ORIGINAL RESEARCH ARTICLE

# Socioeconomic and Household Environmental Determinants of Diarrhoeal Disease in Under-Five Children: A Comprehensive Analysis in Karnataka, India

**Mounika Sree Manivasagan[1], Chaithra Mallaiah[2], Suraj B Manjunath[3], DVSK Manasapriya[4], Yashashwini Anethyar[5], Madhu Basavegowda[6*]**

[1-6]Department of Community Medicine, JSS Medical College, JSS AHER, Mysuru, India

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## ABSTRACT

**Background:** Diarrhoeal disease remains a leading cause of under-five morbidity in India, with substantial sub-state heterogeneity. Karnataka has shown progress overall, yet district-level disparities persist. This study assessed the prevalence and determinants of diarrhoeal morbidity among under-five children in Karnataka using data from the National Family Health Survey-5 (NFHS-5).

**Methods:** A cross-sectional analysis was conducted using NFHS-5 data (2019-2021). A total of 8,140 under-five children from Karnataka were included after applying exclusion criteria. Socio-demographic, maternal, and household environmental variables were examined. Associations were assessed using chi-square tests and bivariable logistic regression, followed by multivariable logistic regression to identify independent predictors, accounting for potential confounders.

**Results:** The overall prevalence of diarrhoea among under-five children in Karnataka was 5.3%, with notable variation across districts. Higher prevalence was observed among children aged 12-23 months, male children, those born to younger mothers (<25 years), children from Scheduled Caste households, and those from poorer wealth quintiles. In the adjusted analysis, maternal age <25 years (AOR = 3.47; 95% CI: 1.31-9.14) and use of unsafe cooking fuel (AOR = 3.89; 95% CI: 1.39-10.91) emerged as significant independent predictors of diarrhoeal morbidity. Unimproved drinking water showed a borderline association. Several factors, including child sex, breastfeeding status, sanitation type, and stool disposal practices, were not independently associated after adjustment.

**Conclusion:** Childhood diarrhoea in Karnataka is influenced by a combination of maternal and household environmental factors. Interventions targeting young mothers and reducing household exposure to unsafe cooking fuels may help further reduce the burden of diarrhoeal morbidity among under-five children.

**Keywords:** NFHS-5, Diarrhoea, Under-Five, Karnataka, WASH, Socioeconomic Inequities, Toilet Sharing, India

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***Correspondence:** Madhu B (Email: madhub@jssuni.edu.in)

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## INTRODUCTION

Diarrhoeal disease remains a major cause of childhood morbidity and mortality, particularly in low- and middle-income countries. In 2021, diarrhoea accounted for nearly 9% of all deaths among children under five worldwide.[1] More recent estimates indicate that diarrhoea ranks as the third leading cause of under-five mortality, accounting for approximately 443,832 deaths annually.[2] India has made progress in reducing child mortality over recent decades; however, diarrhoeal disease continues to pose a substantial public health challenge. According to NFHS-4 (2015-16), 9.2% of Indian children under five experienced a diarrhoeal episode in the two weeks preceding the survey. Significant geographic variation has been reported, with spatial analyses identifying hotspot districts primarily in Uttar Pradesh and Odisha, and cold-spot districts across southern, northern, eastern, and northeastern regions of India, underscoring the need for context-specific public health strategies.[3]

The persistent burden of diarrhoea has prompted the Government of India to implement several interventions, including the Intensified Diarrhoea Control Programme (IDCF) and more recent Water, Sanitation, and Hygiene (WASH) initiatives.[4,5] These efforts align with global frameworks such as the WHO/UNICEF Global Action Plan for Pneumonia and Diarrhoea (GAPPD) and Sustainable Development Goal (SDG) 3.2, which emphasise eliminating preventable childhood deaths by 2030.[6,7] Despite improvements in sanitation coverage and child health services, diarrhoeal disease continues to affect vulnerable populations, underscoring the need to understand the drivers of persistent transmission.

Childhood diarrhoea results from a complex interplay of socio-demographic, environmental, and nutritional factors. Established risk factors include younger child age, rural residence, lower maternal education, and poorer household economic status.[3] Environmental determinants such as unsafe drinking water, inadequate sanitation, open defecation, and poor housing conditions significantly contribute to enteric infections.[8,9] Undernutrition, inadequate handwashing, and suboptimal infant feeding practices further increase susceptibility to diarrhoeal disease.[10-12] As many of these determinants are modifiable, identifying high-risk groups at sub-national levels is essential for targeted interventions.

Although childhood diarrhoeal disease has been extensively examined in India, most empirical evidence is derived from national or broad regional analyses that primarily report pooled prevalence estimates and associated risk factors at aggregate levels. Existing studies[3,8,9] using NFHS data have largely focused on inter-state or national-level patterns, with limited emphasis on systematic district-level analytical assessments within individual states. The NFHS-5 (2019-21) fact sheets for Karnataka report a diarrhoea prevalence of 5.3% among children under five, reflecting a marginal increase compared to NFHS-4, despite documented improvements in sanitation coverage, access to drinking water, and child health services.[13] However, district fact sheets are designed to provide descriptive summaries and do not examine district wise variation in socio-demographic and environmental determinants through analytical modelling. Consequently, they do not elucidate intra-state heterogeneity, risk gradients, or clustering of vulnerable sub-populations across districts. This limitation constrains the translation of survey findings into actionable, district-specific priorities, which are increasingly essential under India's decentralised health planning and targeted child health interventions.

In this context, the present study examines the socio-demographic and environmental determinants of diarrhoeal disease among children under five across all districts of Karnataka using NFHS-5 (2019-21) data. By analysing district-representative data and identifying significant predictors of childhood diarrhoea, this study aims to generate evidence that can support locally tailored, district-specific public health strategies and advance Karnataka's progress toward national and global child health targets.

## METHODOLOGY

**Study design and setting:** This study employed a cross-sectional analytical design using data from the National Family Health Survey-5 (NFHS-5) conducted in Karnataka, India, between July and December 2019. NFHS-5 is part of the global Demographic and Health Survey (DHS) program and provides district-level, population-based estimates on maternal and child health, nutrition, and household environmental conditions.

**Conceptual framework:** The conceptual framework for this study was developed based on existing literatures[8-9,14-20] that explains the multifactorial nature of childhood diarrhoeal diseases. The framework hypothesises that diarrhoea among under-five children is influenced by socio-demographic and Household environmental factors.

**Data source and study population:** Data were obtained from the publicly available NFHS-5 child recode (KR) dataset, accessed with prior authorization from the DHS Program. The survey collected information from 26,574 households and 30,455 women aged 15-49 years in Karnataka.

For the present analysis, all children aged 0-59 months living with interviewed women were considered. Children who were not de jure residents, had missing information on diarrhoea status, or whose mothers responded "don't know" to the diarrhoea question were excluded to ensure analytic consistency. The final analytical sample consisted of 8,140 under-five children, of whom 461 experienced diar-

rhoea in the two weeks preceding the survey. The detailed flow chart is in Figure 1.

**Sampling Design:** NFHS-5 follows a multistage stratified sampling design. In rural areas, villages served as primary sampling units (PSUs), while Census Enumeration Blocks were used in urban areas. Households were selected using systematic random sampling. Sampling strata were defined by district and place of residence. This design ensures representativeness at district, state, and national levels.

To account for the complex survey design, all analyses incorporated sampling weights, primary sampling units (PSUs), and stratification using the svyset command in Stata. This ensured nationally representative and unbiased estimates by adjusting for unequal probabilities of selection, clustering, and stratification inherent to the NFHS sampling design.

Survey settings were defined using the following Stata command:

```
gen wt = v005/1000000
svyset [pw=wt], psu(v021) strata(v023) singleunit
(centered)
```

**Outcome Variable:** Childhood diarrhoea was defined as the occurrence of diarrhoea in the two weeks preceding the survey, based on maternal recall (variable *h11*). Responses were recoded into a binary outcome (1 = had diarrhoea, 0 = no diarrhoea), while "don't know" responses were treated as missing and excluded from regression analyses.

**Explanatory variables**

**Sociodemographic factors:** This study analysed various sociodemographic variables to examine their association with the occurrence of diarrhoeal diseases among under-five children in Karnataka, using NFHS-5 data. The selected predictor variables, based on pre-existing literature, included: age of the child (in months) (categorized into <12, 12-23, 24-35, 36-47, and 48-59), sex of the child (male or female), birth weight in grams (<2500 and >2500), and birth order (grouped as 1, 2-3, and >3).

Additionally, place of residence (urban or rural), Social group (SC, ST, OBC, and others), Religion (Hindu, and others includes muslim. Christian, Sikh, Buddist, Jain and other religion), whether the child was currently being breastfed (yes or no), and the mother's age in years (<25, 25-34, >35) were included. Other factors analysed were the mother's highest educational level (Illiterate & Primary, Secondary & Above), currently working (Yes or no), DHS wealth quintiles were regrouped into Poor (poorest and poorer), Middle, and Rich (richer and richest). and the mother's mass media exposure, such as radio, television and newspaper, is categorised as (yes or no).

**Household environmental factors:** Drinking water source was categorised as improved (piped water, public taps, tube wells, protected wells, community water points) or unimproved (unprotected wells, surface water, tanker trucks). Cooking fuel was grouped as clean (electricity, LPG, biogas) or unclean (kerosene, coal, wood, crop residues, dung). Toilet facility was classified as improved (flush toilets, ventilated improved pit latrines, pit latrines with slab) or unimproved (open defecation, pit latrines without slab). Shared sanitation indicated whether toilet facilities were shared with other households. Disposal of the youngest child's stool was categorised as safe (disposed in toilet/latrine) or unsafe (left in the open, disposed in garbage or drains). Floor material was classified as clean (cement, tiles, polished stone, marble, granite) or unclean (mud, sand, dung, raw wood). Wall material was categorized as clean (cement, concrete, burnt bricks, stone with cement) or unclean (mud, bamboo, thatch, unburnt bricks). Roof material was classified as clean (RCC, cement, metal sheets, tiles) or unclean (thatch, mud, plastic sheets).

Children from households with missing information or who were not de jure residents were excluded from the respective analyses. Housing material variables (floor, wall, and roof) were initially explored but excluded from the final multivariable model due to limited variability and perfect prediction in some categories.

**Ethical clearance:** To utilize the 2019-21 NFHS dataset from the Demographic and Health Surveys (DHS) Program for this study, formal permission was obtained from the DHS Program. The data were accessed and analyzed in compliance with all guidelines, rules, and regulations set forth by the DHS Program. Researchers seeking to access the dataset are required to register at https://dhsprogram.com/ data/available-datasets.cfm and submit a request letter describing the project's objectives and intended use of the data.

**Statistical Analysis:** Data were analysed using STATA software version 17 (StataCorp, TX, USA) (https://www.stata.com/). Descriptive statistics summarized the prevalence of diarrhoea across explanatory variables. Bivariate associations were assessed using Pearson's chi-square tests.

Unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) were estimated using separate logistic regression models for each explanatory variable. Variables with biological plausibility and prior epidemiological relevance were included in the multivariable logistic regression model to estimate adjusted odds ratios (AORs). Survey-weighted logistic regression models accounted for sampling weights, clustering, and stratification. Multicollinearity was assessed using variance inflation factors derived from a linear probability model, with all VIF values below 5, indicating no evidence of collinearity. Model adequacy was evaluated based on theoretical relevance, stability of estimates, and consistency between unadjusted and adjusted models, as conventional goodness-of-fit tests are not appropriate for complex survey data.

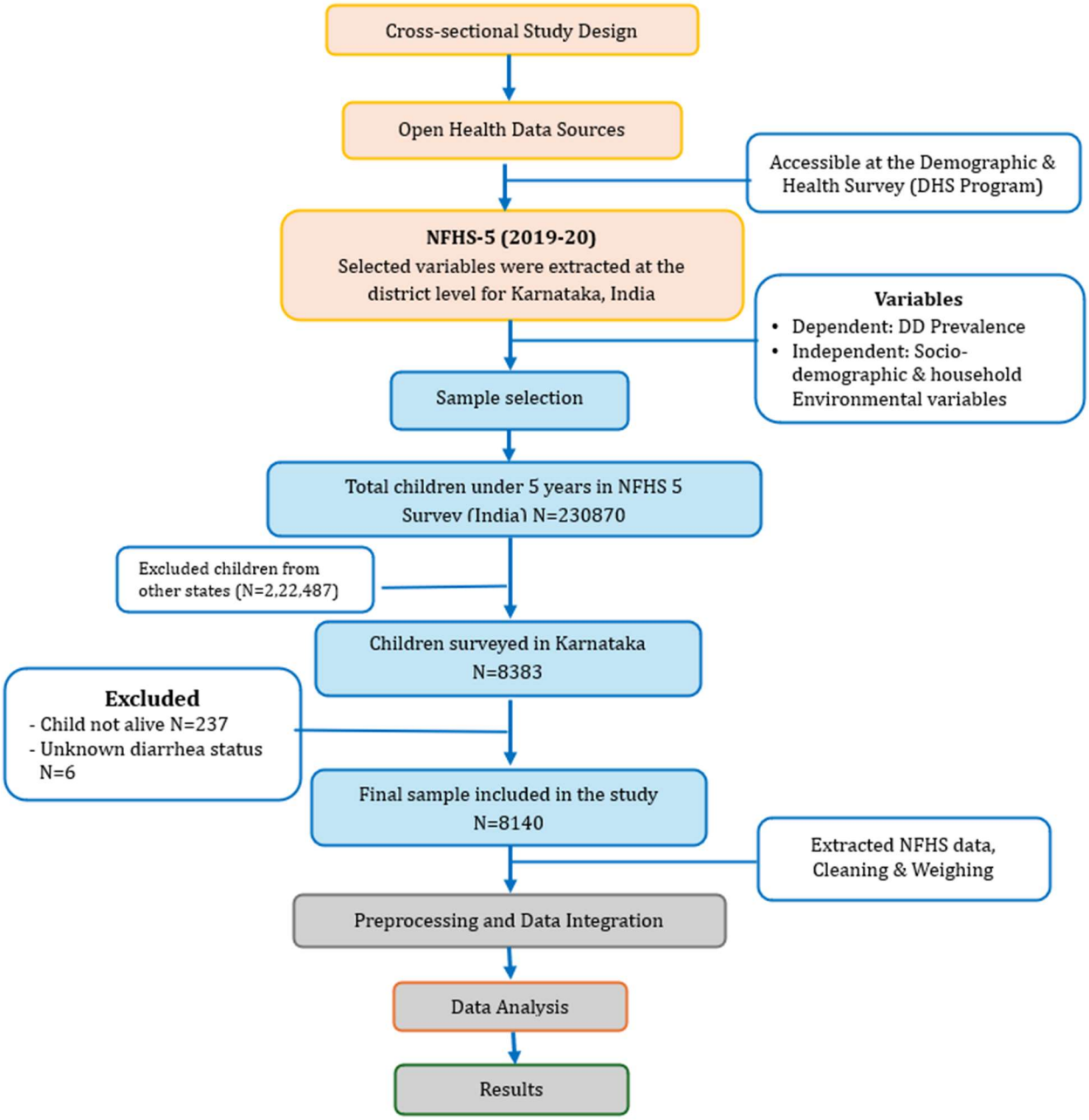


**Figure 1: Flow chart of the study**

## RESULTS

The district-wise distribution of the prevalence of Diarrhoea among children under 5 in Karnataka is shown in figure 2. The prevalence of diarrhoea among children under five in Karnataka from 2019 to 2021 varied significantly across districts, with an overall prevalence of 5.3%. The highest prevalence was observed in Gadag (10.37%), followed by Kalaburagi (9.44%), Davanagere (9.25%), Bidar (9.03%), and Haveri (8.95%), indicating a higher burden in parts of northern and central Karnataka. In contrast, relatively lower prevalence was noted in Dharwad (1.84%), Bengaluru (2.17%), Mysuru (2.98%), and Mandya (3.12%). Coastal districts such as Udupi (3.53%) and Dakshina Kannada (3.85%) showed comparatively lower prevalence.

A total of 8140 under 5 children were included in the study. Table 1 describes the socio-economic and demographic characteristics of under-five children included in the study in Karnataka. The age distribution of children was relatively uniform across categories, with the largest proportion in the 48-59 months age group (21.86%). Slightly more than half of the children were male (51.14%). Nearly two-thirds of children (64.07%) had a birth weight ≥2500 g, while 35.93% were of low birth weight. More than half of the children were of second or third birth order (51.35%), followed by first-born children (45.00%). Most mothers were aged 26-34 years (60.77%), and a substantial proportion had attained secondary or higher education (79.71%).

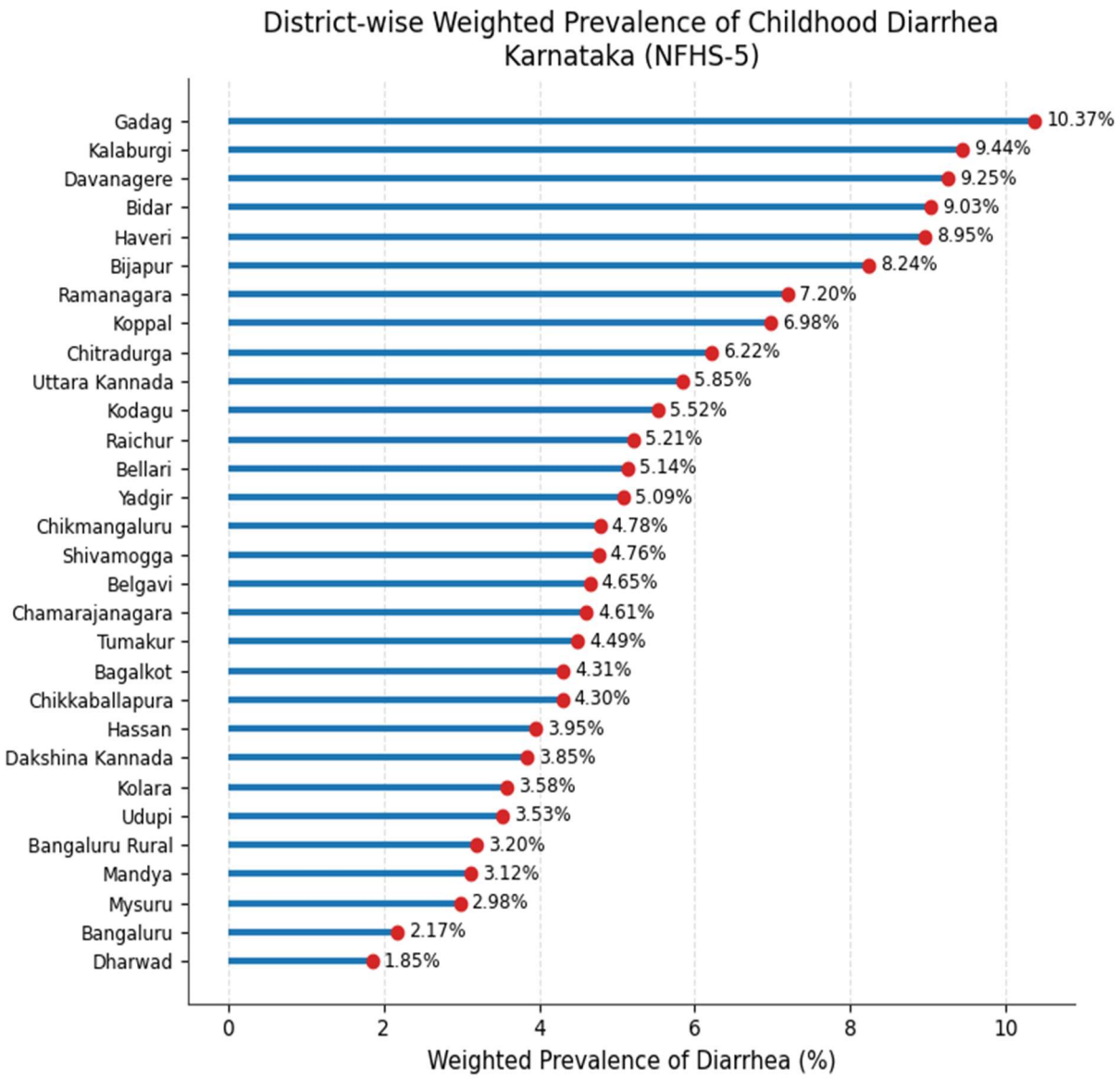


**Figure 2: Prevalence of diarrhoea among 0-5 aged children in the districts of Karnataka, 2019-21**

More than half of the children (56.31%) were currently breastfed, and the majority of mothers had mass media exposure (77.04%). Approximately 71.37% of mothers were not currently working. In terms of socio-cultural characteristics, the majority of children belonged to the Hindu religion (82.65%), and Other Backward Classes (OBC) constituted the largest social group (54.28%). With respect to economic status, children were fairly evenly distributed across poor (30.85%), middle (31.61%), and rich (37.54%) wealth categories. A larger proportion of children resided in rural areas (71.77%) compared to urban areas (28.23%).

The occurrence of diarrhoeal diseases shows significant associations with several socio-economic and demographic factors. Age of the child showed a strong and statistically significant association with diarrhoeal morbidity ($\chi^2 = 10.74$, $p = 0.001$), with the highest prevalence observed among children aged 12-23 months (8.08%), followed by those aged <12 months (6.86%), and a declining trend with increasing age.

A significant association was also noted with sex of the child ($\chi^2 = 3.96$, $p = 0.046$), where male children (6.03%) had a slightly higher prevalence of diarrhoea compared to females (5.28%). Maternal age was significantly associated with diarrhoeal occurrence ($p = 0.046$), with higher prevalence among children of mothers aged <25 years (6.13%).

Children belonging to Scheduled Castes (7.07%) and those from poorer households (6.53%) experienced significantly higher prevalence of diarrhoea compared to other social groups ($p = 0.027$) and wealth categories ($p = 0.035$), respectively. Current breastfeeding status showed a strong association ($\chi^2 = 16.17$, $p = 0.001$), with a higher prevalence among currently breastfed children (6.33%) compared to those not breastfeeding (4.81%).

No statistically significant associations were observ-

d with birth weight, birth order, maternal education, maternal employment status, maternal mass media exposure, religion, or place of residence ($p$ >0.05).

Table 2 presents the household environmental characteristics of under-five children in Karnataka along with the occurrence of recent diarrhoeal disease across these characteristics. The majority of households reported access to an improved source of drinking water (94.11%), while 5.89% relied on unimproved sources. Most households used safe cooking fuel (76.76%), although nearly one-quarter (23.24%) continued to use unsafe fuels.

Regarding housing conditions, a large proportion of households had clean floor materials (91.15%), whereas 23.24% and 23.14% of households had unclean wall and unclean roof materials, respectively. With respect to sanitation, nearly three-quarters of households had improved toilet facilities (72.57%), while 27.43% used unimproved sanitation. Toilet sharing was uncommon, with 95.16% of households reporting non-shared toilet facilities. The safe disposal of the youngest child's stool was relatively low, with only 41.57% reporting safe disposal practices, while 58.43% practiced unsafe disposal.

**Table 1: Occurrence of diarrhoeal diseases according to socio-economic & demographic characteristics of respondents in Districts of Karnataka (from the NFHS-5, 2019-20)**

| Variable | Total children (%) | Child with history of recent Diarrhoea (% from total children) | *p*-Value |
|---|---|---|---|
| **Age of Child (in Months)** | | | |
| <12 | 1619 (19.89) | 111 (6.86) | **0.001** |
| 12-23 | 1585 (19.47) | 128 (8.08) | |
| 24-35 | 1581 (19.42) | 85 (5.38) | |
| 36-47 | 1576 (19.36) | 62 (3.93) | |
| 48-59 | 1779 (21.86) | 75 (4.22) | |
| **Sex of the child** | | | |
| Male | 4163 (51.14) | 251 (6.03) | **0.046** |
| Female | 3977 (48.86) | 210 (5.28) | |
| **Birth Weight** | | | |
| <2500 | 2925 (35.93) | 160 (5.47) | 0.438 |
| >2500 | 5215 (64.07) | 301 (5.77) | |
| **Birth Order of a Child** | | | |
| 1 | 3500 (45) | 176 (5.03) | 0.102 |
| 2-3 | 4180 (51.35) | 251 (6) | |
| >3 | 460 (5.65) | 34 (7.39) | |
| **Mother age (years)** | | | |
| <25 | 2658 (32.65) | 163 (6.13) | **0.046** |
| 26-34 | 4947 (60.77) | 270 (5.46) | |
| 35 & above | 535 (6.57) | 28 (5.23) | |
| **Mother's Highest education** | | | |
| Illiterate & Primary | 1652 (20.29) | 106 (6.42) | 0.438 |
| Secondary & above | 6488 (79.71) | 355 (5.47) | |
| **Currently Breastfeeding** | | | |
| No | 3556 (43.69) | 171 (4.81) | **0.001** |
| Yes | 4584 (56.31) | 290 (6.33) | |
| **Mass Media exposure of Mother** | | | |
| No | 1869 (22.96) | 130 (6.96) | 0.185 |
| Yes | 6271 (77.04) | 331 (5.28) | |
| **Currently Working** | | | |
| No | 870 (71.37) | 51 (5.86) | 0.581 |
| Yes | 349 (28.63) | 21 (6.02) | |
| **Religion** | | | |
| Hindu | 6728 (82.65) | 385 (5.72) | 0.539 |
| Others | 1412 (17.35) | 76 (5.38) | |
| **Social group** | | | |
| SC | 1768 (21.72) | 125 (7.07) | **0.027** |
| ST | 979 (12.03) | 43 (4.39) | |
| OBC | 4418 (54.28) | 228 (5.16) | |
| Others | 975 (11.98) | 65 (6.67) | |
| **Wealth Index** | | | |
| Poor | 2511 (30.85) | 164 (6.53) | **0.035** |
| Middle | 2573 (31.61) | 146 (5.67) | |
| Rich | 3056 (37.54) | 151 (4.94) | |
| **Place of Residence** | | | |
| Urban | 2298 (28.23) | 133 (5.79) | 0.134 |
| Rural | 5842 (71.77) | 328 (5.61) | |

The occurrence of recent diarrhoeal episodes varied across several household environmental characteristics. A statistically significant association was observed with roof material ($\chi^2$ = 4.026, $p$ = 0.045), where children residing in households with unclean roof materials had a higher prevalence of diarrhoea (6.75%) compared to those with clean roofs (5.32%).

A strong and significant association was also found for shared toilet facilities ($\chi^2$ = 26.80, $p$ <0.001). Children from households sharing toilets with other households experienced a substantially higher prevalence of diarrhoea (10.32%) than those with non-shared toilet facilities (5.16%). A marginal association was observed between cooking fuel type and diarrhoeal occurrence, with higher prevalence among households using unsafe fuels (p = 0.054).

Although higher diarrhoeal prevalence was observed among households using unimproved drinking water sources, unimproved sanitation, and unsafe child stool disposal, these associations did not reach statistical significance ($p$ >0.05). No significant associations were found with floor material or wall material.

Table 3 presents the Bivariable and Multivariable Logistic Regression Analysis of factors associated with diarrhoeal morbidity among under-five children in Karnataka. Child age showed a strong association with diarrhoea. Compared with children aged <12 months, those aged 24-35 months, 36-47 months, and 48-59 months had significantly lower odds of diarrhoea, indicating a declining risk with increasing age. Female children had lower odds of diarrhoea compared to males (OR = 0.80, $p$ = 0.047).

Children who were currently breastfed had significantly higher odds of diarrhoea (OR = 1.55, $p$ <0.001). Belonging to the Scheduled Caste group (OR = 1.48, $p$ = 0.005) and living in poor or middle-wealth households were also associated with increased odds of diarrhoeal morbidity. From an environmental perspective, sharing toilet facilities was strongly associated with diarrhoea (OR = 2.57, $p$ <0.001), while unsafe cooking fuel showed a borderline association (OR = 1.30, $p$ = 0.055).

After adjusting for potential confounders, only a few factors remained independently associated with diarrhoeal morbidity. Children of mothers aged <25 years had significantly higher odds of diarrhoea compared to those whose mothers were aged 26-34 years (AOR = 3.47; 95% CI: 1.31-9.14). Conversely, children of mothers with illiterate or primary education showed significantly lower odds of diarrhoea compared to those whose mothers had secondary or higher education (AOR = 0.16; 95% CI: 0.03-0.77).

Among environmental factors, use of unsafe cooking fuel emerged as a significant independent predictor, with nearly four times higher odds of diarrhoea compared to households using safe fuel (AOR = 3.89; 95% CI: 1.39-10.91). Unimproved drinking water showed a borderline association (AOR = 3.56; $p$ = 0.052), while sharing toilet facilities, although strongly associated in crude analysis, did not retain statistical significance after adjustment.

Other variables, including child sex, birth weight, birth order, wealth index, place of residence, sanitation facility type, and child stool disposal practices, were not independently associated with diarrhoeal morbidity in the adjusted model ($p$ > 0.05).

**Table 2: Occurrence of diarrhoeal diseases according to Household environmental characteristics of respondents in Districts of Karnataka (from the NFHS-5, 2019-20)**

| Variable | Total children (%) | Child with history of recent Diarrhoea (% from total children) | *p*-Value |
|---|---|---|---|
| **Source of Drinking Water** | | | |
| Unimproved | 442 (5.89) | 30 (6.79) | 0.178 |
| Improved | 7057 (94.11) | 392 (5.55) | |
| **Cooking fuel** | | | |
| Safe | 5494 (76.76) | 291 (5.3) | **0.054** |
| Unsafe | 1754 (23.24) | 136 (6.58) | |
| **Main Floor material** | | | |
| Unclean | 665 (8.85) | 38 (5.71) | 0.638 |
| Clean | 6849 (91.15) | 389 (5.68) | |
| **Main Wall material** | | | |
| Unclean | 1754 (23.24) | 106 (6.04) | 0.242 |
| Clean | 5794 (76.76) | 318 (5.49) | |
| **Main Roof material** | | | |
| Unclean | 1733 (23.14) | 117 (6.75) | **0.045** |
| Clean | 5755 (76.86) | 306 (5.32) | |
| **Toilet Facilities** | | | |
| Improved | 5471 (72.57) | 293 (5.36) | 0.169 |
| Unimproved | 2068 (27.43) | 131 (6.33) | |
| **Toilet facilities are shared with other households** | | | |
| Not shared | 5522 (95.16) | 285 (5.16) | **<0.001** |
| Shared | 281 (4.84) | 29 (10.32) | |
| **Disposal of the youngest Child's stool** | | | |
| Safe | 1848 (41.57) | 99 (5.36) | 0.279 |
| Unsafe | 2597 (58.43) | 164 (6.31) | |

**Table 3: Bivariable and Multivariable Logistic Regression Analysis of Factors Associated with Diarrhoeal Morbidity among Under-Five Children in Karnataka, India (NFHS-5, 2019-20)**

| Variable | Crude OR [95% CI] | p-value | Adjusted OR [95% CI] | p-value |
|---|---|---|---|---|
| **Age of Child in Months (Ref <12 Months)** | | | | |
| 12-23 | 1.080 (0.76,1.53) | 0.665 | 2.38 (0.68,8.24) | 0.168 |
| 24-35 | 0.614 (0.43,0.85) | **0.005** | 1.94 (0.25,14.57) | 0.515 |
| 36-47 | 0.464 (0.31,0.67) | **0.001** | 1.39 (0.18,10.33) | 0.741 |
| 48-59 | 0.470 (0.33,0.66) | **0.001** | 0.90 (0.07,10.79) | 0.939 |
| **Female (Ref Male)** | 0.799 (0.64,0.99) | **0.047** | 1.52 (0.57,4.06) | 0.305 |
| **Birth Weight <2500 gm (Ref ≤2500 gm))** | 0.913 (0.72,1.14) | 0.438 | 0.42 (0.15,1.24) | 0.120 |
| **Birth Order (Ref Order 1)** | | | | |
| 2-3 | 1.22 (0.95,1.55) | 0.105 | 1.28 (0.50,3.22) | 0.595 |
| >3 | 1.47 (0.96,2.24) | 0.074 | 4.08 (0.80,20.10) | 0.090 |
| **Mother age (years) (Ref 26-34 yrs)** | | | | |
| <25 | 1.207 (0.96,1.51) | 0.102 | 3.47 (1.31,9.14) | 0.012 |
| 35 & above | 0.714 (0.46,1.09) | 0.199 | 1.84 (0.22,15.05) | 0.563 |
| **Mother's education Primary or below (Ref Secondary & above)** | 1.107 (0.85,1.43) | 0.439 | 0.16 (0.03,0.77) | **0.024** |
| **Currently working (Ref Non-working)** | 1.15 (0.68,1.95) | 0.582 | 2.55 (0.93,6.93) | 0.066 |
| **Currently breastfeeding (Ref No breastfeeding)** | 1.553 (1.25,1.92) | **0.001** | 1.57 (0.40,6.12) | 0.507 |
| **No Mass Media exposure of Mother (Ref Mass Media exposure present)** | 1.190 (0.91,1.54) | 0.186 | 0.69 (0.23,2.07) | 0.511 |
| **Non-Hindu Religion (Ref Hindu)** | 1.118 (0.78,1.60) | 0.54 | 0.68 (0.17,2.71) | 0.590 |
| **Caste (Ref OBC)** | | | | |
| SC | 1.477 (1.12,1.94) | **0.005** | 2.23 (0.65,7.63) | 0.196 |
| ST | 0.884 (0.61,1.27) | 0.511 | 2.23 (0.65,7.63) | 0.332 |
| Others | 1.290 (0.86,1.92) | 0.213 | 2.07 (0.55,7.73) | 0.272 |
| **Wealth Index (Ref Rich)** | | | | |
| Poor | 1.381 (1.03,1.83) | **0.027** | 0.72 (0.14,3.73) | 0.701 |
| Middle | 1.378 (1.01,1.87) | **0.042** | 0.89 (0.30,2.65) | 0.837 |
| **Rural Residence (Ref Urban Residence)** | 1.236 (0.93,1.63) | 0.134 | 0.51 (0.14,1.85) | 0.305 |
| **Unimproved Source of Drinking Water (Ref improved)** | 1.322 (0.87,1.98) | 0.180 | 3.56 (0.98,12.82) | **0.052** |
| **Unsafe Cooking fuel (Ref safe cooking fuel)** | 1.304 (0.99,1.71) | 0.055 | 3.89 (1.39,10.91) | **0.010** |
| **Unimproved Toilet Facilities (Ref improved)** | 1.207 (0.92,1.58) | 0.170 | 1.88 (0.57,6.16) | 0.291 |
| **Toilet facilities are shared with other households (Ref Not shared)** | 2.573 (1.77,3.72) | **0.000** | 3.11 (0.84,11.54) | 0.088 |
| **Unsafe Disposal of the youngest Child's stool (Ref safe)** | 1.190 (0.86,1.63) | 0.280 | 2.61 (0.81,8.41) | 0.106 |

Note: Survey Weighted Bivariable and Multivariable Logistic Regression Analysis

## Discussion

The present study examined the prevalence and determinants of Diarhoea among under-five children in Karnataka using NFHS-5 data, with a focus on sociodemographic and household environmental factors associated with childhood diarrhoea during 2019-2021. The overall prevalence of diarrhoea (5.3%) indicates that diarrhoea remains a significant public health concern in the state, despite improvements in water, sanitation, and maternal and child health indicators.

The prevalence of diarrhoea varied considerably across districts, with higher levels observed in districts such as Gadag, Kalaburagi, Davanagere, Bidar, and Haveri, and lower prevalence in districts including Dharwad, Bengaluru Urban, Mysuru, and Mandya. These differences likely reflect variations in socio-economic conditions, household environments, and access to health and sanitation services across districts.

**Sociodemographic determinants:** The age pattern, with peak prevalence in the 12-23-month group and a decline thereafter, is epidemiologically coherent and reflects the high-risk weaning window when complementary feeding, crawling, and increased environmental contact amplify exposure to enteric pathogens. This pattern is consistent with the previous studies in Malawi, Africa[20].

Male children exhibited slightly higher prevalence of diarrhoea compared to females. This is possibly due to biological susceptibility and differential caregiving or outdoor exposure. This finding is consistent with a previous survey (NFHS 4) in India.[9] Maternal age showed a significant independent association, with children of mothers aged below 25 years having higher odds of diarrhoea. This may reflect limited caregiving experience, lower health awareness, or reduced access to resources among younger mothers. This finding is supported by previous study conducted in Pakisthan.[21]

The inverse adjusted association between low maternal education and diarrhoea which consistently report a protective effect of higher maternal education on child health outcomes. This finding contrasts with evidence from a previous study in India.[3]

Birth weight and birth order were not significantly associated with diarrhoeal. These findings suggest that postnatal environmental exposures and caregiving practices may play a more prominent role in diarrhoeal risk than perinatal characteristics in this population.

Children from Scheduled Castes and those belonging to poorer wealth categories experienced higher odds of diarrhoeal in the crude analysis, underscoring persistent socio-economic disparities in child health

outcomes. This finding is supported by the previous findings[8]. However, these associations were attenuated after adjustment, suggesting that household environmental conditions and maternal characteristics may mediate the relationship between socio-economic status and diarrhoeal risk.

Maternal employment status and mass media exposure were not significantly associated with diarrhoeal morbidity. The lack of association may indicate that these factors alone do not directly influence diarrhoeal risk, or that their effects are mediated through other socio-economic and environmental pathways.

**Environmental and Household Determinants:** The strong independent association between unsafe cooking fuel and diarrhoea, with nearly fourfold higher odds in exposed households, suggests that domestic combustion using solid or unsafe fuels may contribute to enteric risk via multiple mechanisms, including increased particulate deposition on food and utensils, reduced ventilation, and coexisting poor housing and hygiene conditions. While most prior work on solid fuels has focused on respiratory outcomes, recent evidence from study conducted in Nepal supports this finding.[22]

The borderline association of unimproved drinking water in the adjusted model is directionally consistent with the extensive literature linking unsafe water to paediatric diarrhoea, and the high coverage of "improved" sources in Karnataka may mask important differences in actual water quality, continuity of supply, and point-of-use handling. This finding is supported by the Previous study[23]. Sharing toilet facilities was strongly associated with diarrhoea in the bivariate analysis, this finding aligns with the Systematic review demonstrating increased diarrhoea risk from shared sanitation due to poor maintenance, high user load, and environmental contamination.[24]

Despite relatively high coverage of improved water and sanitation facilities, unsafe disposal of child stool was common. Although not independently associated with diarrhoea in this analysis, unsafe stool disposal remains a critical hygiene concern and may contribute to ongoing transmission of infection within households and communities. The lack of significant associations may reflect improvements in basic housing and sanitation infrastructure across the state or insufficient variability within the sample.

A major strength of this study is the use of NFHS-5 data, which are large-scale, population-based, and representative at the district and state levels. The analysis appropriately accounted for the complex survey design through application of sampling weights, clustering, and stratification, yielding unbiased population estimates. The inclusion of both crude and adjusted survey-weighted logistic regression models allowed for transparent assessment of confounding and identification of independent risk factors, consistent with best practices in epidemiological analysis.

However, certain limitations should be acknowledged. The cross-sectional design precludes causal inference, and observed associations should be interpreted as correlational. Diarrhoeal morbidity was based on maternal self-report for the two weeks preceding the survey and may be subject to recall or reporting bias. Some household environmental variables were highly correlated, leading to reduced precision and exclusion of certain predictors in multivariable models due to collinearity or sparse data. The NFHS dataset does not include pathogen-specific information, restricting the ability to identify the etiological agents responsible for diarrhoeal episodes. Additionally, unmeasured factors such as hand-washing behaviour, food hygiene practices, and local environmental contamination could not be assessed within the available data.

Despite these limitations, the findings provide robust, policy-relevant evidence on the social and environmental determinants of childhood diarrhoea in Karnataka and underscore priority areas for targeted interventions within existing maternal and child health programmes.

## CONCLUSION

This study demonstrates that childhood diarrhoeal disease in Karnataka remains strongly influenced by a combination of maternal characteristics and household environmental conditions. Younger maternal age, lower maternal education, use of unsafe cooking fuels, and shared sanitation facilities were independently associated with higher odds of diarrhoeal illness among under-five children. These findings reinforce the need for integrated public health strategies that extend beyond child-focused interventions to include improvements in female education, clean household energy transitions, and access to private sanitation. Addressing these structural and behavioural determinants is essential for sustained reductions in diarrhoeal morbidity in line with child survival and Sustainable Development Goal targets.

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**Availability of Data:** The NFHS-5 dataset analyzed in this study is publicly available from the DHS Program upon registration at https://dhsprogram.com/data/

**Declaration of Non-use of Generative AI Tools:**

This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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