Determinants of Anemia Among Children Aged 6 to 59 Months in Dilla Town, Southern Ethiopia: A Facility Based Case Control Study

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Abstract

Background. Globally, anemia is a widespread public health problem associated with increased risk of morbidity and mortality. Under 5 children have greater risk of anemia. The level of burden and the risk factors for anemia vary in different settings. Identifying local factors will have important implications for health intervention programs aimed to tackle the burden. Our study aims to investigate the determinants of anemia among under 5 children in the study area. *Methods.* Facility based unmatched case control study was conducted among 413 (137 cases and 276 controls) children of Dilla town. Cases were children who had hemoglobin level of less than 11 g/dl and controls were children aged 6 to 59 months with hemoglobin ≥11 g/dl. Quota and simple random sampling was used for cases and controls respectively. Data on socio-demographic, dietary diversity score, food security, anthropometry, hemoglobin level, malaria infection and intestinal parasites were collected. Data were analyzed with SPSS version 25. Bi-variate and multivariate binary logistic regression analysis was used to identify independent determinants of anemia. *P*-value less than .05 were used to declare statistical significance. *Result.* In the multivariate analysis, having more than 1 under 5 children in the households (AOR = 3.03, 95%CI = 1.35-6.81), intestinal parasitosis (AOR = 4.42, 95%CI = 2.07-9.44), food insecurity (AOR = 2.75, 95% CI = 1.39-5.45), and stunting (AOR = 6.09, 95% CI = 2.53-14.67) were determinants of anemia among children aged 6 to 59 months. *Conclusion.* Some of the identified factors are modifiable that could be targeted to reduce childhood anemia. Family planning education, provision of anti-helminthic drugs and ensuring household food security will be beneficial to tackle anemia.

Keywords

anemia, determinants, children 6 to 59 months, south Ethiopia

What do we already know about this topic?
Anemia in children and women is a public health concern globally.
How does your research contribute to the field?
It will shade a light on contributing factors of anemia in low income setting.
What are your research's implications toward theory, practice, or policy?
The implication could be it will point out pertinent factors to focus on to mitigate childhood anemia.

Background

According to the World Health Organization (WHO), Anemia can be defined as a decrease in the concentration of circulating red blood cells or hemoglobin (Hgb) concentration and a related impaired capacity to transport oxygen. It is also defined as hemoglobin level below 11 mg/dl for children 6 to 59 months of age.[1] Childhood anemia is one of the main deficiency diseases in the world, resulting in increased risk of mortality.[2,3]

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Universally 818 million children under the age of 5 and women are affected by anemia, mainly those living in developing countries. About 1 million of them die every year and about 67.6% of under 5 children in Africa are suffering from anemia indicating anemia as a severe public health problem. In Eastern Africa, it is estimated that 3 quarters of under 5 children suffer from anemia.[1]

In Ethiopia, according to the demographic and health survey findings in 2016, more than half of children 6 to 59 months (57%) suffer from some degree of anemia: 25% were mildly anemic, 29% were moderately anemic, and 3% were severely anemic. The incidence of anemia decreases with the child's age, ranging from a high of 78% among children age 6 to 8 months to a low of 40% among children age 48 to 59 months. The prevalence of anemia generally decreases with increasing maternal educational status and improving household (HH) wealth.[4]

WHO has developed a classification system to facilitate international comparisons of anemia as a public health problem, the problem is considered severe if anemia prevalence is ≥40%, moderate from 20% to 39.9%, and mild from 5% to 19.9%.[5] The causes of anemia are multi-factorial, interlinked, and context-specific. The risk factors of anemia most often cited in the literature are low family income and low maternal level of education, lack of access to healthcare services, inadequate sanitary conditions, and a diet with poor quantities of iron.[1,6]

The risk factors for anemia vary in different settings; they include having intestinal parasites and malaria.[7] Micronutrient deficiency, particularly that of iron, has a direct impact on the nutritional status of young children and is the most common cause of anemia.[8] Other factors, including folate and vitamin B12 and Vitamin A deficiency, socio-economic status, parental education, and many more are also associated with childhood anemia.[9] Therefore, it is important to understand the scope and strength of individual risk factors for anemia in populations where anemia is common to design more effective interventions.[10] Iron deficiency is frequently reported to be the major cause of anemia with an estimate that 50% of anemia worldwide is attributable to iron deficiency. However, the frequency of wide-ranging risk factors for anemia in developing countries like iron deficiency, vitamin A deficiency, infection, and genetic risk factors, are not routinely measured in a single population.[10,11]

In Sub-Saharan Africa, where under-nutrition, HIV, malaria, and helminthiasis are prevalent, iron supplementation intervention single-handedly may not sufficiently tackle anemia.[12-15] The 2015 WHO report highlighted that 43% of under-5 children were anemic universally, the lion share(62.3%) being in African,

53.8% in South-East Asia, and 21.9% in Western Pacific Region.[16]

The Ethiopian Demographic and Health Survey (EDHS) studies revealed the prevalence of anemia among children aged between 6 and 59 months varied from one region to another in Ethiopia. The Southern Nations, Nationalities, and Peoples' Region (SNNPR) prevalence of anemia among children aged between 6 and 59 months was (50%). Children in rural areas (58%) are more likely to be anemic than those in urban areas (49%).[4]

It is well underlined that anemia in early ages (6-59 months) has a more devastating effect on cognition, motor development and growth, academic performance, immunity, and susceptibility to infections.[17] Studies from different parts of Ethiopia have shown that childhood anemia is still a major public health concern. In this regard, our study aimed to identify different factors that have important implications for health intervention programs to improve the level of childhood anemia in the study area.

Methods

Study Area and Period

The study was carried out in Dilla town which is the administrative center of the Gedeo zone in the SNNPR. It is 360 km away from Addis Ababa and 90 km from Hawassa the administrative center of the region. Total area of the town is 135 km^2. It has one main road that passes through the town from Addis Ababa to Moyle.

The town has a longitude and latitude of 6°24′36″N and 38°18′36″E coordinates respectively with an elevation of 1570 m above sea level. The total population is 91 135 among which 44 656 (49.0%) are males and 46 479 (51.0%) are females, and the total number of under 5 children is 14 226. The total number of household is 19 812. The town has 1 referral hospital, 2 health centers, 9 private clinics, 3 pharmacies, 9 drug stores, and 4 Rural Drug Vendors. There are 3 sub-city each contain 3 kebeles, a total of 9 kebeles in the town. The study was carried out from January 21 to April 30/2019.

Study Design and Period

➢ Facility based unmatched case control study was conducted from January 21/2019 to April 30/ 2019.

Study Population

➢ Selected children aged 6 to 59 months with their mother/caregiver who visited public health

institutions for any medical service during the study period.

Inclusion Criteria

➢ For Cases

All children aged 6 to 59 months with their mother/caregiver and had hemoglobin level <11 g/dl were cases.

➢ For Controls

All children aged 6 to 59 months with their mother/caregiver and had hemoglobin level ≥11 g/dl were controls.

These are children who come to health facility for the services like vaccination and well baby clinic (Child growth monitoring clinic).

Exclusion Criteria

➢ Children who received blood transfusion within last 2 months prior to data collection.
➢ Children who got diagnosed of anemia within 2 months and on medication.
➢ Critically ill children.

Sample Size Determination

Sample size was calculated using double population proportions sample size formula by Open Epi software version 3.1. Child age, family size, maternal education, dietary diversity, and meat consumed were considered as major determinant of children 6 to 59 months of age anemia as reported by a previous studies.[18-20] Among those factors reportedly associated with anemia, the one that gave the maximum sample size based on power of 80%, with 95% confidence level, odds ratio and case to control ratio of 1:2 was considered. Therefore total sample size calculated was 375; adding 10% possible non-response rate, the total sample size was 413 (137 cases and 276 controls).

Data Collection Procedures

Face to Face Interview

The data were collected using structured questionnaires by interviewing the care takers of children. During the data collection period the target study populations were selected based on the sample size of the study which was a total of 413 (137 cases and 276 controls). All children aged 6 to 59 months who visit those public health institutions were checked for Hgb levels and then categorized

as anemic and non-anemic until the sample size was reached for both cases and controls. The study participants were selected by convenience sampling.

Measurements

Blood test: Blood tests were done for hemoglobin measurement and malaria status. A portable hemoglobin meter (HemoCue 301 Hb, Angelholm, Sweden) was used to determine hemoglobin concentration. A capillary blood sample was collected aseptically by sterile single-use disposable lancet from the finger tip, and values were adjusted for smoking using the WHO/CDC guideline.[21] Malaria test was also done using microscopic slide and was examined by 100× microscopic objective in the medical laboratory room of each health institutions.[22]

Anthropometric measurements: Measurements of height and weight were taken according to the WHO's guideline. A calibrated seca weighting scale (www.seca.com) with intervals of 0.1 kg was used to measure body weight. An infant length board with a sliding foot board to the nearest 0.1 cm was used to measure the recumbent length of children aged less than 24 months. A wooden scale with a sliding head piece was used to measure the standing height of children aged 24 months and older.

The nutritional status was classified using the World Health Organization (WHO) Anthro program, version 3.2.2 (WHO, GE, Switzerland) for weight/age (W/A), height/age (H/A), and weight/height (W/H).[23]

Stool examination: For the assessment of helminthes infection, containers were given to each children care takers and they were asked to collect and bring sufficient amount, 1 g (pea size) of stool sample of their children's feces at the time of data collection, which is immediately after completed the interview.[24] Analysis was done using direct microscopy (saline smear/wet mount) for determining intestinal parasite infection. Direct smear was done by emulsifying about 2 mg of stool using physiological saline (0.85% NaCl solution) on a microscopic slide and was examined by 10× and 40× microscope objective in the medical laboratory room of each health institutions.[24]

Dietary assessment: A 24-hour dietary recall method was used to assess dietary practice. Dietary Diversity Score of children were calculated by asking mothers/caregivers about the food items their children consumed in the past 24 hours preceding the survey. All food items consumed by the children in the last 24 hours preceding the survey were categorized into 7 food groups as (1) grains, roots, and tubers, (2) legumes and nuts, (3) milk and milk products, (4) flesh foods, (5) eggs, (6) vitamin-A rich fruits and vegetables, and (7) other fruits and vegetables. Finally, the food groups consumed by the child were counted to obtain dietary diversity score.[25]

Food insecurity: Food insecurity was measured by HFIAS (Household Food Insecurity Access Scale) tool developed by FANTA (Food and Nutrition Technical Assistant) project. The tool has 9 questions asking household's about the 3 domains of food insecurity: feeling uncertainty of food supply, insufficient quality of food, and insufficient food intake and its physical consequences in the last month. The households participating in the study were categorized into the 4 levels of food-security (food secure, mildly food insecure, moderately food insecure, and severely food insecure) based on the guideline's recommendation.[26]

Wealth index: Household wealth index was constructed using household asset data through PCA (Principal Component Analysis) based on interview responses adopted from Ethiopian Demographic and Health Survey. The presence or absence of each household items such as plow oxen, table, Animal-drawn cart, chair, etc. were asked and their responses were coded as "0" for No and "1" for Yes. Principal Components with Eigen values greater than 1 and total variance explained more than 60% were retained to construct scores; then ranked into tertiles (low, middle, and high for wealth).[27]

Operational Definitions

- Poor dietary diversity: dietary diversity score of less than 4 food categories.[28]
- Good dietary diversity: dietary diversity of more than or equal to 4 food categories.[28]
- Insecticide treated bed net (ITN) utilized: A child (index child) who was reported to have slept under ITN during the night prior to the survey.[29]
- Smoker individual in household: a person who smokes any tobacco product, either daily or occasionally (daily: means at least once a day and occasionally: means not every day).[30]

Data Analysis Procedure

Data entered into EPI data version 3.1 were exported to Statistical Package for Social Sciences (SPSS) version 25 for cleaning and analysis. Frequency distributions and cross-tabulations were done. Principal Component Analyses (PCA) was done for household wealth index score. Principal Components with Eigen values greater than 1 and total variance explained more than 60% were retained to construct scores; then ranked into tertiles (low, middle, and high for wealth). Bivariate analysis was done and all variables which had association with the outcome variable at $P < .25$ were selected for multivariate analyses. Multivariate binary logistic analysis was done to identify independent determinants of

anemia. Adjusted odds ratio (AOR) with 95% Confidence interval were used to determine the strength of association. Variables with $P < .05$ was considered to indicate statistical significance. Multi-co linearity was checked using Variance inflation factor (VIF).

Data Quality Assurance

The questionnaires first developed in English version then translated to Amharic and then translated to Gede-uffa (local) language. Back translation to English version was done to ensure its consistency.

Two days intensive training to data collectors and supervisors, about the purpose, study tools and the overall data collection procedures were given. In addition, pre-testing of the study tools were carried out in 5% of the total sample size at health facilities, which are closer but outside the proposed study area. A total of 3 diploma nurses and 3 laboratory technicians were employed as data collectors, and 3 health officers were assigned as supervisors. The collected data were reviewed and checked for completeness by the supervisors and principal investigators. Proper functionality and technical performance of instruments were cross-checked by using quality control samples, for Hemocue checked against CBC machine. Comparisons of Hemocue machines with CBC (Complete blood count) machine, Sysmex analyzer (Sysmex XS-500i) were done. The results of Pearson correlation coefficients of Hemocue machines with Sysmex analyzer was 0.995.

The potential confounder can be managed hence we used a multivariable regression model and we restricted some potential confounders by exclusion criteria.

Ethical Approval and Informed Consent

Ethical approval was obtained from Dilla University, Medicine and Health Science College, Institutional Review Board with reference number 012/19-01. Permission was also obtained from concerned bodies of Dilla town. Prior to data collection, written informed consent was obtained from each parents/caregiver of the study participants. Confidentiality of the information was assured and privacy of the respondents were maintained. Positive results were communicated to the physician for further diagnosis, treatment, and follow up.

Results

A total of 413 child-mother pairs were included in this study. Out of the total 137 cases, 73 (53.3%) children were males. From the total 276 controls, 157 (68.3%) were males. The mean ages was 25.22 months: 23.59

($\pm$12.83) for cases and 26.03 ($\pm$14.41) for controls. Nearly half of the cases 74 (54%) and controls 132 (47.8%) were in the age groups of 6 to 23 months. Caretakers' age ranged 15 to 49 years and their mean age was 27.32 years: 27.66 ($\pm$5.03) for cases and 27.16 ($\pm$4.66) for controls. The status of other socio economic and demographic variables by cases and controls are shown in Table 1.

Maternal and Child Health Care Related Factors

The majority of cases 83 (60.6%) and controls 204 (73.9%) started complementary feeding at age of 6 months. On the other hand more than half of the mothers of the cases 42 (55.3%) and controls 138 (64.2%) used iron folate supplementation during their pregnancy. Out of 413 participants, fresh stool sample was collected from 340 (82.3%) children and for the remaining 73 (17.7%) children stool examination was not done, because their parents refused. The status of other maternal and child health care related variables by cases and controls are shown in Table 2.

Household Wealth Index Related Factors

Regarding household wealth index status, 54 (39.4%) of cases and 79 (28.6%) of controls have low wealth index level, while 41 (29.9%) of cases and 98 (35.5%) of controls have middle wealth index level and 42 (30.7%) of cases and 99 (35.9) of controls have high wealth index level. There were 3 components that explained the majority of variance and the result of the total variance was 75.443%.

Regarding source of drinking water, 59 (43.1%) of cases and 116 (42%) of controls of households used pipe water (safe drinking water) source. On the other hand, 77 (56.2%) of cases and 168 (60.9%) controls households use local pit latrines. The status of other environmental variables by cases and controls are shown in Table 3. The household food security status among cases and controls are shown in Figure 1.

Variables Independently Associated With Anemia

A total of 4 variables were independently associated with anemia as shown in Table 4. Children's living in households with more than 1 child were 3 times more likely to be anemic than children living in households with only 1 child (AOR=3.03, 95%CI: 1.35-6.81), a child with intestinal parasitosis was 4 times more likely to have anemia than a child without (negative) intestinal parasitosis (AOR=4.42, 95%CI: 2.07-9.44). Children living in households with food insecurity were 2.7 times more likely to have anemia compared to counterparts (AOR=2.75, 95%CI: 1.39-5.45). Stunted child was 6 times more likely to be anemic as compared to their non-stunted counterparts (AOR=6.09, 95%CI: 2.53-14.67).

Hosmer and Lemeshow's goodness-of-fit test with chi-square of 4.45 with *P*-value of .486, hence the model was fit for the data.

Discussion

The result of this study showed that the factors independently associated with children anemia among children 6 to 59 months of age in Dilla town were number of under 5 years children living in the households, intestinal parasites, household food insecurity, and children nutritional status were associated with child anemia. The Global Burden of Diseases study showed that anemia in children was one of the most common causes of child death in Ethiopia, and continues to be a major public health problem.[31]

This study has shown that more than 1 under 5 years children living in the households were independently associated with anemia among children 6 to 59 months of age. This finding is consistent with study done in Damot Sore district, Southern Ethiopia of which more than 1 under 5 children within a household 4 times more likely to be anemic as compared to household with 1 under 5 years[28] and also the finding consistent with a study done in National level of Ethiopia,[9] Debre Berhan,[32] Namutumba district, Uganda,[33] Kebri Beyah Refugee Camp, Somali Region, Ethiopia[34] and study done using EDHS data in Ethiopia.[35] It is implied that the prevalence of anemia among children aged between 6 and 59 months in Ethiopia was higher in the households with more number of children under 5 relative to households with lower number of children under 5, and under 5 children living in households with many siblings of same age category in a low-income setting were subjected to increased competition for resources which results in major child health constraints such as stunting and nutritional deficiencies.[9,36]

Intestinal parasitosis was another variable that independently associated with anemia among children 6 to 59 months of age. This finding is consistent with study done in, Hawassa City, Southern Ethiopia,[7] Gondar, Northwest Ethiopia,[37] Burma, Myanmar,[38] and USA.[39] This could be explained by the role of intestinal parasites that suck blood and also damage the intestinal wall, causing blood leakage. This could be worsened by delayed or

Table 1. Socio-Demographic, and Economic and Care Related Characteristics.

Variables	Number of cases (137)	Number of controls (276)	Total (413)
Sex of the children			
Male	73 (53.3%)	157 (56.9%)	230 (55.7%)
Female	64 (46.7%)	119 (43.1%)	183 (44.3%)
Age of the children (in months)			
6-23	74 (54%)	132 (47.8%)	206 (49.9%)
24-35	35 (25.5%)	67 (24.3%)	102 (24.7%)
36-47	20 (14.6%)	46 (16.7%)	66 (16%)
48-59	8 (5.8)	31 (11.2%)	39 (9.4%)
Age of mothers(in years)			
15-24	36 (26.3%)	82 (29.7%)	118 (28.6%)
25-34	82 (59.9%)	182 (60.9%)	250 (60.5%)
35-49	19 (13.9%)	26 (9.4%)	45 (10.9%)
Educational status of mothers			
No formal education	56 (40.9%)	106 (38.4%)	162 (39.2%)
Formal education	81 (59.1%)	170 (61.6%)	251 (60.8%)
Educational status of fathers			
No formal education	27 (19.7%)	52 (18.8%)	79 (19.1%)
Formal education	110 (80.3%)	224 (81.2%)	334 (80.9%)
Ethnicity			
Gedeo	68 (49.6%)	140 (50.7%)	208 (50.4%)
Gurage	15 (10.9%)	21 (7.6%)	36 (8.7%)
Oromo	20 (14.6%)	28 (10.1%)	48 (11.6%)
Amhara	16 (11.7%)	35 (12.7%)	51 (12.3%)
Others	18 (13.1%)	52 (18.8%)	70 (16.9%)
Religion			
Protestant	74 (54%)	168 (60.9%)	242 (58.6%)
Orthodox	31 (22.6%)	61 (22.1%)	92 (22.3%)
Muslim	22 (16.1%)	32 (11.6%)	54 (13.1%)
Catholic	10 (7.3%)	15 (5.4%)	25 (6.1%)
Marital status			
Not married	16 (11.7%)	15 (5.4%)	31 (7.5%)
Married	121 (88.3%)	261 (94.6%)	382 (92.5%)
Mothers occupation			
Unemployed	121 (88.3%)	227 (82.2%)	348 (84.3%)
Government/private employee	16 (11.7%)	49 (17.8%)	65 (15.7%)
Fathers occupation			
Unemployed	91 (66.4%)	136 (49.3%)	227 (55%)
Government/private employee	46 (33.6%)	140 (50.7%)	186 (45%)
Family size			
≤5	108 (78.8%)	233 (84.4%)	341 (82.6%)
>5	29 (21.2%)	43 (15.6%)	72 (17.4%)
No. of <5 years children within HH			
More than 1 child	39 (28.5)	41 (14.9%)	80 (19.4%)
One child	98 (71.5%)	235 (85.1%)	333 (80.6%)
Wealth index			
Low	54 (39.4%)	79 (28.6%)	133 (32.2%)
Middle	41 (29.9%)	98 (35.5%)	139 (33.7%)
High	42 (30.9%)	99 (35.9%)	141 (34.1%)

Others: Sidamo, Wolaita, Silte; Not married: Single + Divorced + Widowed.

absence of treatment of parasites resulting in adverse outcomes like anemia. When children play they can easily acquire the infection as those parasites live in soil which makes it easier to be contracted and also drinking

Table 2. Maternal and Child Health Care Related Factors.

Variables	Number of cases (137)	Number of controls (276)	Total (413)
Child illness within 2 weeks			
No	64 (46.7%)	168 (60.9%)	232 (56.2%)
Yes	73 (53.3%)	108 (39.1%)	181 (43.8%)
Diarrhea			
No	73 (53.3%)	188 (68.1%)	261 (63.2%)
Yes	64 (46.7%)	88 (31.9%)	152 (36.8%)
Malaria status			
No malaria	95 (69.3%)	186 (91.6%)	281 (82.6%)
P. falciparum	22 (16%)	6 (3%)	28 (8.2%)
P. vivax	15 (11%)	10 (4.9%)	25 (7.4%)
P. mixed	5 (3.7%)	1 (0.5%)	6 (1.8%)
Nutritional status			
WAZ			
<−2	101 (73.7%)	14 (5.1%)	115 (27.8%)
≥−2	36 (26.3%)	262 (94.9%)	298 (72.2%)
Height for age z-score (HAZ)			
<−2	77 (56.2%)	15 (5.4%)	92 (22.3%)
≥−2	60 (43.8%)	261 (94.6%)	321 (77.7%)
WHZ			
<−2	34 (24.8%)	26 (9.4%)	60 (14.5%)
≥−2	103 (75.2)	250 (90.6%)	353 (85.5%)
Intestinal parasites			
Positive	31 (31%)	182 (75.8%)	213 (62.6%)
Negative	69 (69%)	58 (24.2%)	127 (37.4%)
Vaccination status of children			
Not vaccinated at all	17 (12.4%)	12 (4.3%)	29 (7%)
Not timely vaccinated	101 (73.7%)	232 (84.1%)	333 (80.6%)
Timely vaccinated	19 (13.9%)	32 (11.6%)	51 (12.4%)
Monthly GMP			
No	88 (64.2%)	184 (66.7%)	272 (65.9%)
Yes	49 (35.8%)	92 (33.3%)	141 (34.1%)
Introduction time of CF			
Early or Late	54 (39.4%)	72 (26.1%)	126 (30.5%)
At 6 months	83 (60.6%)	204 (73.9%)	287 (69.5%)
Breast feeding practice of mothers			
Not breast feed at all	42 (30.3%)	103 (37.3%)	145 (35.1)
Sub optimal	34 (35.8%)	52 (30.1%)	86 (32.1%)
Optimal	61 (64.2%)	121 (69.9%)	182 (67.9%)
Appropriately utilized IF during ANC			
Not utilized at all	61 (44.5%)	61 (22.1%)	122 (29.5%)
For <3 months	34 (44.7%)	77 (35.8%)	111 (38.1%)
For ≥3 months	42 (55.3%)	138 (64.2%)	180 (61.9%)
Smoking person within households			
Not smoking	118 (86.1%)	253 (91.7%)	371 (89.8%)
Smoking	19 (13.9%)	23 (8.3%)	42 (10.2%)

un-boiled water can easily cause a parasite infection that could be the cause of intestinal bleeding induced anemia.[37,38] The association of anemia with parasitic infections that cause bleeding (eg, hookworm infection and schistosomiasis) or dysentery (eg, trichuriasis and amoebiasis) is well documented.[39] Moderate-to-heavy hookworm infections (caused by *Ancylostoma duodenale* and/or *Necator americanus*) is known to drain nearly 50 ml of blood daily and thereby decreasing the blood cell count, hemoglobin, and serum proteins. The

Table 3. Environmental Health, Sanitation, Morbidity, and Household Diet Modification Factors.

Variables	Number of cases (137)	Number of controls (276)	Total
Source of drinking water			
Piped inside compound	59 (43.1%)	116 (42%)	175 (42.4%)
Public	48 (35%)	120 (43.5%)	168 (40.7%)
Protected well/spring	22 (16.1%)	32 (11.6%)	54 (13.1%)
Unprotected well/spring	1 (0.7%)	0 (%)	1 (0.2%)
No fixed facilities	7 (5.1%)	8 (2.9%)	15 (3.6%)
Toilet			
No facility/bush/field	6 (4.4%)	3 (1.1%)	9 (2.2%)
Local pit latrine	77 (56.2%)	168 (60.9%)	245 (59.3%)
VIP latrine	54 (39.4%)	102 (37%)	156 (37.8%)
Others(flash toilet)	0 (%)	3 (1.1%)	3 (0.7%)
Availability of ITN			
No	76 (55.5%)	161 (58.3%)	237 (57.4%)
Yes	61 (44.5%)	115 (41.7%)	176 (42.6%)
Utilization of ITN			
No	13 (21.3%)	28 (24.3%)	41 (23.3%)
Yes	48 (78.7%)	87 (75.7%)	135 (76.7%)
IDDS			
Not diversified	54 (39.4%)	60 (21.7%)	114 (27.6%)
Diversified	83 (60.6%)	216 (78.3%)	299 (72.4%)
Household food insecurity			
Food insecured	58 (42.3%)	47 (17%)	105 (25.4%)
Food secured	79 (57.7%)	229 (83%)	308 (74.6%)
Fermented foods preparation			
No	70 (51.1%)	99 (35.9%)	169 (40.9%)
Yes	67 (48.9%)	177 (64.1%)	244 (59.1%)
Germinated or soaked foods			
No	111 (81%)	233 (84.4)	344 (83.3%)
Yes	26 (19%)	43 (15.6%)	69 (16.7%)
Construction materials of house floor			
Natural floor earth/sand/dung	55 (40.1%)	73 (26.4%)	128 (31%)
Others (cemented)	82 (59.9%)	203 (73.6%)	285 (69%)

Food insecurity = mild + moderate + severe food insecurity status.

chronic blood loss from the gastrointestinal tract considers the main mechanism that leads to iron deficiency and iron deficiency anemia.[39]

Regarding food insecurity, households with food insecurity were also independently associated with anemia among children 6 to 59 months of age. This finding is consistent with study done in Wolaita Zone, Southern Ethiopia[40] and Damot Sore District, Wolaita Zone, Southern Ethiopia[41] and USA.[42] But this result disagrees with the findings reported from Iran[43] and India[44] that showed as, there were no relations with household food insecurity and anemia status of children.

In this study, association with household food insecurity might be due to instability of people lived in Gedeo Zone, who were internally displaced people (IDP) influenced people living in Dilla town, and also climate change (El-Niño effect) which shifted seasonal rainfall,

reduced yield, and agricultural productivity. So, to cope with food insecurity at the household level, children and other household members reduce consumption of diversified foods (especially, animal source iron-rich and enhancing or vitamin C-rich foods) worsen childhood anemia.[41]

The nutritional status of children in this study, stunted children were independently associated with anemia among children 6 to 59 months of age. This result is consistent with study done in Ethiopia Demographic Health Survey (EDHS 2016),[4] Western Kenya,[45] Damot Sore district, Southern Ethiopia,[28] Debre Berhan[32] and Kebri Beyah Refugee Camp, Somali Region, Ethiopia.[34] The association of stunting and anemia in children might be due to the households' food insecurity problems and unstrengthened child health caring capacity both at heath institutions and at household level.
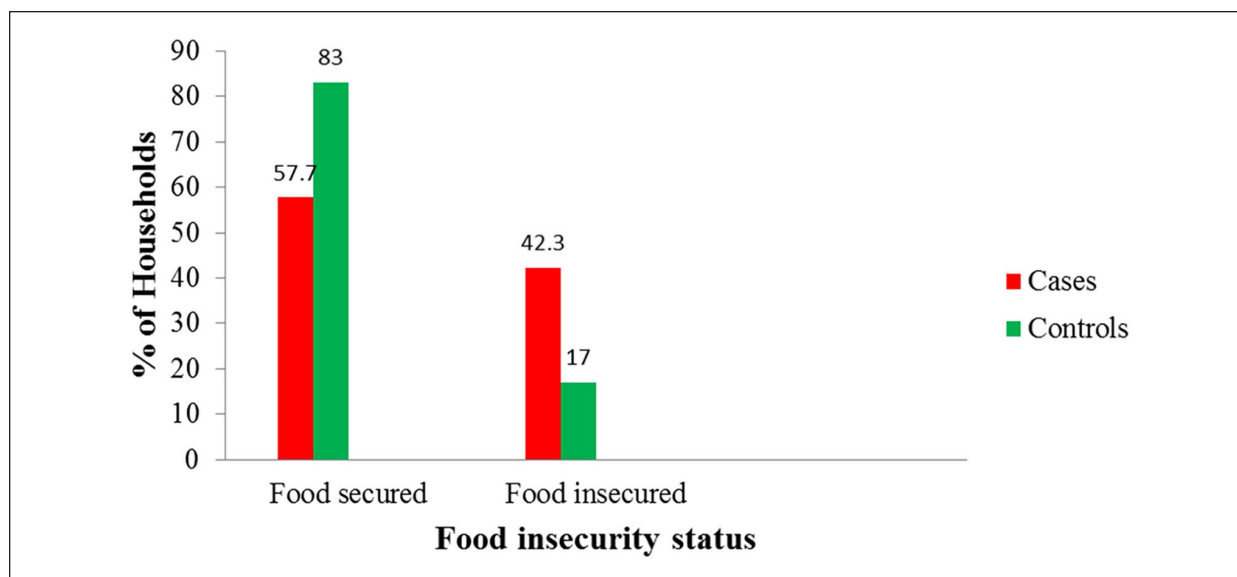
Figure 1. Food insecurity status among households with children 6 to 59 months of age in Dilla town, Gedeo Zone, Southern Ethiopia, 2019.

Table 4. Independent Predictors of Anemia.

Associated factors	Number of cases (137)	Number of controls (276)	Crude odds ratio (COR) (95%CI)	AOR (95%CI)	P-value
No. of <5 years children within HH					
More than 1 child	39 (28.5%)	41 (14.9%)	2.28 (1.39-3.752)	3.03 (1.35-6.81)	.001
One child	98 (71.5%)	235 (85.1%)	1	1	
Intestinal parasites					
Positive	31 (31%)	182 (75.8%)	6.98 (4.17-11.71)	4.42 (2.07-9.44)	
Negative	69 (69%)	58 (24.2%)	1	1	.001
HH food insecurity					
Food insecure	58 (42.3%)	47 (17%)	3.58 (2.25-5.68)	2.75 (1.39-5.45)	.004
Food secure	79 (57.7%)	229 (83%)	1	1	
HAZ					
<−2Z	77 (56.2%)	15 (5.4%)	22.3 (12.0-41.5)	6.09 (2.53-14.67)	.001
≥−2Z	60 (43.8%)	261 (94.6%)	1	1	

Statistically significant at *P*-value < .05.

Some of the limitation of this study is that cases and controls are not matched and there may be a recall bias even if efforts are made to minimize it. The use 24 hour recall method does not show the usual dietary intake. One of the strong aspects could be a relatively adequate sample size.

The findings of this study can be generalized with caution to the study area. Hence, study participants are not necessarily patients and we believe their visit to the health facilities can be considered as naturally random.

Conclusion

The study identified some modifiable risk factors such as number of under 5 years children living in the households, intestinal parasites, household food insecurity,

and child nutritional status that could be targeted to reduce childhood anemia in Dilla town. Factors associated with childhood anemia were number of under 5 years children in the household, intestinal parasitosis, household food insecurity, and stunting.

Authors' Contributions

MJ and RH originated the research question, participated in proposal development, data collection, analysis, interpretation and critically reviewed the manuscript. AD participated during

data collection, analysis and interpretation of the data. All the authors have read and approved the final version of the manuscript. After this study was done MJ has moved to Hawassa City Health Bureau. But Dr AD is primarily not at the study site but highly contributed to this work as mentioned in the authorship statement.

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Availability of Data and Materials

All the data included in this manuscript can be accessed from the corresponding author upon request through the email address.

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