Do Health and Demographic Surveillance Systems benefit local populations? Maternal care utilisation in Butajira HDSS, Ethiopia

Mesganaw Fantahun Afework¹*, Seifu Hagos Gebregiorgis¹, Meselech Asseged Roro¹, Alemayehu Mekonnen Lemma¹ and Saifuddin Ahmed²

¹Department of Reproductive Health and Health Service Management, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia; ²Department of Population, Family and Reproductive Health, Bill & Melinda Gates Institute for Population and Reproductive Health, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA

Background: The benefits of Health and Demographic Surveillance sites for local populations have been the topic of discussion as countries such as Ethiopia take efforts to achieve their Millennium Development Goal targets, on which they lag behind. Ethiopia’s maternal mortality ratio is very high, and in the 2011 Ethiopia Demographic and Health Survey (2011 EDHS) it was estimated to be 676/100,000 live births. Recent Global Burden of Disease (GBD) and estimates based on the United Nations model reported better, but still unacceptably high, figures of 497/100,000 and 420/100,000 live births for 2013. In the 2011 EDHS, antenatal care (ANC) utilization was estimated at 34%, and delivery in health facilities was only 10%.

Objectives: To compare maternal health service utilization among populations in a Health and Demographic Surveillance System (HDSS) to non-HDSS populations in Butajira district, south central Ethiopia.

Design: A community-based comparative cross-sectional study was conducted in January and February 2012 among women who had delivered in the 2 years before the survey.

Results: A total of 2,296 women were included in the study. One thousand eight hundred and sixty two (81.1%) had attended ANC at least once, and 37% of the women had attended ANC at least four times. A quarter of the women delivered their last child in a health facility. Of the women living outside the HDSS areas, 715 (75.3%) attended ANC at least once compared to 85.1% of women living in the HDSS areas [adjusted odds ratio (AOR) 0.59; 95% CI 0.46, 0.74]. Of the women living outside the HDSS areas, only 170 (17.9%) delivered in health facilities and were assisted by skilled attendants during delivery, whereas 30.0% of those living in HDSS areas delivered in health facilities (AOR 0.66; 95% CI 0.48, 0.91).

Conclusion: This paper provides possible evidence that living in an HDSS site has a positive influence on maternal health. In addition, there may be a positive influence on those living nearby or in the same district where an HDSS is located even when not included in the surveillance system.

Keywords: demographic; surveillance; Ethiopia; antenatal care; skilled attendance; facility delivery

Responsible Editor: Peter Byass, Umeå University, Sweden.

*Correspondence to: Mesganaw Fantahun Afework, Department of Reproductive Health and Health Service Management, School of Public Health, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia, Email: mesganaw.f@gmail.com

Received: 28 February 2014; Revised: 12 May 2014; Accepted: 6 June 2014; Published: 4 July 2014

Ethiopia’s maternal mortality ratio (MMR) is very high and was estimated at 676/100,000 live births by the 2011 Ethiopia Demographic and Health Survey (2011 EDHS), while maternal health service utilization is low (1). Recent Global Burden of Disease (GBD) and estimates based on the United Nations model reported better, but unacceptably high, figures of 497/100,000 and 420/100,000 live births in 2013 (2, 3). In the 2011 EDHS, antenatal care (ANC) utilization was estimated at 34%, and only 10% of the deliveries took place in health facilities (1). Studies on maternal health are timely and relevant as the Millennium Development Goal (MDG) target year 2015 is approaching and Ethiopia and many sub-Saharan African countries are...
Health and Demographic Surveillance System (HDSS) sites provide data on vital events and a sampling frame and base population for community-based research in countries where vital registration systems are non-existent or weak (6–9). An HDSS collects and monitors the demographic and health characteristics of a population living in a well-defined geographic area. The process starts with a baseline census followed by regular update of key demographic events (birth, death, and migration) and health events through systematic data collection procedures at set intervals (6).

There are many advantages of HDSS sites as a platform for research and research capacity building and in providing evidence-based interventions for health development (8–16). For example, it was reported that the Butajira HDSS site in Ethiopia was used in 20 PhD dissertations, 40 MPH/MSc theses, and over 100 articles that were published in reputable journals (Unpublished proceedings of the School of Public Health, College of Health Sciences, Addis Ababa University Retreat, 2013).

It has also been speculated that HDSS sites may have better health indicators compared to populations not under surveillance because the repeated data collection and measurement could function as a passive intervention resulting in behavior change. In addition, populations from HDSS areas are often exposed to studies that may provide interventions (9). Comparability and representativity of HDSS populations in Ethiopia with the nation as a whole have been explored to a certain extent; mortality trends have been comparable (17), but the benefits of living in an HDSS site on health status have not been investigated.

The objective of this study is to compare maternal health service utilization in populations living in areas under HDSS and populations not under HDSS in Butajira district, south central Ethiopia.

Methods

Study design and period

We conducted a community-based comparative cross-sectional study in January and February 2012.

Study area

The study was conducted in the Butajira district in south central Ethiopia. The district is located in the Southern Nations Nationalities and Peoples Region (SNNPR), which is one of nine administrative regions of Ethiopia.
Data entry and analysis

Data were double entered by experienced data clerks. Data entry and analysis was performed using STATA 12. Frequency distribution of sociodemographic characteristics of the study population and the coverage of maternal health services were computed. A wealth index score was calculated for each household using the principal component analysis (PCA) method from the household durable goods and household structural conditions (e.g., materials used to construct walls, roof, floors of houses, type of toilet, and land possession). These variables have been used to categorize wealth in the EDHS (1). Households were ranked according to the total wealth score and then divided into wealth quintiles as a proxy of household economic status.

Multivariate logistic regression models were used to estimate odds ratios (95% confidence intervals) to determine the association between living in HDSS kebeles or non-HDSS kebeles and use of ANC and delivery in health facilities. Logistic regression analysis was employed to control potential confounding factors including place of residence, educational status, religion, number of deliveries, and wealth status.

Results

The sociodemographic characteristics of the study population are shown in Table 1. A total of 2,296 women were included in the study. One thousand three hundred and forty-seven (58.7%) were from HDSS kebeles, while 949 (41.3%) were from non-HDSS kebeles. The majority (74.9%) were rural residents and belonged to the age group 20–29 (56.3%). One thousand three hundred and twenty-five (57.7%) were unable to read and write. About 97% of the women were married and 62% were Muslim. Occupation-wise, 62% were housewives and 4.4% combined household chores with farm work.

ANC attendance and delivery in a health facility

One thousand eight hundred and sixty-two (81.1%) women in the study had attended ANC at least once, and 37% of the women had attended ANC at least four times. Twenty-five percent of the women delivered their last child in a health facility.

Association between living in an HDSS kebele and other factors with attending ANC at least once

Table 2 shows data regarding whether living in an HDSS kebele along with certain sociodemographic characteristics are associated with attending ANC at least once. Seven hundred and fifteen (75.3%) of the women living outside the HDSS areas attended ANC at least once compared to 85.1% of women living in the HDSS areas [adjusted odds ratio (AOR) 0.59 (95% CI 0.46, 0.74)]. When adjusted for other factors, wealth quintile and number of deliveries were statistically significantly associated with attending ANC at least once. The odds of attending ANC at least once was about 3.5 times higher among the richest compared to the poorest. Those who had delivered seven or more times had an approximately 40% lower chance of attending ANC at least once compared to those who had delivered once or twice. Age group, place of residence (urban vs. rural), religion, occupational status, educational status, and marital status did not show statistically significant association with ANC attendance at least once in this study population.

Association between living in an HDSS kebele and other factors with ANC attendance at least four times

Five hundred and twenty-five (39.0%) of the women who lived in HDSS kebeles had attended ANC at least four times, and 316 (33.3%) of those who lived in non-HDSS areas had attended ANC at least four times. Living in HDSS kebeles did not have a significant association with ANC attendance at least four times [AOR 0.97 (95% CI 0.73, 1.30)].

---

Table 1. Sociodemographic characteristics of women who delivered a baby in the 2 years preceding the survey in Butajira HDSS and non-HDSS sites, south central Ethiopia 2012 (N = 2,296)

| Characteristics                  | Number | Percent |
|----------------------------------|--------|---------|
| HDSS site                        |        |         |
| Yes                              | 1,347  | 58.7    |
| No                               | 949    | 41.3    |
| Age group                        |        |         |
| 15–19                            | 116    | 5.1     |
| 20–29                            | 1,290  | 56.3    |
| 30–39                            | 772    | 33.1    |
| 40–49                            | 112    | 4.9     |
| Place of residence               |        |         |
| Urban                            | 577    | 25.1    |
| Rural                            | 1,719  | 74.9    |
| Level of education               |        |         |
| None (unable to read and write)  | 1,325  | 57.7    |
| Primary                          | 749    | 32.6    |
| Secondary                        | 165    | 7.2     |
| College                          | 57     | 2.5     |
| Marital status                   |        |         |
| Currently married                | 2,216  | 96.5    |
| Widowed, divorced, never married | 80     | 3.5     |
| Religion                         |        |         |
| Orthodox christian               | 681    | 29.7    |
| Muslim                           | 1,411  | 61.5    |
| Protestant                       | 192    | 8.4     |
| Catholic                         | 10     | 0.4     |
| Occupation                       |        |         |
| Farmer and housewife             | 100    | 4.4     |
| Housewife                        | 1,521  | 66.2    |
| Employee                         | 459    | 20.0    |
| Others                           | 216    | 9.4     |
Variables that were significantly associated with ANC attendance at least four times included place of residence, wealth quintile, and number of deliveries. The odds of rural residents attending ANC was about 30% lower than those living in urban areas [AOR: 0.70 (95% CI: 0.51, 0.95)]. Those who belonged to the rich and richest quintiles were more likely to attend ANC at least four times compared to the poorest [AOR: 2.33 (95% CI: 1.67, 3.24)], [AOR: 3.91 (95% CI: 2.62, 5.84)], respectively. The odds of attending ANC at least four times by women who delivered 7 times or more was 42% lower than women who had delivered 1 or 2 times [AOR: 0.58 (95% CI 0.38, 0.88)].

### Table 2. Association between living in an HDSS site or not and sociodemographic characteristics with antenatal care attendance at least once, in Butajira district, south central Ethiopia 2012

| Characteristics                      | Had antenatal care | Crude odds ratio (95% CI) | Adjusted odds ratio (95% CI) |
|--------------------------------------|--------------------|---------------------------|-----------------------------|
| HDSS site                            |                    |                           |                             |
| Yes                                  | 1,146 (85.1)       | 201 (14.9)                | 1.00                        |
| No                                   | 715 (75.3)         | 234 (24.7)                | 0.54 (0.43, 0.67)           |
| Place of residence                   |                    |                           |                             |
| Urban                                | 530 (91.8)         | 47 (8.2)                  | 1.00                        |
| Rural                                | 1,331 (77.4)       | 388 (22.6)                | 0.30 (0.22, 0.42)           |
| Age group (years)                    |                    |                           |                             |
| 15–19                                | 100 (96.2)         | 16 (3.8)                  | 1.00                        |
| 20–29                                | 1,078 (83.6)       | 212 (16.4)                | 0.81 (0.45, 1.44)           |
| 30–39                                | 602 (78.0)         | 170 (22.0)                | 0.57 (0.31, 1.01)           |
| 40–49                                | 78 (69.6)          | 34 (30.4)                 | 0.37 (0.18, 0.75)           |
| Women's educational status           |                    |                           |                             |
| None                                 | 1,015 (76.6)       | 310 (23.4)                | 1.00                        |
| Primary                              | 665 (84.8)         | 114 (15.2)                | 0.99 (0.72, 1.34)           |
| High school                          | 156 (94.6)         | 9 (5.5)                   | 5.29 (2.59, 11.22)          |
| College/University                   | 55 (96.5)          | 2 (3.5)                   | 8.40 (2.00, 50.05)          |
| Wealth quintile                      |                    |                           |                             |
| Poorest                              | 346 (75.2)         | 114 (24.8)                | 1.00                        |
| Poor                                 | 344 (74.9)         | 115 (25.1)                | 0.99 (0.72, 1.34)           |
| Middle                               | 355 (77.3)         | 104 (22.7)                | 1.12 (0.82, 1.54)           |
| Rich                                 | 380 (82.8)         | 79 (17.2)                 | 1.28 (0.92, 1.80)           |
| Richest                              | 436 (95.0)         | 23 (5.0)                  | 6.25 (3.82, 10.28)          |
| Marital status                       |                    |                           |                             |
| Currently married                    | 1,798 (81.1)       | 418 (18.9)                | 1.00                        |
| Currently unmarried                  | 63 (78.8)          | 17 (21.3)                 | 0.86 (0.49, 1.55)           |
| Occupation                           |                    |                           |                             |
| Farmer and housewife                 | 70 (70.0)          | 30 (30.0)                 | 1.00                        |
| House wife                           | 1,227 (80.7)       | 294 (19.3)                | 1.79 (1.12, 2.85)           |
| Employee                             | 387 (84.3)         | 72 (15.7)                 | 2.30 (1.36, 3.89)           |
| Other                                | 177 (81.9)         | 39 (18.1)                 | 1.95 (1.08, 3.50)           |
| Religion                             |                    |                           |                             |
| Orthodox Christian                   | 569 (83.6)         | 112 (16.4)                | 1.00                        |
| Muslim                               | 1,119 (79.3)       | 292 (20.7)                | 0.75 (0.59, 0.97)           |
| Protestant                           | 162 (84.4)         | 30 (15.6)                 | 1.06 (0.67, 1.69)           |
| Catholic                             | 9 (90.0)           | 1 (10.0)                  | 1.77 (0.23, 37.70)          |
| Number of deliveries                  |                    |                           |                             |
| 1–2                                  | 708 (87.5)         | 101 (12.5)                | 1.00                        |
| 3–4                                  | 534 (79.7)         | 136 (20.3)                | 0.56 (0.42, 0.75)           |
| 5–6                                  | 361 (77.8)         | 103 (22.2)                | 0.50 (0.37, 0.68)           |
| 7+                                   | 258 (73.1)         | 95 (26.9)                 | 0.39 (0.28, 0.54)           |

*Significant associations (P < 0.05).
As shown in Table 3, the odds of delivering in health facilities for women living in a non-HDSS kebele were lower than those for women living in an HDSS kebele [AOR: 0.66 (95% CI 0.48, 0.91)]. Strong statistically significant associations were found between women delivering in health facilities and their educational status, wealth status, and number of deliveries. Those who had a college education had a higher chance of delivering in health facilities [AOR: 4.84 (95% CI 1.98, 11.84)], while the odds of delivering in health facilities were much lower for women who lived in a non-HDSS kebele compared to those living in an HDSS kebele [AOR: 0.66 (95% CI 0.48, 0.91)].

**Table 3.** Association of living in HDSS site or not and sociodemographic characteristics with place of delivery in Butajira district, south central Ethiopia 2012

| Characteristics                        | Place of delivery | COR (95% CI)       | AOR (95% CI)       |
|----------------------------------------|-------------------|--------------------|--------------------|
| **HDSS site**                          |                   |                    |                    |
| Yes                                    | 404 (30.0)        | 943 (70.0)         | 1.00               | 1.00               |
| No                                     | 170 (17.9)        | 779 (82.1)         | 0.51 (0.41, 0.63)  | 0.66 (0.48, 0.91)* |
| **Place of residence**                 |                   |                    |                    |
| Urban                                  | 345 (59.8)        | 232 (40.2)         | 1.00               | 1.00               |
| Rural                                  | 229 (13.3)        | 1,490 (86.7)       | 0.10 (0.08, 0.13)  | 0.70 (0.48, 1.03)  |
| **Age group (years)**                  |                   |                    |                    |
| 15–19                                  | 80 (35.7)         | 144 (64.3)         | 1.00               | 1.00               |
| 20–29                                  | 714 (29.3)        | 1,813 (71.7)       | 0.71 (0.53, 0.95)  | 0.77 (0.46, 1.25)  |
| 30–39                                  | 408 (21.5)        | 1,490 (78.5)       | 0.49 (0.36, 0.67)  | 1.13 (0.61, 2.09)  |
| 40–49                                  | 32 (11.0)         | 259 (89.0)         | 0.22 (0.13, 0.35)  | 1.85 (0.77, 4.49)  |
| **Women's educational status**         |                   |                    |                    |
| None                                   | 440 (14.2)        | 2,658 (85.8)       | 1.00               | 1.00               |
| Primary                                | 434 (31.8)        | 931 (68.2)         | 2.82 (2.41, 3.29)  | 1.20 (0.91, 1.60)  |
| High school                            | 291 (72.4)        | 111 (27.6)         | 15.84 (12.36, 20.39) | 3.73 (2.27, 6.14)*  |
| College/University                     | 72 (85.7)         | 12 (14.3)          | 36.25 (32.43, 88.56) | 4.84 (1.98, 11.84)*       |
| **Wealth quintile**                    |                   |                    |                    |
| Poorest                                | 22 (4.8)          | 438 (95.2)         | 1.00               | 1.00               |
| Poor                                   | 29 (6.3)          | 430 (93.7)         | 1.34 (0.73, 2.46)  | 1.17 (0.65, 2.09)  |
| Middle                                 | 48 (10.5)         | 411 (89.5)         | 2.33 (1.34, 4.05)  | 1.97 (1.15, 3.81)*  |
| Rich                                   | 148 (32.2)        | 311 (67.8)         | 9.47 (5.79, 15.62) | 5.81 (3.44, 9.81)*  |
| Richest                                | 327 (71.2)        | 132 (28.8)         | 53.36 (32.43, 88.56) | 17.5 (9.85, 31.26)*  |
| **Marital status**                     |                   |                    |                    |
| Currently married                      | 1,144 (24.3)      | 3,562 (75.7)       | 1.00               | 1.00               |
| Currently unmarried                    | 93 (38.3)         | 150 (61.7)         | 1.93 (1.46, 2.54)  | 1.49 (0.85, 2.63)  |
| **Religion**                           |                   |                    |                    |
| Orthodox Christian                     | 205 (30.1)        | 476 (69.9)         | 1.00               | 1.00               |
| Muslim                                 | 315 (22.3)        | 1,096 (77.7)       | 0.67 (0.54, 0.82)  | 0.82 (0.62, 1.08)  |
| Protestant                             | 52 (27.1)         | 140 (72.9)         | 0.86 (0.59, 1.25)  | 0.87 (0.55, 1.39)  |
| Catholic                               | 1 (10)            | 9 (90)             | 0.26 (0.01, 2.00)  | 1.07 (0.12, 9.58)  |
| **Occupation**                         |                   |                    |                    |
| Farmer and housewife                   | 5 (5.0)           | 95 (95.0)          | 1.00               | 1.00               |
| Housewife                              | 331 (21.8)        | 1,190 (78.2)       | 5.28 (2.05, 14.85) | 1.95 (0.74, 5.19)  |
| Employee                               | 188 (41.0)        | 271 (59.0)         | 13.18 (5.05, 37.48) | 1.95 (0.71, 5.36)  |
| Other                                  | 50 (23.2)         | 166 (76.8)         | 5.72 (2.10, 16.92) | 2.03 (0.71, 5.74)  |
| **Number of deliveries**               |                   |                    |                    |
| 1–2                                    | 722 (40.7)        | 1,053 (59.3)       | 1.00               | 1.00               |
| 3–4                                    | 282 (20.1)        | 1,119 (80.0)       | 0.37 (0.31, 0.43)  | 0.43 (0.31, 0.60)*  |
| 5–6                                    | 158 (15.4)        | 868 (84.6)         | 0.27 (0.22, 0.32)  | 0.39 (0.25, 0.61)*  |
| 7+                                     | 73 (9.8)          | 669 (90.2)         | 0.15 (0.12, 0.20)  | 0.24 (0.14, 0.44)*  |

*Significant associations (P < 0.05).
higher for the richest compared to the poorest women [AOR: 17.5 (95% CI: 9.85, 31.26)]. Number of lifetime deliveries (per woman) was inversely related to recently delivering in a health facility. The odds of a woman delivering in a health facility among those who had seven or more deliveries was less than a quarter of those who had one or two deliveries [AOR: 0.24 (95% CI: 0.14, 0.44)].

Discussion

We used a community-based study to assess whether living in an area (kebele) in which an HDSS is being run contributes to better maternal health service utilization or not.

The results of this study indicate that a woman who lives in a non-HDSS kebele is less likely to use ANC at least once compared to a woman living in an HDSS kebele. This difference might be related to the better awareness about maternal health care that the population of HDSS sites has due to exposure to several years of surveillance and research activities.

The WHO advocates a minimum of four target-oriented ANC visits during pregnancy to deal with problems that may arise at different periods of pregnancy and to improve pregnancy outcomes (20). Although a higher proportion of women in HDSS kebeles had attended ANC at least four times, the difference between non-HDSS and HDSS kebeles was not statistically significant when adjusted for other factors. Women in general may find it difficult to repeatedly go to health facilities during pregnancy even if there is better awareness about the advantages of ANC among women living in HDSS kebeles.

The odds of women delivering their babies in a health facility in non-HDSS kebeles are about half of those women living in HDSS kebeles, indicating a clear advantage for women living in HDSS kebeles. Health facility delivery (skilled attendance at birth) is considered one of the most important, if not the most important, predictor of maternal mortality (4). This is because maternal mortality and complications are not predictable and most maternal deaths occur around the time of delivery. Thus, living in HDSS kebeles is likely to be associated with lower maternal mortality than in non-HDSS kebeles.

Overall, ANC attendance and health facility delivery for women living in the study areas appear much higher than the national and regional averages reported in the 2011 EDHS (1). The national ANC coverage (where coverage is at least one visit) was reported to be 34%, and coverage in the region where BRHP is located, the SNNPR, was 27%. Delivery in health facilities was reported to be about 10% in the region, whereas the results of this study indicate ANC coverage of 80% and health facility delivery of 25%. The EDHS results are presented as averages for the nation as a whole or for administrative regions such as SNNPR. Therefore, it is difficult to compare the results of the study for this district with that of the EDHS reports. In addition, the data for EDHS coverage pertains to 5 years preceding the survey (i.e. 2011), whereas this study deals with women who delivered in the 2 years prior to mid-2012. Assuming that the average EDHS results for the country or region represent the study district, a possible explanation for the current health service utilization is that there may have been a general increase after the results of the EDHS survey were announced and more vigorous work was done in the country to improve maternal health service utilization as achieving MDG 5 became worrisome. However, it can be argued that such a change might not have been achieved in such a short time. Thus, the HDSS kebeles, and to a lesser but appreciable extent the neighboring non-HDSS kebeles, may have benefited from activities in the HDSS sites.

It has been reported that studies conducted within the Butajira HDSS site accrued some health benefits including the treatment of certain childhood diseases under study in the past (7, 18). However, specific interventions to address maternal health or maternal health service utilization have not been documented in the past 15 years. Thus, the results of this study indicate that improved maternal health service utilization can probably be attributed to the general effect of the ongoing surveillance activities.

Benefits for local populations residing in HDSS sites such as Butajira have often been questioned by community members, health authorities, visitors, and researchers; this question provided the motivation for conducting the current study (21). BRHP has made attempts to provide data on vital events and results of studies to local health authorities and administrators in annual workshops and bulletins for use in health planning and decision making, although this has not been done regularly and consistently during recent times. However, certain PhD theses works in Butajira have challenged the issue of data ownership and use by the community and concerned government sectors (21). It was emphasized that the most immediate and, in hindsight, the most obvious knowledge from the 21 years of BRHP had not been systematically reported where it belonged – in the local community of the Butajira District – despite continuous collection of relevant data. Fatigue of the community and lack of immediate benefits were considered to be challenges for continuous data collection for INDEPTH sites that include the Butajira HDSS site (22).

In conclusion, this paper provides likely evidence of the positive influence of living in an HDSS site for maternal health and perhaps of the positive influence of residing in the same district where an HDSS is located, even when not included in the system. Periodic, well-designed
research will still be necessary in order to produce data on the benefits of HDSS for local populations. This is particularly important in countries such as Ethiopia where a number of HDSS sites have been recently established. The need to give due attention to the local benefits of living in HDSS sites through proper planning, implementation, and monitoring and evaluation of activities in established and emerging HDSS sites cannot be undermined.

We recommend that further studies explore the concrete interventions in HDSS sites that make a difference in health service utilization and other outcomes.

Conflict of interest and funding

The authors declare that they have no competing interests. This research was partially funded by the Bill & Melinda Gates Institute for Population and Reproductive Health, Johns Hopkins University, for which the authors are grateful.

References

1. Central Statistics Agency, Ethiopia and ICF International, Ethiopian Demographic and Health Survey, 2011. Final Report Addis Ababa, Ethiopia and Calverton, Maryland, USA; 2012. Available from: http://www.unicef.org/ethiopia/ET_2011_EDHS.pdf.
2. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, Shackelford KA, Steiner C, Heuton KR, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Available from: http://www.thelancet.com [published 2 May, 2014], http://dx.doi.org/10.1016/S0140-6736(14)60696-6.
3. WHO, UNICEF, UNFPA, The World Bank, and United Nations Population Division Maternal Mortality Estimation Inter-Agency Group. Maternal mortality in 1990–2013. Available from: http://www.who.int/gho/maternal_health/countries/et.pdf.
4. The Official United Nations Site for MDG Indicators. Official Millennium Development Goal Indicators. Available from: http://mdgs.un.org/unsd/mdg/host.aspx?Content=#indicators/officiallist.htm [cited 20 January 2014].
5. Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, et al. Maternal mortality for 181 countries, 1980–2010: a systematic analysis of progress towards Millennium Development Goal 5. Lancet 2010; 375: 1609–23.
6. INDEPTH Network: DSS concepts and methods: core concepts of DSS. In: Sankoh OA, ed. Population and health in developing countries. Population, Health and Survival at INDEPTH sites. Canada: IDRC; 2002, pp. 1–10.
7. Berhane Y, Wall S, Kebede D, Emmelien A, Engueselasie F, Byass P, et al. Establishing an epidemiological field laboratory in rural areas – potentials for public health research and interventions. The Butajira Rural Health Program 1987–99, Ethiop J Health Dev Special issue 1999: 13.
8. Buyse K. Do Health and Demographic Surveillance Systems (HDSS) contribute to the health of the African Community? Masters in Medicine Thesis. Universiteit Gent. Academic Year 2009–2010. Available from: ib.ugent.be/fulltext/RUG01/001458829/RUG01-001458829_2011_0001_AC.pdf [cited 10 May 2014].
9. Yazoume Y, Marily W, Alex E, Jacques BOE, Osman S, Health and demographic surveillance systems: a step towards full civil registration and vital statistics system in sub-Sahara Africa? BMC Public Health 2012; 12: 741. doi: 10.1186/1471-2458-12-741.
10. Binka FN, Bawah AA, Phillips JF, Hodgson A, Adjuik M, MacLeod B. Rapid achievement of the child survival millennium development goal: evidence from the Navrongo experiment in Northern Ghana. Trop Med Int Health 2007; 12: 578–83.
11. Hoj L, Cardoso P, Nielsen BB, Hvidman L, Nielsen J, Aaby P. Effect of sublingual misoprostol on severe postpartum haemorrhage in a primary health centre in Guinea-Bissau: randomised double blind clinical trial. BMJ 2005; 331: 723–27.
12. Derman RJ, Kodkany BS, Goudar SS, Geller SE, Naik VA, Bellad MB, et al. Oral misoprostol in preventing postpartum haemorrhage in resource-poor communities: a randomised controlled trial. Lancet 2006; 368: 1248–53.
13. Herbst AJ, Cooke GS, Barnighausen T, Kany A, Tanser F, Newell ML. Adult mortality and antiretroviral treatment roll-out in rural KwaZulu-Natal, South Africa. Bull World Health Organ 2009; 87: 754–62.
14. Alonso PL, Lindsay SW, Armstrong JRM, de Francisco A, Shenton FC, Greenwood BM, et al. The effect of insecticide-treated bed nets on mortality of Gambian children. Lancet 1991; 337: 1499–502.
15. Valentin-Branth P, Steinsland H, Gjessing HK, Santos G, Bhan MK, Dias F, et al. Community-based randomized controlled trial of reduced osmolarity oral rehydration solution in acute childhood diarrhea. Pediatric Infect Dis J 1999; 18: 789–95.
16. Habluetzel A, Diallo DA, Esposito F, Lamizana L, Pagnoni F, Lengeler C, et al. Do insecticide-treated curtains reduce all-cause child mortality in Burkina Faso? Trop Med Int Health 1997; 2: 855–62.
17. Byass P, Worku A, Berhana Y. DSS and DHS: longitudinal and cross-sectional viewpoints on child and adolescent mortality in Ethiopia. Popul Health Metr 2007; 5: 12.
18. Berhana Y, Byass P. Butajira DSS Ethiopia. In: INDEPTH Network, ed. Population and health in developing countries. Volume 1. Part III. INDEPTH DSS site profiles. International Development Research Centre; 2002. Available from: http://www.idrc.ca/en/ev-9435-201-1-DO_TOPIC.html#begining [cited 20 December 2013].
19. Karim A, Betemariam W, Yalaw S, Alemu H, Cornell M, Mekonnen Y. Programmatic correlates of maternal healthcare seeking behaviors in Ethiopia. Ethiop J Health Dev 2010; 24: 92–9.
20. WHO (2002). Antenatal care randomized trial: manual for the implementation of the new model. Geneva: WHO.
21. Emmelien A, Counted — and then. Trends in child mortality within an Ethiopian demographic surveillance site. Umeå, 2009. Available from: http://www.diva-portal.org/smash/get/diva2:210633/FULLTEXT01.pdf [cited 12 January 2014].
22. Hirve S. Health demographic surveillance in Africa and South Asia, INDEPTH network Meeting (Abstract). BMC Proceedings 2013; 7(Suppl 5): 10.