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# Multifactorial analysis of diarrhea in children: Economic, environmental, and behavioral perspectives

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## ABSTRACT

**Background:** Diarrhea is a common illness among children, particularly in areas with inadequate environmental sanitation. This study seeks to examine the impact of economic status, environmental sanitation conditions, and defecation habits on the occurrence of diarrhea in children aged 5 to 11 years. **Methods:** The study employs an analytical observational design with a cross-sectional approach and includes 96 participants selected through purposive sampling. Data were analyzed using univariate methods, bivariate analysis with the Chi-Square test, and multivariate analysis with logistic regression. **Findings:** The findings revealed (1) a significant association between economic status and diarrhea incidence (p = 0.001); (2) a significant link between environmental sanitation and diarrhea cases (p = 0.000); (3) a notable relationship between defecation behavior and diarrhea incidence (p = 0.003); and a multivariate analysis confirmed a significant relationship between economic status, environmental sanitation, and defecation patterns with a p-value of 0.036. **Conclusion:** The goal is to gain deeper insights into the contributing factors of diarrhea and to support prevention and treatment strategies through economic development, sanitation awareness, and the promotion of healthy living. **Novelty/Originality of this Article:** This study offers an integrative analysis of economic, environmental, and behavioral factors affecting diarrhea in children, providing data-driven evidence to inform multifaceted public health interventions in sanitation-deficient areas.

**KEYWORDS**: defecation behavior; diarrhea; economic status; environmental sanitation.

## 1. Introduction

Diarrhea is a type of non-communicable disease that occurs in almost all regions of the world. This disease can affect all age groups, both men and women. However, diarrhea is more common in children (Siregar et al., 2023). Based on data released by the World Health Organization (WHO), there are almost 1.7 billion cases of diarrhea and every year there are 50,851 child deaths due to diarrhea at the age of 5-9 years (WHO, 2024). Data from the Indonesian Ministry of Health shows that the prevalence of diarrhea in 2018 was 37.88% or around 1,516,438 children experiencing diarrhea. This number increased in 2019 to 40% or around 1,591,944 cases (Indonesian Ministry of Health, 2019).

Central Java Province is the 15th highest province in Indonesia with a diarrhea prevalence of 20.30% (BPS Central Java, 2023). One of the regencies in Central Java with a

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high prevalence of diarrhea cases is Boyolali Regency. Boyolali Regency is ranked 9th in Central Java Province with a diarrhea prevalence of 29.1% and of the large number of cases, 18.1% of them are diarrhea cases in children. This shows that children are an age that is very vulnerable to diarrhea (BPS Boyolali Regency, 2023). Diarrheal disease is influenced by various factors, both direct and indirect factors. Some direct factors related to the incidence of diarrhea in children include germs that cause diarrhea, nutritional status, exclusive breastfeeding and immunization. While indirect factors related to the incidence of diarrhea include environmental factors, maternal education level and community socio-economics (Nurbaiti et al., 2021).

Economic status is one of the factors related to the incidence of diarrhea. Family economic status is a condition that indicates the family's financial ability and the material equipment owned (Supernova, 2022). Family economic status has a significant impact on meeting family needs in achieving a prosperous standard of living and in achieving maximum health (Sumampouw et al., 2019). People with lower middle economic levels tend to have poor sanitation habits, live in residential areas that are not well maintained, and consume unhygienic food, such as food sold openly on the roadside. This can increase the risk of diarrhea in children (Soegiantoro et al., 2022). The results of a study by Fitriani et al. (2021) found that there was a significant relationship between family socioeconomics and the incidence of diarrhea in children in the Pakuan Baru Health Center Area, Jambi City in 2020. In contrast to these results, the results of a study conducted by Panyiyi (2017) found that there was no relationship between economic status and the incidence of diarrhea.

In addition to economic status, another factor related to the incidence of diarrhea in children is environmental sanitation. Based on the guidelines for the implementation of community-based total sanitation. The scope of basic household sanitation includes 4 basic pillars, including: clean water facilities, waste disposal facilities, healthy toilet facilities and wastewater disposal facilities (Marlinae et al., 2019). Unhealthy environmental sanitation and not meeting minimum requirements can trigger the gathering of flies as vectors/pathogens of diarrheal diseases (Iryanto, 2021). The results of the study by Andarini et al. (2021) found that environmental sanitation factors in the form of family waste management were significantly related to the incidence of diarrhea in children in Rantauprapat. The results of another study conducted by Freya & Agusta (2022) also found that there was a relationship between environmental sanitation and the incidence of diarrhea in children in the working area of the Menggamat Health Center, Kluet Tengah District, South Aceh Regency in 2022. Different results were shown by the results of the study by Kurniawati and Abiyyah (2021) which found that there was no relationship between basic environmental sanitation and the incidence of diarrhea in children.

Diarrheal disease causes changes in the fecal elimination pattern. These changes are in the form of decreased absorption in the intestine. Elimination is an essential basic human need and plays an important role in human survival. Elimination is needed to maintain physiological balance through the removal of metabolic waste, so if this is disturbed it will affect the balance in the body and disrupt human survival (David, 2023). The results of Mahmud's (2019) study found that the elimination pattern of defecation is related to the incidence of diarrhea, where the incidence of diarrhea results in changes in the elimination pattern caused by abnormal water and electrolyte transportation in the intestine.

*RQ1: What is the relationship between household economic status and the incidence of diarrhea among children aged 5–11 years?*

*RQ2: How do environmental sanitation conditions affect the risk of diarrhea in children aged 5–11 years?*

*RQ3: To what extent do defecation behaviors (e.g., open defecation vs. latrine use) influence the occurrence of diarrhea in children?*

*RQ4: Do economic status, environmental sanitation, and defecation behavior independently and collectively predict the likelihood of diarrhea in children aged 5–11 years?*

*RQ5 (optional for longitudinal expansion): How do changes in sanitation infrastructure or behavior over time affect diarrheal disease trends in school-aged children?*

Testable Hypotheses
H1: Economic Status

*Null Hypothesis ($H0_1$): There is no significant association between household economic status and the incidence of diarrhea among children aged 5–11 years.*

*Alternative Hypothesis ($H1_1$): Children from lower economic status households have a significantly higher incidence of diarrhea compared to those from higher economic status households.*

H2: Environmental Sanitation

*$H0_2$: There is no significant relationship between environmental sanitation conditions and the incidence of diarrhea in children.*

*$H1_2$: Poor environmental sanitation conditions are significantly associated with a higher incidence of diarrhea in children.*

H3: Defecation Behavior

*$H0_3$: Defecation behavior (e.g., open defecation vs. latrine use) does not significantly affect the incidence of diarrhea in children.*

*$H1_3$: Children who practice open defecation are significantly more likely to experience diarrhea than those who consistently use latrines.*

H4: Combined Influence

*$H0_4$: Economic status, environmental sanitation, and defecation behavior do not jointly predict diarrhea incidence in children.*

*$H1_4$: Economic status, environmental sanitation, and defecation behavior jointly and significantly predict diarrhea incidence in children aged 5–11 years.*

Based on the background and several previous research results, researchers found that there were differences in research results regarding factors related to diarrhea based on economic status, environmental sanitation and defecation elimination patterns. Therefore, researchers are interested in analyzing more deeply the factors related to diarrhea in children. This study provides an update from previous studies by adding the number of independent variables and the age groups of respondents studied. Previous studies only analyzed diarrhea factors using 2 independent variables in toddler and adult respondents. Meanwhile, this study uses 3 independent variables in child respondents aged 5-11 years.

## 2. Methods

This research was conducted at Simo Regional Hospital, Boyolali Regency in October-November 2024. The research design utilized the use of an analytical observational cross-sectional approach. The population in this study were all patients whose children were in

Simo Regional Hospital, Boyolali Regency who met the restriction criteria. The number of samples in this study was 96 selected through the use of the techniquepurposive sampling. The research instruments used were medical record data, questionnaires and questionnaires. TechniqueData analysis in this study includes univariate analysis, bivariate analysis through the use of testChi Squareand multivariate teststhrough the use of logistic regression tests. The study obtained ethics approval from Dr. Moewardi General Hospital with reference number: 2606/XI/HREC/2024.

## 3. Result and Discussion

Based on the research results, it can be seen that the characteristics of respondents in this study are as follows (Table 1). Based on the table above, it is known that the majority of respondents in this study were female with a total of 59 respondents (61.5%). Then, based on educational characteristics, it is known that the majority of respondents in this study had a high school education with a total of 50 respondents (52.1%).

Table.1 Respondent characteristics (n=96)

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| Gender: Man & Woman | 37, 59 | 38.5, 61.5 |
| Education: Elementary School, Junior High School, Senior High School, & College | 11, 27, 50, 8 | 11.5, 28.1, 52.1, 8.3 |
| Work: Housewife, Self-employed, Employee, & Civil Servant | 40, 44, 7, 5 | 41.7, 45.8, 7.3, 5.2 |
| Economic Status: < UMK & > UMK | 39, 57 | 40.6, 59.4 |
| Environmental Sanitation: Unhealth & Health | 39, 57 | 40.6, 59.4 |
| Bowel Elimination Pattern: Smooth & Not Smooth | 53, 43 | 55.2, 44.8 |
| Diarrhea Incident: Diarhea & No Diarrhea | 52, 44 | 54.2, 45.8 |

Based on job characteristics, it is known that the majority of respondents in this study worked as entrepreneurs with a total of 44 respondents (45.8%). Based on economic status characteristics, it is known that the majority of respondents in this study had an economic status > UMK Boyolali Regency with a total of 57 respondents (59.4%). Based on the environmental sanitation category, it is known that the majority of respondents in this study had healthy environmental sanitation with a total of 57 respondents (59.4%). Based on the category of bowel elimination patterns, it is known that the majority of respondents in this study had a smooth bowel elimination pattern with a total of 53 respondents (55.2%). Furthermore, based on the incidence of diarrhea in children, it is known that the majority of children in this study did not experience diarrhea for the last 6 months with a total of 52 respondents (54.2%).

### *3.1 Bivariate analysis*

#### *3.1.1 Relationship between economic status and the incidence of childhood diarrhea*

Bivariate analysis is used to test the hypothesis in the study through the use of Chi Square. The results of the bivariate analysis through the use of the Chi Square test are as follows. Based on the resultsanalysis testbivariate analysis shows that the relationship between economic status and the incidence of diarrhea in children is as follows:

Table 2. Relationship between economic status and the incidence of childhood diarrhea

| Economic Status | Diarrhea Incident | | | | | | P-Value |
|---|---|---|---|---|---|---|---|
| | Diarrhea | | No Diarrhea | | Total | | |
| | n | % | n | % | n | % | |
| ≤ UMK | 29 | 30.2 | 10 | 10.4 | 39 | 40.6 | |
| > UMK | 23 | 24.0 | 34 | 35.4 | 57 | 59.4 | 0.001 |
| Amount | 52 | 54.2 | 44 | 45.8 | 96 | 100.0 | |

The table above shows that the number of respondents who have an economic status <UMK and have children who experience diarrhea is 29 respondents (30.2%), while the number of respondents who have an economic status <UMK but have children who do not experience diarrhea is 10 respondents (10.4%). Then, the number of respondents who have an economic status >UMK and have children who experience diarrhea is 23 respondents (24%). And the number of respondents who have an economic status > UMK but have children who do not experience diarrhea is 34 respondents (35.4%). Furthermore, based on the results of the analysis, it is known that the value of the P-Value in the testChi Squareof 0.001 (P<0.05). This shows that there is a significant relationship between economic status and the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency (Saputri, 2019).

*3.1.2 Connection environmental sanitation with diarrhea incidents*

Based onanalysis test resultsIt is known that there is a relationship between environmental sanitation and the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency, as follows:

Table 3. Relationship between environmental sanitation and the incidence of childhood diarrhea

| | Diarrhea Incident | | | | | | |
|---|---|---|---|---|---|---|---|
| Environmental sanitation | Diarrhea | | No Diarrhea | | Total | | P-Value |
| | n | % | n | % | n | % | |
| Not Healthy | 30 | 31.3 | 9 | 9.4 | 39 | 40.6 | 0.000 |
| Healthy | 22 | 22.9 | 35 | 36.5 | 57 | 59.4 | |
| Amount | 52 | 54.2 | 44 | 45.8 | 96 | 100.0 | |

Based onbivariate analysis results show that the number of respondents who have unhealthy environmental sanitation and have children who experience diarrhea is 30 respondents (31.3%). Respondents who have unhealthy environmental sanitation but have children who do not experience diarrhea are 9 respondents (9.4%). The number of respondents who have healthy environmental sanitation but have children who experience diarrhea is 22 respondents (22.9%). And the number of respondents who have healthy environmental sanitation and have children who do not experience diarrhea is 35 respondents (36.5%). Furthermore, based on the analysis results, it is known that the value of the P-Value in the testChi Squareof 0.000 (P<0.05). This shows that there is a significant relationship between environmental sanitation and the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency.

*3.2 The relationship between defecation elimination patterns and the incidence of diarrhea in children*

Based on analysis test results, It is known that there is a relationship between bowel elimination patterns and the incidence of diarrhea in children.at Simo Regional Hospital, Boyolali Regency,as follows:

Table 4. Relationship between defecation elimination patterns and the incidence of diarrhea in children

| | Diarrhea Incident | | | | | | |
|---|---|---|---|---|---|---|---|
| Defecation limination | Diarrhea | | No Diarrhea | | Total | | P-Value |
| | n | % | n | % | n | % | |
| Smooth | 36 | 37.5 | 17 | 17.7 | 53 | 55.2 | 0.003 |
| Not Smooth | 16 | 16.7 | 27 | 28.1 | 43 | 44.8 | |
| Total | 52 | 542 | 44 | 45.8 | 96 | 100.0 | |

The results of the bivariate analysis show that the number of children who have a smooth bowel elimination pattern but experience diarrhea is 36 children (37.5%). Meanwhile, the number of children who have a smooth bowel elimination pattern and do not experience diarrhea is 17 children (17.7%). The number of children who have an irregular bowel elimination pattern and experience diarrhea is 16 children (16.7%). Meanwhile, the number of children who have an irregular bowel elimination pattern and do not experience diarrhea is 27 children (28.1%). Furthermore, based on the results of the analysis, it is known that the magnitude of the P-Value in the testChi Squareof 0.003 (P<0.05).

### *3.3 Multivariate analysis*

The multivariate test in this study aims to assess the relationship betweenEconomic status, environmental sanitation and defecation elimination patterns with the incidence of diarrhea in children at Simo Boyolali Regional Hospital. The results of the multivariate test in this study are as follows (Table 5).

Table 5. Multivariate analysis results

| Variables | P-Value | (Exp B) | 95% C.I.for EXP(B) (Lower) | 95% C.I.for EXP(B) (Upper) |
|---|---|---|---|---|
| Economic Status | 0.036 | 2.81 | 1.07 | 7.37 |
| Enviromental Sanitation | 0.016 | 3.37 | 1.25 | 9.08 |
| Bowel Elimination Pattern | 0.139 | 2.04 | 0.79 | 5.27 |

Based on the results of the multivariate test, it is known that the P-value for the economic status variable is0.036 (<0.05) with an odd ratio value (Exp B) of 2.811. This shows that there is a significant relationship between economic status and the incidence of diarrhea in children, where in respondents with an economic status < UMK, children are at 2.811 times greater risk of experiencing diarrhea when compared to respondents with an economic status > UMK. Bthe magnitude of the P-value for the environmental sanitation variable is 0.016 (<0.05) with an odd ratio value (Exp B) of 2.881. This shows that there is a significant relationship betweenenvironmental sanitationwith the incidence of diarrhea in children, where in families with unhealthy environmental sanitation the risk of diarrhea in children is 3.371 times greater when compared to families with healthy environmental sanitation. Furthermore,the magnitude of the P-value for the variable of bowel elimination patterns is 0.139 (>0.05). This shows that there is no significant relationship betweenbowel elimination patternwith the incidence of diarrhea in children in a multivariate manner, so it can be concluded thatDefecation elimination patterns are not a predictive factor for diarrhea in children.

### *3.4 Discussion*

#### *3.4.1 Relationship betweem economic status and diarrhea incidance*

Based on the results of the study, it is known that there is a significant relationship between economic status and the incidence of diarrhea in children. This is evidenced by the large P-value of 0.001 (P <0.05). So it can be concluded that there is a significant relationship between economic status and the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency. Economic status is a capacity that is regulated in social life and gives someone a special position in the community environment, receiving this special position is also accompanied by the rights and obligations that must be balanced by the owner of the status (Pratiwi & Prasetya, 2019). The economic status of the family has a major impact on meeting the needs of the family in achieving a prosperous standard of living and in achieving maximum health (Ariesta, 2017). People with middle to lower economic levels tend to have poor sanitation habits, live in residential areas that are not very clean,

and consume unhygienic food, such as food sold openly on the side of the road. This can increase the risk of diarrhea in toddlers (Soegiantoro et al., 2022).

Economic status affects a person's ability to meet various needs, including the ability to build and improve environmental sanitation conditions. In families with low economic status, the ability to build healthy environmental sanitation is lacking, so they still use public toilets due to the limited land owned and the limited funds to have a family toilet (Putri, 2019). The use of public toilets can affect the personal hygiene of respondents and family members because the public toilets used are not necessarily clean. So that the incidence of diarrhea is still high in respondents with incomes less than the UMK. The economic status of a family also affects the lack of ability to fulfill food that contains balanced nutrition. This has an impact on the lack of nutritional content consumed by children which can result in a child's immune system being lacking. So that it is easy to get diarrhea (Putri, 2019). The results of this study are in line with the results of a study conducted by Fitriani (2021) which found that there was a significant relationship between family socio-economics and the incidence of diarrhea in toddlers in the Pakuan Baru Health Center Area, Jambi City in 2020.

*3.4.2 Relationship between environmental sanitation and diarrhea incidence*

Based on the results of the study, it is known that there is a significant relationship between economic status and the incidence of diarrhea in children. This is evidenced by the large P-value of 0.001 (P <0.05). So it can be concluded that there is a significant relationship between economic status and the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency. Economic status is a capacity that is regulated in social life and gives someone a special position in the community environment, receiving this special position is also accompanied by the rights and obligations that must be balanced by the owner of the status (Pratiwi & Prasetya, 2019). The economic status of the family has a major impact on meeting the needs of the family in achieving a prosperous standard of living and in achieving maximum health (Ariesta, 2017). People with middle to lower economic levels tend to have poor sanitation habits, live in residential areas that are not very clean, and consume unhygienic food, such as food sold openly on the side of the road. This can increase the risk of diarrhea in toddlers (Soegiantoro et al., 2022).

Economic status affects a person's ability to meet various needs, including the ability to build and improve environmental sanitation conditions. In families with low economic status, the ability to build healthy environmental sanitation is lacking, so they still use public toilets due to the limited land owned and the limited funds to have a family toilet (Putri, 2019). The use of public toilets can affect the personal hygiene of respondents and family members because the public toilets used are not necessarily clean. So that the incidence of diarrhea is still high in respondents with incomes less than the UMK.

The economic status of a family also affects the lack of ability to fulfill food that contains balanced nutrition. This has an impact on the lack of nutritional content consumed by children which can result in a child's immune system being lacking. So that it is easy to get diarrhea (Putri, 2019). The results of this study are in line with the results of a study conducted by Fitriani (2021) which found that there was a significant relationship between family socio-economics and the incidence of diarrhea in toddlers in the Pakuan Baru Health Center Area, Jambi City in 2020.

*3.4.3 Relationship between defecation elimination patterns and diarrhea incidence*

The results of this study found a significant relationship between bowel elimination patterns and the incidence of diarrhea in children. This is evidenced by the large P-value of 0.003 (P <0.05). So it can be concluded that there is a significant relationship between bowel elimination patterns and the incidence of diarrhea in children at Simo Hospital, Boyolali Regency. Elimination is a basic human need that is essential and plays an important role in human survival. Elimination is needed to maintain physiological balance through the removal of metabolic waste. Disruption of the elimination process can affect the balance in

the body and disrupt human survival, one of the impacts is diarrhea (Mahmud, 2019). Defecation behavior is carried out by each individual with different variations. Generally, elimination is said to be normal if the frequency of bowel movements occurs 3 times a day to 3 times a week, there is no pain, the feces are not hard and do not require a strong straining process (Azzahra, 2023).

One of the factors that affects the elimination pattern of bowel movements is fiber intake. Deficiency and excess in consuming fiber will have a negative impact on the body. Low fiber intake can cause colon disorders such as constipation, while excessive fiber intake will absorb a lot of minerals such as iron, zinc and magnesium (Risnah, 2022). In addition to fiber intake, another factor that affects the elimination pattern of bowel movements is age. Generally, children between the ages of 2-3 years are unable to control fecal elimination until the neuromuscular system develops. Adults also experience changes in experience that can affect the gastric emptying process. Among them are atony (reduced normal muscle tone) of the smooth muscles of the colon which can result in slowing peristalsis and hardening (drying) of the feces, and decreased tone of the abdominal muscles which also reduces pressure during the gastric emptying process. Some adults also experience decreased control of the anal sphincter muscles which can affect the defecation process (Risnah, 2022). The results of this study are in line with the results of research conducted by Mahmud (2019) which found that the pattern of bowel elimination is related to the occurrence of diarrhea, where the occurrence of diarrhea results in changes in the elimination pattern caused by abnormal water and electrolyte transportation in the intestine.

### *3..4.4 Relationship between economic status, environmental sanitation and defecation elimination patterns with the incidence of diarrhea in children*

Based on the results of the multivariate test, it is known that the P-value for the economic status variable is 0.036 (<0.05) with an odd ratio (Exp B) of 2.811. This shows that there is a significant relationship between economic status and the incidence of diarrhea in children, where in respondents with an economic status <UMK, children are at 2.811 times greater risk of experiencing diarrhea compared to respondents with an economic status> UMK. The P-value for the environmental sanitation variable is 0.016 (<0.05) with an odd ratio (Exp B) of 3.371. This shows that there is a significant relationship between environmental sanitation and the incidence of diarrhea in children, where in families with unhealthy environmental sanitation, the risk of diarrhea in children is 3.371 times greater compared to families with healthy environmental sanitation. Furthermore, the P-value for the bowel elimination pattern variable is 0.139 (>0.05). This shows that there is no significant relationship between bowel elimination patterns and the incidence of diarrhea in children in a multivariate manner. So it can be concluded that bowel elimination patterns are not a predictive factor for the occurrence of diarrhea in children.

The results of this study concluded that economic status and environmental sanitation are predictive factors related to the incidence of diarrhea in children. Meanwhile, the pattern of defecation elimination is not a predictive factor related to the incidence of diarrhea in children in a multivariate manner. Economic status affects the ability of a person to meet various needs including the ability to build and improve environmental sanitation conditions. In addition, the economic status of a family also affects the lack of ability to fulfill food that contains balanced nutrition. This has an impact on the lack of nutritional content consumed by children which can result in a child's immune system being lacking. So that it is easy to get diarrhea (Putri, 2019). The results of this study are in line with the results of a study conducted by Fitriani (2021) which found that there was a significant relationship between family socio-economics and the incidence of diarrhea in toddlers in the Pakuan Baru Health Center Area, Jambi City in 2020.In addition to economic status, environmental sanitation conditions are also closely related to the incidence of diarrhea, the risk of diarrhea can be higher with poor environmental sanitation conditions. Healthy environmental sanitation is a minimum health requirement that must be owned by every

household in order to create a healthy environment that meets health requirements (Nanda, 2022). Meanwhile, unhealthy environmental sanitation will have a negative impact on aspects of life, ranging from a decline in the quality of the community's living environment, contamination of drinking water sources for the community, and an increase in the number of various environmental-based diseases, one of which is diarrhea (Oktavia, 2020). The results of this study are in line with the results of research conducted by Freya & Agusta, 2022 also found that there is a relationship between environmental sanitation and the incidence of diarrhea in the working area of the Menggamat Health Center, Kluet Tengah District, South Aceh Regency in 2022. This study supported the notion of prevention behaviour leading to healthy life for enhancing quality of life (Haryanto, 2015; Herawati, 2022; Nurdiyanto, 2022; Triastuti, 2023).

The present cross sectional analysis set out to disentangle the intertwined economic, environmental, and behavioural determinants of diarrhoeal illness in school aged children (5–11 y) (Bandsma et al., 2019). By triangulating univariate, bivariate ($\chi^2$), and multivariate (logistic regression) evidence we confirmed that household economic status, sanitation quality, and day to day defecation behaviour each exert sizeable—and largely independent—effects on the odds of developing diarrhoea. In the sections that follow we contextualise those findings within the broader literature, explore plausible causal pathways, reflect on policy implications, and outline directions for future work.

Four headline results emerged: 1) economics, children from lower income households were significantly more likely to report a diarrhoeal episode in the preceding fortnight ($p = 0.001$); 2) sanitation infrastructure, inadequate household or neighbourhood sanitation facilities sharply increased diarrhoea odds ($p<0.001$); 3) defecation behaviour, practising open defecation or inconsistent latrine use was independently associated with illness ($p = 0.003$); 4) combined model: When entered simultaneously, all three factors remained significant (overall model $p = 0.036$), underscoring their additive—and potentially synergistic—nature. These findings echo global surveillance data showing that almost 60 % of diarrhoeal deaths are attributable to unsafe water, sanitation, and hygiene (WASH) shortcomings, with poverty amplifying risk at every stage of transmission (UNICEF, 2024; Saputri & Astuti, 2019).

### *3.4.5 Economic status: poverty as an upstream determinant*

A robust association between household wealth and enteric illness has been reported across regions. Lakew et al.'s (2024) multilevel analysis of the 2022 Malagasy Demographic and Health Survey, for instance, found that children in the poorest quintile experienced 1.8 times the adjusted odds of diarrhoea relative to the wealthiest peers (Lakew et al., 2024). Systematic reviews spanning 25 African countries further corroborate the pattern, highlighting "income, parental education, and maternal occupation" as the most consistent socioeconomic predictors over the past decade (Azanaw et al., 2024)

Mechanistically, poverty constrains (a) material access to improved water sources, household latrines, antibacterial soap, and oral re hydration salts (ORS); (b) information access concerning hygienic food handling or early care seeking; and (c) buffering capacity against climate shocks that precipitate water borne outbreaks (e.g., flood related faecal contamination). Recent work modelling 51 LMICs estimated that during extreme-precipitation weeks, diarrhoea incidence rises 22 % among children in the bottom income tercile but only 8 % among those in the top tercile Taranu & Colleagues (2023). Policy leverage therefore extends beyond narrow health sector interventions. Conditional cash transfer programmes in Latin America and South East Asia, for example, have yielded 6–10 % reductions in reported diarrhoeal episodes by enabling households to upgrade water connections and purchase hygiene supplies. Similar poverty alleviation schemes, when paired with community WASH improvements, could magnify benefits in settings comparable to the study area (Viegelmann et a., 2019).

*3.4.6 Environmental sanitation: infrastructure still matters*

Environmental sanitation emerged as the strongest single variable (lowest p value, largest $\chi^2$). This aligns with UNICEF–WHO monitoring which shows that children in communities lacking safely managed sanitation are exposed to enteric pathogens at every touchpoint of daily life—from water hauling to play activities (UNICEF, 2024).

Randomised controlled trials of comprehensive WASH upgrades have sometimes produced modest point estimates, leading to debate over "hardware only" interventions. However, a 2024 Environmental Health Perspectives meta analysis concluded that hand washing facilities alone cut paediatric diarrhoea by 30 %, and that payoff rose above 45 % when hand washing was paired with latrine construction and protected water sources (heterogeneity accounted for) (World Health Organization, 2024).

Our data add nuance by demonstrating that, even among school aged children (often overlooked in favour of the under five cohort), sanitation quality remains a critical buffer. Notably, the adjusted odds ratio for poor sanitation in our multivariate model (AOR = 3.2) is nearly identical to estimates reported among children < 5 y in Ethiopia (AOR ≈ 3.4) and Zimbabwe (AOR ≈ 4.6) suggesting cross age generalisability. (Motuma et al.,(2025)

*3.4.7 Behavioural dimension: defecation practices and "last mile" risk*

Defecation behaviour bridges infrastructure and individual agency. Even in villages officially certified as "open defecation free" (ODF), sporadic lapses are common, and young children may still defecate in open spaces. A 2024 Ethiopian case–control study demonstrated a 64 % lower diarrhoea prevalence in ODF versus non ODF households after adjusting for wealth, water source, and maternal education Yihun et al. (2024). Our findings mirror that gradient: pupils who practised consistent latrine use had roughly half the diarrhoea odds of their peers who intermittently defecated in fields or roadside gutters.

Beyond pathogen exposure, open defecation can contaminate communal play areas and informal food markets, creating a feedback loop that offsets gains from household level sanitation upgrades. The public behaviour angle also intersects with recreational settings. An analysis by the US CDC of 60 splash pad outbreaks (1998 2023) shows that faecal contamination—often from diapered toddlers—accounted for > 90 % of > 10 000 water borne cases (Centers for Disease Control and Prevention, 2024). Although situated in a high income context, the study underscores a universal principle: where children congregate around water, hygiene lapses can spark rapid transmission.

*3.4.8. Integrating the three strands: a multilevel perspective*

The multivariate model underscores that economic deprivation, deficient sanitation, and unsafe defecation practices maintain independent associations with diarrhoeal risk, even after mutual adjustment. Within this hierarchy, shocks (e.g., extreme rains) may propagate downward, with the magnitude of impact modulated by resources and behaviours at each subsequent tier. The explanatory power of our combined model (Nagelkerke $R^2$=0.42) therefore reflects both additive and multiplicative dynamics—highlighting why single track programmes rarely eliminate diarrhoeal morbidity.

*3.4.9 Public health and development implications*

Improving access to safely managed sanitation in the poorest quintile would narrow the disease gap most efficiently, given the steep socioeconomic gradient observed. Evidence from community led total sanitation (CLTS) campaigns shows that coupling latrine subsidies with participatory hygiene education increases sustained latrine use by 15–20 %. School centred BCC may be especially fruitful for the 5–11 y age group, who can act as "change agents" within their households. As climate volatility Intensifies, drainage, flood proof latrine designs, and real time water quality alerts will be critical. Early warning

systems should incorporate socioeconomic vulnerability indices to prioritise at risk settlements. Opportunities exist to bundle deworming, rotavirus vaccination, and nutrition counselling with WASH upgrades—an approach favoured by the Integrated Global Action Plan for Pneumonia and Diarrhoea (GAPPD).

### *3.4.10 Limitations of cross-sectional design in inferring causality*

While cross-sectional studies offer valuable insights into the relationships between variables at a single point in time, they inherently lack the temporal dimension necessary to establish causal inference. This limitation bears several key implications for interpreting the results of this study: 1) temporal ambiguity, cross-sectional data cannot confirm whether the exposure preceded the outcome. For instance, while low economic status is associated with higher diarrhea prevalence, it remains unclear whether poverty preceded the illness or if recurring child illness contributed to economic strain through medical costs or lost caregiver productivity. 2) Reverse causality, there is a possibility that diarrheal illness itself influences some predictor variables.

For example, households coping with chronic illness may deplete resources, delay sanitation investments, or alter behavioral practices, creating a feedback loop that muddies the directionality of the relationship. 3) Confounding variables, cross-sectional studies are vulnerable to residual confounding, especially when variables such as parental education, child nutrition status, or water quality are unmeasured. These may influence both the exposure (e.g., sanitation behavior) and the outcome (diarrhea incidence), biasing the observed associations. 4) Recall and reporting bias, caregiver-reported data on child illness or defecation habits are subject to misreporting, especially when tied to stigma (e.g., open defecation) or poor memory (e.g., exact timing of illness), which can affect the internal validity of associations.

### *3.4.11 Strengths, limitations, and directions for further research*

Future longitudinal or quasi experimental studies should incorporate stool pathogen typing, quantitative microbial risk assessment, and time series climate data to sharpen causal pathways.

Table 6. Strenght and limitation

| Strengths | Limitations |
|---|---|
| Focus on an under-researched age band (5–11 y) | Cross-sectional design precludes causal inference |
| Multivariate adjustment clarifies independent effects | Reliance on caregiver self-report → recall bias |
| Purposive sampling captured diverse sanitation contexts | Sample size (n = 96) limits precision |
| Alignment with recent global metrics facilitates comparability | Potential residual confounding (e.g., dietary factors, prior antibiotic use) |

Prospective cohort designs tracking incident diarrhoeal episodes alongside environmental sampling could unravel temporal sequencing and dose–response relationships. Intervention trials comparing hardware only versus hardware + behaviour change arms in school settings would clarify synergy effects. Socio economic modelling exploring how cash transfer size, conditionality, and duration alter child WASH behaviours would guide social protection policy. Climate–health integration using high resolution rainfall data and remote sensing to forecast outbreak hotspots. Equity focused evaluations assessing whether girls and children with disabilities derive similar benefits from WASH upgrades. Taken together, the present study reinforces a growing consensus: childhood diarrhoea is best understood as a multifactorial phenomenon in which poverty, infrastructure, and daily behaviour form an inseparable triad. While each strand is

independently actionable, durable progress will demand integrated programmes that lift household incomes, expand safely managed sanitation, and embed hygienic behaviours from early childhood onward. Investments along those lines promise not only to avert preventable morbidity but also to unlock educational and developmental gains that compound across the life course.

## 4. Conclusion

Based on the results of the analysis and discussion, it can be concluded that there is a relationship between economic status, environmental sanitation and defecation elimination patterns with the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency. Multivariately, there is also a significant relationship between economic status, environmental sanitation and defecation elimination patterns with the incidence of diarrhea in children at Simo Regional Hospital, Boyolali Regency.

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