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Comorbidity of diarrhea and respiratory infection symptoms, and associated factors among under-five children in Gondar City, Northwest Ethiopia: a community-based cross-sectional study

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Abstract

Background Childhood morbidity is frequently characterized by more than one health condition. Children under the age of five in low- and middle-income countries including Ethiopia experience multiple episodes of diarrhea and respiratory infection symptoms. However, there have been limited studies on comorbidities of diarrhea and respiratory infection symptoms. In addition, most studies conducted in Ethiopia seek separate outcomes for diarrhea and respiratory infection symptoms. Therefore, this study aimed to determine the prevalence of diarrhea and respiratory infection symptoms comorbidity, and associated factors among under-five children in Gondar City.

Methods Community-based cross-sectional study was conducted in Gondar City among under-five children from April 05 – May 04, 2023. Multi-stage sampling technique was used to collect a sample of 836. A structured questionnaire was employed through an interview-administered method for data collection at participants' homes. Bivariable and multivariable binary logistic regression analyses were undertaken to identify predictors of childhood comorbidity of diarrhea and respiratory infection symptoms.

Results The comorbidity prevalence of diarrhea and respiratory infection symptoms in under-five children was 17.22% [CI: 14.8%-19.9%]. Mothers/caretaker age < 25 years (AOR = 3.52 at 95% CI: 1.64, 7.5), mothers/caretakers who had no formal education (AOR = 4.42 at 95% CI: 2.08, 9.94), family size > 5 (AOR = 4.52 at 95% CI: 2.13, 9.61), second birth order (AOR = 2.67 at 95% CI: 1.31, 5.41), children playground not clean (AOR = 2.19 at 95% CI: 1.01, 4.71), started supplementary feeding at age > 6 months (AOR = 4.51 at 95% CI: 1.50, 13.58), mothers/caretakers who didn't wash their hands after visiting latrine (AOR = 2.03 at 95% CI: 1.03, 4.03), mothers/caretakers who didn't wash their hands with soap and water (AOR = 1.92 at 95% CI: 1.00, 3.69) were significantly associated factors with under five children comorbidity of diarrhea and respiratory infection symptoms.

Conclusions According to the findings, the prevalence of diarrhea and respiratory infection symptoms comorbidity was higher and variation in the amount of comorbidity is explained by maternal and child predictors. Educating mothers/caregivers about hand washing, sanitation, hygiene, and supplementary feeding is a key approach for the prevention and control of comorbidities in children.

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Keywords Comorbidity, Diarrhea, Respiratory infection symptoms, Gondar, Ethiopia

Background

Childhood morbidity is frequently characterized by more than one health condition [1]. Globally, pneumonia which is the main complication of Acute respiratory infection (14%) and diarrhea (14%) kills more children under the age of five than Human Immunodeficiency Virus (4%), malaria (16%), and measles (1%), combined [2]. Around 40 and 60 percent of children worldwide receive adequate treatment for the symptoms of diarrhea and acute respiratory infections (ARIs), respectively; nonetheless, diarrhea and ARI continue to be the leading causes of death for under five children [3]. According to World Health Organization reports, each year diarrhea takes the lives of more than 525,000 children under five years worldwide [4]. According to a systematic analysis conducted in 2015, approximately 4.4 million children under the age of five will die from infectious diseases such as diarrhea and ARI by 2030, with Sub-Saharan Africa accounting for 60% of these deaths [5]. In addition around 3 billion people use biomass [6] which is attributed to Indoor air pollution causing 1.5 to 2 million deaths per year worldwide, with 1 million occurring in children under the age of five due to ARI [7].

Acute respiratory infections in Sub-Saharan Africa, account for 42% of child fatalities [8] exposure to indoor air pollution during early childhood, impairs lung function and aggravates pre-existing conditions such as asthma [9]. Ethiopian Demographic and Health Survey 2016 found a 4.3 per cent childhood comorbidity of diarrhea and ARI among 9917 under-five children and residence, vaccination, and mother's education were factors associated with comorbidity [10]. 50,320 infant deaths each year in Ethiopia due to IAP which represents 4.9% of the country's overall illness burden [11]. EDHS 2016 report says 12% of under-five children experienced diarrhea in the two weeks preceding the survey [12]. Malnutrition and failure to thrive are also well-known risk factors for ARI therefore a causal link between diarrhea and subsequent risk of ARI is biologically plausible [13]. Confections of diarrhea and ARI were extremely common among children under five years of age seeking care due to overlapping risk factors such as poor indoor air environment, inadequate provision of water, hygiene, sanitation, overcrowding, breastfeeding for the first 6 months, socioeconomic status, the type of house the child lived in, the maternal occupation, are common risk factors for two diseases [2, 14]. Due to this factors comorbidity of diarrhea and respiratory infection symptoms diseases are

common in under-five children in Africa and specifically, in Ethiopia. Therefore, this study provides insights for healthcare providers, highlighting the specific risks associated with ignoring comorbidities, which can lead to correct prioritization of public health interventions. There is limited evidence on the comorbidity of these two conditions, as most studies examine each condition separately. Accordingly, this study aimed to identify the prevalence of diarrhea and respiratory infection symptoms comorbidity, and associated factors among children under five children in Gondar City, Ethiopia, 2023.

Methods

Study design and setting

A community-based cross-sectional study was conducted in Gondar City among under-five children between April 05 – May 04, 2023. Gondar City is approximately 734.3 km, from Addis Ababa and about 180 km from Bahir Dar City the capital of the Amhara region [15, 16]. According to the most recent administration report, Gondar has an estimated population of more than 454,446, with 218,378 men and 236,068 women. In the City, there are a total of 41,623 under-five children 20,191 males and 21,432 females. It has six sub-City administration areas comprised of 36 kebeles. The City has nine health centers, one referral hospital, and one general hospital that serves the people of Gondar City and the surrounding area (Fig. 1).

Sample size calculation and sampling procedures

The sample size was calculated using a single population proportion formula while keeping the following assumptions in mind: $P=50\%$ of children with comorbidity of diarrhea and respiratory infection symptoms and (no previous study in the study area at the time of the study), 95% confidence interval, 5% margin of error (d), and design effect 2.

$$n = \frac{\left(\frac{Z\alpha}{2}\right)^2 P(1-P)}{d^2} = \frac{(1.96)^2 * 0.5 * 0.5}{0.05^2} = 384$$

By taking 10% of the non-response rate, then the total sample size was 845.

The target populations were included in the study using multi-stage sampling technique with a total of two stages (Fig. 2).

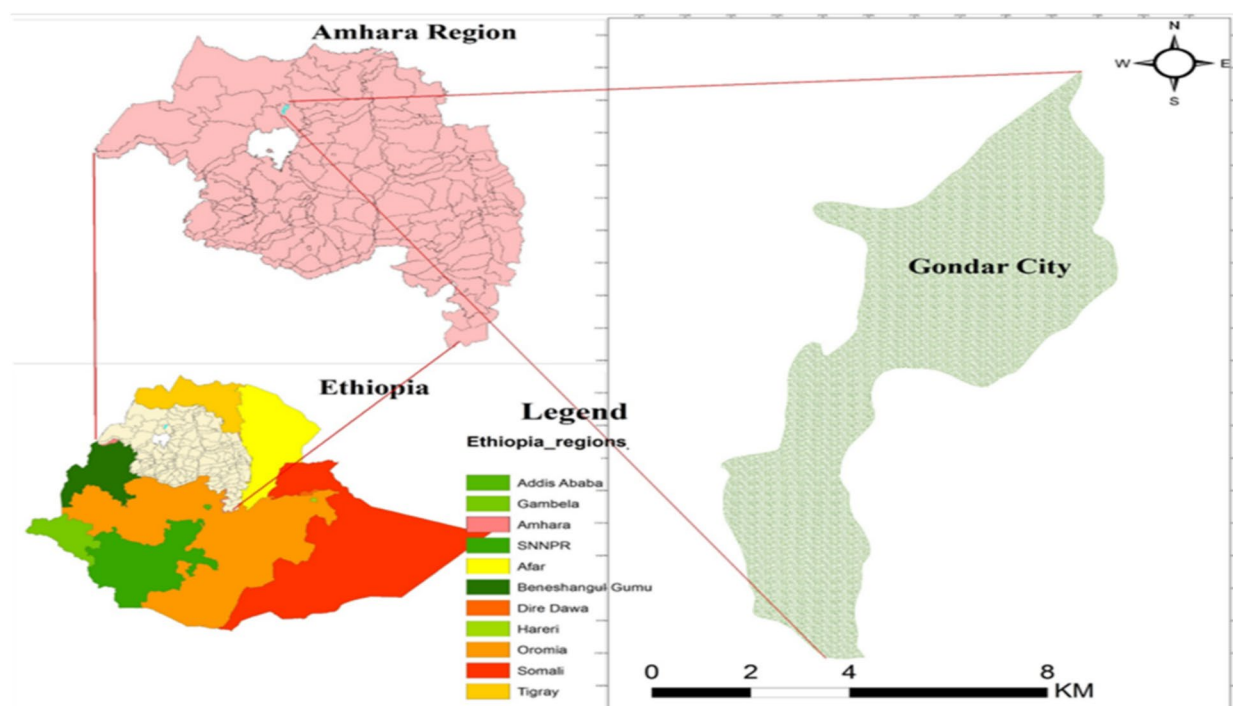


Fig. 1 Map of the Gondar City, Northwest Ethiopia

Data collection tools and procedures

Structured and pretested questionnaires were used to collect data. The questionnaire was prepared based on a review of relevant literature [17–20]. The questionnaire was first prepared in English language and translated to the local Amharic language, and back-translated into English to check consistency. Data were collected from mothers/primary caretakers using an interviewer-administered method. The questionnaire includes a total of four parts which include the socio-demographic characteristics, the child's diarrhea and respiratory infection symptoms, environmental, household and behavioral factors respectively. Data collectors were given two-day training on the tool & exercise it. The questionnaire discussed thoroughly question by question. The data collection process and completeness of data were closely supervised.

Measurement of study variables

Comorbidity was defined as the mother/caretaker self-reported that a child had the occurrence of diarrhea and respiratory infection symptoms together or in a sequential manner [2]. Respiratory infection symptoms were defined as the mother/caretaker self-reported the child had been suffering from cough,

shortness of breath, wheezing, phlegm and blocked or running nose in the past two weeks [21]. Diarrhea was defined as the mother/caretaker self-reported that the child had three or more loose or watery stools in 24 h, in the past two weeks before data collection [22].

Data processing and analysis

All the questionnaires were checked manually for completeness, coded, and entered into EPI info version 7.1.5.2 and exported to Stata version 14.1 software for further analyses. Descriptive analyses were done to describe variables using summary measures, frequencies, figures & tables. Comorbidity of diarrhea and respiratory infection symptoms evaluated by running binary logistic regression. Then explanatory variables with a P -value < 0.20 in bivariable logistic regression were analyzed in multivariable regression. The degree of association between outcome & explanatory variables was assessed using odds ratios and a 95% confidence interval.

Independent Variables with a p -value < 0.05 in multivariable regression are considered statistically significant. Finally, the multi-collinearity of variables was assessed by calculating the Variance Inflation Factor (VIF). Additionally, the Goodness of fit of the model was checked by Hosmer and Lemeshow.

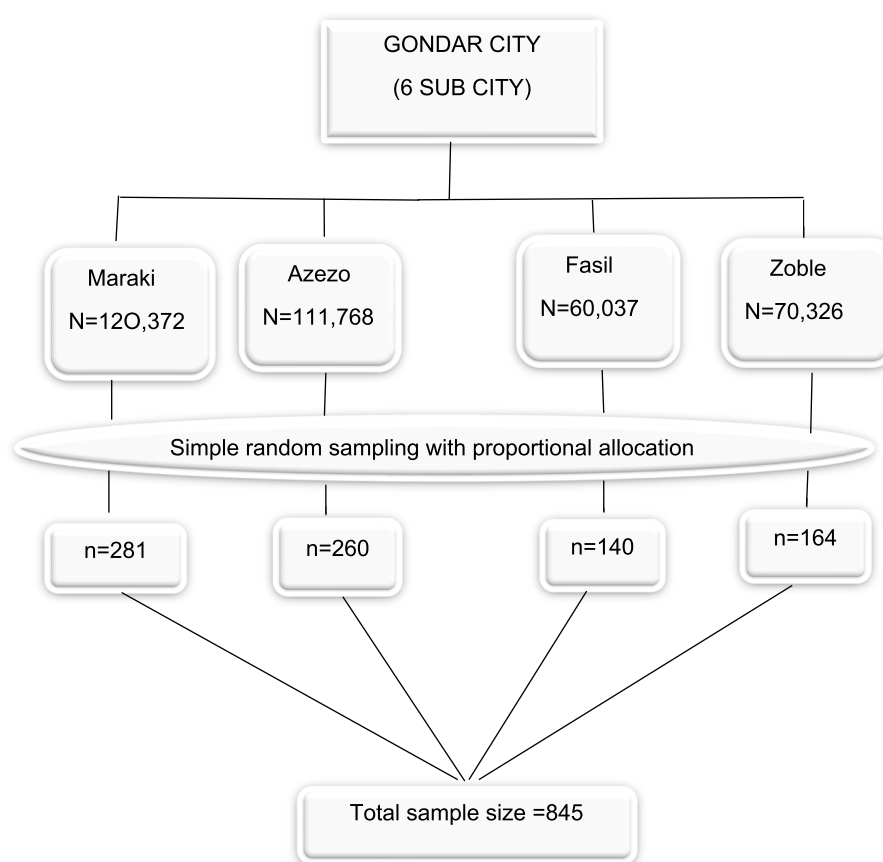


Fig. 2 A Flow chart of the sampling procedures for the selection of study participants in Gondar City, northwest Ethiopia, 2023

Results

Socio-demographic characteristics of mothers/caretakers

A total of 836 participants were enrolled in this study, with a response rate of 98.93%. Seven hundred seventy-nine (93.18%) were female caretakers and fifty-seven were male caretakers (6.82%), the median age is 29. The majority (87.44%) of study participants were Orthodox Christian in religion followed by Muslims (9.69%). Five hundred eighteen (61.96%) of caretakers were housewives (Table 1).

Child-related socio-demographic factors

Of the 836 under five children, the majority, 255 (30.50%), were between 48 and 59 months old, while 243 (29.07%) were between 24 and 35 months. Four hundred thirty (51.44%) were males and four hundred six (48.56%) were females (Table 2).

Housing characteristics and latrine facility status

Only a few households (6.94%) have kitchen exhaust and the majority of the households six hundred seventy-one (80.26%) constructed their house with mud and less

than one-fifth (19.14%) constructed their house with the concert. More than three-fourths (88.28%) of the households have latrine facilities from this majority of facilities were pit latrines with slab (79.89%) and (85.77%) households have shared latrine facilities and less than one-fifth (18.78%) of the household have hand washing facilities. (79.19%) household practice cooking inside the house (Table 3).

Waste disposal and water-related characteristics of the respondents

More than half (58.37%) of household uses a garbage can for waste disposal and eight hundred (95.69%) have improved water source (Table 4).

Childhood diarrheal diseases and respiratory infection symptoms comorbidity in Gondar City

The prevalence of diarrhea among under-five children was 24.64% and the prevalence of respiratory infection symptoms among under-five children was 35.29%.

Table 1 Socio-demographic characteristics of mothers/caretakers in Gondar City between March –April 2023($n = 836$)

Variable	Category	Frequency(n)	Percent(%)
Sex	Female	779	93.18
	Male	57	6.82
Age	<25	191	22.85
	25-27	193	23.09
	28-31	152	18.18
	≥32	300	35.89
The median age of the mother/caretaker is 29 ± 7.63 (SD)			
Religion	Orthodox	731	87.44
	Muslim	81	9.69
	Other*	24	2.87
Marital status	Married	719	86.00
	Divorced	46	5.50
	Other**	71	8.50
Educational status	No	123	14.71
	Primary	263	31.46
	Secondary and above	450	53.83
Education status of the spouse	No	91	11.65
	Primary	216	27.66
	Secondary and above	474	60.69
Average monthly Income(Ethiopian Birr)	1000-4876	213	25.48
	4877-5643	206	24.64
	5644-8000	243	29.07
	≥8001	174	20.81
Occupation of mother	Housewife	518	61.96
	Farmer	8	0.96
	Student	24	2.87
	Private	112	13.40
	Government	132	15.79
	Merchant	31	3.71
	Other***	11	1.32
Occupation of spouse	Farmer	11	1.42
	Student	7	0.90
	Private	486	62.71
	Government	190	24.52
	Merchant	53	6.84
	Other***	28	3.61
House ownership	Private/owned	229	27.39
	Rent from kebele	71	8.49
	Rent from private	530	63.40
	Neither	6	0.72
Family size	≤5 persons	638	76.32
	> 5 persons	198	23.68
Relation of the Respondent to the child	Mother	748	89.47
	Caretaker	88	10.53
Number of rooms	One	513	61.36
	Two	191	22.85
	Three and above	132	15.79
Separate bedroom	No	607	72.61
	Yes	229	27.39
Separate kitchen	No	598	71.53
	Yes	238	28.47

Others* = Protestant, Jewish, or Catholic

Other**=single, separated, widowed

Others*** = daily laborer, driver, or priest

Table 2 Child-related socio-demographic factors in Gondar City between March–April 2023 ($n = 836$)

Variable	Category	Frequency(n)	Percent (%)
Age in month	< 12	87	10.41
	12–23	79	9.45
	24–35	243	29.07
	36–47	172	20.57
	48–59	255	30.50
Sex	Male	430	51.44
	Female	406	48.56
Birth order of a child	First	330	39.47
	Second	269	32.18
	Third	112	13.40
	Fourth	81	9.69
	Fifth and above	44	5.26
Number of under-five children in the household	One	571	68.30
	Two	246	29.43
	Three or more	19	2.27

The comorbidity prevalence of diarrhea and respiratory infection symptoms among under-five children

The comorbidity prevalence of diarrhea and respiratory infection symptoms at a 95% confidence interval was 17.22% [CI: 14.8%–19.9%] (Fig. 3).

Determinants of comorbidity among under-five children

On bivariable analysis, the age of the mother/caretakers, educational status of mother/caretaker, educational status of spouse, average monthly income, family size, number of rooms, birth order, separate bedroom, child sex, kitchen cleanse, a father with asthma, charcoal, smoking in the building, cleaning frequency, hand washing facility, kitchen floor, flies observed around the latrine facilities, refuse disposal, child playground, uncollected garbage, exposure to animal allergens in past, supplementary feeding, breastfeeding status, feed powder milk, feeding with hand, wash hand before food preparation and eating, wash hand after feeding child, wash hand after visiting latrine, wash with soap and water and wash hand with only water were significantly associated with comorbidity of diarrhea and respiratory infection symptoms.

Finally, on multivariable analysis, the age of mothers/caretakers < 25 years, educational status of mothers/caretakers, birth order, family size, child playground, supplementary feeding, hand washing with soap and water, and hand washing after visiting latrine were significantly associated with under-five children's comorbidity of diarrhea and respiratory infection symptoms.

Under-five children whose mothers/caretakers age < 25 years were 3.52 times more likely to develop comorbidity than those whose age was higher and more

mature (AOR = 3.52 at 95% CI: 1.64, 7.55). Under-five children whose mothers/caretakers had no education were 4.42 times more likely to encounter comorbidity than those who enrolled in secondary and above formal educations (AOR = 4.42 at 95% CI: 2.08, 9.40). Households with family size greater than five were 4.52 times more likely to develop comorbidity of children under five years than their counterparts (AOR = 4.52 at 95% CI: 2.13, 9.61). Under five children whose birth order is second were 2.67 times more likely to encounter comorbidity than those with first orders (AOR = 2.67 at 95% CI: 1.31, 5.41).

Under five children whose playground is not clean were 2.19 times more likely to develop comorbidity than their counterparts (AOR = 2.19 at 95% CI: 1.01, 4.71). Under-five children who started supplementary feeding at an age greater than 6 months were 4.51 times more likely to develop comorbidity than their under-five children who started supplementary feeding at 6 months and lower (AOR = 4.51 at 95% CI: 1.50, 13.58).

Under five children whose mothers/caretakers didn't wash their hands after visiting latrine regular basis, their children were 2.03 times more likely to develop comorbidity than their counterparts (AOR = 2.03 at 95% CI: 1.03, 4.03). Under five children whose mothers/caretakers didn't wash their hands with soap and water their children were at 1.92 times higher risk of encountering comorbidity than those who wash their hands with soap and water regularly (AOR = 1.92 at 95% CI: 1.00, 3.69) (Table 5).

Bi-variable and multi-variable binary logistic regression analysis of associated factors with comorbidity

Discussion

A community-based cross-sectional study was conducted to determine the prevalence and factors associated with comorbidity of diarrhea and respiratory infection symptoms among under-five children in Gondar City. Children who experienced both diarrhea and respiratory infection symptoms have a prevalence of 17.22% which is higher than the previous study conducted in Ethiopia EDHS 4.6% [10] and Kenya DHS (2.2%) [2] children had comorbidity from diarrhea and ARI respectively.

Similarly, the prevalence was higher than Ghana and Congo DHS having a comorbidity of diarrhea and ARI was 11% and 3.9% consecutively [23, 24]. Similarly, Adedokun's [25] Nigerian study found that 9% of under-five children had comorbidity. In addition, the prevalence was higher than the study conducted in Myanmar which was 3.7% [26]. Our finding was comparable with a scoping review from 6 studies stating that the prevalence of

Table 3 Housing characteristics and latrine facility status in Gondar City between March –April 2023(*n* = 836)

Variable	Category	Frequency(n)	Percent (%)
Kitchen exhaust	No	778	93.06
	Yes	58	6.94
No functional windows	None	80	9.57
	One	564	67.46
	Two	147	17.58
	≥ Three	45	5.38
Floor construction mud	No	165	19.74
	Yes	671	80.26
Floor construction materials concrete	No	676	80.86
	Yes	160	19.14
Floor construction brick	No	815	97.49
	Yes	21	2.51
Wall surface water base paint	No	340	40.67
	Yes	496	59.33
Ceiling surface	Wooden	662	79.19
	Painted	174	20.81
Damp stains	No	278	33.25
	Yes	558	66.75
Visible mold	No	351	41.99
	Yes	485	58.01
Cooking	Inside	662	79.19
	Outside	174	20.81
Hand washing facility	No	679	81.22
	Yes	157	18.78
Latrine	No	98	11.72
	Yes	738	88.28
Type of latrine	Flush to septic tank	51	6.93
	Flush to pit latrine	25	3.40
	VIP	71	9.65
	Pit with slab	581	78.94
	Pit without slab	8	1.09
The proximity of the latrine from home	1–9 m	550	74.46
	≥ 10 m	188	25.54
Faeces around the pit hole	No	213	28.92
	Yes	525	71.08
Faeces around the compound	No	527	63.04
	Yes	309	36.96
If the household has no latrine where do they dispose of the human waste	Open field	86	87.76
	Other*	12	12.24
Ownership of latrine	Private	105	14.23
	Shared	633	85.77
Child playground	Not clean	615	73.56
	Clean	221	26.44

Other* = Buried underground, plastic bags

multimorbidity among under-five children in sub-Saharan African countries ranged from 1.2% to 24.8%.

The overall prevalence in our finding shows a higher burden of experiencing both diarrhea and respiratory

infection symptoms than the previously done research. This could be because the current study mainly includes City inhabitants since City slum areas are often characterized by poor sanitation, overcrowding, and limited

Table 4 Waste disposal and water-related characteristics in Gondar City between March –April 2023(*n* = 836)

Variable	Category	Frequency(n)	Percent (%)
Waste disposal	Pit	14	1.67
	Open	268	32.06
	Burning	49	5.86
	Garbage	488	58.37
	Other*	17	2.03
Waste Collection container	Plastic	785	93.90
	Iron	2	0.24
	Jerry can	40	4.78
	Other**	9	1.08
Source of water supply	Improved	800	95.69
	Unimproved	36	4.31
Daily requirements of water	< 20 liters	52	6.22
	≥ 20 liters	784	93.78
How long it takes to reach the water source(round trip)	< 15 min	765	91.51
	≥ 15 min	71	8.49

Other* = Dispose into the river

Other** = pot

access to clean water and healthcare [27]. Furthermore, there is a difference in sociodemographic characteristics, and environmental factors such as climate and geographical differences because most of them are based on country-wide surveys [28].

Finally, a recall period of 2 weeks for diarrhea and 12 months for respiratory infection symptoms would lead the child to experience an enormous amount of

respiratory infection symptoms which increases the chance of the child having comorbidity. The prevalence of diarrhea and respiratory infection symptoms was 24.28% and 35.29% respectively. Diarrhea and respiratory infection symptoms prevalence were comparable with the study conducted in eastern and northern Ethiopia at 22.5% and 22.1% [29, 30] and the study conducted in Gondar City at 37.5% respectively [31].

The prevalence of diarrhea was lower in comparison to a study conducted in the Southern part of Ethiopia 30.5% [32] and Northern part of Ethiopia almost half or 54% [33] of under-five children have diarrhea and higher in comparison to the studies conducted in other Ethiopia regions kamashi, farta and Addis Ababa 14.5%,16.7% and 11.9% respectively [34–36]. The prevalence of respiratory infection symptoms was lower in comparison to the studies conducted in India [37, 38] and higher than the study conducted previously in Gondar University Hospital pediatrics ward and Addis Ababa consecutively [11, 39].

We observed that children whose mothers/caretakers had no education their children more likely they have both conditions many findings also suggest this [2, 10, 25, 32, 40]. This is most likely due to a combination of circumstances like mothers/caretakers who had no formal education may be unaware of how to prevent diarrhea and ARI. For example, she/he is unaware of the significance of nursing, basic hygiene, and vaccination.

Children whose mothers/caretakers age between < 25 years are more likely to have morbidity of the two conditions than 25 years and above which is consistent with the finding from Kenya, Iran, and Nigeria [2, 25, 41]. This is due to the

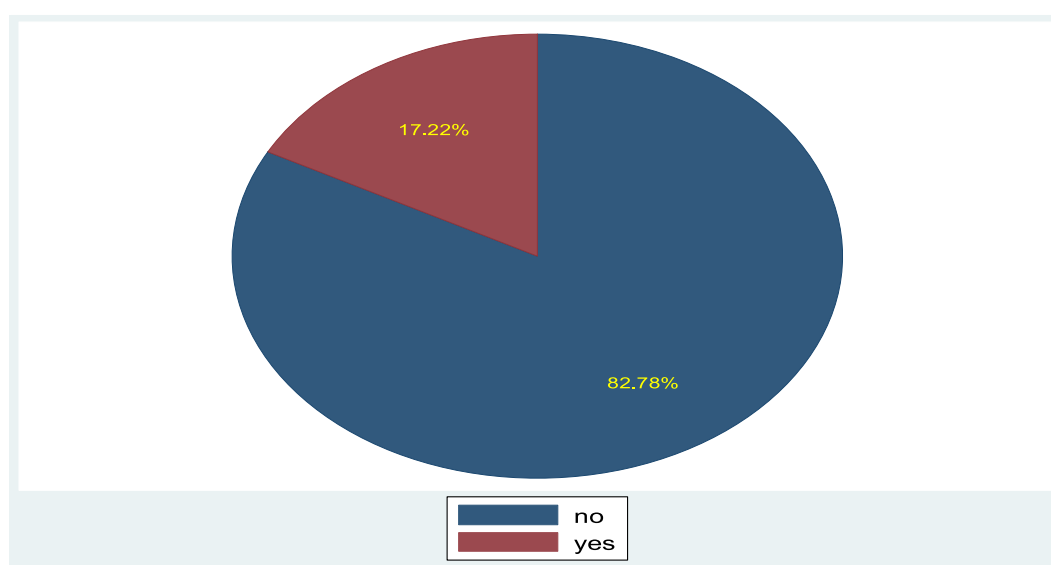
**Fig. 3** The comorbidity prevalence of diarrhea and respiratory infection symptoms (cough, phlegm, shortness of breath, wheezing and runny nose) among under-five children in Gondar City, northwest Ethiopia, 2023

Table 5 Factors associated with under-five children comorbidity of diarrhea and respiratory infection symptoms in Gondar City northwest Ethiopia, 2023

Variables	Categories	Child with Comorbid		COR (CI%95)	AOR (CI%95)
		No	Yes		
Age of mother/caretaker	< 25	132	59	3.27(2.06,5.21)	3.52(1.64,7.55) *
	25–27	170	23	0.99(0.56,1.80)	1.54(0.66,3.63)
	28–31	126	26	1.51(0.87,2.61)	2.03(0.94,4.38)
	≥ 32	264	36	1	1
Educational status of mother/caretaker	No	69	54	3.33(2.08,5.33)	4.42(2.08,9.40) *
	Primary	213	50	1	1
	Secondary and above	410	40	0.41(0.26,0.65)	0.85(0.42,1.72)
Educational status of spouse	No	72	19	0.92(0.50,1.68)	0.87(0.34,2.19)
	Primary	168	48	1	1
	Secondary and above	408	66	0.56(0.37,0.85)	1.29(0.66,2.50)
Average monthly income (Ethiopian Birr)	1000–4876	166	47	2.61(1.44,4.74)	0.75(0.30,1.86)
	4877–5643	156	50	2.96(1.63,5.35)	1.74(0.72,4.16)
	5644–8000	213	30	1.30(0.69,2.44)	1.46(0.61,3.46)
	≥ 8001	157	17	1	1
Family size	≤ 5	557	81	1	1
	> 5	135	63	3.20(2.19,4.68)	4.52(2.13,9.61) *
Number of under five	One	469	102	1	1
	Two	210	36	0.78(0.52,1.19)	0.56(0.30,1.07)
	Three and more	13	6	2.12(0.79,5.71)	1.51(0.33,6.82)
Number of room	One	413	100	1.29(0.83,2.03)	0.76(0.33,1.74)
	Two	161	30	1	1
	Three and above	118	14	0.63(0.32,1.25)	1.42(0.52,3.92)
Birth order	First	284	46	1	1
	Second	207	62	1.84(1.21,2.81)	2.67(1.31,5.41) *
	Third	93	19	1.26(0.70,2.26)	1.23(0.46,3.31)
	Fourth	69	12	1.07(0.53,2.13)	0.32(0.09,1.09)
	Fifth and above	39	5	0.79(0.29,2.11)	0.25(0.05,1.14)
Separate bedroom	No	493	114	1.53(0.99,2.36)	1.42(0.60,3.39)
	Yes	299	30	1	1
Child sex	Male	347	83	1.35(0.94,1.94)	1.41(0.81,2.46)
	Female	345	61	1	1
Kitchen cleanse	Clean	488	69	1	1
	Not clean	204	75	2.60(1.80,3.74)	1.62(0.86,3.04)
Father with asthma	No	665	132	1	1
	Yes	27	12	2.23(1.10,4.53)	2.04(0.63,6.55)
Charcoal	No	192	23	1	1
	Yes	500	121	2.02(1.25,3.25)	1.06(0.46,2.46)
Smoking in the building	No	637	115	1	1
	Yes	55	29	2.92(1.78,4.77)	1.78(0.78,4.09)
Cleaning frequency	One time	331	74	1.35(0.90,2.02)	1.03(0.53,2.02)
	Two times	279	46	1	1
	Three times	64	21	1.99(1.11,3.56)	2.01(0.79,5.10)
	> 3 times	18	3	1.01(0.28,3.56)	1.72(0.24,12.3)
Hand washing facility	No	552	127	1.89(1.10,3.24)	0.78(0.32,1.86)
	Yes	140	17	1	1
Kitchen floor	Clay & mud	576	122	1.34(0.76,2.36)	0.83(0.32,2.12)
	Cement	104	15	1	1
	Other	12	7	3.75(1.28,10.9)	2.15(0.40,11.57)
Flies observed around the latrine facilities	No	226	15	1	1
	Yes	439	122	4.18(2.39,7.39)	2.15(0.95,4.86)
Refuse disposal	Pit	12	2	1	1
	Open	212	56	1.58(0.34,7.28)	0.21(0.03,1.40)
	Burning	39	10	1.53(0.29,8.01)	0.26(0.03,2.19)
	Garbage can	419	69	0.98(0.21,4.51)	0.31(0.05,1.91)
	Other	10	7	4.2(0.70,24.94)	0.54(0.05,5.38)
Child playground	Not clean	484	131	4.33(2.39,7.83)	2.19(1.01,4.71) *
	Clean	208	13	1	1

Table 5 (continued)

Variables	Categories	Child with Comorbid		COR (CI%95)	AOR (CI%95)
		No	Yes		
Uncollected garbage/solid waste	No	179	11	1	1
	Yes	513	133	4.21(2.22,7.98)	1.43(0.58,3.54)
Exposure to animal allergens in past	No	641	126	1	1
	Yes	51	18	1.79(1.01,3.17)	1.12(0.44,2.87)
Supplementary feeding	< 6 month	111	11	1	1
	= 6 month	448	45	1.01(0.50,2.02)	1.40(0.47,4.18)
	> 6 month	133	88	6.67(3.39,13.1)	4.51(1.50,13.58) *
Breastfeeding status	Exclusive	21	5	1.47(0.53,4.02)	1.87(0.32,10.75)
	Partial	214	65	1.87(1.29,2.71)	1.69(0.94,3.02)
	Not	457	74	1	1
Feeding the child powder milk	No	551	126	1.79(1.05,3.03)	0.91(0.40,2.06)
	Yes	141	18	1	1
Feeding the child with a hand	No	160	12	1	1
	Yes	532	132	3.30(1.78,6.13)	1.30(0.44,3.80)
Wash hands before food preparation and eating	No	67	46	4.37(2.84,6.74)	1.86(0.80,4.29)
	Yes	625	98	1	1
Wash hands after feeding the child	No	143	42	1.58(1.05,2.36)	1.92(0.85,4.35)
	Yes	549	102	1	1
Wash hands after visiting the latrine	No	257	101	3.97(2.69,5.86)	2.03(1.03,4.03) *
	Yes	435	43	1	1
Wash hands with soap and water	No	136	61	3.00(2.05,4.39)	1.92(1.00,3.69) *
	Yes	556	83	1	1
Wash hands with only water	No	319	26	1	1
	Yes	373	118	3.68(2.36,5.74)	1.74(0.95,3.21)

AOR adjusted odds ratio, CI confidence interval, COR crude odds ratio

Hosmer and Lemeshow test = 0.7502 showed that the model was fitted well

* = statistically significant at $p < 0.05$

* = statistically significant at $p < 0.01$

* = statistically significant at $p < 0.001$

reason that older mothers/caretakers have more experience in preventing and managing childhood diseases and taking responsibility than the younger ones for their children. In addition, young women are believed to be fresh to childcare methods and hence lack such experience.

Children with second birth order are significantly associated with both conditions. Studies also showed that diarrhea occurrence is related to their birth order [42, 43]. Possible explanations for this association, first, later-born children may not receive as much attention from their parents, which could lead to poorer health outcomes. Secondly, later-born children may be less likely to be breastfed, which is protective against diarrhea and ARI. Children who started supplementary feeding greater than six months high likely to develop these conditions than those who started at 6 months and below, this finding also supported by Feachem published in the Bulletin of the World Health Organization reviews the evidence on the effectiveness of supplementary feeding programs in reducing the incidence and severity of diarrhea diseases in young children [44].

The explanation for this is starting supplementary feeding at 6 months can improve the immune system and reduce the risk of malnutrition which will lead to a lower chance of getting diarrhea and respiratory infection symptoms than their counterparts. Children with play-grounds not clean have odds of comorbidity much higher than those who have clean playgrounds. This is because filthy surfaces contain infectious germs and this is corroborated by studies that found that poor sanitation and hygiene are linked to intestinal protozoa infections and diarrhea in those under-five in northern Ethiopia, it was also supported by findings from Bangladesh and Côte d'Ivoire [20, 45, 46].

The odds of comorbidity were higher among households that have a family size greater than five and this was consistent with studies from Uganda and Tanzania [47, 48]. The main reason for this is that larger families are more likely to live in crowded conditions, which can increase the risk of infection. Additionally, larger families may have fewer resources to invest in preventive measures, such as hand washing and access to clean water.

Mothers/caretakers who didn't wash their hands after visiting the latrine and those who didn't wash their hands with soap and water regularly their children were associated with higher odds of experiencing both diarrhea and respiratory infection symptoms. The explanation for this is washing your hands properly with soap and water can help to prevent the spread of germs (like bacteria and viruses) and can help to break the chain of infection and prevent the spread of germs that cause these diseases.

Other findings from developing countries like Bangladesh, Benin, Burkina, Faso Cambodia, Ghana, India, and Kenya also claim that hand hygiene interventions can reduce the incidence of diarrhea by 23% to 48% and the incidence of respiratory infections by 15% to 35% in schoolchildren in developing countries [49]. Studies from the University of Gondar Comprehensive Specialized Hospital and Lao People's Democratic Republic supported this evidence stating that effective hand washing can prevent both diarrhea and ARI incidence [39, 50].

Even though this study did not find a significant relationship between income level breastfeeding status, kitchen floor, latrine availability, ownership of a latrine, the number of under-five, waste disposal method, and water source, other studies found that there is a significant association between getting sick for children with diarrhea and ARI with these factors [22, 42, 51–53].

Conclusion

In this study, the prevalence of diarrhea and respiratory infection symptoms was relatively high in Gondar City. The independent predictors for comorbidity of diarrhea and respiratory infection symptoms are the mother/caretaker's age, mother/caretaker's education, child age, birth order, family size, supplementary feeding, and child playground, kitchen cleanses and hand hygiene practice. Preventive measures targeting both conditions simultaneously offer significant healthcare benefits for under-five populations.

Abbreviations

ARI	Acute respiratory infection
AOR	Adjusted odds ratio
CI	Confidence Interval
COR	Crude odds ratio
DHS	Demographic and Health survey
EDHS	Ethiopia Demographic and Health Survey
Epi-Info	Epidemiological information software
HIV	Human immune deficiency virus
IAP	Indoor air pollution
STATA	Statistics and data

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Authors' contributions

The study was designed by L.D. All the A.D, J.A and K.A participated in data collection, data processing and coding. Z.G and G.Y participated in data analysis and interpretation of findings. L.D prepared the manuscript. All the authors read and approved the final manuscript.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Research and Institutional Review Board of the Institute of Public Health, College of Medicine and Health Science University of Gondar (reference number: IPH/2501/2023), the importance of the study was explained to study participants and we have informed the right to withdraw at any time during the study period. Informed consent was obtained from all the study participants of the study. All collected records were kept confidential. No personal identification such as name was collected to maintain the privacy and confidentiality of participants. Children who were found to be sick during the visits were informed to visit the nearby health Institution immediately. At all levels, officials were contacted and permission from administrators was secured.

Consent for publication

This manuscript does not contain any individual person's data.

Competing interests

None of the authors have any competing interests in the manuscript.

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