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Study design for the 2019 baseline survey of newly established longitudinal surveillance woredas as the field lab to serve child health improvement project of Benishangul-Gumuz region, Ethiopia

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ABSTRACT

To achieve the goal of providing real-time scientific evidence on child health status and determinants in Benishangul-Gumuz (BG) region of Ethiopia, regional health authority, academia, hospitals, and communities decided to establish a longitudinal open cohort field lab for under-5 (U5) children in the region. The study initiated with a cross-sectional as the baseline for subsequent observation as a cohort study. Multi-stage stratified cluster sampling was applied. The survey questionnaire covered diverse topics and administered by 9 sections: 1) identification; 2) background information of household; 3) respondent/informant (caregiver); 4) reproductive and maternal health of mothers; 5) children characteristics; 6) illness experience of children; 7) child death experience; 8) early child development assessment; and 9) clinical signs and parameters of the children. The study was conducted in July 2019. Nine-hundred eighty-six U5 children from 692 households were established as study participants in Assosa in BG region. Mortality rate of U5 children, infants, neonates

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Nefa SA, Ibrahim AM, Mulushewa SS, Siyum GA, Birhanu BG, Battle J, Oh J; Data curation: Nefa SA, Ibrahim AM, Mulushewa SS, Amentie MA; Formal analysis: Nefa SA, Ibrahim AM, Mulushewa SS, Lee HY, Amentie MA; Investigation: Mulushewa SS, Wonga MM, Amentie MA, Chebo AF; Methodology: Nefa SA, Ibrahim AM, Mulushewa SS, Amentie MA, Birhanu BG, Bawah AA, Subramanian SV, Oh J; Project administration: Nefa SA, Ibrahim AM, Mulushewa SS, Wonga MM, Lee HY, Siyum GA, Amentie MA, Oh J; Resources: Siyum GA, Oh J; Software: Nefa SA, Ibrahim AM, Mulushewa SS, Amentie MA, Gobezeayehu AG; Supervision: Wonga MM, Chebo AF, Birhanu BG, Oh J; Validation: Nefa SA, Ibrahim AM; Writing - original draft: Nefa SA, Ibrahim AM, Mulushewa SS, Oh J; Writing - review & editing: Nefa SA, Ibrahim AM, Mulushewa SS, Wonga MM, Lee HY, Siyum GA, Chebo AF, Birhanu BG, Battle J, Hiluf MK, Kebedom AG, Gobezeayehu AG, Robins A, Bawah AA, Subramanian SV, Oh J.

were 88.3%, 70.7%, and 28.3%, respectively, per 1,000 live birth. 32.8% of the children experienced acute illness within 2 weeks; 79.7% of these children with acute illness sought health service at health facilities; health center was the most common health facility to seek services (79.0%). The 6.4% of the children had repeated or chronic illness and 2.9% of the children had illness lasting more than 3 months. The 68.9% of mothers used antenatal care more than 4 times, only 21.9% of the children were delivered at home while the rest of the children were born at health facilities (88.1%). Vaccine completion rate at age 2 was 77.2%. This study site will serve the field laboratory for evidence-based child health policy implementation in BG region by effective communication between regional health authority, academia, health facilities, and donor agencies based on well-matched real-time surveillance and research evidence need and provision.

Keywords: Child health; Ethiopia; Cohort baseline survey; Study design; Child mortality

INTRODUCTION

Ethiopia is an example of a country which achieved Millennium Development Goal 4 (child health). Under-5 (U5) mortality of Ethiopia reduced 69% from 205 per 1,000 live birth in 1990 to 64 per 1,000 in 2013 (3 years ahead deadline; the target was 67 per 1,000).^{1,2} Nonetheless, subnational inequality persists in child and maternal health. Inequality is particularly problematic for neonatal and infant health and a challenge that has been acknowledged as well as in other Sub-Saharan countries.³⁻⁵ While 86.5% of neonates at Addis Ababa were born at health facility, only 21.0% of neonates were born at health facility at Benishangul-Gumuz (BG) region, one of the poorest areas in Ethiopia with Gambela, Afar, and Somali region, in 2014.³ Also, Islamic countries and communities such as BG region showed higher child mortalities than global estimate.⁶ The latest (2016) Ethiopian Demographic Health Survey (DHS) ranked BG region as the region with the second highest U5 mortality (98 deaths per 1,000 live births) after Afar region (125 per 1,000) while the national average was 67 per 1,000. However, this underserved subnational region in Ethiopia was inadequately financed support to overcome poor indicators. Nor were external grants adequate for addressing the inequality problem, despite its designation by the federal government as a ‘developing region’ where priority was to be consigned to reducing subnational regional disparities.⁷

In 2014, this situation in BG region drew the attention of some bilateral agencies including the Korea International Cooperation Agency (KOICA). KOICA supported maternal, neonatal, and child health (MNCH) in BG region for 3 years from December 2015 to December 2018, in alliance with other increasing charitable activities.⁸ Recently, KOICA has considered possibility of extending the cooperation term for the BG region to accelerate the ongoing changes with focusing more on child health for coming 5 years (2020–2024) based on the positive cooperation experience and improved MNCH indicators with BG regional health bureau, which used the KOICA support well to improve MNCH indicators in the region.

The knowledge base for supporting for local stakeholder's need toward up-to date situation information about their own region is crucial in order to utilize external grant support more effectively including appropriate intervention program development at the beginning phase. However, compared to reliable scientific information quantity and diversity at the federal government level, the prevailing gap in unmet local infrastructure need has not been filled, even though local need is rather high relative to the better circumstances of other areas such

as capital city, Addis Ababa. Decentralization is increasingly acknowledged by the federal government of Ethiopia. This unmet knowledge base in the health policy arena has prevailed because of the paucity of sustainable local knowledge generation mechanisms owing to a paucity of human, technical, and financial resources in the locality.⁹ Global level needs for this surveillance were established for longitudinal follow-up-based understanding for people's health including children and elderlies.^{10,11} Several number of sites in other Sub-Saharan countries were also established to clarify causes of child mortality to serve their areas by maintaining surveillance area with diverse range of information gathering.¹² The BG regional health bureau, Assosa University, and Assosa Hospital jointly decided to establish a new surveillance administrative unit for 3 reasons.

First, conventional monitoring may not be enough to guarantee to see real impact of program happen or not before the project impact evaluation while health system quality improvement is not necessarily easy. More frequent assessment of real-world change should be ongoing to see the theory of change work well or not to achieve truly positive impact of the new program.

Second, longitudinal follow-up of every year cohort of the newborn may be able to provide changing characteristics of the environment of the children including changes of caregivers health service seeking behavior and household environment, which should be considered to control for simultaneously while health system improvement impact is accessed.

Third, there is ample need to expand the compilation of feed-back from the people. Not only is it important know understand the extent of need, but it is also essential to develop an understanding of optimal ways to address this problem.

Fourth, achieving a comprehensive understanding of actual community circumstances affecting child health conditions and the service system performance permits comparison of realistic conditions that prevail at the community level with the hypothetical perspectives that arise in the context of planned activities or theories of change. The first round of the surveillance already could support the process of conducting a rapid situation analysis for improving the KOICA supported child health development program. Based on evidence emerging from this surveillance mechanism, the status of child health, the changes that arise, and the remaining unmet needs of the communities in the region can be monitored and communicated to the regional health authority and local partners in the project. This paper reports the baseline survey methods conducted in July 2019 and key socio-demographic characteristics of these newly established surveillance areas of BG region and basic characteristics of the study population to serve in-depth studies and follow-up longitudinal studies over time.

METHODS

Study design

This baseline study, which is currently a cross-sectional study, will be serving as the baseline study of the cohort of the surveillance area under the new child health improvement program in BG region in Ethiopia (2020–2024).

Study setting

The study was done in three woredas (3rd level of the sub-national administrative unit of the Ethiopia) of Assosa zone (2nd level of the sub-national administrative unit of the country) in

BG region (1st level of sub-national administrative unit of country), which is 1 of 9 regions, and located in the northwest part of the country. The name of the region literally means 2 local ethnic groups name: Berta (also called as Benishangul) and Gumuz. The BG region has 3 zones: Assosa, Kamashi, and Metekel. Among these 3 zones, Assosa is the capital zone of the BG region. The BG region covers 50,699 km² (4.6% of whole Ethiopia) and has 1,127,001 population based on projection of Ethiopian government in 2018 (1.03% of the total population of Ethiopia).⁴ Health care service were provided by health posts (the grass root level health administrative unit in the country) with health extension workers, health centers (as the next referral unit) with health professionals such as nurses, midwives, pharmacist, medical assistants, and medical doctors as well as laboratory technicians, and primary hospitals and general hospitals (as the final referral center in the region) with pediatric unit.

Assosa zone was purposefully selected based on proximity from the location of regional health bureau among three zones of BG region for near-real-time regular monitor of changing child health status from onset of illness, health-seeking behaviors of caregivers, to treatment results as well as satisfaction of the caregivers by maintaining sampled kebeles for longitudinally as a newly established field epidemiologic laboratory area for the new child health improvement program of BG region during coming 5 years from this study, which was done for the new program that has been under the consideration of KOICA and UNICEF Ethiopia country office for a grant support. Assosa zone, as one of the three zones in BG region, has 439,786 projected population in 211 kebeles through 7 woredas. The people in Assosa zone has been served by 403 health post, 51 health centers, 3 primary hospitals, and 2 general hospitals.

Sample size

Allowing main concerning variable prevalence for each future study around 50%, we have calculated that 1,001 households were needed to detect effect size at a significance level of 0.05 with absolute precision with 1%, and design effect as 2.6 and allowing the rate of non-response up to 10%.

Sampling

A multistage stratified cluster sampling method was applied for this study. Stratification was done at the unit of woreda ($n = 7$), 3rd level of sub-national administrative unit, from Assosa zone. Among 7 woredas, 3 woredas (one per each level) were selected at the second stage of sampling based on three level of performance stratum (2 high-, 3 middle-, and 2 low-performing woreda). Nationally adopted maternal and child health performance indicators were utilized to stratify the 7 woredas into 3 performance-based sub-groups. The regional health bureau data-base was reviewed for this indicators per each woreda; 5 indicators were chosen to stratify the woreda based on completeness of the data: 2 antenatal care (ANC) coverage indicators (at least once as well as more than 4 visits); skilled delivery attendance; proportion of U5 children with pneumonia received antibiotic treatment; and the proportion of children treated for diarrhea. From Assosa zone, a woreda was randomly selected among the woredas list per each stratum among performance-based three strata. Bambasi woreda from high performing woredas stratum, Mengie woreda from middle performing stratum, and Sherokole woreda from low performing stratum were selected, respectively. One or more clusters were randomly selected at the unit of kebele from the list of the whole kebeles from each selected woreda through selecting kebele one by one to reach more than 300 U5 children per each woreda with next level sampling (individual child). Once kebeles were selected, sampling whole U5 children (census per each selected kebele) of the kebele was done for each selected kebele. Every household having at least one U5 children was selected

Fig. 1. Flow diagram depicting the sampling process.
U5 = under-5.

to include all the U5 children in each selected kebele. **Fig. 1** presents the sampling method and the sample distribution of the study, respectively.

Survey questionnaire

The survey questionnaire covered diverse topics and administered by 9 sections. First 3 sets of questions were for household level ($n = 692$). Next 6 sets of questions were for individual children level ($n = 986$) even though some of questions were asked only for the latest born child while most of individual questions were asked for every U5 child ($n = 692$): 1) identification whether any U5 children were born within last 5 years in the sampled household; 2) background information of the household such as drinking water sources, household assets, and etc.; 3) respondent/informant (caregiver) such as educational attainment, age and etc.; 4) reproductive and maternal health of mothers such as ANC visit, delivery at health facility, and etc.; 5) children characteristics such as sex, age, and etc.; 6) illness experience of children such as any acute illness within 2 weeks, any chronic illness¹³ lasting more than 3 months, and etc.; 7) child death experience; 8) early child development assessment; and 9) clinical signs and parameters of the children such as respiratory rate, O2 saturation measured by pulse oximeter, and etc.

Data collection, management, and quality assurance

Data were collected by face-to-face interview by 15 interviewers using smartphones (web-based data collection software, SurveyCTO; Doherty, Inc., Cambridge, MA, USA), which can last more than 15 hours in the field without recharging of electricity, from July 18 to July 27, 2019. Interviewers were recruited from the local data collectors within BG Region and then were trained at the workshop (lecture, role playing, mock-interview, discussion,

and exercising the data collecting device) for 3 days. Seven supervisors accompanied the interviewers who is randomly selected for data input quality assurance. Data were cleaned, edited, and analyzed using SPSS statistical analysis software version 23 (SPSS Inc., Chicago, IL, USA). For this study design paper, descriptive analysis results only are presented. All the association results will be published elsewhere.

Ethics statement

This study was approved by the Ethics Committee at Regional Health Bureau of BG region (Certificate No. 239/te/h/00/03).

RESULTS

All U5 children living in three kebeles from Bambasi woreda (high performing stratum), 2 kebeles from Mengie woreda (middle performing), and one kebele from Sherokole woreda (low performing) were selected to reach at least 300 U5 children per each woreda. Considering the small population structure of kebele unit, the names of kebeles were not presented to maintain anonymity in this study design paper. From the households, which has at least one U5 child born within last 5 years, in the selected Kebeles, the total number of U5 children was 986 from 692 households. The response rate was 100% (986/986). The number of U5 children and households of each woreda and kebele is presented in **Table 1**.

Socio-demographic characteristics of the household were presented in **Table 2**. The average monthly household income was 1,771 Birr (63 USD equivalent). The average number of family members was 6 (range, 1–14). Most common material of the roof of the dwelling unit was thatch/mud (53.5%) and the floor of it was earth/sand (88.6%). The main drinking water source of the household was borehole with a hand pump (74.4%). Firewood and/or straw were mostly used energy source for cooking (99.2%). There were a few households without separate kitchen for cooking (4.9%). Most of the households has insecticide treated bed net (90.0%) and 86.1% of the household sprayed within the last 1 year.

General characteristics of caregivers were presented in **Table 3**, experience of reproductive, maternal health services for the child in **Table 4**, the study children's general characteristics in **Table 5**, child illness experience in **Table 6**, child deaths experience in **Table 7**, and early child development index (ECDI) score in **Table 8**. The average age of caregivers of the U5 children was 29 (range, 18–78 years). The most popular religion of caregivers was Muslim (95.5%). Most caregiver's relationship type was monogamy (82.5%) while polygamy was less common (17.5%). Half of the caregivers graduated from primary school (48.3%) and 39.7% of caregivers had no formal schooling while the rest of them had equal or higher than secondary school attainment. About three quarters (77.6%) of the caregivers were farmer as a main occupation.

Table 1. Number of households and U5 children included in the study

Variables	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Households	283	207	202	692
U5 children	343	327	316	986
Infant (under 1)	98	75	110	283
Neonate	14	14	65	93

U5 children counts included infants, which also included neonates. Infant counts included neonates.
U5 = under-5.

Table 2. General characteristics of households

Characteristics	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Household size (number of members) (n = 692)				
2-4	90 (31.8)	63 (30.4)	62 (30.7)	215 (31.1)
5-6	119 (42.0)	65 (31.4)	48 (23.8)	232 (33.5)
7-8	59 (20.8)	49 (23.7)	53 (26.2)	161 (23.3)
8+	15 (5.3)	30 (14.5)	39 (19.3)	84 (12.1)
Household income (n = 692) (Unit: Birr)				
Low (less than 600)	133 (47.0)	41 (19.8)	45 (22.3)	219 (31.6)
Moderate (601-1,000)	61 (21.6)	64 (30.9)	53 (26.2)	178 (25.7)
High (more than 1,001)	89 (31.4)	102 (49.3)	104 (51.5)	295 (42.6)
Most common material of the roof of the dwelling (n = 692)				
Thatch/mud	117 (41.3)	107 (51.7)	146 (72.3)	370 (53.5)
Rustic mat/plastic sheet	6 (2.1)	0 (0.0)	9 (4.5)	15 (2.2)
Reed/bamboo	8 (2.8)	71 (34.3)	8 (4.0)	87 (12.6)
Metal/corrugated iron	152 (53.7)	29 (14.0)	39 (19.3)	220 (31.8)
Most common material of the floor of the dwelling (n = 692)				
Earth/sand	267 (94.3)	192 (92.8)	154 (76.2)	613 (88.6)
Dung	1 (0.4)	1 (0.5)	0 (0.0)	2 (0.3)
Wood/bamboo	6 (2.1)	6 (2.9)	42 (20.8)	54 (7.8)
Cement	9 (3.2)	8 (3.9)	5 (2.5)	22 (3.2)
Ceramic tiles	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Carpet	0 (0.0)	0 (0.0)	1 (0.5)	1 (0.1)
Livestock ownership (n = 692)				
Yes	236 (83.4)	174 (84.1)	164 (81.2)	574 (82.9)
No	47 (16.6)	33 (15.9)	38 (18.8)	118 (17.1)
Separate room for livestock (n = 574)				
Yes	220 (93.2)	168 (96.6)	163 (99.4)	551 (96.0)
No	16 (6.8)	6 (3.4)	1 (0.6)	23 (4.0)
Main drinking water source (n = 692)				
Piped water in to dwelling	76 (26.9)	5 (2.4)	0 (0.0)	81 (11.7)
Piped water into compound	55 (19.4)	0 (0.0)	35 (17.3)	90 (13.0)
Borehole with hand pump	152 (53.7)	202 (97.6)	161 (79.7)	515 (74.4)
Surface water (with unprotected spring)	0 (0.0)	0 (0.0)	6 (3.0)	6 (0.9)
Separate kitchen (n = 692)	271 (95.8)	186 (89.9)	201 (99.5)	658 (95.1)
Own bed net (n = 692)	260 (91.9)	181 (87.4)	182 (90.1)	623 (90.0)
Household sprayed within last one year (n = 692)	252 (89.0)	178 (86.0)	166 (82.2)	596 (86.1)
Wall painted or covered by dung, paper, ash or anything after being sprayed (n = 596)	25 (9.9)	38 (21.3)	24 (14.5)	87 (14.6)
Wealth quintile (n = 574)				
Lowest	50 (21.2)	43 (24.7)	16 (9.8)	109 (19.0)
Second	46 (19.5)	30 (17.2)	39 (23.8)	115 (20.0)
Middle	37 (15.7)	36 (20.7)	41 (25.0)	114 (19.9)
Fourth	46 (19.5)	31 (17.8)	38 (23.2)	115 (20.0)
Highest	57 (24.2)	34 (19.5)	30 (18.3)	121 (21.1)

Values are presented as number of subject (%). Frequency is calculated excluding missing values.

Table 4 shows the latest childbirth related maternal service characteristics: contraception, ANC coverage and frequency, place and timing of ANC, and place and birth attendants of birth. Around half (54.3%) of the caregivers ever used modern contraceptive method for their family planning. Injectables and implants were the major methods used (96.5%). Most of the pregnant women used ANC at least once (91.1%) while 68.9% pregnant women utilized ANC more than 4 times during the pregnancy of the indexed children. Most common health facility for ANC was health center (90.6%). The 6.7% of mothers were detected to have syphilis infection during the ANC screening blood test for the latest child while 2.8% of mothers were screened as HIV positive. Only 24.3% of pregnant mother utilized ANC within the 1st trimester. The proportion of birth at health facility was 78.1%.

Table 3. General characteristics of caregivers

Characteristics	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Caregivers age group (n = 663)				
15–19	5 (1.9)	7 (3.5)	7 (3.6)	19 (2.9)
20–24	65 (24.3)	44 (21.9)	63 (32.5)	172 (25.9)
25–29	87 (32.5)	65 (32.3)	57 (29.4)	209 (31.5)
30–34	47 (17.5)	46 (22.9)	19 (9.8)	112 (16.9)
35–39	51 (19.0)	26 (12.9)	35 (18.0)	112 (16.9)
40–44	9 (3.4)	13 (6.5)	11 (5.7)	33 (5.0)
45–49	4 (1.5)	0 (0.0)	2 (1.0)	6 (0.9)
Nature of relationship (n = 685)				
Monogamy	266 (94.3)	133 (64.9)	166 (83.8)	565 (82.5)
Polygamy	16 (5.7)	72 (35.1)	32 (16.2)	120 (17.5)
Religion of care giver (n = 692)				
Orthodox	22 (7.8)	1 (0.5)	8 (4.0)	31 (4.5)
Muslim	261 (92.2)	206 (99.5)	194 (96.0)	661 (95.5)
Protestant	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Educational status of caregiver (n = 692)				
No formal education	109 (38.5)	93 (44.9)	73 (36.1)	275 (39.7)
Primary education	130 (45.9)	89 (43.0)	115 (56.9)	334 (48.3)
Secondary education	37 (13.1)	23 (11.1)	12 (5.9)	72 (10.4)
Higher education	7 (2.5)	2 (1.0)	2 (1.0)	11 (1.6)
Occupation of the caregiver (n = 643)				
Unemployed	3 (1.1)	37 (17.9)	9 (4.5)	49 (7.1)
Farmer	257 (90.8)	145 (70.0)	135 (66.8)	537 (77.6)
Gold miner	0 (0.0)	4 (1.9)	39 (19.3)	43 (6.2)
Government/private employee	23 (8.1)	18 (8.7)	10 (5.0)	51 (7.4)
Other	0 (0.0)	3 (1.4)	9 (4.5)	12 (1.7)

Values are presented as number of subject (%). Frequency is calculated excluding missing values.

Table 5 shows the study children characteristics. There were more boys (53.1%) than girls. Among the study population, the number of infants (age 1) was 283 (28.7%) including 93 neonates (9.4%). Twin children occupied 3.3%. The 13.2% of the children were born with low birth weight (lower than 2,500 gram) while 16.4% of children with large birth weight (larger than 4,000 gm). The 71.7% of the children began breastfeeding within an hour of birth. The proportion of those who completed vaccination was 77.2% (at age 2) and 76.9% (at age 3), respectively.

Table 6 shows U5 children's illness experience: acute child illness, health seeking behavior, and treatment results, and repetitive or chronic illness experience. The 32.8% of U5 children had illness experience during the last 2 weeks from the survey day. Among these children with illness, 79.7% of them sought health service at health facility by their caregiver. Most common facility visited was health center (79.0%) followed by hospital (13.7%). Among children who had illness experience within two weeks prior to this survey, 16.2% were repeated episodes of similar illness, and 6.4% of the children had symptom lasting more than 2 weeks from the illness onset on the day of the interview. Cough, fever, and diarrhea were the most common symptoms among the symptoms lasting more than 2 weeks. The 2.9% of those children had symptoms lasting more than 3 months.

According to caregiver report, 61 children died within five years preceding this survey. Among those, 25 deaths were under the age of five at the time of death. **Table 7** presented death characteristics of the study children. The neonatal mortality rates, infant mortality rates, and U5 mortality rates of the study children were 28.3%, 70.7%, and 88.3%, respectively.

Table 4. General characteristics of reproductive and maternal health of the latest children's mothers

Variables	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Pregnant women during the survey (n = 583)	18 (7.1)	14 (8.7)	9 (5.3)	41 (7.0)
Pregnancy planned (n = 41)	15 (5.3)	7 (3.4)	6 (3.0)	28 (4.0)
Family planning ever use (n = 692)				
Yes	255 (90.1)	59 (28.5)	62 (30.7)	376 (54.3)
No	28 (9.9)	148 (71.5)	140 (69.3)	316 (45.7)
Family planning use within the latest 5 years before the study among those who ever used (n = 376)				
Yes	249 (97.6)	47 (79.7)	47 (75.8)	343 (91.2)
No	6 (2.4)	12 (20.3)	15 (24.2)	33 (8.8)
Family planning use by type (n = 343)				
Oral pills	2 (0.8)	3 (6.4)	51 (0.6)	10 (2.9)
Injectable	126 (50.6)	27 (57.4)	30 (63.8)	183 (53.4)
Implants	120 (48.2)	17 (36.2)	11 (23.4)	148 (43.1)
IUD/loop	1 (0.4)	0 (0.0)	1 (2.1)	2 (0.6)
ANC visit during the pregnancy of the indexed children (n = 971)				
At least once	332 (97.4)	290 (91.5)	263 (84.0)	885 (91.1)
More than 4 times	268 (78.6)	245 (77.3)	156 (49.8)	669 (68.9)
Place of ANC visit during the pregnancy of the indexed children (n = 885)				
Home	5 (1.5)	2 (0.7)	4 (1.5)	11 (1.2)
Health post	25 (7.5)	10 (3.4)	14 (5.3)	49 (5.5)
Health center	291 (87.7)	275 (94.8)	236 (89.7)	802 (90.6)
Hospital	11 (3.3)	3 (1.0)	8 (3.0)	22 (2.5)
Other	0 (0.0)	0 (0.0)	1 (0.4)	1 (0.1)
Gestational age at first visit for youngest child (n = 613)				
1st trimester	37 (13.9)	57 (31.8)	55 (32.9)	149 (24.3)
Fourth to fifth month	136 (50.9)	89 (49.7)	84 (50.3)	309 (50.4)
Sixth to seventh month	73 (27.3)	28 (15.6)	19 (11.4)	120 (19.6)
Eighth or later	21 (7.9)	5 (2.8)	9 (5.4)	35 (5.7)
ANC service components for youngest child (n = 613)				
Weight measured	263 (98.5)	174 (97.2)	156 (93.4)	593 (96.7)
Blood pressure measured	261 (97.8)	174 (97.2)	158 (94.6)	593 (96.7)
Blood sample taken	264 (98.9)	168 (93.9)	103 (61.7)	535 (87.3)
Urine sample taken	260 (97.4)	163 (91.1)	93 (55.7)	516 (84.2)
Any abnormal ANC screening result (n = 613)				
Syphilis	77 (28.8)	8 (4.5)	12 (7.2)	97 (15.8)
HIV/AIDS	40 (15.0)	0 (0.0)	1 (0.6)	41 (6.7)
Hepatitis B	15 (5.6)	0 (0.0)	2 (1.2)	17 (2.8)
Abnormal urine test	0 (0.0)	0 (0.0)	2 (1.2)	2 (0.3)
Unknown	7 (2.6)	8 (4.5)	6 (3.6)	21 (3.4)
Unknown	15 (5.6)	0 (0.0)	1 (0.6)	16 (2.6)
Place of birth for the indexed children (n = 933)				
Health post	3 (0.9)	4 (1.3)	9 (3.2)	16 (1.7)
Health center	279 (83.3)	200 (63.5)	180 (63.6)	659 (70.6)
Hospital	30 (9.0)	1 (13.5)	13 (4.6)	54 (5.8)
Home	23 (6.9)	100 (31.7)	81 (28.6)	204 (21.9)

Values are presented as number of subject (%). Frequency is calculated excluding missing values.

IDU = intrauterine device; ANC = antenatal care; HIV = human immunodeficiency; AIDS = acquired immunodeficiency syndrome.

Middle performing woreda showed higher mortality than low performing, measured by the aforementioned 5 maternal and child health indicators, woreda (213 U5 deaths per 1,000 live births), respectively. About a quarter of death cases did not get chance for treatment (24%). Most common place of the treatment for the death cases were health center (77.8%) and government hospital (16.7%).

ECDI scores were presented in **Table 8**. The children living in the high performing in MNCH showed a bit better ECDI than those in the low performing woreda children. More detailed ECDI analysis results will be published elsewhere later.

Table 5. Characteristics of the study children

Variable	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Child's sex (n = 971)				
Male	186 (54.5)	159 (50.2)	171 (54.6)	516 (53.1)
Female	155 (45.5)	158 (49.8)	142 (45.4)	455 (46.9)
Age group (n = 970)				
Neonate	14 (4.1)	14 (4.3)	65 (20.6)	93 (9.4)
Age 1 (infant)	98 (28.6)	75 (22.9)	110 (34.8)	283 (28.7)
Age 2	64 (18.7)	67 (20.5)	50 (15.8)	181 (18.4)
Age 3	62 (18.1)	57 (17.4)	50 (15.8)	169 (17.1)
Age 4	56 (16.3)	73 (22.3)	62 (19.6)	191 (19.4)
Age 5	61 (17.8)	45 (13.8)	40 (12.7)	146 (14.8)
Twin pregnancy (n = 986)	13 (3.8)	7 (2.1)	13 (4.1)	33 (3.3)
Birth order (n = 986)				
1	82 (23.9)	124 (37.9)	86 (27.2)	292 (29.6)
2-3	110 (32.1)	121 (37.0)	84 (26.6)	315 (31.9)
4-5	92 (26.8)	45 (13.8)	61 (19.3)	198 (20.1)
6+	59 (17.2)	37 (11.3)	85 (26.9)	181 (18.4)
Weighed children at birth in cases of facility delivery (n = 729)				
Yes	279 (89.4)	201 (93.5)	141 (69.8)	621 (85.2)
No	16 (5.1)	8 (3.7)	21 (10.4)	45 (6.2)
I don't know	17 (5.4)	6 (2.8)	40 (19.8)	63 (8.6)
Birth weight of children delivered at health facility (kg) (n = 621)				
>2.5 (small weight)	39 (14.0)	11 (5.5)	32 (22.7)	82 (13.2)
2.5-4	156 (55.9)	141 (70.1)	94 (66.7)	391 (63.0)
>4 (large weight)	48 (17.2)	39 (19.4)	15 (10.6)	102 (16.4)
Unknown	36 (12.9)	10 (5.0)	0 (0.0)	46 (7.4)
Colostrum fed (for the young child) (n = 651)				
Yes	67 (24.4)	105 (54.1)	50 (27.5)	222 (34.1)
No	208 (75.6)	89 (45.9)	132 (72.5)	429 (65.9)
Breast feeding initiation (for the youngest child) (n = 651)				
Within an hour	226 (82.2)	111 (57.2)	130 (71.4)	467 (71.7)
Within a day	34 (12.4)	57 (29.4)	20 (11.0)	111 (17.1)
After a day	15 (5.5)	26 (13.4)	32 (17.6)	73 (11.2)
Sun light exposure initiation (for the youngest child) (n = 555)				
Before a week	11 (4.2)	5 (3.2)	28 (20.0)	44 (7.9)
Within a week	30 (11.5)	6 (3.9)	9 (6.4)	45 (8.1)
After a week	77 (29.5)	66 (42.9)	57 (40.7)	200 (36.0)
After a month	143 (54.8)	77 (50.0)	46 (32.9)	266 (47.9)
Ointment applied during sunlight exposure for young child (n = 555)	225 (86.2)	145 (94.1)	131 (93.5)	501 (90.2)
Completed vaccination (n = 955)				
Age 2	51 (81.0)	46 (68.7)	42 (84.0)	139 (77.2)
Age 3	44 (71.0)	45 (78.9)	41 (82.0)	130 (76.9)

Values are presented as number of subject (%). Frequency is calculated excluding missing values.

DISCUSSION

This paper presents the study design and basic characteristics of the households and individuals such as the study children and the caregivers of the children and children's health status including illness experience and deaths as well as health service utilization including children and their biological mother's reproductive and maternal service utilization during their unborn baby period.

The health service seeking behavior indicators were not as low as previous period measured at the latest DHS (2016) even though the BG region is much disadvantaged in many socioeconomic states of the area. This is even not lower compared to national average and even higher than other health service seeking behavior in rural area of Ethiopia.² These

Table 6. U5 children's illness experience

Variables	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherokole woreda (low performing)	Total
Any acute illness (n = 956)	75 (22.2)	143 (45.1)	96 (31.9)	314 (32.8)
Top 5 reported acute illness symptoms (n = 956)				
Cough	40 (11.8)	115 (36.3)	49 (16.3)	204 (21.3)
Difficulty of or fast breathing	9 (2.7)	21 (6.6)	16 (5.3)	46 (4.8)
Fever	11 (3.3)	91 (28.7)	53 (17.6)	155 (16.2)
Diarrhea	13 (3.8)	87 (27.4)	39 (13.0)	139 (14.5)
Vomiting	4 (1.2)	28 (8.8)	19 (6.3)	51 (5.3)
Sought treatment among those with acute illness (n = 314)	60 (81.1)	110 (77.5)	78 (82.1)	248 (79.7)
Place of treatment for the reported symptom (n = 248)				
Home by home remedy	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Home by HEWs	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Hospital	2 (3.3)	32 (29.1)	0 (0.0)	34 (13.7)
Health center	47 (78.3)	76 (69.1)	73 (93.6)	196 (79.0)
Health post	9 (15.0)	2 (1.8)	3 (3.8)	14 (5.6)
Others	0 (0.0)	0 (0.0)	2 (2.6)	2 (0.8)
Unknown	2 (3.3)	0 (0.0)	0 (0.0)	2 (0.8)
Outcome of the treatment of the acute illness symptom during last 2 weeks (n = 248)				
Improved	53 (88.3)	104 (94.5)	70 (89.7)	227 (91.5)
Same	7 (11.7)	5 (4.5)	81 (0.3)	20 (8.1)
Worsen	0 (0.0)	1 (0.9)	0 (0.0)	1 (0.4)
Repetitive similar illness symptom (of the acute illness symptom during last 2 weeks; n = 314)	21 (28.0)	22 (15.4)	8 (8.3)	51 (16.2)
Having symptoms that lasted more than 2 weeks (n = 956)	12 (3.6)	44 (13.9)	5 (1.7)	61 (6.4)
Cough	8 (2.4)	30 (9.5)	4 (1.3)	42 (4.4)
Fever	4 (1.2)	19 (6.0)	3 (1.0)	26 (2.7)
Difficulty/fast breathing	1 (0.3)	1 (0.3)	1 (0.3)	3 (0.3)
Diarrhea	2 (0.6)	14 (4.4)	2 (0.7)	18 (1.9)
Ear discharge	1 (0.3)	1 (0.3)	0 (0.0)	2 (0.2)
Any illness lasting 3 or more months within the past 1 year (n = 956)				
Yes	20 (5.9)	4 (1.3)	4 (1.3)	28 (2.9)
No	318 (94.1)	313 (98.7)	297 (98.7)	928 (97.1)

Values are presented as number of subject (%). Frequency is calculated excluding missing values.

U5 = under-5; HEW =health extension worker.

improved indicators were also triangulated by mini DHS report 2019, which was released on September 2019. This improvement could be attributable to active implementation of the recent BG regional health bureau's newly established maternal and child health program, which was financially supported by KOICA grant. However, the children's health status including mortality and chronic morbidity of the BG region was still relatively poor, which might be aligned with the poor socioeconomic condition of the region. The children's illness incidence experience seemed to be not extremely high or low compared to the illness experience of other similar low-income countries such as Dhaka in Bangladesh,¹⁴ little lower in case of diarrhea incidence than previous studies in Ethiopia.^{15,17} U5 mortality were similar in other rural areas in neighborhood countries in East Africa¹⁸ while it is a little lower than previous study period in the BG region even if it is still now low enough to be accepted.¹⁹ This discrepancy between relatively active health care seeking behavior of the caregivers and relatively poor children's health can be explained by low quality health system of the BG region, which calls for investing more effort for improving quality in health system in the region.²⁰ This discrepancy can be triangulated by observing that the better performance area, defined by health service utilization index, had not better but worse health states such as higher mortality or higher non-treated or chronic illness compared to even the low performance area. This nature stresses not only on the importance of individual's health seeking behavior and improving service coverage but also on the importance societal

Table 7. Characteristics of the deaths of the U5 children

Variables	Bambasi woreda (high performing)	Mengie woreda (middle performing)	Sherkole woreda (low performing)	Total
Age at death (n = 25)				
0 to 24 hr	1 (10.2)	2 (26.7)	0 (0.0)	3 (10.6)
0 to 1 mon (neonate)	3 (30.6)	5 (66.7)	0 (0.0)	8 (28.3)
0 to 1 yr (infant)	3 (30.6)	13 (173.3)	4 (36.4)	20 (70.7)
0 to 5 yr (U5 children)	3 (30.6)	16 (213.3)	6 (54.5)	25 (88.3)
Received treatment (n = 25)				
Yes	2 (66.6)	13 (81.2)	3 (50.0)	18 (72.0)
No	0 (0.0)	3 (18.7)	3 (50.0)	6 (24.0)
Unknown	1 (33.3)	0 (0.0)	0 (0.0)	1 (4.0)
Place of treatment (n=18)				
Home	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Traditional healer	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Health center	1 (50.0)	11 (84.6)	2 (66.7)	14 (77.8)
Government hospital	1 (50.0)	2 (15.4)	0 (0.0)	3 (16.7)
Private clinic	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Private hospital	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Pharmacy, drug seller/store	0 (0.0)	0 (0.0)	1 (33.3)	1 (5.6)
Sex of deceased (n = 25)				
Male	2 (66.6)	6 (37.5)	2 (33.3)	10 (40.0)
Female	1 (33.3)	10 (62.5)	4 (66.6)	15 (60.0)
Place of death (n = 25)				
Home	2 (66.7)	11 (68.8)	5 (83.3)	18 (72.0)
Hospital	1 (33.3)	2 (12.5)	1 (16.7)	4 (16.0)
Other health facility	0 (0.0)	1 (6.3)	0 (0.0)	1 (4.0)
Other	0 (0.0)	1 (6.3)	0 (0.0)	1 (4.0)
Don't know	0 (0.0)	1 (6.3)	0 (0.0)	1 (4.0)

Values are presented as number of subject (mortality rate). Frequency is calculated excluding missing values.
U5 = under-5.

preparation for quality health service and environment in the region.²¹ Without the latter, the former could not be translated to better health of children.²² Improving children's health in the region may need diverse activities from the provider level such as clinical competency improvement training including refresher training and pre-service training quality improvement to system level quality improvement activities such as supply chain and referral chain improvement and transportation and financial support for the sick children.²⁰

These basic study findings were used for developing comprehensive interventions and allocating future additional grant, if any, to improve child health in the BG region, which has been under consideration of KOICA and UNICEF as the newly coming grant to the region for coming 5 years, through the program planning workshop in September 2019. More detailed in-depth analysis will be done by the local and supporting international research team together

Table 8. ECDI scores by woreda performance stratum

Child age group	Bambasi woreda (high performing)		Mengie woreda (middle performing)		Sherokole woreda (low performing)		Total	
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD
0–5 months	37	29.4 ± 5.3	35	28.8 ± 5.0	31	28.0 ± 5.2	103	28.8 ± 5.1
6–11 months	26	39.2 ± 5.1	35	39.6 ± 4.5	25	37.1 ± 7.3	86	38.7 ± 5.6
12–17 months	37	47.9 ± 5.6	46	48.9 ± 5.7	46	44.6 ± 6.6	129	47.1 ± 6.3
18–23 months	25	54.5 ± 3.6	16	52.2 ± 3.4	13	51.7 ± 3.9	54	53.1 ± 3.8
24–29 months	43	57.2 ± 1.9	52	57.6 ± 2.1	42	55.1 ± 4.3	137	56.7 ± 3.1
30–35 months	33	57.3 ± 2.7	14	56.6 ± 2.6	28	56.3 ± 0.87	75	56.8 ± 3.6
Total	201	-	198	-	185	-	584	-

ECDI = early child development index; SD = standard deviation.

to find out the social determinants children's health in the BG region and will be published elsewhere soon. Additional findings will be also used to establish new activities or revise current activities to improve child health outcomes in the region. The changes in child health in BG will be closely monitored using these study villages as the longitudinal observation cohort as well as the intervention cohort for small scale local health policy experiment before scale-up to the region or wider geographical area beyond the region if strong positive evidence appears.

The merits of this study are the following. These study sites will be used for additional mini-surveys and qualitative researches to rapidly assess the changes due to any new regional health policy intervention as well as regular monitoring regional policymakers' evidence need. In this regard, these study sites will be served as not only observational cohort but also intervention cohort for mini-implementation research or rapid policy impact analysis to provide rapid feed-back to regional health authority. Closer dialogue between community, regional health authority, regional academic institution and regional health facilities based on this study site could give more opportunities to the regional improvement in people's health than conventional efforts, so called, 'knowledge translation,' which is emphasized from research communities to policymakers with hope to have more research-policy dialogue with policymakers based on their research results. Also, this dialogue could also provide more opportunity beyond so called 'evidence-based policy,' which is stressed by some policymaker-community to formulate safer policy to prevent or reduce policy-failure by active utilization of relevant research evidence.

Evidence demand and supply does not necessarily match well in real world. However, this matching would be more easily done in this BG region because this cohort study site establishment was jointly decided by the regional stakeholder's discussion: regional health authority, regional academia, as well as donor agency. By this way, this close monitoring surveillance area would be able to contribute for improving children's health in BG region and other similar nearby communities in Ethiopia.

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