

# Relative burden of diarrheal cases in under-five children before and during COVID-19 pandemic in Ethiopia: a retrospective study

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## Research Article

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# Abstract

**Background:** The burden of diarrhea in under-five children is a problem in Ethiopia. The different measures taken to prevent COVID-19 pandemic are believed to have impact on the burden of diarrhea. However, there is no data that shows the association of COVID-19 pandemic and burden of diarrhea in under-five children. The aim of this study was to assess burden of diarrheal cases and associated factors among under-five children that attended primary health centers before and during COVID-19 pandemic in Addis Ababa and Debre Berhan, Ethiopia.

**Methods:** This retrospective study was carried out using data extracted from under-five children registered from January 2019 to December 2020 in Teklehaymanot Health Center, Addis Ababa, and 04 kebele health center, Debre Berhan, Ethiopia. Data analysis was made by SPSS statistics version 20.

**Results:** A total of 11, 337 under-five registers of two years were reviewed. Diarrhea was the second leading cause for visiting health facilities to under-five children. The overall prevalence of diarrhea was 19.8%, with 20.2% before and 18.6% during COVID-19. There was no statistically significant difference for diarrhea before or during COVID-19 pandemic (AOR=1.117, 95%CI=0.898, 1.389). Higher prevalence was seen in male (21%) and in age range between 12-24 months (22.6%). Male had less likelihood to have diarrhea compared to female (AOR= 0.832, 95% CI=0.756, 0.915). Children with age <6 months were 1.5 times more likelihood to have diarrhea (AOR= 1.474= 95% CI= 1.240, 1.753) compared to age range with > 24 months. Children who lived in Addis Ababa had two times more risk of getting diarrhea (AOR= 1.903, 95% CI=1.717, 2.109) compared to children who lived in Debre Berhan. Diarrhea occurred 3 times during spring (AOR= 2.615=95%=2.239, 3.053) and 1.3 times in winter (AOR= 1.319=95% CI=1.133, 1.536) compared to summer.

**Conclusions:** The burden of diarrhea remains high. However, the impact of COVID-19 on diarrhea for under-five children was not statistically significant. Sex, age, seasonality, and study area were associated with the diarrhea. We recommend assessment of community practices of the COVID-19 prevention measures, season dependent pathogens of diarrhea, and creating active health facility based surveillance for better understanding of the impact.

## Introduction

Many under-five children fail to reach their developmental milestones: physical, emotional, social and cognitive development due to poverty, poor health and nutrition, and deficient care in developing countries (1). Children who suffer from stunted growth tend to have more frequent episodes of several infectious diseases including diarrhea (2). World Health Organization (WHO) (3) defined diarrhea as a passage of three or more loose or liquid stools per day(3). Poor nutritional status leads to greater risk of diarrhea (4) and occurrence of infection by diarrheagenic bacteria (5). Children with acute malnutrition are three times more likely to die from diarrhea than children with better nutritional status (6). Poor

hygiene conditions, poor sanitation, lack of access to clean water supply and inadequate personal hygiene are also associated with 90% of diarrheal disease occurrence in developing countries (7).

Diarrheal diseases have been recognized as a serious global health problem and still under-five children and the elderly are the most vulnerable to it (8). Diarrheal disease kills more number of children than AIDS (acquired immunodeficiency syndrome), malaria, and measles combined globally (9). According to WHO, diarrhea was the second leading cause of death in under-five children in 2017 (3). Regardless of significantly declined global under-five mortality rate, the highest under-five mortality rate remains in the WHO African region(10). Countries in sub-Saharan Africa and South Asia account for almost 90% of global diarrheal deaths in children (11). Over 1.23 million under-five children die due to pneumonia and diarrhea globally before reaching their 5<sup>th</sup> birthday (12). About 1,200 young children die every day of diarrhea (12) and 70% of all pneumonia and diarrhea deaths in under-five children occur in 15 pneumonia and diarrhea high-burden countries. Ethiopia is the fifth among 15 pneumonia and diarrhea high-burden countries(12).

According to global health estimates, diarrheal disease was the third leading causes of death in Ethiopia next to neonatal conditions and lower respiratory infections for both sexes among all age groups in 2019 (13). Specifically, it was the second causes (next to lower respiratory infections) of death for children aged from 1-4 years old (13).

Based on the data from Ethiopia Demographic and Health Surveys (DHS)(14-17), both under-five mortality and diarrhea prevalence declined from 2000 compared to 2016. Prevalence of diarrhea in under-five children was 24% in 2000 (14), 18% in 2005 (15), 13% in 2011(16), and 12% in 2016 (17). Similarly the under-five mortality was 97 per 1000 live births in 2000 (14), 77 in 2005 (15), 59 in 2011 (16), and 48 in 2016 (17). However, the reduction rate for both mortality and prevalence of diarrhea were very slow contrary to the expectation. A systemic review and meta-analysis study done with 31 studies revealed that the pooled prevalence of diarrhea among under-five children in Ethiopia was 22% (18). Many recent local studies also showed the prevalence of diarrhea in under-five children ranging from 10.2% to 29.9% (19-25). Diarrheal disease has contributed to 38.4% of deaths from infectious and parasitic diseases and 8% of the total death in Ethiopia (26). These showed the burden of diarrhea in under-five children is a serious problem in Ethiopia.

Many efforts have been done globally and locally for the control of diarrheal diseases (27-29).The integrated global action plan for the prevention and control of pneumonia and diarrhea published in 2009 and 2013 to achieve a global 75% reduction in incidence of severe pneumonia and diarrhea in under-five children by 2025 (12). Regardless of appreciated efforts made so far, nowadays the COVID-19 pandemic made great crisis in the health sectors and catastrophic effects on people's lives globally (30). The catastrophic impact of the COVID-19 pandemic threatens to reverse progress in protecting the children from preventable illnesses, mainly from pneumonia and diarrhea (12). Moreover, diarrhea is a common early symptom in a significant proportion of patients with COVID-19 infection (31) which could increase the prevalence of diarrhea. On the other hand, the prevention and control measures such as frequent

hand washing, decreasing person to person contact like hand shaking for prevention of COVID-19 changes the incidence of some infectious diseases including intestinal infectious diseases (32). Thus, it is not known that the impact of COVID-19 is either increase the diarrhea problem or reduce it for under-five children in Ethiopia. The aim of the present study was to assess burden of diarrheal cases among under-five children that attended primary health centers before and during COVID-19 pandemic.

## **Materials And Methods**

### **Study area and settings**

A retrospective study was carried out using data extracted from register of under-five children enrolled in Teklehaymanot Health Center, Addis Ababa and 04 Kebele Health Center, Debre Berhan, Ethiopia. Addis Ababa is the capital city of Ethiopia. According to Population and Housing Census 2007, the city has 2,739,551 population (33) and administratively divided in to 11 sub cities. Debre Berhan is a town located 130 km far from Addis Ababa. The town has a total population of 65,231 (33) and 14 administrative kebeles. Currently, the population growths are believed to be high in both area and like for example the Addis Ababa Population in 2021 has been estimated to be 5, 005, 524 (34). The first report of COVID-19 was in China on 31 December 2019 (35), in Ethiopia on 13 March 2020 (36) and WHO declared it as a pandemic on 11 March 2020 (35). The period for data collection considered the time when COVID-19 first reported (from January 2019) to include data for characterizing seasonal variation of the diarrhea. However, the time when WHO declared COVID-19 as a pandemic was used to classify data in to before and during COVID-19 pandemic.

### **Data collection method and procedure**

Only those patients with full information recorded in the under-five OPD (Out Patient Department) register were included for analysis. Socio-demographic data and clinical illness were collected. The under-five OPD register was used as data source. The collected data included visiting date (day, month and year), study area, age, sex, and registered clinical presentations. Both health centers use integrated management of newborn and childhood illness guideline (37) for registration of under-five OPD. Data was extracted manually from this register using developed structured format.

### **Statistical analysis**

The collected data were entered into an Excel spread sheet and cross-checked for the correctness before analysis. Data analysis was made by transforming the data from Excel into IBM SPSS Statistics version 20. Descriptive statistics such as frequency and percent distribution were done. The difference between variables was computed by using a Chi Square statistic. Significance was considered at a P-value less than 0.05. The association between occurrence of diarrhea and independent variables were computed using binary logistic regression. Crude odds ratio (COR) and adjusted odds ratio (AOR) were used to present the results. The distribution of diarrhea prevalence and seasonal diarrhea prevalence were presented in graph.

## **Ethical Consideration**

The study was carried out after obtaining ethical clearance from Akililu Lemma institute of pathology Institutional review board, Addis Ababa University. A written permission was obtained from the administrative office of each health facility for conducting the research in under-five unit of health centers.

## **Results**

### **Socio-Demographic Characteristics**

A total of 11, 337 children attended the two Health Centers and found registered on under-five OPD registers viewed within two years period. Of this, 7894 (69.6%) were at Tekle Hymanot Health Center, Addis Ababa and 3443 (30.4%) were from Kebele 04 Health center, Debre Berhan. A total of 6234 (55%) were male and 5103 (45%) were female. The mean age of the patients was 25.15 months. Majority of the patients (44.5%) were in age ranges greater than 24 months. Higher number of patients visited health facilities in 2019 (7358, 64.9%) compared to in 2020 (3979, 35.1%). Detail information on socio-demographic characteristics is presented in Table 1.

Table 1. Socio-demographic characteristics of under-five children who visited health facilities in Addis Ababa and DebreBerhan from 2019 to 2020 in Ethiopia.

<b>Variables</b>		<b>Frequency</b>	<b>Percent</b>
<b>Sex</b>	Male	6234	55.0%
	Female	5103	45.0%
	Total	11337	100.0%
<b>Age</b>	< 6 moths	1280	11.3%
	7-11 months	1553	13.7%
	12-24 months	3454	30.5%
	> 24 months	5050	44.5%
	Total	11337	100.0%
<b>Study site</b>	Addis Ababa	7894	69.6%
	Debre Berhan	3443	30.4%
	Total	11337	100.0%
<b>Year of visit</b>	2019	7358	64.9%
	2020	3979	35.1%
	Total	11337	100.0%
<b>Visit time relative to Covid-19</b>	Before COVID-19	8197	72.3%
	During COVID-19	3140	27.7%
	Total	11337	100.0%
<b>Season of visit</b>	Spring (Tseday)	3437	30.3%
	Winter (Bega)	3137	27.7%
	Autumn (Belg)	2872	25.3%
	Summer (Kiremt)	1891	16.7%
	Total	11337	100.0%

### **Clinical illness of under-five children**

Different clinical illnesses of the under-five children were obtained from the records. Table 2 shows detail about the clinical presentations of the patients. Diarrhea was the second leading cause for visiting health facilities to under-five children. The overall rate of diarrheal cases among under-five children who visited health centers was 19.8%, and 17.6% was for Addis Ababa and 24.7% was for Debre Berhan. The prevalence of diarrhea in male was 21% and 18.3% in female. Higher prevalence was seen in age range between 12-24 months (1-2 years).

Table 2. Clinical illnesses of under-five children who visited health facilities Tekle Haymanot HC , Addis Ababa and Kebele 04, HC, DebreBerhan from 2019 to 2020 in Ethiopia.

Diseases presentation	Frequency (%)					
	Year of visit			Visit time relative to covid-19		
	2019	2020	Total	Before	During	Total
<b>Tonsillitis</b>	1707 (23.2%)	829 (20.8%)	2536 (22.4%)	1916(23.4%)	620 (19.7%)	2536 (22.4%)
<b>Diarrhea</b>	1498 (20.4%)	742 (18.6%)	2240 (19.8%)	1656 (20.2%)	584 (18.6%)	2240 (19.8%)
<b>Cough or cold no pneumonia</b>	950 (12.9%)	525 (13.2%)	1475 (13.0%)	1092 (13.3%)	383 (12.2%)	1475 (13.0%)
<b>Pneumonia</b>	705 (9.6%)	255 (6.4%)	960 (8.5%)	756 (9.2%)	204 (6.5%)	960 (8.5%)
<b>Skin infections</b>	360 (4.9%)	465 (11.7%)	825 (7.3%)	390 (4.8%)	435 (7.3%)	825 (7.3%)
<b>Intestinal problem</b>	370 (5.0%)	192 (4.8%)	562 (5.0%)	398 (4.9%)	164 (5.2%)	562 (5.0%)
<b>AURTI</b>	356 (4.8%)	155 (3.9%)	511 (4.5%)	411 (5%)	100 (3%)	511 (4.5%)
<b>Eye infections</b>	240 (3.3%)	114 (2.9%)	354 (3.1%)	262 (3.2%)	92 (2.9%)	354 (3.1%)
<b>Acute febrile illness</b>	149 (2.0%)	88 (2.2%)	237 (2.1%)	160 (2%)	77 (2.5%)	237 (2.1%)
<b>Ear infections</b>	156 (2.1%)	64 (1.6%)	220 (1.9%)	177 (2.2%)	43 (1.4%)	220 (1.9%)
<b>Asthma</b>	132 (1.8%)	47 (1.2%)	179 (1.6%)	139 (1.7%)	40 (1.3%)	179 (1.6%)
<b>Mouth infection</b>	74 (1.0%)	48 (1.2%)	122 (1.1%)	82 (1%)	40 (1.3%)	122 (1.1%)
<b>AGE and Tonsilitis</b>	66 (0.9%)	47 (1.2%)	113 (1.0%)	80 (1%)	33 (1.1%)	113 (1.0%)
<b>Malnutrition</b>	52 (0.7%)	46 (1.2%)	98 (0.9%)	61 (0.7%)	37 (1.2%)	98 (0.9%)
<b>Trauma or burn or injury</b>	48 (0.7%)	31 (0.8%)	79 (0.7%)	55 (0.7%)	24 (0.8%)	79 (0.7%)
<b>UTI</b>	43 (0.6%)	21 (0.5%)	64 (0.6%)	45 (0.5%)	19 (0.6%)	64 (0.6%)
<b>Lymphoid disease</b>	24 (0.3%)	9 (0.2%)	33 (0.3%)	24 (0.3%)	9 (0.3%)	33 (0.3%)



<b>Tonsillitis and eye infections</b>	11 (0.1%)	4 (0.1%)	15 (0.1%)	11 (0.1%)	4 (0.1%)	15 (0.1%)
<b>Anemia</b>	11 (0.1%)	4 (0.1%)	15 (0.1%)	11 (0.1%)	4 (0.1%)	15 (0.1%)
<b>Mumps</b>	12 (0.2%)	2 (0.1%)	14 (0.1%)	12 (0.1%)	2 (0.1%)	14 (0.1%)
<b>Tachycardia</b>	6 (0.1%)	6 (0.2%)	12 (0.1%)	7 (0.1%)	5 (0.2%)	12 (0.1%)
<b>Severe dehydration</b>	5 (0.1%)	4 (0.1%)	9 (0.1%)	5 (0.1%)	4 (0.1%)	9 (0.1%)
<b>URTI and IP</b>	5 (0.1%)	2 (0.1%)	7 (0.1%)	6 (0.1%)	1 (0%)	7 (0.1%)
<b>Measles</b>	5 (0.1%)	2 (0.1%)	7 (0.1%)	6 (0.1%)	1 (0%)	7 (0.1%)
<b>Others*</b>	373 (5.1%)	277 (7%)	650 (5.7%)	454 (5.5%)	196 (6.2%)	650 (5.7%)
<b>Total</b>	7358 (100.0%)	3979 (100.0%)	11337 (100.0%)	8197 (100%)	3140 (100%)	11337 (100.0%)

\* Include: Diarrhea and tonsillitis, Epilepsy, malaria, tuberculosis, prolapse of anus, vaginal discharge, and congenital abnormal teeth. AURTI=Acute respiratory infection, AGE= acute gastroenteritis, UTI=Urinary tract infection, IP=Intestinal problems.

The prevalence of diarrhea was higher both in 2019 (20.4%) and before COVID-19 (20.2%) compared to 2020 (18.6%) and during COVID-19 (18.6%). Highest in May (28.8 %) and lowest in November (11%) prevalence was seen in the overall data. More information presented in figure 1 and 2. The diarrhea prevalence was higher in autumn (26%).

### Factors associated with diarrhea in under-five children

Male under-five children had less likelihood to have diarrhea compared to female (AOR= 0.832, 95% CI=0.756, 0.915). Children whose age ranges from 12-24 months were less at risk of getting diarrhea (AOR= 0.836, 95% CI= 0.750, 0.932) compared to age range greater than 24 months. However, children with age range less than 6 months were 1.5 times more likelihood to have diarrhea (AOR= 1.474= 95% CI= 1.240, 1.753) compared to age range with greater than 24 months. Under-five children who lived in Addis Ababa had two times more risk of getting diarrhea (AOR= 1.904, 95% CI=1.717, 2.109) compared to children who lived in Debre Berhan. There was no statistically significant likelihood of getting diarrhea for under-five children who visited health facilities either before or during COVID-19 pandemic (AOR=1.117, 95% CI=0.898, 1.389). Diarrhea occurred 3 times during spring (AOR= 2.615=95%=2.239, 3.053) and 1.3 times in winter (AOR= 1.319=95% CI=1.133, 1.536) compared to summer. Table 3 represents factors associated with diarrhea.

Table 3. Factors associated with diarrhea in under-five children at health facilities in Addis Ababa and Debre Berhan, Ethiopia from 2019-2020.

Variables		Diarrhea			COR (95%, CI)	AOR (95%, CI)	P-value	
		Yes	No	Total				
Sex	Male	1308 (21.0%)	4926 (79.0%)	6234 (100.0%)	0.842 (0.766, 0.924)	<b>0.832</b> <b>(0.756, 0.915)</b>	<b>0.000</b>	
	Female	932 (18.3%)	4171 (81.7%)	5103 (100.0%)	1.00	1.00		
Age	<6 months	188 (14.7%)	1092 (85.3%)	1280 (100.0%)	1.377 (1.162, 1.632)	<b>1.474</b> <b>(1.240, 1.753)</b>	<b>0.000</b>	
	6-11 months	304 (19.6%)	1249 (80.4%)	1553 (100.0%)	0.974 (0.844, 1.125)	1.033 (0.892, 1.196)		0.664
	12-24 months	780 (22.6%)	2674 (77.4%)	3454 (100.0%)	0.813 (0.731, 0.904)	<b>0.836</b> <b>(0.750, 0.932)</b>		<b>0.001</b>
	>24 months	968 (19.2%)	4082 (80.8%)	5050 (100.0%)	1.00	1.00		
Study site	Addis Ababa	1389 (17.6%)	6505 (82.4%)	7894 (100.0%)	1.538 (1.396, 1.694)	<b>1.903</b> <b>(1.717, 2.109)</b>	<b>0.000</b>	
	Debre Berhan	851 (24.7%)	2592 (75.3%)	3443 (100.0%)	1.00	1.00		
Year of visit	2019	1498 (20.4%)	5860 (79.6%)	7358 (100.0%)	0.897 (0.813, 0.989)	0.957 (0.786, 1.166)	0.664	
	2020	742 (18.6%)	3237 (81.4%)	3979 (100.0%)	1.00	1.00		
Visit relative to Covid-19	Before pandemic	1656 (20.2%)	6541 (79.8%)	8197 (100%)	0.902 (0.813, 1.002)	1.117 (0.898, 1.389)	0.321	
	During pandemic	584 (18.6%)	2556 (81.4%)	3140 (100%)	1.00			
Season of visit	Spring (Tseday)	411 (12.0%)	3026 (88.0%)	3437 (100.0%)	2.394 (2.067, 2.223)	<b>2.615</b> <b>(2.239, 3.053)</b>	<b>0.000</b>	
	Winter (Bega)	617 (19.7%)	2520 (80.3%)	3137 (100.0%)	1.328 (1.158, 1.523)	<b>1.319</b> <b>(1.133, 1.536)</b>	<b>0.000</b>	
	Autumn (Belg)	748 (26.0%)	2124 (74.0%)	2872 (100.0%)	0.923 (0.808, 1.056)	0.900 (0.785, 1.033)	0.134	

Summer (Kiremt)	464 (24.5%)	1427 (75.5%)	1891 (100.0%)	1.00	1.00
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## Discussion

Diarrhea remains a leading killer of young children, despite the availability of a simple treatment solution, accounting for approximately 8% of all deaths among children under-five worldwide in 2017 (38). Pneumonia, diarrheal diseases, malaria and measles are the four major infectious diseases that cause death in under-five children globally (39). And about 25% of the overall diarrheal burden has been attributed to diarrhea among under-five in Africa (39). The global sustainable developmental goal aimed to reduce the prevalence of neonatal mortality to 12.5% and under-five mortality to 25% by the year 2030 (27). However, the COVID-19 pandemic brought many health emergencies (30) and would have negative impacts in achieving the goal as the plan. The present study determines burden of diarrhea using data before and during COVID-19 pandemic.

The overall prevalence of diarrhea in under-five children in this study was 19.8%. This finding is similar with studies done in Northwest Ethiopia, 19.8%(40), Debre Berhan, 16.4%(24), Southwest Ethiopia, 21.8% (41), Eastern Ethiopia, 22.5%(42), Somalia, 22.4% (43), Kenya, 18.7%(44), and India, 21.7%(45). Furthermore, a systematic review and meta-analysis study done in Ethiopia revealed similar finding, 22% prevalence of diarrhea in under-five children (18). Inconsistent to the present finding, higher prevalence of diarrhea in under-five children reported in Southern Ethiopia, 30.9% (46), North Central Ethiopia, 29.9% (25), North Shoa of Ethiopia, 31.4%(47), Western Ethiopia, 24%(19), Cameroon, 26.1%(48), and north Sudan, 28% (49). This discrepancy may be due to different in exposure to risk factors of diarrhea present in different area. On the other hand, there are other studies done that reported lower prevalence in compare to the present study. Some of these studies include 8.5% in Addis Ababa (50), 13.6% in Southern Ethiopia (51), 14.5% in Bahr Dar (21), 14.5% in Western Ethiopia (52), 12.1% in Tanzania (53), 11.2% in Nigeria (54), and 4.4% in Malaysia (55). The Ethiopian DHS 2016 reported 12% prevalence of diarrhea (17) which is lower than the present study. The differences may be due to different in study design (e.g. facility based vs community based) that the present study was health facilities based involving on-going cases in the general population and likely to have higher value.

In the present study, the prevalence of diarrhea in Debre Berhan (24.7%) was greater than Addis Ababa (17.6%). This result agrees with study done in Uganda where high prevalence of 59.8% diarrheal diseases in under-five children reported for rural areas compared to urban areas with 42.6% (56). There are certain factors such as mother's education, quality of housing, sharing of water sources, sanitation facilities and use of surface water that may influence childhood diarrhea outcomes in urban versus rural. For example in a study done in Uganda (56) found that rural homes without pit latrines registered 94.0% cases (p-value=0.0053) compared to 5.5% without latrines in urban area which could contribute to high prevalence of diarrhea in rural area. However, statistical analysis showed that the risk of getting diarrhea is 2 times in Addis Ababa greater than Debre Berhan (OR=1.903. 95% CI=1.717, 2.109). This contradiction may be due to difference in a mechanism influenced by population density and/or the built environment (57). The

impact of environmental conditions such as dry condition which could result in water scarcity and/or increased accumulation of fecal contamination in the environment, and the high rainfall and flooding in urban may flush enteric pathogens into waterways used for drinking water, leading to greater exposure and in turn higher risk of diarrhea (57). In addition, the impact of COVID-19 may have more contributions in urban than rural (58).

Males children had greater prevalence (21%) of diarrhea as compared with female children (18.3%), statistically significant ( $p=0.000$ ) in the present study. In the present study females found to be at greater risk of getting diarrhea than boys, it could be a cultural bias in care-seeking behaviour that favours boys and the finding agrees with other studies (44, 59). The prevalence of diarrhea was found to be associated with age less than 6 months ( $p<0.000$ ) and 12-24 months ( $p<0.001$ ) and agrees with study done in Cameroon (48). Children with age less than 6 months were 1.5 times at risk of getting diarrhea (AOR=1.474, 95% CI=1.240, 1.753) compared to age greater than 24 months. These children in age group 12-24 months were less likelihood to have diarrhea (AOR= 0.838, 95% CI=0.750, 0.932) compared to age greater than 24 months.

The prevalence of diarrhea before COVID-19 occurrence (20.2%) was greater than during COVID-19 (18.6%), not statistically significant ( $p=0.292$ ) in the present study. The impact of COVID-19 pandemic on diarrhea might be negative (12, 31) or positive (32). It is better to characterize the aetiology of the diarrhea, particularly during the COVID-19 pandemic, and the community actual practice of the prevention measures of COVID-19 that helps in the prevention of diarrhea. The reduction of prevalence of diarrhea from 2019 (20.4%) to 2020 (18.6%) agrees with other reports (14-17). The Ethiopia DHS data showed that a decrement in diarrhea prevalence among under-five children over the study period, from 24% in 2000 to 18% in 2005 (14, 15), to 13% in 2011(16) and to 12% in 2016 (17). However, the rate of decrement in diarrhea prevalence was very slow, 6% from 2000-2005, 5% from 2005-2011, and 1% from 2011-2016. This tells us the diarrheal burden is still remaining high.

The greatest prevalence was in May (34%) and autumn season (26.0%) in 2019 in the present study. In the overall analysis, the prevalence of diarrhea was high in May (at the end of autumn), June and July (summer) in 2019 but fall during this time in 2020. The prevalence was increased from January to April in Addis Ababa (Figure 1) and from January to July in Debre Berhan (figure 2) during COVID-19. And the prevalence decreased from April to November in Addis Ababa and from July to November in Debre Berhan during Covid-19. This may be due to the campaign done against COVID-19 that includes proper hand washing. However, beginning on November in both study sites (Figure 1 and 2), the prevalence of diarrhea was getting higher and higher during COVID-19. It may be due to decrement in or back to the usual hand wash practices of the community. Overall prevalence of diarrhea was 12% in spring, 19.7% in winter, 26.0% in autumn and 24.5% in summer (figure 3). Diarrhea occurrence was more likely 3 times during spring (AOR=2.975, 95% CI=2.549, 3.473) and 1.5 times during winter (AOR=1.530, 95% CI=1.329, 1.762) compared to during summer. The finding agrees with study done in India (60) and Nepal (61). The variation across different months and seasons may be due to the season dependent pathogens. Like for example, in a study done in China showed that diarrhea was predominant due to bacteria in summer and

virus in winter (62). Establishing active health facility based surveillance will allow clear understanding on occurrence of diarrhea with its aetiology and seasonality. The seasonal variation for prevalence of diarrhea may depends on pathogen spectrum and their seasonality (62) as well as actual community practice of COVID-19 prevention measures that help in the prevention of diarrhea.

## Conclusions

Diarrheal disease is a global killer and sub-Saharan Africa and South Asia account for almost 90% of global diarrheal deaths in children. Ethiopia is the fifth among 15 pneumonia and diarrhea high-burden countries. A dilemma assumptions that either the catastrophic impact of COVID-19 threatens to reverse progress in protecting the children from preventable illness or the prevention and control measures of COVID-19 changes the incidence of some infectious disease including diarrhea was our reason for conducting the present study. In the present study, diarrhea was the second leading clinical illness that cause under-five children to visit health facility. Diarrhea remains high and the overall prevalence of diarrhea was 19.8%. The present study found that the impact of COVID-19 was not statistically significant on diarrhea. Sex, age, study area, and season were predictor variables for diarrhea.

Thus, characterizing community practice of COVID-19 prevention measures that help in prevention of diarrhea for better understanding the impact of COVID-19 pandemic on diarrhea, characterizing season dependent pathogens, sustaining the on-going interventions are recommended. Moreover, creating active health facility based surveillance with comprehensive laboratory detection of enteropathogens will provide data on pathogen spectrum, and COVID-19 impact on diarrhea.

## Abbreviations

AIDS = Acquired Immunodeficiency Syndrome, AOR =Adjusted Odds Ratio, COR= Crude Odds Ratio, DHS= Demographic and Health Survey, OPD= Out Patient Department, WHO =World Health Organization

## Declarations

### Ethics approval and consent to participate

Ethical approval for the study was obtained from Aklilu Lemma institute of pathology Institutional review board, Addis Ababa University. All the study methods were carried out in according to relevant guideline and regulations. Written informed consent was obtained from parents or legal guardian(s) of participants and a witnessed consent was obtained for illiterate parents or legal guardian(s).

### Consent for publication

Not applicable.

### Availability of data and materials

There is no remaining data and materials; all information is clearly presented in the main manuscript.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

TZ was the principal investigator who contributed to origin, the idea and design of the study. TZ, TE, AM and TA collected, entered, analysed, interpreted the data, prepared the manuscript, contributed to data analysis, interpretation and drafted the manuscript. All authors read and approved the final manuscript.

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## Figures

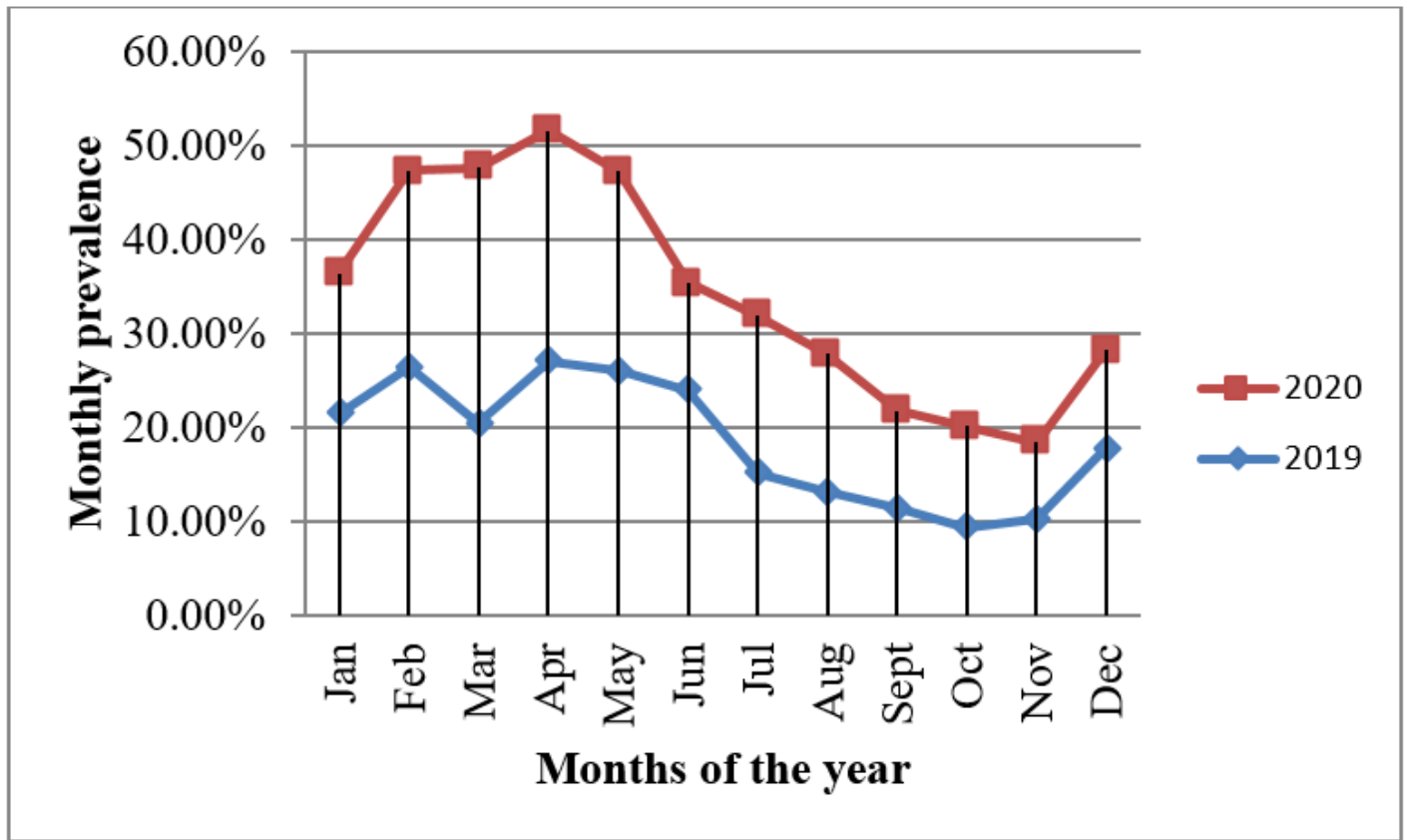
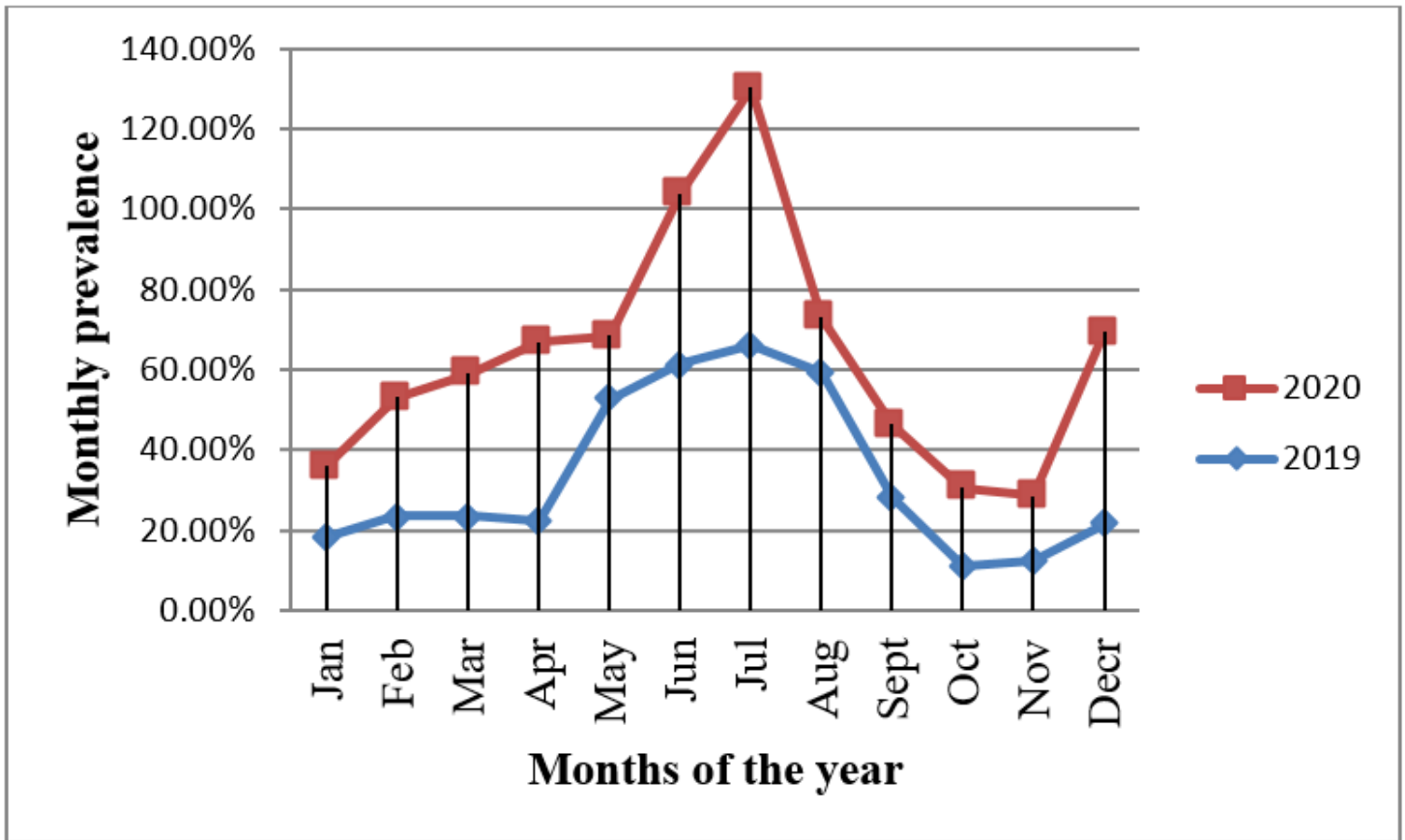


Figure 1

**Distribution of prevalence of diarrhea by months in under-five children in Addis Ababa, Ethiopia.** The blue curve represents prevalence of diarrhea in month for under-five children in 2019. The red curve represents prevalence of diarrhea in month for under-five children in 2020.



**Figure 2**

**Distribution of prevalence of diarrhea by months in under-five children in Debre Berhan, Ethiopia.** The blue curve represents prevalence of diarrhea in month for under-five children in 2019. The red curve represents prevalence of diarrhea in month for under-five children in 2020.

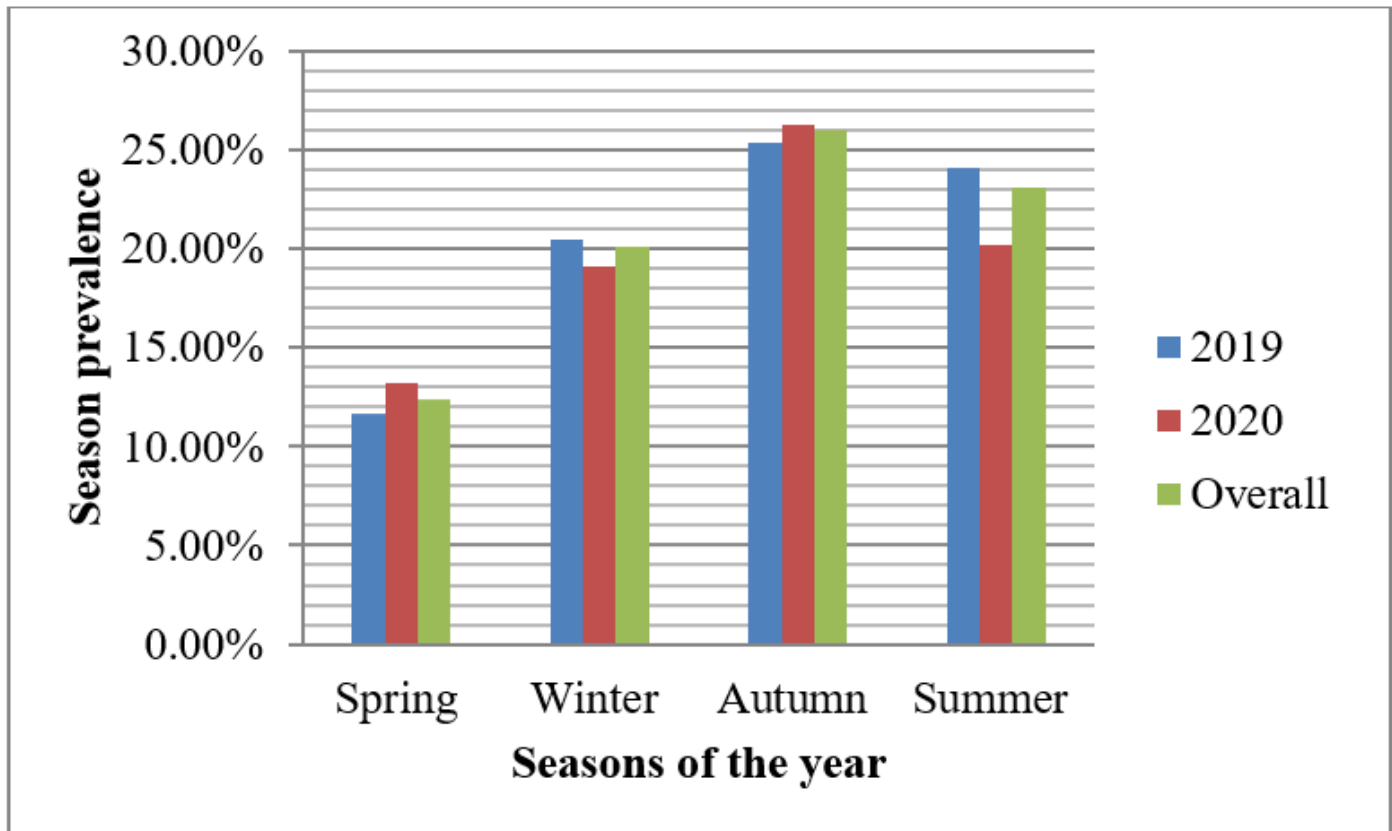


Figure 3

**Seasonal distribution of prevalence of diarrhea in under-five children in Addis Ababa and Debre Berhan, Ethiopia.** The blue bar represents prevalence of diarrhea in spring, winter, autumn and summer seasons for under-five children in 2019. The red bar represents prevalence of diarrhea in spring, winter, autumn and summer seasons for under-five children in 2020. The green bar represents overall prevalence of diarrhea in spring, winter, autumn and summer seasons for under-five children.