Prevalence of Diarrhea, Intestinal Parasites, and Associated Factors Among Under-Five Children in Dabat District, Northwest Ethiopia: Multicenter Cross-sectional Study

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ABSTRACT

BACKGROUND: Despite global interventions to prevent and control diarrhea, it remains a public health problem leading to childhood morbidity and mortality majorly in developing countries. According to the World Health Organization, data from 2021 indicated that diarrheal disease is responsible for 8% of deaths in children under the age of 5. In the world, more than 1 billion under-five children live in poverty, social exclusion, and discrimination affected by intestinal parasitic infections and diarrhea disease. In sub-Saharan African countries like Ethiopia, diarrheal diseases and parasite infections continue to cause significant and persistent morbidity and mortality in under-five children. Therefore, the purpose of this study was to assess the prevalence and associated factors of intestinal parasites and diarrheal diseases in children under the age of 5 years in Dabat District, Northwest Ethiopia in 2022.

METHOD: A community-based, cross-sectional study was carried out from September 16 to August 18th 2022. Four hundred households with at least one child under the age of 5 years were recruited by simple random sampling technique. Sociodemographic, clinical, and behavioral factors were also collected using pretested interviewer-administered questionnaires. Data was entered into Epi-data version 3.1 and exported to Statistical Package for Social Science (SPSS) version 25 for analysis. Binary logistic regression was performed to identify factors associated with diarrhea and intestinal parasitic infections. The level of significance was computed at a *P*-value ⩽ .05. Descriptive statistics such as frequency and other summary statistics were used for describing sociodemographic variables and determining the prevalence of diarrhea and intestinal parasites. Tables, figures, and texts were used to present the findings. The variables having a *P*-value of less than .2 in the bivariable analysis were entered into the multivariable analysis at a *P*-value of ⩽*.5*.

RESULTS: According to this study, the prevalence of diarrhea and intestinal parasites among under-five children was 20.8% (95% CI: [16.8-37.8] and 32.5% (95% CI: [28.6, 37.8], respectively. In multivariable logistic analysis at a *P*-value of ⩽.5, the educational level of mothers (Adjusted odds ratio [AOR]: 3.7, 95% CI: [1.52, 8.95], residence (AOR: 4.7, 95% CI: [1.52, 8.09]), undernutrition (AOR: 3.6, 95% CI: [1.09, 11.3]), latrine availability (AOR:3.9, 95% CI: [1.23, 9.56]), types of the latrine (AOR: 5.9, 95% CI: [3.42, 11.66]), water treatment (AOR = 7.6; 95% CI: [6.4, 12.7]), eating uncooked vegetable or fruits (AOR = 4.6; 95% CI: [1.025, 15.2]), and source of water (AOR = 4.5; 95% CI: [2.32,8.92]) were significantly associated with diarrheal disease. Intestinal parasitic infection was also significantly associated with undernutrition (AOR = 3.9; 95% CI: [1.09, 9.67]), latrine availability (AOR = 2.1; 95% CI:[1.32, 9.32]), types of the latrine (AOR = 2.8; 95% CI: [1.92, 8.12]) residence (AOR = 4.7; 95% CI: [1.52, 8.09]), water treatment, source of water for drinking (AOR = 4.5; 95% CI: [2.32, 8.92]), eating uncooked vegetables or fruits (AOR = 6.7:95% CI: [3.9, 9.8]), and deworming children with anti-parasitic medication (AOR = 2.4; 95% CI: [1.34, 5.62]), washing hands after latrine used (AOR = 2.2: 95% CI: [1.06, 3.86]).

CONCLUSION: The prevalence of diarrhea and intestinal parasite among under-five children was 20.8% and 32.5%, respectively. Undernutrition, latrine availability, types of latrines, residence, eating uncooked vegetables or fruits, and source of water for drinking and water treatment were associated with intestinal parasitic infection and diarrheal disease. Deworming children with antiparasitic medications and washing hands after latrine use was also significantly associated with parasitic infection. Hence, awareness creation activities on latrine utilization and building, keeping personal hygiene, safe water supply, feeding cooked vegetables or fruits, taking anti-parasitic medications, practice hand washing habit after toilet use are strongly recommended.

KEYWORDS: Prevalence, under-five children, diarrhea, intestinal parasite, Ethiopia

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Introduction

Despite global interventions to prevent and control diarrhea, it remains a public health problem leading to childhood morbidity and mortality majorly in developing countries.[1] It is more common in areas with inadequate housing, unsafe drinking water, lack of sanitation, and poor eating habits.[2] Diarrhea remains a public health problem of under-5 years old children that affects poor countries.[3,4] The leading causes of diarrhea deaths are severe dehydration and fluid loss for most people and children.[3] According to the World Health Organization, data from 2021 indicated that diarrheal disease is responsible for 8% of deaths in children under the age of 5.[2] In the world, more than 1 billion children under the age of 5 years are affected by intestinal parasitic infection due to malnutrition and living in poverty.[4] The Indian National Family Health Survey indicates that between 2016 and 2020, the nationwide prevalence of childhood diarrhea increased from 9% to 9.2%.[2] The electronic gastrointestinal clinical surveillance and reporting system in China has also revealed that there are 180 000-190 000 episodes of diarrhea overall, with 35% of those cases being infectious diarrhea.[5]

In low-income countries, particularly in sub-Saharan Africa, the morbidity and mortality from diarrheal diseases in under-5 years old children are still significant and persistent.[6] In Africa, 4 out of every 10 deaths of under-five children are related to diarrheal disease.[7] In Uganda, diarrhea contributes to more than 140 000 annual deaths and 7.1% of overall were under-five children.[1] In Ethiopia, diarrhea is one of the leading causes of death in under 5 children.[8,9] In Ethiopia, the prevalence of diarrhea among under-5 years old children varies from region to region. For example, it was 11% in Nekemet town,[10] 14.7% in rural kebeles of Adama,[11] and 22.1% in a rural area of North Gondar.[12] There are various risk factors for diarrhea disease in developing countries including poor personal and environmental hygiene, poor housing condition, lack of latrine availability, household economic status, place of residence, washing hand habits, and feeding styles.[13,14]

Children are most frequently affected by intestinal parasitic infection, which is related to their poor hygiene habits and their weakened immune systems.[15] According to Switzerland's Tropical and Public Health report in 2010, approximately 3.5 billion people are exposed to intestinal parasitic infection and more than half of them are children.[16] According to the world health organization, over 270 million pre-school and over 600 million children live in areas where the parasites are intensively transmitted.[17] Various studies reported that intestinal parasites showed varied prevalence rates across different countries; for instance, in Saudi Arabia, 28.7%,[18] in Palestine, 27.3%,[19] 48% in Sudan,[20] and 19% in Ethiopia.[21] The distribution of intestinal parasites in Ethiopia is varied across the various regions. Therefore, it is essential to monitor local intestinal parasite distributions to develop effective control and prevention strategies, particularly for high-risk groups. As a result, the current study seeks to determine the prevalence of intestinal parasites, diarrhea, and their associated factors among under-five children in the Dabat district, northwest Ethiopia.

Material and Methods

Study area and period

A community-based crossectional study was carried out from August 19 to November 28, 2022, in the Dabat district, northwest Ethiopia, 2022. There are 4 urban kebeles and 39 rural kebeles in Dabat Wereda, which is in the northwest of Ethiopia (Figure 1). There are around 775 km between this location and Addis Ababa, the capital of Ethiopia. A primary hospital and 6 health centers can be found in Dabat Woreda. In total, 2 003 000 people are thought to reside.

Source and study population

All under-five children living in the Dabat district were considered as the source population. All under 5 children living in the selected kebeles were also taken as the study population.

Eligibility criteria

Inclusion criteria. At the time of data collection, all under-five years old children whose mothers had resided in the research area for 6 and above months were included in the study. When there are multiple children under the age of 5 years old living together, the child who has recently had diarrheal episodes was also acceptable.

Exclusion criteria. Under-five years old children whose mothers had resided in the research area for less than 6 months, as well as those who were not volunteer to participate, ill to participate, and were not included in the study.

Sample size determination and sampling technique

The sample size was calculated based on a single population proportion formula by taking prevalence (P = 30.5%) from a study conducted in northeastern Ethiopia.[9] By using a lottery method, 2 urban and 12 rural kebeles were selected. In the 14

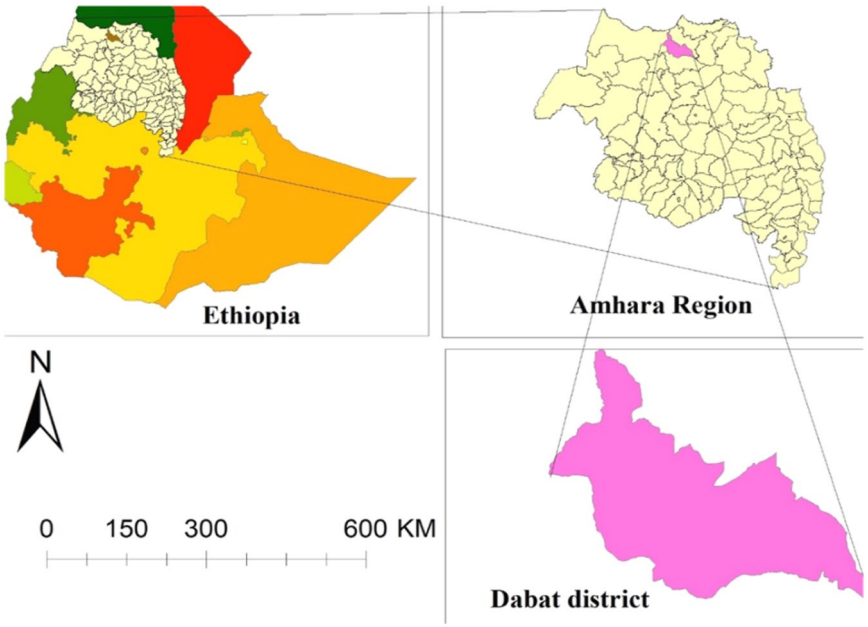

Figure 1. Location of Dabat district.

chosen kebeles, a proportionate distribution was created. By applying the formula $K = N/nf$, where (K = interval, N = population, n = sample). The K interval for each was calculated by dividing the total number of children under the age of 5 in the chosen kebeles by the overall sample size. As a result, the fourth unit interval, $K = N/nf$, equals 1600/400. Every fourth individual was recruited for the study, which employed the lottery method to select a random number between 1 and 4. We used a random sampling technique to reduce the bias and we have also tried to use reminders such as holidays to minimize the recall bias.

Sampling Technique

Study variables

Dependent variable. Diarrhea (Yes/No)
Parasitic infections (Yes/No)

Independent variables. Socio-demographic and economic variables: Age of the mother's education and marital status of parents, place of residence, age of the child, child's sex, deworming, and household wealth status were assessed.

Environmental and related factors: Sources of water, round-trip time taken to obtain water for consumption, latrine availability, washing hand habits, washing vegetables before use, child's meal, and type of toilet was also assessed.

Operational Definition

Diarrhea: It is defined as the passage of 3 or more loose or liquid stools per 24 hours.[22]

Intestinal parasitic infections (IPIs): The participant was recorded as positive for at least one protozoonon or helminth.[23]

Data collection tools and procedure

During data collection, an interviewer-administered questionnaire was used to collect data related to children's demographics, personal hygiene practices, eating and playing routines, and handwashing behaviors. At the children's residences, detailed inspections of the water sources and restrooms were done. A pre-tested and organized questionnaire addressed to the mother contained information on the independent variables, sociodemographic factors, behavioral traits of the mother and child, and previous medical histories. Using calibrated standard instruments, the selected children's weights and heights were also determined.

Anthropometric measurements

We measured the weight of under 5 children age by using a calibrated beam or a digital infant scale. We Ensured the infant is not wearing any clothes and remove the diaper before measuring the weight. The weight was measured to the nearest 0.01 kg or 0.5 ounces. For children older than 24 months, a balanced floor scale or electronic floor scale was used. We measured the length of under 5 children by asking the Assistant to lay the child down on his/her back on the measuring board and stand directly behind the child's head, then measured the distance from the top.

Stool sample collection

The randomly selected families were first informed briefly of the purpose of the study by the stool sample collectors. After that, the stool sample collectors gave the mothers of the children a piece of paper and told them to have their children

defecate on it. Following defecation on the paper, the mother of the children was told to put feces into the collection container and place around 50 g of the feet inside. We avoided the specimen contact with urine. We labeled the stool cup with the identification number, date, and time of collection and transferred the entire specimen into the stool cup using the tongue depressor provided or another handy implement. Children who failed to produce the stool sample were scheduled and provided the sample on another day. Repeated visits were caried out until we get stool samples done. We Submitted the specimen to the lab within 2 hours of collection. We have determined the food and water contamination indirectly by asking questions to parents about handling and storage conditions. The mother's or the children's privacy wasn't violated in any way when the stool samples were being collected. The stool sample collectors placed the plastic cup with the stool sample inside a cool box just after the plastic cup had been coded and labeled

Detection of ova/cyst/trophozoite of parasites in stool samples

We used the formalin-ether concentration (FEC) technique and direct stool examination (wet mount) techniques to detect intestinal parasite ova in stool samples. On a clean slide, one drop of physiological saline was placed. Three to five specimens were emulsified in a saline solution using an applicator stick. A cover slip was placed over the preparation, and a microscope was employed to determine the presence or absence of intestinal parasites. For the FEC method, approximately 4 mL of 10% formol water was used to emulsify approximately 1 g of a solid stool sample or 2 mL of watery stool. 3 mL more of the 10% formol water was added, and it was thoroughly mixed by shaking. The sieved suspension from the emulsified stool specimens was then put into a conical test tube (centrifuge). Following the addition of 3 mL of diethyl ether, the tube was stopped, mixed for 1 minute with a tissue wrapped around the top, and the stopper was then removed. After that, it was centrifuged for 1 minute at 3000 rpm by a centrifuge machine (model SSU-173). The tube was inverted to remove the ether, feces debris, and formalin, leaving behind the sediment. The layer of feces and debris on the tube's side was removed with a stick. The tube was returned to its upright position and the fluid from the sides of the tube was allowed to drain to the bottom. The bottom of the tube was taped to resuspend and mix the sediment. The sediment was transferred to a slide and covered with a cover glass and was examined microscopically using the 10× objective for focusing and the 40× objective for proper identification. Standard operating procedures were used for every laboratory procedure during the laboratory examination, stool specimen collection, transportation, and storage. We used stool sample collection and transportation containers that are leak-proof, dry-clean, and free from any traces of disinfectants. We ensured the correct labeling of stool sample containers using the date of sample collection and the code of the study participants. All stool specimens were stored in an ice box for transportation and were preserved at 4°C in the laboratory until analyzed for the ova of parasites. Triplicate examinations of the stool samples were applied to improve the recovery rate of intestinal parasites. Moreover, the expiry date of normal saline, ether, and formol was evaluated before stool sample preparation and examination. The double slide Kato-Katz technique was used to microscopically screen for helminth infections in one aliquot, while the direct saline and iodine wet mount method was used to screen for protozoan infections in the other. To evaluate the results, a typical stool ovum, and parasite test using one concentration technique was conducted for each child who was chosen for the study. The test was carried out by the principal investigator and a professional in laboratory technology at the Dabat primary hospital laboratory. The mothers got a dry, clean, leak-proof container at the time of the interview, labeled with the child's identification number for the collection of stool samples the following day. The mothers received training on how to take the sample as well. With the aid of the wooden spoon, the stool was collected as the child defecated and placed 3 to 5 spoonfuls of stool into the sample container. Field personnel received training in appropriate hygiene and biosafety practices. Slides were then prepared in the lab for wet mount using saline and iodine, and they were then microscopically inspected first under low power (10 times magnification) bright field, then under high power (40 times magnification). The formalin-ethyl acetate method was then used to concentrate the material. Iodine-stained slides were created and once more inspected under a microscope. Children who had positive stool tests also received anti-parasitic therapy

Data Management and statistical analysis

The collected data were coded and entered into Epi Data version 3.1 and then exported to Statistical Package for Social Science (SPSS) version 25 for analysis. Descriptive statistics such as frequency, percentage, and other summary statistics were used for describing socio-demographic variables and determining the prevalence of diarrhea and intestinal parasitic infection. Tables, figures, and texts were used to present the findings. Bivariable logistic regression analysis was applied to identify factors associated with outcome variables. The chi-squared test was used to test the associations between the dependent and independent variables. All variables with P-value $\leq .2$ from bivariable logistic regression analysis were entered into the multivariable logistic regression model. We have found the VIFs were less than 5. The Hosmer and Lemshow goodness-of-fit test was used to check the final model fitness of each parasitic infection and diarrhea indicator. This was done using the forward elimination variable selection method. The strength of the association between dependent

and associated factors was determined using the odds ratio with a 95% confidence interval (CI). We have checked the multicollinearity using the variance inflation factor and tolerance test.

Result

A total of 400 households with at least one under-five children enrolled in the study with a 100% respondence rate. The majority of the under-five children were females (69.2%) with a mean age of 30.68 months with a standard division of ±3.49 months. The mean age of the mothers was 32.67 years with an SD of ±7.381 years. The majority of children's mothers were married (68.3%). More than one-third of the study participants were residents (38%). Nearly 30% of mothers had no formal education (29.3%) (Table 1).

Environmental and related characteristics of the study participants

Two-thirds of the study participants (73%) had no private latrines. Twenty-three percent of study participants used an open-field defecation field. Around 40% of the study participants drank water from rivers or unprotected wells. Eighty-three percent of households did not have access to water. Of the total mothers, 24% did not wash their hands after using latrines. Nearly 15% of under-five children did not get fresh meals. Of the total participants (24.5%) used dipping to obtain their water from storage containers. The majority of the mothers (76%) reported doing their hand washing after the latrine was used (Table 2).

Prevalence of diarrhea among under-five children in Dabat district

The overall prevalence of diarrhea from a total of under-five children was 20.8% (83/400) (95% CI, 16.8-24.8). The prevalence of diarrhea was higher among undernutrition children (75%). The prevalence of diarrhea was also higher among study participants who used open defecation fields (64%). Children who lived in the rural area experienced a higher rate of diarrhea (47.8%). Forty-five percent of children were affected by diarrhea disease by feeding contaminated foods (45%) (Figure 2).

Bivariable and multivariable analysis of diarrhea among under-five children,2022

In the bivariable analyses, the diarrheal disease was associated with the mother's marital status, nutritional status of the children, availability of latrines, types of latrines, mother's educational status, source of drinking water, consumption of treated water, a habit of washing hands and eating uncooked vegetables or fruits. Multivariable logistic regression was applied to components from bivariable logistic regression with a *P*-value of .2. Therefore, by multivariable logistic regression with a *P*-value of (≤.05), the nutritional status of children, latrine availability, types of latrines, residence, educational status, treatment of water before consumption, and washing vegetables before consumption were statistically significant with diarrhea disease. However, marital status was not significantly associated with diarrhea disease in multivariable logistic analysis. As a result, the risk of having the diarrheal disease was shown to be 3.6 times higher in undernourished children than in normal children (AOR = 3.6; 95% CI: 1.09-11.32). In comparison to children whose mothers had private latrines, those whose mothers did not have access to them have a higher risk of developing the diarrheal disease (AOR = 3.9; 95% CI: 1.09-11.3).

Children born from mothers who could not read and write had a higher risk of developing diarrhea than children born from mothers who had a diploma and above (AOR = 3.7; 95% CI: 1.07-8.95). Compared to children who resided in urban areas, children in rural areas had a higher likelihood of developing diarrhea (AOR = 4.7; 95% CI: 1.52-8.08). Children from families who used open defecation fields had a greater risk of having diarrheal disease than those from households who used private latrines (AOR = 5.9; 95% CI: 1.2-11.66). Under-five children who live in homes without clean water have a 7.6 times higher chance of developing diarrhea disease (Table 3).

Prevalence of intestinal parasites among under-five children in Dabat district

The total prevalence of intestinal parasites among the total study participants was 32.5% (95% CI: 28.6-37). In this study, Giardia lamblia was highest prevalent among identified intestinal parasites (39.2%) (Figure 3).

Bivariable and multivariable analysis of intestinal parasite among under-five children in Dabat district, 2022

Bivariable and multivariable logistic regression analysis was used to identify a potential risk factor. Compared to children who ate cooked vegetables or fruits, those who regularly ate uncooked vegetables and fruits had a greater chance of having an intestinal parasite infection (AOR = 6.7; 95% CI: 3.9-9.8). Mothers who did not frequently wash their hands after using the latrine were more likely to expose their children to intestinal parasite infection than mothers who did it (AOR = 2.2; 95% CI: 1.06-3.86). Compared to parents who had private latrines, parents who used open defecation filed were more likely to expose their children to intestinal parasite infection (AOR = 3.2; 95% CI: 1.08-3.22). Those with undernutrition under-five children had a 2.1-fold higher risk of having an intestinal parasite infection than children who had normal nutritional status (AOR = 2.1; 95% CI: 1.09-3.6). Intestinal parasite infection was more common in children who lived in rural regions compared to urban areas (AOR = 3.2; 95% CI: 1.08-3.22). Compared to children who drank treated water, those who

Table 1. Sociodemographic characteristics of the study participants in Dabat District Northwest Ethiopia, 2022.

VARIABLES	CATEGORY	FREQUENCY	PERCENTAGE
Sex of the children	Male	123	30.8
	Female	277	69.2
Age of children in months	18-24 mo	173	33.2
	25-47 mo	132	33
	48-59 mo	95	33.8
Age of mother in years	18-24	17	4.3
	25-35	195	48.7
	Sex of childrenn	188	47
Marital status of mothers	Married	273	68.3
	Divorced	43	10.8
	Single	56	14
	Windowed	28	7
Residence	Rural	152	38
	Urban	248	62
The Educational level of mothers	Cannot read and write	117	29.3
	Read and write	46	11.5
	Primary school (grade1-8)	14	3.5
	Secondary school (grades 9-12)	77	19.3
	Diploma and above	46	36.5
The educational level of the father	Cannot read and write	118	29.5
	Read and write	44	11
	Primary school (grade1-8)	11	2.8
	Secondary school (grades 9-12)	71	17.8
	Diploma and above	156	39
Occupation of mother	Housewife	144	36
	Government employee	204	51
	Private work	41	10.3
	Students	11	2.8
Occupation of father	Government employee	211	52.8
	Marchant	50	12.5
	Farmer	124	31
	Student	15	3.8
Number of under-five children	One	321	80.3
	Two	60	15
	Three	19	4.8
BMI of children	(Normal) ⩾11.5	231	58.5
	(Underweight) ⩽11.5	166	41.5

Table 2. Environmental and related characteristics of the study participants in Dabat district, Northwest Ethiopia, 2022.

VARIABLES	CATEGORIES	FREQUENCY	PERCENT
Latrine ownership	Yes	294	73.5
	No	106	26.5
Types of latrines used	Open defecation	92	23
	Public latrine	53	13.3
	Private latrine	255	63.7
Causes of diarrhea	Chewing sugar cane	6	7.2
	Eating contaminated food	38	45.8
	Drinking dirty water	25	30.1
	Eating uncooked cabbage	11	13.3
	Eating sweet food	3	3.6
Major water source	Pip	245	61.3
	Protected well/spring	81	20.3
	Unprotected well/spring/river	74	18.5
Water availability at all time	Yes	78	19.5
	No	322	80.5
Water container	Jerrican	371	92.8
	Others (pot, plastic bucket)	29	7.2
Household water treatment	Yes	296	74
	No	104	26
Methos used to treat water before drinking	Boiling	60	15
	Chlorination	232	58
	Sedimentation	108	27
Covering water storage	Yes	333	83
	No	67	17
How do you take water from the drinking water storage container?	pouring	303	75.8
	Dipping	97	24.5
Preparing children's meals while mothers are having diarrhea	Yes	160	40
	NO	240	60
Mothers/caregivers hand washing after toilet use	Yes	304	76
	No	96	24
Washes vegetables before use	Yes	303	75.8
	No	97	24.2
Children's meal	Rarely fresh	58	14.5
	Sometimes fresh	77	19.3
	Always fresh	265	66.3

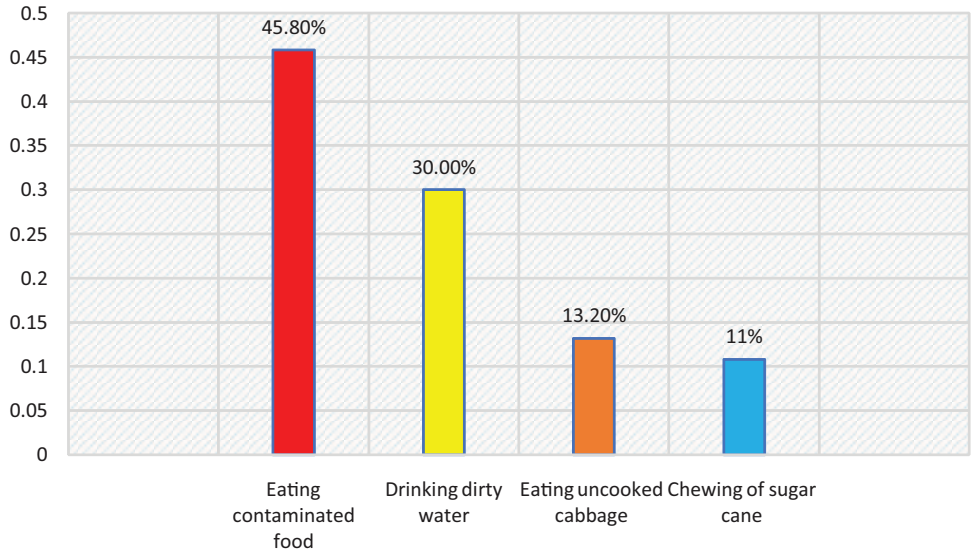

Figure 2. Figure: Causes of diarrhea among under-five children in Dabat district,2022 (N = 83).

Table 3. Bivariable and multivariable logistic regression analysis of diarrhea and associated factors among under-five children in the Dabat district, 2022.

VARIABLES	CATEGORY	DIARRHEA DISEASE		COR (95% CI)	AOR (95% CI)	*P*-VALUE
		YES	NO			
Marital status mother	Married	38 (14%)	234 (86%)	1	1	1
	Divorced	17 (39.5%)	26 (60.5%)	4 (1.99-8.15)	2.3 (0.59-9.2)	.07
	Single	21 (37.5%)	35 (62.5%)	3.7 (1.94-7)	2.45 (0.63-9.47)	.34
	Windowed	7 (25%)	21 (75%)	2 (0.81-5.15)	2.6 (0.4-16)	.067
Nutrition status of children	Undernutrition (MAUC < 11.5)	63 (75%)	21 (25%)	1.36 (1.6-7.8)	3.6 (1.09-11.3)	.003*
	Normal (MAUC > 11.5)	62 (19.7%)	253 (80.3%)	1	1	1
Latrine availability	Yes	59 (55.7)	47 (44.3%)	1		1
	No	24 (8.2%)	269 (91.8%)	14 (7.78-24.7)	3.9 (1.23-9.56)	.002*
Types of latrines	Open defecation	59 (64.1%)	33 (35.9%)	22.11 (14.74-41.6)	5.9 (3.42-11.66)	.04*
	Public latrine	5 (9.4%)	48 (90.6%)	1.28 (0.46-3.61)	1	.08
	Private latrine	19 (7.5%)	236 (92.5%)	1	1	1
Residence	Rural	65 (47.8%)	87 (57.2%)	9.5 (5.33-16.9)	4.7 (1.52-8.09)	.0001**
	Urban	18 (7.3%)	229 (92.7%)	1		1
Educational status of the mother	Unable to read and write	60 (51.3%)	57 (48.7%)	29.5 (11.5-77.19	3.7 (1.07-8.95)	.002*
	Read and write	3 (6.5%)	43 (93.5%)	9.95 (0.44-8.51	1.5 (0.15-16)	.09
	Secondary school(grade9-12)	14 (15%)	79 (85%)	6.22 (2.14-18.02)	1.06 (0.086-13.33	.16
	Diploma and above	5 (3.4%)	140 (96.6%)	1	1	1
Sources of water	Pipe	16 (6.6%)	228 (93.4%)	1	1	1
	Protected well/spring	17 (21%)	64 (79%)	3.78 (1.81-7.9)	2.4 (0.42-14.66)	.086
	Unprotected well/spring /river	50 (67.6%)	24 (32.4%)	28 (3.74-59)	4.6 (1.025-15.32)	.000*

(Continued)

Table 3. (Continued)

VARIABLES	CATEGORY	DIARRHEA DISEASE		COR (95% CI)	AOR (95% CI)	*P*-VALUE
		YES	NO			
Water treatment	No	65 (62.5%)	39 (37.5%)	25.64 (13.71-47.69)	7.6 (6.4-12.7)	.0001*
	Yes	18 (6.1%)	277 (93.9%)	1	1	1
Washing hands after latrine use	No	62 (25.8%)	178 (74.2%)	2.27 (1.33-3.93)	1.27 (0.47-3.45)	.06
	Yes	21 (13.2%)	138 (86.8%)	1	1	1
Eating uncooked vegetables or fruits	No	75 (45.7%)	89 (54.3%)	23 (11.08-55.59	5.6 (6.4-13.5	.03
	Yes	8 (3.4%)	277 (96.6%)	1	1	1

Hosmer and Lemshow = 0.737, *P-value, ⩽.05, **P value <.001.

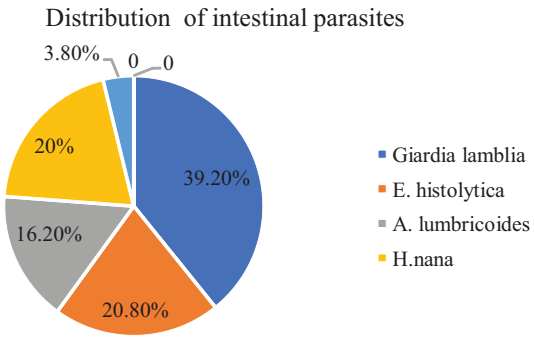

Figure 3. Prevalence of intestinal parasites among under-five children in Dabat district, 2022.

drank untreated water had a higher risk of developing a parasite infection (AOR = 2.3; 95% CI: 1.09-3.7). This study found that children who drank pipe water were a 4.5 times higher chance of having intestinal parasite infection as compared to those children who drank river or well water (AOR = 4.5; 95% CI: 2.32-8.92). The prevalence of intestinal parasites was higher among children who were not dewormed with antiparasitic drugs as compared to those children who were dewormed (AOR = 2.4, 95% CI:1.34-5.62) (Table 4).

Discussion

This study assessed the prevalence and factors associated with diarrheal diseases and intestinal parasitic infection among children below 5 years in the Dabat district, northern Ethiopia in 2022.

In this study, the prevalence of diarrhea among under-five children was 20.8% (95% CI, 16.8-24.8). This study was comparable with the study conducted in the Jabithennan District of northwest Ethiopia (21%).[24] This result was higher as compared to the study conducted in East Africa 14.28%[4] and in Rwanda;13.2%.[25] This high prevalence might be due to the low level of personal hygiene, food hygiene, and sanitation-related knowledge on diarrhea prevention.[26] However, this finding was lower than a study conducted in Congo; 26%,[27] Nigeria; 49.3%,[28] and Nepal; 40.2%.[29] This discrepancy might be due to a difference in socio-demographic characteristics, location, climate, the culture of stool disposal, water access, and the culture of handwashing.[30-32] We found that diarrhea disease was positively associated with undernutrition, latrine availability, and types of latrines. educational status of the mother, water treatment, residence, and feeding cooked vegetables or fruits. Findings from our study indicated that undernutrition children were more likely to have diarrhea disease as compared to children who had normal nutritional status (AOR = 3.6; 95% CI: 1.09-11.3). This study is supported by a study conducted in rural Bangladesh,[33] India,[34] and a study done in the Tigray region of Northern Ethiopia.[35] This could be a result of undernutrition, which slows down the turnover of epithelial cells and causes healing to take longer. This could extend an episode of infectious diarrhea both on its own and by encouraging tissue invasion by other enteric pathogens. Malnutrition may also change the protective host factors, favoring the pathogenic microorganisms' colonization of the intestine.[30,33,36] The likely hood of developing diarrhea disease was 3.9 times higher among children whose families did not access a private latrine as compared to children whose families those private latrines (AOR = 3.9; 95% CI: 1.23-9). This study is consistent with a study conducted in East Africa,[4] in Malaysia.[37] Children who were without access to clean latrines had an increased chance of contamination with microorganisms due to possible contact with fecal materials, which result in an increased chance to dispose of diarrhea disease.[38] In our study, we found that children whose mothers utilized open-field defecation were 5.9 times the chance of having diarrhea disease as compared to mothers who used private latrines (AOR = 5.9; 95% CI: 3.62-11.6). This study is consistent with a study conducted in Kenya.[39] This could be due to increasing the likelihood that children will come into contact with the causing organisms.[40] In this study, children from illiterate parents were more likely to have diarrhea compared to those born to parents with a diploma and above educational level (AOR = 2.4; 95% CI: 1.08-3.2). This study was supported by a study conducted in Indonesia[41] and Nigeria.[42] This might be

Table 4. Bivariable and multivariable logistic regression analysis of parasitic infection and associated factors among under-five children in the Dabat district, 2022.

VARIABLES	CATEGORY	PARASITIC INFECTION		COR (95% CI)	AOR (95% CI)	*P*-VALUE
		YES	NO			
Marital status of children of mothers	Married	84 (30.8%)	178 (75.2%)	1	1	1
	Divorced	20 (46.5%)	23 (55.5%)	1.95 1.09-3.75)	1.8 (0.7-3.9)	.08
	Single	19 (34.5%)	36 (65.5%)	1.18 (0.64-2.19)	0.9 (0.7-11.3)	.12
	Windowed	9 (321%)	29 (67.9%)	1.06 (0.46-2.45)	1.4 (0.85-3.9)	.06
Nutritional status of Children	Undernutrition (MAUC < 11.5	98 (31%)	218 (69%)	3.8 (2.34-6.17)	3.9 (1.09-9.67)	.002*
	Normal (MAUC > 11.5	34 (41%)	49 (59%)	1	1	1
Latrine availability	No	57 (53.8%)	49 (46.2%)	3.3 (2.1-5.37)	2.1 (1.32-9.32)	.04
	yes	75 (25.6%)	218 (74.4%)	1	1	1
Types of latrines	Open defecation	55 (59.8%)	37 (40.2%)	4.8 (2.8-7.9)	3.2 (1.08-3.22)*	.03
	Public latrine	17 (32.8%)	36 (67.9%)	1.5 (0.8-2.9)	1.3 (0.9-3.9)	.13
	Private latrine	60 (23.6%)	194 (76.4%)	1	1	1
Residence	Rural	74 (48.7%)	78 (51.3%)	3.09 (2.005-4.75)	2.8 (1.92-8.12)*	.021
	Urban	58 (23.5%)	189 (76.5%)	1	1	1
Educational status of mothers	Not read and write	61 (52.1%)	56 (47.9%)	4.2 (2.45-7.2)	2.4 (0.98-3.2)	.9
	Read and write	16 (34.8%)	30 (65.2%)	2.06 (4.2)	0.8 (0.89-2.9)	.34
	Secondary school (grade9-12)	25 (27.8%)	65 (72.2%)	2.4 (0.73-7.9)	2.9 (0.94-4.5)	.3
	Diploma and above	30 (20.5%)	116 (79.5%)	1	1	1
Source of water for drinking	Pipe	58 (23.7%)	187 (76.3%)	1	1	1
	Protected well/spring	30 (37.5%)	50 (62.5%)	1.9 (2.56-8.2)	3.1 (0.98-4.9)	.76
	Unprotected well/spring/river	44 (59.5%)	30 (40.5%)	5.6 (1.59-19.9)	4.5 (2.32-8.92)*	.03
Water treatment	No	44 (42.3%)	60 (57.7%)	1.72 (1.08-2.73)	2.3 (1.09-3.7)*	.04
	Yes	88 (29.8%)	207 (70.2%)	1	1	1
Eating uncooked vegetables or fruits	No	65 (39.9%)	98 (60.1%)	1.67 (1.09-2.55)	6.7 (3.9-9.8)*	.001
	Yes	67 (28.4%)	169 (71.6%)	1	1	1
Washing hand habits after latrine used	No	47 (56%)	37 (44%)	2.97 (1.32-8.72)	2.2 (1.06-3.86)*	.003
	Yes	94 (30.2%)	220 (69.8%)	1	1	
Deworming children	No	16 (47,1%)	18 (52.9%)	3.94 (1.8-8.07)	2.4 (1.34-5.62)*	.002
	Yes	66 (18.3%)	295 (81.7%)	1	1	1

due to children who were born from mothers who had higher educational levels reducing the chance to expose their children to diarrhea disease.[43] This study found that children who drank untreated water were 7.6 times higher having diarrhea disease as compared to children who drank treated (AOR = 7.6; 95% CI: 6.4-12.7). This study was in line with a study conducted in Senegal.[44] This may be the result of the fact that collected water is vulnerable to contamination during collection, transit, and storage, which may raise the risk of diarrheal infections.[45] This study showed that children in rural areas were more likely to get the diarrheal disease than those in urban areas (AOR = 4.7; 95% CI: 1.52-8.09). This study is supported by a study conducted by Fagbamigbe et al.[46] This might be brought on by the rural area's lack of social amenities and fundamental infrastructure, such as better water supplies and latrines. The likelihood of being exposed to dangerous pathogens rises as a result.[47] In

the current study, children who eat uncooked vegetables were 5.6 times higher to develop diarrhea compared to those children who did not eat cooked vegetables. This study is consistent with a study done in Addis Ababa, Ethiopia.[48] The reason might be due to children might be exposed to enteropathogenic bacteria found in raw fruit and vegetables.[49] Under-five children who live in Ethiopia continue to experience serious public health issues related to intestinal parasite diseases brought on by helminths and protozoa infections.[50]

According to the current study from the Dabat district in northwest Ethiopia, the overall prevalence of intestinal parasites was 32.5% (95% CI: 28.6-37.8). This study was in line with a study conducted in Northern Mozambique, 31.6%.[51] This finding was higher than a study conducted in Wongji Shoa Sugar Estate, Ethiopia 24.3%.[52] However, this finding was lower than a study done in the Urban Slum of Karachi, Kuwait 52.8%.[53] Geographical disparity, awareness of the need to prevent intestinal parasite infection, and the mode of transmission could all be responsible for this disparity. Additionally, health education provided by health extension workers has a significant impact on people's attitudes toward preventing intestinal infections and providing for their families childcare needs.[54,55] Five intestinal parasite species were found in this study. The most frequent protozoa found in the stool samples were Entamoeba histolytica/dispar and Giardia lamblia. Ascaris lumbricoides were also found in varied prevalence, while Schistosoma mansoni, Hymenolepis nana, and Hookworm were found in 20%, 16%, and 3.8 of the stool samples, respectively. This result was considerably less than a study carried out in Cuba,[56] Nepal,[57] and Pakistan.[53] This discrepancy may be explained by differences in the study participants' consumption of raw vegetables, handwashing practices, and levels of water contamination. Differences in the distribution of species may be caused by the diagnostic methods, socioeconomic status of the parents of the children, and geographic differences. This study showed a significant relationship between intestinal parasitic infection and with Mother's educational level, hand washing habit after latrine used, latrine used, types of latrines, water treated before consumption, and feeding rarely fresh meals. The prevalence of intestinal parasites was 2.4 times higher among children who were born from mothers who have no formal education as compared to children who were born to mothers that had a diploma and above (AOR = 2.4; 95% CI: 1.08-3.2). This study is comparable to a study done in Turkey.[55] This could be due to educated mothers may be aware of the transmission and prevention methods for infectious diseases.[58] This study showed 2.2 increased odds of suffering from an intestinal parasitic infection in a child whose mother had poor handwashing habits compared to those with proper hand washing habits (AOR = 2.2; 95% CI: 1.06-3.86). This stud was consistent with a study conducted in Hawassa, Ethiopia.[21] Dirty hands serve as portals for carrying infectious pathogens to the skin of the child, especially the hands, and further inoculation into the mouth, thus increasing diarrhea.[59] The odds of diarrhea disease among children who were fed uncooked veritable fruits was 6.7 times higher as compared to children who were fed cooked vegetable fruits regularly (AOR = 6.7; 95% CI: 3.9-9.8). This study was comparable to a study conducted in West Africa.[60] This might be due to the uncooked vegetables or fruits prone to a proliferation of bacteria and other intestinal parasites.[49] The likely hood of being infected by intestinal parasites was increased more than 3 folds among children who used Open defecation fields as compared to children who used private latrines (AOR = 3.2; 95% CI: 1.08-3.22). Similar findings were also reported from other parts of Nepal[61,62] and a study done on the Ivory Coast.[63] We explained that using open defecation fields increases the chance of contamination with intestinal parasites.[64] This study reported that the rate of parasitic infection was significantly more among under-five children who were not taking antiparasitic drugs compared to those children who received the antiparasitic drug (AOR = 2.4; 95% CI: 1.34-5.62) his study was supported by a study conducted in Nepal.[65] This might be a result of the antiparasitic medication reducing the number of worms in their bodies.[66]

Limitations

Since the study design was cross-sectional cannot establish the exact cause-and-effect relationships.

Conclusion and Recommendation

The prevalence of diarrhea and intestinal parasite among under-five children was 20.8% and 32.5%, respectively. Undernutrition, latrine availability, types of latrines, residence, feeding uncooked vegetables or fruits, and source of water for drinking and water treatment were associated with intestinal parasitic infection and diarrheal disease. Deworming children with antiparasitic medications and washing hands after latrine use was also significantly associated with parasitic infection. Hence, this study recommended to health policymakers make effective strategies and policies to enhance awareness activities on latrine utilization and building, keeping personal hygiene, safe water supply, feeding cooked vegetables or fruits, taking anti-parasitic medications, practicing hand washing habits after latrine use to reduce diarrhea and parasitic infection in under-five children.

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Author Contributions

Mihret Melese coordinated the process of data collection, data cleaning, statistical analysis, and manuscript writing. Dagnew Getnet, Mihret Melese and Tsegaye Adane, Jember Azanaw, and Wudneh Simegn were involved in the interpretation of the results and writing of the manuscript. All authors reviewed and approved the final manuscript.

Availability of Data and Materials

The datasets used and/or analyzed during this study are available from the corresponding author and provided on a reasonable request.

Consent for Publication

Not applicable.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Ethical Review Committee of the School of Medicine, College of Medicine and Health Sciences, University of Gondar (457/04/2022), and a letter of permission was taken from the Dabat health office (1081/04/2022). After the study participants were adequately briefed about the study, verbal and oral informed consent were taken from each study participant. All methods were performed following the relevant guidelines and regulations of the Declaration of Helsinki.[34] It was confirmed that the study met the ethical and scientific standards outlined in national and international guidelines. Written informed consent was obtained from each study participant. Study participants that have diarrhea and parasitic infection were consulted with physicians for further examinations.

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