 1.5 |
| Total number of deliveries | 1 | 218 | 19.3 |
|  | 2-4 | 720 | 63.7 |
|  | >5 | 192 | 17.0 |
| Infection during the current pregnancy | Yes | 375 | 33.2 |
|  | No | 755 | 66.8 |
| Family history of hypertension | Yes | 142 | 12.6 |
|  | No | 988 | 87.4 |
| Previous history of stillbirth | Yes | 126 | 11.2 |
|  | No | 1004 | 88.8 |
| Previous history of neonatal death | Yes | 230 | 20.4 |
|  | No | 900 | 79.6 |
| Last pregnancy planned | Yes | 779 | 68.9 |
|  | No | 351 | 31.1 |
| Reason for unplanned pregnancy (n=351) | Lack of modern contraceptives | 183 | 52.1 |
|  | Failure of contraceptive method | 127 | 36.2 |
|  | Others | 41 | 11.7 |
| Encountered ODS during last pregnancy | Yes | 244 | 21.6 |
|  | No | 886 | 78.4 |
| Faced ODS during last childbirth | Yes | 128 | 11.3 |
|  | No | 1002 | 88.7 |
| Confronted ODS during last postpartum period | Yes | 195 | 17.3 |
|  | No | 935 | 82.7 |

**S1 File**

**S1 File Table 5:** Description of maternal health care service use among women of reproductive age in the northern zone of Sidama region, Ethiopia, 2022 (N = 1,130)

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Categories | Number | Percent |
| Number of ANC visits | 0 | 542 | 48.0 |
|  | 1-3 | 269 | 23.8 |
|  | >4 | 319 | 28.2 |
| Timing of first ANC visit | No | 542 | 48.0 |
|  | <4 months | 61 | 5.4 |
|  | >4 months | 527 | 46.6 |
| Type of health facility visited during ANC follow up | Government hospital | 135 | 11.9 |
|  | Health Centre | 442 | 39.1 |
|  | Health post | 62 | 5.5 |
|  | Others | 9 | 1.2 |
| Reasons to prefer the above-stated health facilities | Close to my house | 466 | 41.2 |
|  | Competent health worker | 214 | 18.9 |
|  | Other | 9 | 0.8 |
| Type of HCP for the ANC visit | Doctors | 65 | 5.8 |
|  | Nurse | 243 | 21.5 |
|  | Midwives | 396 | 35.0 |
|  | Health officers | 97 | 8.6 |
|  | HEWs | 60 | 5.3 |
|  | I don’t know | 11 | 0.97 |
| Components of ANC |  |  |  |
| Obtained laboratory service | Yes | 447 | 39.5 |
|  | No | 681 | 60.3 |
|  | I don’t know | 2 | 0.2 |
| Provided health messages during ANC visits | Yes | 334 | 29.6 |
|  | No | 791 | 70.0 |
|  | I don’t know | 5 | 0.4 |
| Counseled about ODS | Yes | 228 | 20.2 |
|  | No | 812 | 71.9 |
| Provided information about health facility delivery | Yes | 317 | 28.1 |
|  | No | 270 | 45.8 |
|  | I don’t know | 1 | 0.3 |
| Counseled about BPCR | Yes | 244 | 22.2 |
|  | No | 886 | 78.4 |
| Plan to give birth in HF | Yes | 597 | 52.8 |
|  | No | 533 | 47.2 |
| Mode of delivery | SVD | 1057 | 93.6 |
|  | Instrumental delivery | 41 | 3.6 |
|  | Cesarean delivery | 32 | 2.8 |
| Type of providers attended during childbirth | Doctor | 100 | 8.8 |
|  | Nurse | 222 | 19.6 |
|  | Midwife | 447 | 39.6 |
|  | Health officer | 37 | 3.3 |
|  | HEW | 4 | 0.4 |
|  | TBA | 413 | 36.5 |
|  | Other | 149 | 13.2 |
| Number of PNC visits | No | 836 | 74.0 |
|  | 1-2 | 127 | 11.2 |
|  | >3 | 167 | 14.8 |
| Type of health facility visited during PNC follow up | No | 836 | 74.0 |
|  | Hospital | 24 | 2.1 |
|  | Health Centre | 266 | 23.5 |
|  | Others | 4 | 0.4 |
| Type of providers provided PNC | Doctor | 22 | 1.9 |
|  | Nurse | 72 | 6.4 |
|  | Midwife | 259 | 22.9 |
|  | Health officer | 114 | 10.1 |
|  | HEW | 3 | 0.3 |

**S1 File Table 6:** Descriptive reasons for not utilizing maternal health care service among women of reproductive age in northern zone of Sidama region, Ethiopia, 2022 (N = 1,130)

|  |  |  |  |
| --- | --- | --- | --- |
| Reasons for not using ANC follow | No health problems encountered | 245 | 45.2 |
|  | No or little knowledge of ANC | 182 | 33.8 |
|  | The health institution is too far from my home | 19 | 3.5 |
|  | Long waiting time | 10 | 1.8 |
|  | Poor handling by healthcare providers | 190 | 35.0 |
|  | Lack of transportation | 27 | 4.9 |
|  | Lack of time to go to health institution | 30 | 5.5 |
|  | Others | 4 | 0.7 |
| Reasons for home delivery | The labor was short | 247 | 42.4 |
|  | No nearby health facility | 23 | 3.9 |
|  | The service is not available in the nearby health facility | 11 | 1.9 |
|  | Lack of money for transport | 16 | 2.7 |
|  | Poor handling by health professionals | 231 | 39.7 |
|  | Prefer to deliver in the presence of relatives | 54 | 9.3 |
|  | Fear of manipulation (like episiotomy) | 244 | 41.9 |
|  | Lack of privacy in the health institutions | 147 | 25.2 |
|  | I didn’t know the importance of health facility delivery | 22 | 3.9 |
|  | Opinions of (husband, neighbors, other community members) | 111 | 19.1 |
|  | Other | 9 | 1.5 |
| Reasons for not using PNC visit | No health problems encountered | 515 | 61.0 |
| No or little | Knowledge of PNC | 334 | 39.9 |
|  | The health institution is too far from my home | 18 | 2.2 |
|  | Long waiting time | 13 | 1.6 |
|  | Poor handling by healthcare providers | 123 | 14.7 |
|  | Lack of transportation | 19 | 2.2 |
|  | Lack of time to go to health institution | 27 | 3.2 |
|  | Other | 12 | 1.4 |
| Socio-cultural beliefs that affect MHSU | Availability and influence of traditional healers | 337 | 33.0 |
|  | Availability and influence of spiritual healers | 162 | 14.3 |
|  | Availability and influence of TBAs | 147 | 13.0 |
|  | Fear of using MHS | 203 | 18.0 |
|  | Knowledge of community towards MHSU | 294 | 26.0 |
|  | Father and mother-in-law influence | 255 | 22.6 |
|  | Husband influence | 257 | 22.7 |
|  | Peer influence | 153 | 13.5 |

**Model selection criteria**

The model fitness evaluation test of ANC use showed that the empty model was the least fit (AIC = 1318.02, BIC =1328.08, and log-likelihood = -657.01). Yet, there was significant progress in the fitness of the models, particularly in the final model (AIC = 749.26, BIC = 895.13, and log-likelihood = -345.63). Thus, the final model is best fitted as compared to the other models. Similarly, the model fitness significantly improved from the empty model to the final model in cases of HFD and PNC.

**S1 File Table 7:** Multilevel logistic regression analysis result of a random intercept model for maternal health service use variation at cluster level in north zone of Sidama region, Ethiopia, 2022 (N = 1,130)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Measure of variation | Model 0 (95% CI) | Model 1 (95% CI) | Model 2 (95% CI) | Model 3 (95% CI) | Model 4 (95% CI) |
| **ANC related information** | | | | |  |
| Variance of intercept | 0.23 (0.11, 0.49) | 0.03 (0.01, 0.12) | 0.17 (0.09, 0.33) | 0.02 (0.01, 0.11) | 0.01 (0.06, 4.49) |
| ICC percentage | 35.48 (21.55-52.39) |  |  |  |  |
| MPR | 1.58 (1.37 -1.94) | 1.18 (1.09, 1.39) | 1.48 (1.33, 1.73) | 1.14 (1.09, 1.37) | 1.37 (1.08, 7.49) |
| Model fitness |  |  |  |  |  |
| Log-likelihood ratio | -932.44 | -812.03 | -930.07 | -811.13 | -797.79 |
| AIC | 1868.88 | 1666.07 | 1868.14 | 1664.26 | 1639.57 |
| BIC | 1878.94 | 1771.70 | 1868.26 | 1769.89 | 1750.23 |
| Variance of random coefficient of BPCR plan |  |  |  |  | 0.02 (0.01, 3.69) |
| **Health facility delivery related information** | | | | |  |
| Variance of intercept | 0.31 (0.13, 0.73) | 0.09 (0.02, 0.43) | 0.16 (0.06, 0.46) | 0.04 (0.01, 0.54) | 0.16 (0.04, 0.68) |
| ICC percentage | 28.01 (16.73, 42.97) |  |  |  |  |
| MPR | 1.69 (1.41, 2.25) | 1.33 (1.14, 1.86) | 1.46 (1.26, 1.90) | 1.21 (1.09, 2.01) | 1.46 (1.70, 2.31) |
| Model fitness |  |  |  |  |  |
| Log-likelihood ratio | -900.45 | -832.51 | -895.14 | -827.92 | -826.65 |
| AIC | 1804.90 | 1701.02 | 1802.28 | 1697.85 | 1695.29 |
| BIC | 1814.96 | 1811.56 | 1832.46 | 1803.48 | 1800.92 |
| Variance of random coefficient of ANC use |  |  |  |  | 0.11 (0.04, 0.33) |
| **PNC related information** | | | | | |
| Variance of intercept | 0.99 (0.46, 2.14) | 0.51 (0.16, 1.58) | 0.21 (0.07, 0.62) | 0.08 (0.01, 0.44) | 0.36 (0.20, 1.30) |
| ICC percentage | 50.76 (32.65, 68.68) |  |  |  |  |
| MPR | 2.57 (1.90,4.01) | 1.97 (1.46, 3.30) | 1.55 (1.21, 2.30) | 1.31 (1.09, 1.88) | 1.77 (1.53, 3.59) |
| Model fitness |  |  |  |  |  |
| Log-likelihood ratio | -604.21 | -557.94 | -592.45 | -547.13 | -546.32 |
| AIC | 1212.42 | 1147.89 | 1194.91 | 1132.25 | 1132.65 |
| BIC | 1222.48 | 1228.37 | 1220.06 | 1227.82 | 1233.25 |
| Variance of random coefficient of women’s knowledge of ODS |  |  |  |  | 0.09 (0.02, 0.48) |

PCV: Proportion change in variance; MRR: Median odds ratio and ICC: Intra-class correlation coefficient; AIC: Akaike information criteria; BIC: Bayesian information criteria; CI: confidence interval.

**Effect modification result of ANC**

We entered the interaction terms in the final model for women's education and women's knowledge of ODS, women's education and women's perceived quality of ANC, women's education and women's BPCR, women's knowledge of ANC, and women's perceived quality of ANC service to see if women's education modifies the effect of women's knowledge of ODS, perceived quality of ANC, and BPCR plan, and if women's knowledge of ANC modifies the effect of perceived quality. None of the interaction terms was statistically significant, implying the absence of a significant effect modification.

**Effect modification result of HFD**

We entered the interaction terms in the final model for women's education status and wealth quintile, women's education status and ANC use, women's education and women's perceived quality of ANC, wealth quintile and ANC use, individual mass media use and community level mass media use to see if women's education modifies the effect of wealth quintile, ANC use, women's perceived quality of ANC, if wealth quintile modifies the effects of ANC use, and if individual mass media use modifies the effects of community level mass media use. None of the interaction terms was statistically significant, implying the absence of a significant effect modification.

**Effect modification result of PNC**

We entered the interaction terms in the final model for women's education and women's knowledge of PNC, place of residence and women’s knowledge of PNC, place of residence and women’s knowledge of ODS, place of residence and wealth quintile to see if women's education modifies the effect of women's knowledge of PNC, if place of residence modifies the effect of women’s knowledge of PNC, women’s knowledge of ODS, and wealth quintile. None of the interaction terms was statistically significant, implying the absence of a significant effect modification.

**S1 File Table 8:** Comparison of modified Poisson with robust variance and log-binomial models in estimating ARR ofdeterminants of ANC use

|  |  |  |
| --- | --- | --- |
| Variables | **Log-binomial regression**  **(multivariable)** | **Poisson regression with**  **robust standard errors**  **(multivariable)** |
| **APR (95% CI)** | **APR (95% CI)** |
| **Received model family training** |  |  |
| No | Ref | Ref |
| Yes | 1.19 (1.07, 1.35) \* | 1.19 (1.06, 1.35)\* |
| **Women’s knowledge score on ANC ©** | 1.26 (1.16, 1.36) \*\* | 1.54 (1.31, 1.81)\*\* |
| **Women’s perceived quality of ANC score ©** | 1.02 (1.01, 1.03) | 1.02 (1.01, 1.03)\*\* |
| **Birth preparedness plan** |  |  |
| Poorly prepared | Ref | Ref |
| Well prepared | 1.13 (1.02, 1.25)\* | 1.13 (1.02, 1.25)\* |
| **AIC** | 1649.57 | 1639.57 |
| **BIC** | 1750.23 | 1750.23 |

Variables adjusted in the models were women’s education status, husband’s education status, use of mass media, wealth quintile, age at first pregnancy, last pregnancy status, faced health problems during last pregnancy, woman’s decision-making power, women’s attitude score on ANC, knowledge of obstetric danger signs, community-level mass media use and community-level women literacy.

\*: significant association (*p* < 0.05); \*\*: highly significant association (*p* <0.01); CI: confidence interval; ©: continuous variable; Ref: reference group; AIC: Akaike information criteria; BIC: Bayesian information criteria.

**S1 File Table 9:** Comparison of modified Poisson with robust variance and log-binomial models in estimating ARR ofdeterminants of HFD use

|  |  |  |
| --- | --- | --- |
| Variables | **Log-binomial regression**  **(multivariable)** | **Poisson regression with**  **robust standard errors**  **(multivariable)** |
| **APR (95% CI)** | **APR (95% CI)** |
| **Wealth quintile** |  |  |
| Lowest | Ref | Ref |
| Second | 1.07 (0.85, 1.35) | 1.07 (0.85, 1.35) |
| Middle | 1.35 (1.03, 1.77)\* | 1.35 (1.03, 1.77)\* |
| Fourth | 1.12 (0.91, 1.39) | 1.12 (0.91, 1.39) |
| Highest | 1.15 (0.85, 1.55) | 1.15 (0.85, 1.55) |
| **Antennal care use** | Ref | Ref |
| No | 1.76 (1.36, 2.29)\*\* | 1.76 (1.36, 2.29)\*\* |
| Yes |  |  |
| **Women’s perceived quality score of HFD ©** | 1.02 (1.01, 1.03)\* | 1.02 (1.01, 1.03)\* |
| **Community-level women’s literacy** |  |  |
| Low | Ref | Ref |
| High | 1.55 (1.10, 2.19)\* | 1.55 (1.10, 2.19)\* |
| AIC | 1695.85 | 1695.29 |
| BIC | 1803.48 | 1800.92 |

Variables adjusted in the models were women’s education status, husband’s education status, use of mass media, ANC use, encountered health problems during childbirth, faced health problems during last pregnancy, woman’s decision-making power, women’s knowledge score of PNC, women’s attitude score of PNC, birth preparedness plan, place of residence, community-level mass media use and distance to reach the nearest health facility.

\*: significant association (*p* < 0.05); \*\*: highly significant association (*p* <0.01); CI: confidence interval; ©: continuous variable; Ref: reference group; AIC: Akaike information criteria; BIC: Bayesian information criteria.

**S1 File Table 10:** Comparison of modified Poisson with robust variance and log-binomial models in estimating ARR ofdeterminants of PNC use

|  |  |  |
| --- | --- | --- |
| Variables | **Log-binomial regression**  **(multivariable)** | **Poisson regression with**  **robust standard errors**  **(multivariable)** |
| **Faced health problems during the postpartum period** | **APR (95% CI)** | **APR (95% CI)** |
| No | Ref | Ref |
| Yes | 1.76 (1.16, 2.66) \* | 1.79 (1.18, 2.72)\* |
| **Women’s knowledge of PNC score ©** | 1.17 (1.03, 1.32)\* | 1.11 (1.04, 1.19)\* |
| **Place of residence** |  |  |
| Rural | Ref | Ref |
| Urban | 4.79 (2.69, 5.53) | 3.52 (2.15, 5.78)\*\* |
| **Community-level poverty** |  |  |
| High | Ref | Ref |
| Low | 0.40 (0.23, 0.71) | 0.43 (0.25, 0.73)\* |
| **AIC** | 1135.25 | 1132.65 |
| **BIC** | 1231.40 | 1233.25 |

Variables adjusted in the models were women’s occupation, history of the previous stillbirth, husband’s attitude about maternal health service use, woman’s decision-making power, women’s score on attitude towards PNC, women’s perceived quality of PNC score, birth preparedness plan, women's knowledge of obstetric danger signs and community-level women’s literacy.

\*: significant association (*p* < 0.05); \*\*: highly significant association (*p* <0.01); CI: confidence interval; ©: continuous variable; Ref: reference group; AIC: Akaike information criteria; BIC: Bayesian information criteria.

**References**

1. Kifle D, et al,. Maternal health care service seeking behaviors and associated factors among women in rural Haramaya District, Eastern Ethiopia: a triangulated community-based cross-sectional study. Reprod Health, 2017. 14(1): p. 6. 2017.

2. Getachew T AA, Aychiluhim M,. Focused Antenatal Care Service Utilization and Associated Factors in Dejen andAneded Districts, Northwest Ethiopia. Primary Health Care 4: 170. doi:10.4172/2167-1079.1000170. . 2014.

3. Asfawosen Aregay MA, Huruy Assefa, Wondeweson Terefe,. Factors Associated with Maternal Health Care Services in Enderta District, Tigray, Northern Ethiopia: A Cross Sectional Study, American Journal of Nursing Science. Vol. 3, No. 6, 2014, pp. 117-125. doi: 10.11648/j.ajns.20140306.15 2014.

4. Central Statistical Agency (CSA) [Ethiopia] and ICF. Mini Ethiopia Demographic and Health Survey 2019: Key Indicators Report. Addis Ababa, Ethiopia, and Rockville, Maryland, USA. CSA and ICF. 2019. 2019.

5. Kifle D, Azale T, Gelaw YA and Melsew YA. Maternal health care service seeking behaviors and associated factors among women in rural Haramaya District, Eastern Ethiopia: a triangulated community-based cross-sectional study. *Reproductive Health*. 2017; 14: 6.

6. Huda TM, Chowdhury M, El Arifeen S and Dibley MJ. Individual and community level factors associated with health facility delivery: A cross sectional multilevel analysis in Bangladesh. *PloS one*. 2019; 14: e0211113.

7. Pervin J, Nu UT, Rahman AMQ, et al. Level and determinants of birth preparedness and complication readiness among pregnant women: A cross sectional study in a rural area in Bangladesh. *PloS one*. 2018; 13: e0209076.

8. Hailu D and Berhe H. Knowledge about obstetric danger signs and associated factors among mothers in Tsegedie district, Tigray region, Ethiopia 2013: community based cross-sectional study. *PloS one*. 2014; 9: e83459.

9. Bintabara D, Mohamed MA, Mghamba J, Wasswa P and Mpembeni RN. Birth preparedness and complication readiness among recently delivered women in chamwino district, central Tanzania: a cross sectional study. *Reprod Health*. 2015; 12: 44.

10. Kabakyenga JK, Östergren PO, Turyakira E and Pettersson KO. Knowledge of obstetric danger signs and birth preparedness practices among women in rural Uganda. *Reprod Health*. 2011; 8: 33.

11. Zegeye K GA, Melese T,. The Role of Geographical Access in the Utilization of Institutional Delivery Service in Rural Jimma Horro District, Southwest Ethiopia . Primary Health Care 4: 150. doi:10.4172/2167- 1079.1000150. 2014.

12. Ahmed R SM, Abose S, Assefa B, Nuramo A, Alemu A, et al,. Levels and associated factors of the maternal healthcare continuum in Hadiya zone, Southern Ethiopia: A multilevel analysis. PLoS ONE 17(10): e0275752. https://doi.org/10.1371/journal.pone.0275752 2022.

13. Singh P, Singh KK and Singh P. Maternal health care service utilization among young married women in India, 1992–2016: trends and determinants. *BMC Pregnancy and Childbirth*. 2021; 21: 122.

14. Fatema K. "Impact of Mass Media on the Utilization of Maternal Healthcare Services in South Asia" (2019). Electronic Theses and Dissertations. 2031. https://digitalcommons.memphis.edu/etd/2031 2019.

15. Girmaye E and Mamo K. Assessment of Knowledge, Attitude, and Practice of Skilled Assistance Seeking Maternal Healthcare Services and Associated Factors among Women in West Shoa Zone, Oromia Region, Ethiopia. 2021; 2021: 8888087.

16. Beraki GG, Tesfamariam EH, Gebremichael A, et al. Knowledge on postnatal care among postpartum mothers during discharge in maternity hospitals in Asmara: a cross-sectional study. *BMC Pregnancy Childbirth*. 2020; 20: 17.

17. Shudura E, Yoseph A and Tamiso A. Utilization and predictors of maternal health care services among women of reproductive age in Hawassa University health and demographic surveillance system site, South Ethiopia: a Cross-Sectional Study. *Advances in Public Health*. 2020; 2020: 1-10.

18. Asefa A and Gebremedhin S. Mismatch between antenatal care attendance and institutional delivery in south Ethiopia: A multilevel analysis. 2019; 9: e024783.

19. Jallow IK, Chou YJ, Liu TL and Huang N. Women's perception of antenatal care services in public and private clinics in the Gambia. *International journal for quality in health care : journal of the International Society for Quality in Health Care*. 2012; 24: 595-600.

20. Hailemariam S and Gutema L. Perceived physical accessibility, mother's perception of quality of care, and utilization of skilled delivery service in rural Ethiopia. 2021; 9: 20503121211036794.

21. Wickramasinghe SA, Gunathunga MW and Hemachandra D. Client perceived quality of the postnatal care provided by public sector specialized care institutions following a normal vaginal delivery in Sri Lanka: a cross sectional study. *BMC Pregnancy Childbirth*. 2019; 19: 485.

22. Negash WD and Fetene SM. Multilevel analysis of quality of antenatal care and associated factors among pregnant women in Ethiopia: a community based cross-sectional study. 2022; 12: e063426.

23. Liyew AM and Teshale AB. Individual and community level factors associated with anemia among lactating mothers in Ethiopia using data from Ethiopian demographic and health survey, 2016; a multilevel analysis. *BMC public health*. 2020; 20: 775.

24. Tessema ZT and Animut Y. Spatial distribution and determinants of an optimal ANC visit among pregnant women in Ethiopia: further analysis of 2016 Ethiopia demographic health survey. *BMC Pregnancy Childbirth*. 2020; 20: 137.

25. Chaka EE. Multilevel analysis of continuation of maternal healthcare services utilization and its associated factors in Ethiopia: A cross-sectional study. PLOS Glob Public Health 2(5): e0000517. https://doi.org/10.1371/journal.pgph.0000517. 2022.

26. Zegeye B and Olorunsaiye CZ. Individual/Household and Community-Level Factors Associated with Child Marriage in Mali: Evidence from Demographic and Health Survey. 2021; 2021: 5529375.

27. Fry K. FR, Chakraborty N.M,. Measuring Equity with Nationally Representative Wealth Quintiles. Washington, DC: PSI. . 2014.

28. Vyas S and Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health policy and planning*. 2006; 21: 459-68.

29. Principal component analysis. Available online from https://slideplayer.com/slide/4238108/