












# The Co-Utilization of Oral Rehydration Solution and Zinc for Treating Diarrhea and Its Associated Factors Among Under-Five Children in Ethiopia: Further Analysis of EDHS 2016

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**Introduction:** Diarrhea causes a loss of body water and salt, which can lead to dehydration and death. The use of oral rehydration salts and zinc together is regarded as an effective treatment for diarrhea in resource-poor settings like Ethiopia. However, studies that examine the co-utilization of oral rehydration solution and zinc in the treatment of diarrhea are limited Ethiopia.

**Objective:** To assess the prevalence and associated factors of oral rehydration solution and zinc co-utilization to treat diarrhea in children under the age of five in Ethiopia, EDHS 2016.

**Methods:** Secondary data from the 2016 Ethiopia Demographic and Health Survey (EDHS) was used to investigate the prevalence and factors associated with the co-utilization of ORS and zinc to treat diarrhea in under-five children. A multilevel binary logistic regression model was fitted to identify factors associated with the co-utilization of ORS and zinc. Adjusted odds ratios (AOR) with 95% CI were calculated and used as a measure of associations, and variables having a p-value of less than 0.05 were declared as statistically significant.

**Results:** The national prevalence of ORS and zinc co-utilization was 16.65% (14.66%, 18.84%). Maternal educational status (AOR = 1.45; 95% CI; (1.01, 2.09)), household size (AOR = 1.53; 95% CI; 1.09, 2.16) and distance to health facilities at the community level (AOR = 1.60, 95% CI = 1.02, 2.58) were variables significantly associated with the co-use of ORS and zinc.

**Conclusion:** The co-utilization of ORS and zinc for the management of diarrhea was low in Ethiopia. Education, household size, and distance to health facilities at the community level were significantly associated with the co-utilization of ORS and zinc in Ethiopia.

**Keywords:** associated factor, children, diarrhea, Ethiopia, ORS, zinc

## Introduction

Diarrhea is defined as the passage of three or more loose or watery stools within 24 hours, which might be manifested with the change in a person's daily stool fluidity, frequency, or volume from what is considered normal.<sup>1,2</sup> Diarrhea is the leading cause of morbidity and mortality in children under the age of five worldwide, killing an estimated 533,768 children under the age of five in 2017.<sup>3,4</sup> According to the Ethiopian demographic and health survey report 2016, 13% of under-five children had diarrhea within two weeks preceding the survey,<sup>5</sup> and the third killer of under-five children in Ethiopia.<sup>6</sup> The major complications of diarrheal diseases are, dehydration, infection and malnutrition.<sup>7</sup> Children with diarrhea is mostly dead due to dehydration, which can be treated easily with an oral rehydration solution (ORS).<sup>8</sup>

Although, the co-utilization of ORS and zinc to treat diarrhea is low in Ethiopia, previous studies showed that the co-utilization of ORS and zinc can help to reduce morbidity and mortality of children.<sup>7</sup> According to the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO), childhood diarrhea is treated with prolonged feeding, oral rehydration solutions, and zinc supplementations,<sup>9</sup> but less than 40% of children with diarrhea received the recommended treatment in developing countries.<sup>10</sup> The co-use of ORS and zinc is low in Africa, ranging from 17% in Cote d'Ivoire to 38% in Niger.<sup>11</sup> In Ethiopia, the utilization of ORS and zinc for treating diarrhea were 46% and 33% respectively.<sup>5</sup> However, the co-utilization of ORS and zinc was not yet studied. Hence, understanding the co-utilizations of ORS and zinc as per the recommendation of WHO is important to reduce morbidity and mortality caused by diarrhea. Educational status of the mother, distance from the health facility, and occupation of the mother are some of the factors associated with the co-utilization of ORS and zinc for treating children with diarrhea.<sup>12</sup>

From 2012 to 2016, the Clinton Health Access Initiative (CHAI) worked with governments, health care providers, and communities in India and a few African nations to enhance diarrhea treatment. In certain target locations, the initiative was able to increase the combined usage of ORS and zinc.<sup>13</sup> In the treatment of acute diarrhea, the Integrated Management of Neonatal and Childhood Illness (IMNCI) recommends these two medications. Under the leadership of the federal ministry of health's maternal and child health directorate and nutrition section, Drivers Knowledge Test Ethiopia (DKT/E) and the Micronutrient Initiative (MI) launched a combined ORS and Zinc product to treat childhood diarrhea, which is one of Ethiopia's leading causes of illness and child mortality.<sup>14</sup> Health-care providers treating children with diarrhea should give their caregivers two 1-liter packets of the new ORS to use at home until the diarrhea stops, as well as enough zinc tablets to continue home treatment for 10–14 days.<sup>15</sup> Zinc, when combined with ORS, reduces the duration and intensity of diarrhea, as well as the frequency of diarrhea over the next 2–3 months.<sup>16</sup>

Despite the fact that utilizing ORS in conjunction with zinc has numerous benefits, as demonstrated above, it is rarely used to treat diarrhea in Ethiopian children under the age of five years.<sup>17</sup> Thus, we aimed to assess the co-utilization of oral rehydration solution and zinc for treating diarrhea and its associated factors among under-five children in Ethiopia.

## Method

### Study Design and Setting

A secondary analysis of nationally representative population-based cross-sectional survey was conducted to assess the co-utilization and factors associated with ORS and zinc for treating diarrhea among children with diarrhea in Ethiopia. Ethiopia is the second and the 12th most populous country in Africa and worldwide respectively, which is located in East Africa. The country has an estimated total surface area of 1.1 million square kilometers, with altitudes ranging from 125 meters below sea level in the Afar depression to 4550 meters above sea level in the Semien Mountains Ras Dejen. The study was done by using the EDHS 2016, which is the fourth national survey. The survey addresses all the 11 administrative geographical regions in Ethiopia; which are further subdivided into zones, districts, and Kebeles, the smallest administrative units. A Household Survey of EDHS was conducted by dividing each smallest administrative unit (Kebele) into enumeration areas. Then the enumeration areas was used as a sampling frame. The 2016 EDHS sample was created to offer estimates of key indicators for the entire country, as well as for urban and rural areas individually.

### Study Population and Sampling Procedures

The source population of this study was all under-five children with diarrhea in Ethiopia. The study population was all under-five children with diarrhea within the last two weeks preceding the survey in Ethiopia. The study participants were selected using a two-stage stratified cluster sampling technique. In the first stage, 645 enumeration areas/clusters were selected randomly. In the second stage, a total of 28 households per cluster were selected by using a newly produced household list with an equal likelihood of systematic selection. From a total of 10,641 total deliveries, died children and those who have no diarrhea in the last two weeks were excluded. Finally, a weighted sample of 1228 women with children under the age of five who had experienced diarrhea in the last two weeks before the survey were included in the study.

## Study Variables

### Dependent Variables

The outcome variable of this study was the co-utilization of ORS and zinc for the management of childhood diarrhea, which was dichotomized into “yes=1” if the child uses both ORS and zinc for the management of childhood diarrhea and “no=0” if the child did not use both ORS and zinc for the management of childhood diarrhea.

### Independent Variables

Socio-demographic characteristics (maternal age, child age, sex, residence, education status, marital status, and wealth quintile) and factors like health insurance coverage, distance from the health facility, household size, and media exposure were included as independent variables.<sup>14,18</sup> In this study, media exposure was categorized as yes and no by using the variables (frequency of watching TV, reading a newspaper, and listening to the radio) from the dataset. Accordingly having media exposure was defined as if an individual was exposed to all or either of the three and having no exposure if an individual was not used at least one of those the above mentioned.

## Data Management and Statistical Analysis

The data was accessed in the measure DHS at the DHSprogram.com website, through an online request after registration. The data was extracted from the Kids Record (KR) datasets. Data cleaning, weighting, recording, and analysis were done by using STATA version 14. To adjust for disproportionate samples and non-responses, sample weighting was done for each variable. Descriptive statistics such as weighted frequencies and percentages were used to summarize the data. The multilevel binary logistic regression model was fitted to identify the individual-level and community-level factors associated with the co-utilization of ORS and zinc. The intra-class correlation coefficient (ICC) was calculated to show whether there was a difference in co-utilization of ORS and zinc between clusters, and model comparison was done using deviance ( $-2\log$  likelihood), the model with the lowest deviance value was the best-fitted model. Adjusted Odds Ratio (AOR) with 95% CI was calculated and used as a measure of associations. Variables with a p-value less than 0.25 in the multilevel bivariable logistic regression model were fitted into the multilevel multivariable logistic regression model. Variables with a p-value  $< 0.05$ , in the final model, were declared as significantly associated with the co-utilization of ORS and zinc for the management of childhood diarrhea. A multicollinearity test was done to rule out a significant correlation between variables. The mean variance inflation factor (VIF) was found to be 1.5 and all variables had VIF values less than 10.

## Results

### Socio-Demographic Characteristics of Study Participants

The total weighted sample of 1228 under-five children with diarrhea was included in this study. The majority, 1102 (89.73%) of the children were from rural. More than half, 649 (52.87%) of the children were males. More than two-thirds of children were from households with  $\geq 5$  household size. The majority, 801 (65.27%) of their family had no media exposure. About half of the participants were from high community media exposure (52.54%) and high maternal community education (50.84%). Six hundred thirty-seven (51.90%) of them were from the community with high poverty levels (Table 1).

### Co-Utilization of ORS and Zinc

The overall co-utilization of ORS and zinc for the treatment of diarrhea among children in Ethiopia was 16.65% with a 95% CI (14.66%, 18.84%).

### Random Effect Analysis

Cluster variability accounted for 17.5% of overall ORS and zinc co-utilization in the null model. In the null model, the MOR for the co-utilization of ORS and zinc was 2.21, indicating that there was a difference in the co-utilization between clusters. Children in the cluster with higher zinc utilization had a 2.21 times higher prevalence of ORS and zinc usage than those in the cluster with lower ORS and zinc utilization, which may explain if children drowned at random from various clusters. Model fitness was assessed using deviation, and the model with the lowest deviance (Model III) was chosen since it had the lowest deviance while also having the best fitness (Table 2).

**Table I** Socio-Demographic Characteristics of Respondents in Ethiopia, EDHS 2016

Variables	Weighted Frequency	Percent
Residence		
Urban	126	10.27
Rural	1102	89.73
Child Sex		
Male	649	52.87
Female	579	47.13
Maternal age		
15–19	43	3.53
20–24	263	21.44
25–29	361	29.41
30–34	311	25.29
35–39	164	13.36
40–44	68	5.51
45–49	18	1.45
Maternal education status		
Illiterate	767	62.46
Literate	461	37.54
Husband education status		
Illiterate	567	46.33
Literate	659	53.67
Media exposure		
No	801	65.27
Yes	427	34.73
Household size		
<5	382	31.13
≥5	846	68.87
Wealth Index		
Poor	538	43.81
Middle	268	21.79
Rich	422	34.40
Marital Status		
Other marital status	74	6.03
Married	1154	93.97
Distance of health facility		
Not a big problem	512	41.72
It is a big problem	716	58.28
Covered by health insurance		
No	1187	96.68
Yes	41	3.32
Give ORS		
No	865	70.47
Yes	363	29.53
Give Zinc		
No	819	66.71
Yes	409	33.29
Give ORS and Zinc		
No	1023	83.35
Yes	205	16.65

*(Continued)*

**Table 1** (Continued).

Variables	Weighted Frequency	Percent
Community maternal education		
Low	604	49.16
High	624	50.84
Community media exposure level		
Low	583	47.46
High	645	52.54
Community poverty level		
Low	591	48.10
High	637	51.90
Community level health facility distance		
Low	505	41.14
High	723	58.86

**Abbreviation:** ORS, Oral Rehydration Solution.

**Table 2** Model Comparison and Random Effect Analysis results

Parameters	Null Model	Model I	Model II	Model III
Community-level variance	0.6982	0.5045	0.4940	0.4947
ICC	17.5%	13.3%	13.1%	13.1%
MOR	2.21	1.96	1.95	1.95
PCV	Ref	0.2773	0.2924	0.2913
Deviance (-2LL)	1131.21	1099.17	1106.01	1092.16

**Abbreviations:** ICC, Intra Class Correlation Coefficient; MOR, Median Odds Ratio; PCV, Proportional Change in Variance; LL, Log Likelihood.

## Determinants of Co-Utilization of ORS and Zinc Among Under-Five Children with Diarrhea

The multilevel binary logistic regression model was fitted to identify factors associated with the co-utilization of ORS and zinc for treating diarrhea among under-five children in Ethiopia. First, the crude association of independent variables (Residence, Distance to health facility, Maternal educational status, Media exposure, Wealth Index, Household size, Community health facility distance, Community level media exposure, Community level poverty status) with ORS and zinc co-utilization was assessed. Accordingly, all variables with a p-value <0.25 in the bivariable analysis were entered into the multivariable multilevel regression model (final model). Finally, maternal educational status, household size, and community health facility distance were significantly associated with the combined use of ORS and zinc ( $p < 0.05$ ).

When comparing mothers with formal education to mothers without formal education, the odds of using ORS and zinc during diarrheal sickness were 1.45 (AOR = 1.45; 95% CI; 1.01, 2.09) times higher.

Mothers who were from a household size of less than five were 1.53 (AOR = 1.53; 95% CI; 1.09, 2.16) times higher odds of ORS and zinc utilization for diarrhea management as compared to those mothers who were from household members greater than and equal to five. Furthermore, the odds of ORS and zinc utilization among children with short community health facility distances were 60% higher as compared to their counterparts (AOR = 1.60, 95% CI = 1.02, 2.58) (Table 3).

**Table 3** Multilevel Regression Analysis of ORS and Zinc Utilization Among Under-Five Children with Diarrhea in Ethiopia

Variables	Zinc and ORS Utilization		Prevalence Ratio	
	Yes (N)	No (N)	COR (% CI)	AOR (95% CI)
Residence				
Urban	30.52	95.54	1.99(1.31, 3.02)	1.00(0.59, 1.73)
Rural	173.79	927.47	1	
Distance of health facility				
Not a big problem	93.05	418.98	1.44(1.04, 2.00)	0.87(0.56, 1.35)
It is a big problem	111.25	604.03	1	
Maternal education status				
No education	103.64	662.90	1	
Formal education	100.66	360.11	1.99(1.44, 2.77)	1.45(1.01, 2.09)*
Media exposure				
No media exposure	110.84	690.19	1	
Have media exposure	93.47	332.82	1.85(1.33, 2.57)	1.16(0.74, 1.81)
Wealth Index				
Poor	71.57	466.11	1	
Middle	48.48	218.92	1.38(0.86, 2.20)	1.00(0.57, 1.78)
Rich	84.26	337.99	1.89(1.31, 2.72)	1.02(0.58, 1.80)
Household size				
<5	79.76	302.31	1.79(1.28, 2.51)	1.53(1.09, 2.16)*
≥5	124.55	720.70	1	
Community health facility distance				
Low	105.61	399.36	1.88(1.32, 2.68)	1.60(1.02, 2.58)*
High	98.70	623.65	1	
Community-level media exposure				
Low	70.76	511.78	1	
High	133.55	511.23	1.88(1.31, 2.69)	1.29(0.83, 2.01)
Community-level poverty status				
High	79.50	557.44	1	
Low	124.81	465.57	1.90(1.33, 2.71)	1.24(0.72, 2.15)

Note: \*p < 0.05.

Abbreviations: COR, Crude Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval.

## Discussion

The World Health Organization and United Nations Children's Fund recommend the supplementation of both ORS and zinc as primary management of diarrheal diseases in children as they can reduce the most common complication which is dehydration and also the duration, severity, and recurrence of diarrheal diseases in children.<sup>19,20</sup> This study assessed the prevalence and associated factors of combined use of ORS and zinc for diarrhea management in under-five children using a multi-level logistic regression model. Thus, the study finding revealed that maternal education, household size, and community level distance to health facilities were found to be statistically significant factors.

The utilization of both ORS and zinc in Ethiopia was found to be 16.65% with a 95% CI of (14.66%, and 18.84%). ORS plus zinc use for acute diarrheal management was used relatively uncommonly the Ethiopian population.<sup>21</sup> The poor adoption of ORS plus zinc in this study might be attributable to a lack of advocacy on the part of government health offices, health extension workers, non-governmental organizations, and civic groups engaged in promoting ORS plus zinc supplementation. This magnitude of combined ORS and zinc use estimate is lower than the finding done in Gujarat and Uttar Pradesh India.<sup>22</sup> This might be because our study is national however, the studies in India were in two states and the survey was conducted after the community-based intervention.

When compared to mothers with more than or equal to five household members, mothers with a smaller household size (ie less than five) had a higher likelihood of administering ORS and zinc to their children with diarrhea. The finding is supported by a study done in Ethiopia.<sup>18</sup> This could be because women with fewer family members have more time and are better able to care for their sick children. Furthermore, mothers in smaller households are less likely to experience parenting stress, which might affect recommended child-feeding practices and health-seeking behavior if their kid becomes ill.

The odds of giving ORS and zinc to their under-five children with diarrheal disease were higher among mothers who had formal education as compared to those who have no formal education. The finding of this study is in line with a study conducted in Nigeria,<sup>23</sup> Ethiopia,<sup>18</sup> and India Gujarat.<sup>22</sup> This could be because educated women are more conscious of their children's health and are more likely to take their sick children to the nearest health institution. Besides, the possible justification might be an educated mother is more likely than an uneducated mother to take her sick child to the doctor for treatment and follow-up, as well as to take the prescribed medication.

Community-level distance of health facilities was also found to be associated with ORS and zinc use. Those mothers who reside in the community where health facility accessibility is a big problem were less likely to seek treatment for their sick children than those who are near health institutions. This is in line with studies conducted elsewhere.<sup>24–26</sup> This can be justified by the reason that health care availability affects the health-seeking behavior of mothers. Those who cannot access health facilities around their residence find it difficult to afford the cost of transportation for seeking health services at a distance.<sup>27,28</sup>

However, unlike a study conducted in India Uttar Pradesh,<sup>22</sup> in which media exposure increases the utilization of combined ORS and zinc, there is no significant effect of individual and community level media exposure on combined ORS and zinc uptake in this study. This might be the difference in study population, period, and study design.

This study had both limitations and strengths. The study's strength is that it is based on nationally representative data and uses appropriate analysis methodologies. Furthermore, this is the first study in Ethiopia to evaluate the combined use of ORS and zinc in under-five children during diarrhea therapy. As a result, we are unable to compare our findings to those of other studies due to a lack of relevant literature. However, because the study was done in a cross-sectional design, a clear cause and effect link between the combined ORS and zinc utilization and independent variables remained unknown.

## Conclusion

The study found that both the individual and community level factors were associated with the outcome variable. In this study, factors like having a formal education, household size of less than five, and a short-distance community health facility were significantly associated with the use of both ORS and zinc.

## Abbreviations

AOR, Adjusted Odds Ratio; CI, Confidence Interval; DHS, Demographic and Health Survey; EDHS, Ethiopian Demographic and Health Survey; ICC, Intra Class Correlation; LL, Log-likelihood; ORS, Oral Rehydration Solution; UNICEF, United Nations Children's Fund; WHO, World Health Organization.

## Ethical Consideration

The study was conducted following the guidelines outlined in the Declaration of Helsinki. Ethical clearance was obtained from the Ethical Review Board (IRB) of College of Medicine and Health Sciences, University of Gondar. Informed written consent was obtained before the interview where informed consent for children was obtained from their parents/guardians. Data access was approved after it was requested from the demographic and health survey by registering online from <http://www.dhsprogram.com>. All data used in this study were publicly available, and aggregated secondary data with no personal identity.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

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### Patient Preference and Adherence

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