ORIGINAL ARTICLE

Maternal & Child Nutrition WILEY

Anaemia, anthropometric undernutrition and associated factors among mothers with children younger than 2 years of age in the rural Dale district, southern Ethiopia: A community-based study

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Abstract

Mothers in resource-poor settings are affected by different forms of undernutrition. However, the nutritional status of mothers in rural areas, particularly after delivery, is not well documented. This study assessed haemoglobin levels and body mass index (BMI) of mothers with children below 2 years of age in a rural district of southern Ethiopia. Factors associated with low haemoglobin levels and low BMI were analysed. A community-based cross-sectional study was conducted among 931 mother-child pairs. Structured and standard questionnaires were used to collect data on background information, 24 h dietary recalls, and household food insecurity. Anthropometric and haemoglobin level assessments were performed. Anaemia was defined as haemoglobin levels below 12.0 g/dl, and anthropometric undernutrition was defined as a BMI <18.5 kg/m^2. Multilevel linear regression was used to determine associations. Out of 931 mothers, 12.8% were anaemic and 12.6% had a BMI <18.5 kg/m^2. The prevalence of minimum dietary diversity was 37.8%. The majority (78.5%) of the households were food insecure. Weight (β 0.02; 95% CI: 0.003−0.03), dietary diversity (β 0.08; 95% CI: 0.03−0.12) and secondary school attendance (β 0.34; 95% CI: 0.08−0.59) were associated with the mothers' haemoglobin level. Dietary diversity (β 0.08; 95% CI: 0.01−0.16) and household's wealth (β 0.6; 95% CI: 0.27−0.94) were associated with the mothers' BMI. Findings suggest that education and community-based nutrition interventions must be strengthened to ensure household food security. Implementation of the national food-based strategies should be considered, to improve the dietary diversity and nutritional status of mothers.

KEYWORDS
anaemia, anthropometry, Dale district, dietary diversity, Ethiopia, food insecurity, undernutrition

1 | INTRODUCTION

Maternal undernutrition is a major public health problem and contributes to an intergenerational cycle of undernutrition (Farah et al., 2019). In addition to poverty-related factors affecting the general population, women in the reproductive age group are challenged by the physiology of menstruation and childbearing (Were et al., 2020). Childbearing processe—pregnancy, delivery and lactation—are likewise nutritionally demanding processes that impose several risks on the mother and the child. Examples of major severe outcomes could include intrauterine growth failure, low birth weight, anaemia in the mother and the child, susceptibility to infection (Christian et al., 2015; Patel et al., 2018) and ultimately maternal and child mortality (Christian et al., 2015).

Ethiopia, as a resource-poor country, has a high burden of maternal undernutrition (Zewdie & Fage, 2021). Most settings in Ethiopia experience a shortage of food (Birhanu & Tadesse, 2019; Juju & Sekiyama, 2018), as well as low health service access and utilisation (Areru et al., 2021; Borde et al., 2020). Moreover, there is limited access to a safe water supply and sanitation (Azage et al., 2020; Girum & Wasie, 2017). Studies in Ethiopia have shown that women in the reproductive age group have multiple pregnancies, often close together, and inadequate dietary intake (Aychiluhm et al., 2020; Mamo & Dagnaw, 2021). In 2019, 43% of women had attended at least the four recommended antenatal care (ANC) visits during the most recent pregnancy, and 28% within the first trimester. The corresponding numbers were 32% and 20% in 2016 (Centeral Statstical Agency CSA & ICF, 2016; Ethiopian Public Health Institute EPHI & ICF, 2019). The proportion of institutional delivery in Ethiopia is also low (26% at the national level) (Centeral Statstical Agency CSA & ICF, 2016), making mothers more vulnerable to complications from pregnancy and delivery (Anshebo et al., 2020). A study done in southern Ethiopia reported health service utilisation was 11 times lower among the rural community than in the urban (Areru et al., 2021). The same study also reported that ANC attendance (45%) and delivery service utilisation (41%) were better than post-natal service utilisation (14%).

Body mass index (BMI) is an important indicator of a mother's nutritional status. Studies documented that both being underweight (BMI <18.5 kg/m^2) and overweight (BMI ≥25 kg/m^2) among mothers are associated with adverse outcomes of childbearing (Christian et al., 2015; Félix-Beltrán et al., 2021). Even though there is an increasing rate of obesity and being overweight among mothers (Jaacks et al., 2017; Kaldenbach et al., 2021; Were et al., 2020), maternal anthropometric undernutrition is still a great concern in many resource-poor settings (Berihun et al., 2017; Kenea et al., 2018). Particularly in rural areas of Ethiopia, mothers are affected by anaemia and other forms of undernutrition before pregnancy, during pregnancy and after delivery.

The prevalence of anaemia among mothers aged 15–49 years was reported at 24% in 2016 (Centeral Statstical Agency

CSA & ICF, 2016). Based on the 2019 Ethiopian Demographic and Health Survey (EDHS) report, the percentage of pregnant mothers who took iron supplements for at least 90 days increased to 11% from 5% in 2016 (Ethiopian Public Health Institute EPHI & ICF, 2019). The prevalence of thinness (BMI <18.5 kg/m^2) among mothers aged 15–49 years was also reported at 22% in 2016. Even though minimal improvements are documented at the national level regarding most maternal health indicators, women in the rural and less privileged areas are more likely to be nutritionally challenged. There is limited information on the magnitude of anaemia and anthropometric undernutrition among mothers after delivery in rural areas. The aim of this study was to assess the prevalence of anaemia and undernutrition, specifically low BMI, among mothers with children younger than 2 years of age, and to determine the prevalence of minimum dietary diversity. We also aimed to describe factors associated with low haemoglobin levels and low BMI in the Dale district of the Sidama region in southern Ethiopia.

2 | METHODS AND MATERIALS

2.1 | Study design and setting

In 2018, a community-based cross-sectional study was conducted in seven rural *kebeles* of the Dale district, which is located in the Sidama region in southern Ethiopia. A *kebele* is the smallest administrative unit in Ethiopia. Dale is one of the 19 districts in the Sidama region. In 2017, the total population of the district was about 270,000 people, living in 36 rural and two urban *kebeles*. The main town of the district, Yirga Alem, is located 320 km from Addis Ababa. In the Dale district, there are 33 health posts, 10 health centres, and 1 hospital (Yirga Alem general hospital). At least 1 health post was found in all the seven *kebeles* included in this study. People living in the area

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Key messages

- Anaemia and underweight were less prevalent among mothers with young children in the rural Dale district, southern Ethiopia, than the national report of the Ethiopian Demographic and Health Survey in 2016.

- Dietary diversity is positively associated with haemoglobin level and body mass index among mothers with children younger than 2 years of age.

- The existing nutrition interventions such as the Productive Safety Net Programme need strengthening, to improve the sustained food access to rural households.

- Planing and implementing community-based small-scale activities, such as school gardening, and fish and poultry farming, to ensure the availability and affordability of nutritious foods.
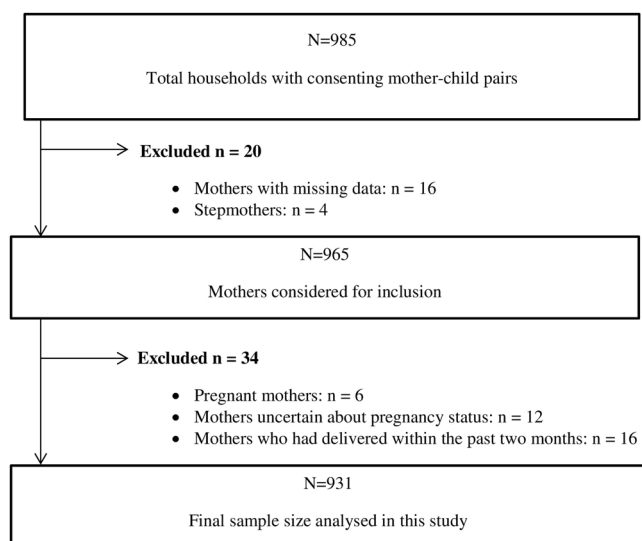
FIGURE 1 Study profile which presents exclusion of study subjects with the reasons for exclusion

were farmers, cultivating ensete (*Ensete ventricosum*), maize, kale, cabbage and haricot beans. Coffee, khat (*Catha edulis*) and fruits are grown in the area as cash crops. The community also keeps livestock, such as cows, goats and sheep.

2.2 | Study participants

Of the 985 mother-child pairs enroled in our larger study, 931 mothers (aged 15–49 years, who had a child younger than 2 years, and were not pregnant, and had not delivered within the past 2 months) were included in this study. A study profile is given in Figure 1.

2.3 | Sample size estimation and sampling procedures

The sample size was calculated using the OpenEpi version 3.01 (Dean et al., 2013) statistical software. We assumed a 95% confidence level, 4% precision and 50% prevalence for a child health condition (stunting), as explained in a parallel paper on child health (a paper under peer review). By considering 1.5 for the design effect and 10% for the nonresponse rate, the final sample size calculated was 990 households with mother-child pairs.

All households with at least one mother aged 15–49 years and one child under the age of 2 years were listed from the seven rural *kebeles*. Using probability proportional to size, households were selected from each *kebele*. As a replacement for eligible participants who had left before potential enrolment, the next household with a similar mother-child pair was taken. A total of 89 replacements were

made because of the official displacement of households from two of the *kebeles* during our data collection period.

2.4 | Data collection

Pre-tested questionnaires were used to collect background household information and the sociodemographic, reproductive and dietary information of mothers. Face-to-face interviews were conducted in the local language, *Sidaamu Afoo*. All the questionnaires used were prepared in English and translated first to Amharic (the official language) and then to *Sidaamu Afoo*. Back translations were performed to check the consistency. Six data collectors (nurses and laboratory technicians) and two supervisors were recruited and trained on interview techniques and measurement procedures. Written consent was obtained before starting the interview, and finger stamps were used for illiterate respondents. In situations where the mother preferred for her husband to answer some of the questions related to her and the household characteristics, we obtained such information from the husband. All measurements were taken for each woman after the interview session.

2.5 | Study variables

The outcome variables in our study were anaemia and anthropometric undernutrition. Anaemia was defined as a haemoglobin level of less than 12.0 g/dl (World Health Organisation WHO, 2011). Anthropometric undernutrition was defined as having a BMI of less than 18.5 kg/m^2 (World Health Organisation WHO, 2019); this state has various descriptions such as 'thinness' and 'underweight'. In short, it reflects a body shape with low weight for its height and is generally an accepted indicator for anthropometric undernutrition at group level. The independent variables were the mother's age, educational status, number of pregnancies, age at first pregnancy, place of last delivery, current use of family planning and dietary diversity scores. The total number of people living in the household, household food insecurity and the household's wealth status were also included.

2.5.1 | Anthropometric measurements

The weight, height and mid-upper arm circumference (MUAC) of the mothers were taken at their home or a nearby place suitable for the measuring instruments. Portable digital SECA weight scales (Seca 874; SECA GmbH) were used to measure the weight of mothers to the nearest 0.1 kg. The mothers' height was measured using portable SECA stadiometers (Seca 213; SECA GmbH) to the nearest 0.1 cm. Mothers were asked to remove extra clothing and shoes before standing on the scales or on the stadiometers. The mother's MUAC was measured using a flexible nonelastic adult MUAC measuring

tape. The weight, height and MUAC were taken twice to minimise measurement errors. The average weight, height and MUAC were calculated during the data entry and used for analysis. The BMI of mothers was computed in SPSS by dividing weight in kilograms by the height in metres squared.

2.5.2 | Haemoglobin level measurements

The mothers' haemoglobin levels were measured with HemoCue HB 301 machines using capillary blood samples obtained by a finger-prick. Haemoglobin levels were adjusted for altitude at 2000 m, since most of our study sites were from 1750–2250 m above sea level (Sullivan et al., 2008).

2.5.3 | The 24 h dietary recall

A list-based method was used to collect the mothers' 24 h dietary recall. The enumerator asked the mother whether she had or had not eaten the listed food items during the past 24 h. Data on 10 food groups (cereals, roots and tubers, legumes and nuts, meat (organ meat, flesh meat and poultry), fish, eggs, milk and dairy products, dark green leafy vegetables, orange-coloured fruits and vegetables and other fruits and vegetables) was collected. The use of fats and oils, sweets and fortified or commercial foods was also assessed. The mother was asked if she had eaten any foods not included in the list. Food groups the mother had eaten were scored 'one', and food groups she had not eaten were scored 'zero'. The dietary diversity score of the mother was obtained by adding up the scores of the 10 food groups. The prevalence of minimum dietary diversity was determined by dividing the total number of mothers with a score of five or higher by the total number of mothers who participated in the study.

2.5.4 | Household food insecurity

Household food insecurity was assessed using the Household Food Insecurity Access Scale (HFIAS), a tool validated for use in Ethiopia (Gebreyesus et al., 2015). The tool comprises nine questions that measure the three domains of food insecurity: uncertainty of food supply, poor dietary quality and inadequate food intake (Gebreyesus et al., 2015; Swindale & Bilinsky, 2006). Information was collected about the households' experiences of the nine situations in the 4 weeks preceding this study. All 'yes' responses were followed by the question: 'How many times in the last 4 weeks?' The frequency of occurrence was then scored 'one' if it was once or twice; 'two' if it was three to ten times; and 'three' if it was more than ten times. All 'no' responses to the nine food insecurity questions were scored 'zero' for the frequency of occurrence. The total HFIAS score ranged from 0 to 27, where higher values indicated more food insecurity. Households were classified into four food insecurity levels based on

the Food and Nutrition Technical Assistance classification guideline (Coates et al., 2007). The prevalence of food security, mild food insecurity, moderate food insecurity and severe food insecurity was determined.

2.5.5 | Wealth index

A household's economic status was determined using principal component analysis in SPSS. The possession of household assets, such as radio, television and mobile phone, and the ownership of livestock, such as cows, sheep, goats, donkeys and hens, was assessed. Housing materials and sources of drinking water were also included to compute the wealth index. The Kaiser–Meyer–Olkin sampling adequacy test was 62%, with a significant (<0.001) Bartlett's test of sphericity. Four out of nine components had an eigenvalue greater than one. Finally, households were ranked into three economic statuses: lower, middle and upper.

2.6 | Data quality control

Measuring instruments were calibrated and cleaned on a regular basis. Practical sessions on measurement procedures were included while training the data collectors. Close supervision was applied throughout the data collection period. All questionnaires were checked for completeness, and any missing information was recaptured whenever possible. The data was double-entered and validated using the EpiData version 3.1 (EpiData Association) software. Conducting the interviews in the local language was an additional strategy that we applied.

2.7 | Statistical analysis

The data was described using SPSS version 25 (IBM Corp.). STATA version 15.1 (Stata Corp.) was used to build the regression models. Descriptive statistics such as frequencies, percentages and means were used to present the continuous and categorical variables. Bivariable linear regressions were computed before running the multivariable linear regression. All variables with a $p < 0.25$ in the bivariable linear regression were included in the multivariable linear regression. The calculated intracluster coefficient was 5.6% (ICC = 0.056); thus, all the regression analyses were performed by adjusting for clustering at the *kebele* level. Multicollinearity between the independent variables was checked before running the multivariable linear regression. The adjusted beta (β) coefficients, with 95% confidence intervals (CI), were used to determine associations between the predictor variables and the outcome variables. The level of significance was set at $p < 0.05$. Correlations between each of the nutritional status indicators: haemoglobin level, BMI and MUAC were also checked. Pearson bivariate correlation coefficients were used to describe correlations between each of these variables.

TABLE 1 Household background and characteristics of mothers in rural Dale district, Ethiopia, 2018 (N = 931, unless otherwise specified)

Variable	Number	%
People living in the household		
Less than five	481	51.7
Five and above	450	48.3
Wealth index		
Lower	285	30.6
Middle	336	36.1
Upper	310	33.3
Household food insecurity		
Food secure	200	21.5
Mild food insecurity	230	24.7
Moderate food insecurity	364	39.1
Severe food insecurity	137	14.7
Age of the mother		
15–24 years	294	31.6
25–34 years	541	58.1
35 years and above	96	10.3
Education		
No education	159	17.1
Primary school	422	45.3
Secondary school and above	350	37.6
Total number of pregnancies		
One	270	29.0
Two or three	396	42.5
Four or five	223	24.0
Six and above	42	4.5
Age at first pregnancy (922)		
Under 18 years	239	25.9
18 years and above	683	74.1
Place of last delivery (923)		
Home	357	38.7
Health institution	566	61.3
Current use of FP method (929)		
Yes	866	93.2
No	63	6.8
Child-bearing complication ever faced		
Yes	39	4.2
No	892	95.8

TABLE 1 (Continued)

Variable	Number	%
Illness in the past 2 weeks		
Yes	31	3.3
No	900	96.7

3 | RESULTS

3.1 | Background information and maternal characteristics

Of the 931 mothers included in the analysis, the majority (59.9%) were aged 25–34 years; 45.3% (422) had attended primary school and 37.6% (350) secondary school (Table 1). More than a third of the mothers had had two or three pregnancies and one-quarter of mothers were under 18 years during their first pregnancy. Home delivery was practiced by 38.3% (357) mothers during the last delivery, and over 90% of the mothers had reported current use of any family planning method. Mothers who reported illness in the 2 weeks prior to our study comprised 3.3% (31) of mothers. Childbearing complications ever faced were reported by 4.2% (39) of mothers, and bleeding was the most common complication faced (14 out of 39 mothers). More than half (51.7%) of the mothers were from households with fewer than five members, and 78.5% of mothers were living in food-insecure households. About 38.8% (361) of the total households were using piped water located at the village level, and the rest of the households were using springs and water pits.

3.2 | Dietary diversity of mothers

Based on a 24 h dietary recall, the mean dietary diversity score of mothers was 4.5 (95% CI: 4.3–4.6). More than half, 62.2% (579 mothers), had a dietary diversity score below five out of 10. During the past 24 h, cereals (97.9%) were the most commonly consumed food group, and meat (20.3%) was the least (Table 2). Nobody ate fish.

3.3 | Household food insecurity

The mean household food insecurity access score was 4.0 (95% CI: 3.8–4.2), and more than three-quarters (78.5%) of the total households were food insecure. Nearly 15% (137) of the total households were severely food insecure (Table 1). The majority (61.1%) of the households had experienced eating a limited variety of food within the past 4 weeks. More than half (56.3%) of the households reported that they were worried about having enough food for the household. Less than 11% of households had

TABLE 2 The 24 h food consumption and dietary diversity of mothers in rural Dale district, Ethiopia, 2018

Food groups	Consumed in the past 24 h	
	Number (N = 931)	%
Cereals and grains	911	97.9
Roots and tubers	761	81.7
Legumes and nuts	224	24.1
Milk and dairy products	576	61.9
All meats including organ meats	189	20.3
Eggs	270	29.0
Green leafy vegetables	835	89.7
Orange coloured fruits	369	39.6
Dietary diversity of the mother		
<Five food groups	579	62.2
≥Five food groups	352	37.8

Note: None of the mothers ate fish in the previous month.

experienced the three severe food insecurity situations (Supporting Information: Table S1).

3.4 | Nutritional and clinical characteristics

The prevalence of anaemia was 12.8% (119 mothers) and the prevalence of underweight was 12.6% (117 mothers). Out of 931 mothers, 30.8% (287) had a MUAC less than 23 cm (Table 3). Of the 931 mothers, 13.6% (127) weighed below 45 kg and 10.5% (98) were below 150 cm tall. The mean haemoglobin level of mothers was 13.2 (95% CI: 13.1–13.3), and the mean BMI of mothers was 20.7 (95% CI: 20.6–20.9) kg/m^2. Continuous variables are given in Table 4.

3.5 | Correlation between haemoglobin level, BMI and MUAC

There was a medium positive correlation (0.549) between haemoglobin level, BMI, and MUAC (Supporting Information: Table S2).

3.6 | Factors associated with haemoglobin level and BMI

The unadjusted and adjusted linear regression coefficients are presented in Table 5. Weight, dietary diversity score and educational status of the mother were independently and positively associated with the haemoglobin level. For each kilogram increase in the weight of the mother, haemoglobin level increased by 0.02 g/dl ($β$ 0.02; 95% CI: 0.003–0.03). As the dietary diversity score increased by one, haemoglobin level increased by 0.08 g/dl ($β$ 0.08; 95% CI: 0.03–0.12). In addition, secondary school attendance was positively associated

TABLE 3 Nutritional status of mothers with a child less than 2 years of age in rural Dale district, Ethiopia, 2018 (N = 931)

Variable	Number	%
Haemoglobin level (g/dl)		
<12.0	119	12.8
≥12.0	812	87.2
Body mass index		
<18.5	117	12.6
18.5–24.9	791	84.9
25.0–29.9	21	2.3
>30.0	2	0.2
Mid-upper arm circumference (cm)		
<23	287	30.8
≥23	644	69.2

with the haemoglobin level of the mother ($β$ 0.34; 95% CI: 0.08–0.59). Likewise, the dietary diversity score and the upper wealth index of the household were positively associated with the BMI of the mother. For each unit increase in the dietary diversity score, BMI increased by 0.08 kg/m^2 ($β$ 0.08; 95% CI: 0.01–0.16). Mothers from households with the upper wealth index had a BMI increase of 0.6 kg/m^2 ($β$ 0.6; 95% CI: 0.27–0.94).

4 | DISCUSSION

Our study assessed the prevalence of anaemia and underweight among mothers with children under 2 years of age in the rural Dale district, southern Ethiopia. In our study, 12.8% of the mothers were anaemic, and 12.6% were underweight. The majority of the mothers had low dietary diversity, and more than three-quarters of the households were food insecure. Dietary diversity, weight and mother's educational level were independently positively associated with haemoglobin level of the mother. In addition, dietary diversity and household's wealth status were independently positively associated with the BMI of the mother.

The prevalence of anaemia in our study was lower than the national report of the EDHS in 2016 (24%) (Centeral Statstical Agency CSA & ICF, 2016). Whereas the EDHS, as a national report, had included all women of reproductive age from urban and rural areas, our study assessed mothers who had children younger than 2 years in rural areas only. The mean haemoglobin level in our study (13.2 g/dl) was higher than the mean in a study that assessed the immediate post-partum anaemia in northwest Ethiopia (12.4 g/dl) (Abebaw et al., 2020). The difference may be due to the time when the mother was assessed after delivery. In our study, mothers who had children under 2 years of age were included, and we excluded those who had given birth in the previous 2 months, whereas the other study assessed mothers immediately after delivery. The study setting could also partially explain the difference; our study was

TABLE 4 Clinical and nutritional characteristics, Ethiopia, 2018 (continuous variables)

Variable	N	Mean (95% confidence interval)	Standard deviation	Median (inter quartile range)	Minimum	Maximum
Mother's age	931	26.9 (26.5–27.2)	5	26 (6)	16	45
Age at first pregnancy	922	17.9 (17.8–18.1)	1.8	18 (2)	14	29
Mother's weight in kg	931	51.8 (51.3–52.2)	6.4	51 (8.3)	35.1	79.1
Mother's height in cm	931	157.9 (157.5–158.4)	6.9	157.5 (9.2)	136	177.4
Body mass index	931	20.7 (20.6–20.9)	2.0	20.7 (2.4)	15	35.2
Mid-upper arm circumference	931	23.5 (23.4–23.6)	1.8	23.5 (1.8)	13.25	31.1
Haemoglobin level in g/dl	931	13.2 (13.1–13.3)	1.2	13.2 (1.4)	7.5	17.1
Total number of pregnancies	931	2.6 (2.5–2.7)	1.6	2 (3)	1	10
Dietary diversity score	931	4.5 (4.3–4.6)	1.9	4 (3)	1	8
Household food insecurity score	931	4 (3.8–4.2)	3.2	4 (5)	0	19
People living in the household	931	4.8 (4.7–4.9)	1.6	4 (2)	3	11
Age of the child in months	931	14.2 (13.8–14.6)	6.1	13.9 (10.2)	2.0	23.9

community based, while the other study was institutional. In addition, mothers in our study may be benefitting from the staple crop ensete, which is a good source of iron (Bosha et al., 2016; Mohammed et al., 2013). However, the prevalence of anaemia in our study was higher than that found in Wolayita zone, southern Ethiopia (11%) (Julla et al., 2018). That study also reported a mean haemoglobin level (13.5 g/dl), which was a little higher than ours (13.2 g/dl). In addition, the median haemoglobin level in our study (13.2 g/dl) was lower than the median reported in a previous study from the rural Sidama zone (the current Sidama region) (13.8 g/dl) (Gebreegziabher & Stoecker, 2017). However, the previous study had included all women in the reproductive age group. Thus, the haemoglobin levels reported in our study might show mothers' situation in terms of recent delivery and lactation (Roba et al., 2018). This finding indicates the need for promoting maternal health services utilisation and iron supplementation for pregnant mothers. While food fortification is a national-level food-based approach to prevent micronutrient deficiency diseases including anaemia (EPHI & ICF, 2019), access to, and utilisation of, fortified foods should be promoted.

Our study found a positive linear association between dietary diversity score and haemoglobin level of the mother. A similar positive association was reported by a study done in the eastern lowlands of Ethiopia (Roba et al., 2015). Moreover, dietary diversity was found to be associated with haemoglobin levels in studies done in other parts of Ethiopia (Alemayehu, 2017; Seifu & Yilma, 2020). In addition, low dietary diversity was found among more than half of the mothers (62.4%) in our study; this is in line with a study done in the Amhara region, northern Ethiopia, which reported 66% (Fentahun & Alemu, 2020). Our study also showed that 40% of the mothers had consumed fruits during the previous 24 h. This proportion is low, as the area is among the fruit-producing areas in Ethiopia (Biazin et al., 2018). However, most fruits are seasonal and mainly used for income-generation purposes (Adane et al., 2019).

In general, our findings showed that low dietary diversity among mothers is a persistent problem, calling for national actions in addition to local interventions. The local interventions can consider school farming, and fish and poultry farming, using the locally available resources. Intervention at the national level may include establishing rural food markets, to improve accessibility and affordability of nutritious foods at the local market. In addition, it will encourage people to be engaged in diverse agricultural activities (home gardening, fish and poultry farming), to generate income from the local market (Hirvonen & Headey, 2018). Furthermore, the use of a wild grain (amaranth) in this area, where low dietary diversity was a common problem, should be considered. A recent study from southern Ethiopia reported the potential of this important plant for improving haemoglobin levels among children (Orsango et al., 2020).

We did not find any previous study in Ethiopia that evaluated the association between weight and haemoglobin status of mothers. Our study showed that the weight of the mother was positively associated with haemoglobin level; this was in agreement with a study done among rural Indian adolescent girls (Ahankari et al., 2020).

In our study, secondary school attendance was also shown to be positively associated with the haemoglobin level of the mother. Again, a similar association was reported by a study done in the rural areas of Ethiopia (Roba et al., 2015). Another study from Arba Minch district, southern Ethiopia (Tikuye et al., 2019) also reported a similar association; however, that study included only those mothers who had given birth in the previous 6 months. This finding may indicate that education may influence one's nutritional status in different ways; for example, educated people can have better income to afford nutritious foods. Even though mothers in our study were not employed, educated mothers may have more information and better creativity to help improve their income. Hence, education can be one

TABLE 5 Regression coefficients (crude and adjusted) of independent variables with the outcome variables: haemoglobin level (g/dl) and body mass index (kg/m^2), in rural Dale district, Ethiopia, 2018

Variable	Haemoglobin level of the mother		Body mass index of the mother	
	Unadjusted coefficients (95% CI)	Adjusted coefficients (95% CI)	Unadjusted coefficients (95% CI)	Adjusted coefficients (95% CI)
Mother's age	−0.02 (−0.03 to −0.002)	0.002 (−0.02 to 0.02)	−0.003 (−0.03 to 0.02)	
Mother's age at first pregnancy	0.02 (−0.02 to 0.07)		−0.02 (−0.09 to 0.05)	
Weight in kg	0.03 (0.02−0.04)	0.02 (0.003−0.03)*		
Height in cm	0.03 (0.02−0.04)	0.01 (−0.001 to 0.03)		
Dietary diversity score	0.1 (0.04−0.14)	0.08 (0.03−0.12)**	0.14 (0.06−0.22)	0.08 (0.01−0.16)*
Household food insecurity score	−0.02 (−0.04 to 0.003)	−0.02 (−0.04 to 0.004)	−0.03 (−0.07 to 0.01)	−0.02 (−0.06 to 0.02)
Number of people living in the household	−0.08 (−0.12 to −0.03)	−0.05 (−0.14 to 0.04)	0.03 (−0.06 to 0.11)	
Total number of pregnancies	−0.08 (−0.13 to −0.04)	−0.003 (−0.11 to 0.1)	−0.01 (−0.1 to 0.08)	
Educational status				
no education	1	1	1	
primary school	0.28 (0.07−0.5)	0.15 (−0.08 to 0.37)	0.3 (−0.08 to 0.67)	0.16 (−0.22 to 0.53)
secondary school	0.51 (0.29−0.74)	0.34 (0.08−0.59)*	0.57 (0.18−0.97)	0.32 (−0.08 to 0.72)
Place of last delivery (923)				
home	1	1	1	
health institution	0.12 (−0.05 to 0.28)	0.02 (−0.14 to 0.18)	0.07(−0.21 to 0.36)	
Current use of family planning method (929)				
no	1	1	1	
yes	0.2 (− 0.1 to 0.5)	0.1 (−0.21 to 0.4)	0.66 (0.14−1.19)	0.57 (0.04−1.09)
Wealth index				
lower	1	1	1	
middle	0.03 (−0.15 to 0.22)	−0.04 (−0.22 to 0.14)	0.09 (−0.23 to 0.40)	0.04 (−0.28 to 0.35)
upper	0.13 (−0.06 to0.32)	−0.02 (−0.22 to 0.18)	0.77 (0.44−1.09)	0.60 (0.27−0.94)***

Note: Variables with $p \geq 0.25$ in the bivariable (unadjusted) regression were excluded from the multivariable (adjusted) regression.

*$p < 0.01$; **$p < 0.05$; ***$p < 0.001$.

of the factors which help to improve the nutritional status and the health of mothers.

The majority of mothers (85%) in our study were in the normal range of BMI (18.5 to 24.9 kg/m^2). The prevalence of underweight in our study (12.6%) was lower than in studies from northwest Ethiopia (25%) (Berihun et al., 2017) and the Afar region (33%) (Mulaw et al., 2021). The difference may be due to the regional differences documented by other studies, that showed that undernutrition among mothers of the reproductive age group in southern Ethiopia was less prevalent (Dagnew & Asresie, 2020; Sserwanja & Kawuki, 2020). The mean (SD) BMI in our study was 20.7 (2.0) kg/m^2; this was the same as the 2016 national EDHS report (20.7 kg/m^2) (Centeral Statstical Agency CSA & ICF, 2016). However, the prevalence of overweight in our study (2.5%) was lower than the EDHS report (8%). The difference can be explained

by the different scope and setting: nationwide survey compared to a rural district study. Another study from northwest Ethiopia reported a prevalence of overweight (about 2%) that was very similar to our finding (Berihun et al., 2017).

In our study, the dietary diversity of the mother was positively associated with BMI, which was in line with a study from another district in southern Ethiopia (Boke et al., 2021). However, the other study was done in the town of the district, unlike ours. In addition, our findings showed that the household wealth index (the upper quartile) was positively associated with BMI. Similarly, the above-mentioned study from southern Ethiopia (Boke et al., 2021) reported a positive association between a household's upper wealth index and the BMI of mothers. This association may be due to the fact that wealthier people can have better access to more nutritious animal-source foods. However, this implies the

need for the promotion of a healthy lifestyle among wealthier people, who are in a food transition, to prevent overweight, obesity, and associated non-communicable diseases (Hailemariam et al., 2020; Yeshaw et al., 2020).

In our study, the prevalence of household food insecurity was high (78.5%), though it was not associated with the haemoglobin level or BMI of the mother. The possible explanation for the lack of association may be that dietary diversity is a better indicator of haemoglobin level than household food insecurity, as demonstrated in this study. People may respond 'no' to most of the HFIAS questions if they think that they have enough ensete or maize only; they may not realise the risk of monotonous diets. It was also shown in this study that the majority of households reported that they had eaten a limited variety of food in the 4 weeks prior to this study. Hence, micronutrient deficiency diseases like anaemia are more related to food quality rather than quantity. The other possible reason may be that mothers have received iron supplementation during pregnancy, even though this was not fully assessed in the current study.

However, the Sidama region (the former Sidama zone) was one of the areas where the Productive Safety Net Programme (PSNP) has been working since 2005 (Galato, 2020); nevertheless, household food insecurity has remained a major problem (Dafursa & Gebremedhin, 2019). The possible explanation is that the programme is targeting highly vulnerable and drought-prone areas. The drought-prone areas in the Sidama region are Boricha and Loko Abaya, which are located in the Central Rift Valley region (Belayneh et al., 2020). Severely food-insecure households in a few *kebeles* of the Dale district are being supported by the programme. Although our study found that the majority of the households had mild to severe food insecurity, the programme was operating in only three of our study *kebeles*. We did not obtain data from individual households regarding this programme. Another possible explanation for the high food insecurity might be seasonality issues; our data was collected from August to November, known for relative food shortage. In addition, we did not analyse complications faced during pregnancy, delivery or after delivery, and are not able to tell whether these were associated with any of the nutritional problems among mothers.

4.1 | Strengths and weaknesses of the study

The strengths of this study included being a community-based study using a random sampling technique and the analytical approach using a multilevel mixed-effect model to account for clustering. Collecting comprehensive data, through interviews, measurements and rapid field tests, was an additional strength of our study. On the other hand, the limitations of our study included selection bias, recall bias and measurement bias. Selection bias was due to the replacement of some mothers who left their residence before enrolment and a potential recall bias was due to self-reported data such as age, past reproductive events and dietary recall. However, to minimise bias, we used strategies such as taking all measurements twice and formulating questions in different ways. Survivor bias may also exist, since our samples were mother-child pairs, and mothers who had lost their children were not included. In addition, the fact that we have no data from the local health facilities concerning women's health service coverage may create some bias.

5 | CONCLUSION

In our study, anaemia and underweight were less and moderately prevalent, respectively, among mothers who had a child less than 2 years of age, compared to the 2016 national EDHS report. However, the majority of the mothers had low dietary diversity. In addition, our findings showed that poor dietary diversity was a single factor positively associated with both low haemoglobin levels and low BMI. Household food insecurity was experienced by the majority of mothers, but did not predict the nutritional status of mothers in our study. However, it is obvious that access, availability and sustainability of nutritious foods were sparse. Education and promotion of minimum dietary diversity among mothers may help to improve their nutritional status. Strengthening the existing nutrition interventions like PSNP and planning new community-based nutrition interventions may help to improve access to nutritious food in rural households. Moreover, the missed opportunity of using the wild amaranth grain should be considered.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL STATEMENT

Ethical approval was obtained from Hawassa University College of Medicine and Health Sciences Institutional review board, Ethiopia (reference number; IRB/025/10, Date: 21/12/2017) and from Norwegian Regional Ethical Committee (REK), Norway (reference number; 2018/90/REK Vest, Date: 07/03/2018). All the necessary official letters were obtained from the concerned bodies at regional and district levels. The respondent's signature or finger stamp was obtained before enrolment to signify their willingness to participate in our study. The data is kept in a secured place to maintain confidentiality. Furthermore, personal or household identifiers were not used to communicate our findings.

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