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Research Article

# Determinants of Child Stunting in Madhya Pradesh: The Role of Household Infrastructure and Dietary Practices in Achieving Zero Hunger

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## Abstract

Child stunting, which is defined as low height for age, is one of the critical public health issues in Madhya Pradesh, India, with alarmingly high prevalence rates. This study examines the impact of household infrastructure and dietary practices on stunting, using district-level data from the National Family Health Survey (NFHS-5). Poor access to sanitation, clean drinking water, and proper dietary diversity emerged as significant determinants of stunting, compounded by socioeconomic disparities and maternal education levels. Logistic regression analysis shows predictors such as the wealth index, maternal BMI, and extended duration's of breastfeeding all have significant effects in protection against stunting. On the contrary, high fruit intake and grain consumption indicated high odds ratios for stunting. Significant predictors of child stunting in Madhya Pradesh are identified by logistic regression analysis. Children from particular castes had lower odds of stunting (adjusted odds ratio of 0.95, $p = 0.03$), indicating a weak but statistically significant caste effect. Mothers' education significantly lowered the chances of stunting, with an adjusted odds ratio of 0.87 and a p-value of less than 0.001. Higher Maternal BMI has been demonstrated to correlate with reduced odds of stunting, with an adjusted odds ratio of 0.97 ($p < 0.001$). Male children are considerably more prone to stunting compared to females, with an adjusted odds ratio of 0.85 and a p-value of less than 0.001. Sanitation and access to clean drinking water significantly decrease stunting, with adjusted odds ratios of 1.00 ($p < 0.001$) for sanitation and 0.99 ($p = 0.01$) for water. Housing quality, demonstrates a modest yet significant impact on reducing stunting (adjusted odds ratio of 0.99, $p = 0.01$). These findings indicate that certain pivotal factors, including maternal education, health, wealth, sanitation, and clean water consumption, are essential to child growth and stunting. Regression analysis revealed both significant and subtle findings regarding the relationship between dietary practices and child stunting. An extended breastfeeding period demonstrates a protective effect against stunting, evidenced by an adjusted odds ratio of 0.99 (95% CI: 0.99-0.65, $p < 0.001$). Collectively, these findings call for targeted policy intervention to improve infrastructure facilities in households; promote dietary diversification (vegetables, legumes, and grain, home gardening, and animal-source food); and enhance education to achieve the goal of sustainable development related to zero hunger and clean water and sanitation.

## Keywords

Stunting, WASH, Hunger, Nutrition, SDG

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# 1. Introduction

A food and agriculture system that focuses on both human health and environmental sustainability would play a vital role in the fight against global food insecurity. After these difficulties, in 2015, the UN General Assembly adopted the Zero Hunger Sustainable Development Goal. However, food insecurity still lingers because the report of 2023 State of Food Security and Nutrition in the World report indicated that about 735 million people worldwide go to bed hungry. This figure represents a rise of around 122 million compared to 2019, before the COVID-19 pandemic [19]. The most critical outcome of food insecurity and malnutrition is child stunting, which has both immediate and long-term implications.

Stunted children have a higher chance of illness and mortality, lower cognitive and physical development, and lower learning capacity. As adults, they are more vulnerable to infections and noncommunicable diseases, experience lower productivity, and face economic constraints [15]. Given these severe implications, child stunting is among the leading concerns in global health efforts; it is, in fact, the first of six goals under the Global Nutrition Targets for 2025 [18] and an important indicator under the Zero Hunger SDG [17]. One critical factor contributing to child stunting is nutrition, which has a fundamental role in cognitive development. Proper nutrition during early childhood not only improves physical growth but also enhances brain function, learning ability, and academic performance.

Research indicates that school-based treatments aimed at executive function, such as boosting nutritional intake, can significantly contribute to higher educational performance. [6]. Addressing food insecurity thus requires an integrated approach linking agricultural sustainability with improved nutrition and investments in child development, with the ultimate aim of leading to the greater ends of breaking that cycle of poverty and hunger. Child stunting, or low height-for-age, remains a chronic health problem in India and is one of the significant issues persisting in Madhya Pradesh. According to NFHS-5, Madhya Pradesh continues to record alarmingly high rates of stunting, an indication of the persistence of socioeconomic inequalities and infrastructural gaps [10]. Stunting not only limits physical growth but also compromises cognitive development, thereby reducing the potential for education and economic gain and perpetuating cycles of inter-generational poverty and poor health [16]. Household infrastructure and dietary practices are critical factors in the multifaceted determinants of stunting [16]. The inadequacy of access to safe drinking water, sanitation, and hygiene (WASH) facilities, coupled with poor dietary diversity and feeding practices, is are major contributor to the prevalence of stunting [12]. While these factors have been studied independently, their combined impact within the sociocultural and economic context of Madhya Pradesh remains underexplored.

Addressing stunting is integral for the achievement of the Sustainable Development Goals, including SDG 2 (Zero Hunger) and SDG 6 (Clean Water and Sanitation). Madhya Pradesh is a critical context that will help in understanding how the interplay between household infrastructure and dietary practices could affect child nutrition. Key enablers and barriers that influence child nutrition are required to guide region-specific interventions and policies. The present paper aspires to close this knowledge gap by providing evidence-based insights on the determinants of stunting in Madhya Pradesh.

## 1.1. Household Infrastructure and Its Impact on Child Nutrition

Household infrastructure is the key factor in determining child nutrition and health. Main aspects such as safe drinking water, sanitation facilities, clean fuel for cooking, and housing conditions determine a healthy environment in which children can grow and thrive [12]. In areas like Madhya Pradesh, household infrastructure is the most significant cause of child stunting and malnutrition. Lacking a clean water supply, the danger of waterborne diseases is high. Poor sanitary facilities also imply that there is poor hygiene, which puts children at a higher risk of infection, thus hindering nutrient uptake. Similarly, cooking using solid fuels in UN-ventilated spaces results in indoor air pollution, leading to respiratory ailments and decreased appetite among children.

Furthermore, overcrowding and poor ventilation, among other sub-optimal housing conditions, also increase the risks to health. Such factors lead to a vicious cycle where illness and poor living conditions compound malnutrition, which results in long-term growth and developmental challenges. These issues need investments in upgrading WASH facilities, promoting clean energy for cooking, and overall improvements in living conditions. Strengthening household infrastructure is important for reducing malnutrition and supporting sustainable development goals, especially in vulnerable regions like Madhya Pradesh.

## 1.2. Dietary Practices and Their Role in Child Nutrition

Dietary practices greatly influence the nutritional status and well-being of children. Adequate dietary diversity and access to relevant nutrients are important for physical growth, cognitive development, and a strong immune system [13]. In fact, in areas such as Madhya Pradesh, poor dietary practices significantly lead to malnutrition and stunting in children.

According to the National Family Health Survey, Madhya Pradesh dietary habits are extremely low. Surprisingly, 87.07% of youngsters do not consume any fruits, resulting in a lack of vitamins and minerals required for growth and develop-

ment. Furthermore, 91.21% of children are deficient in milk and milk products, which are the key providers of calcium and protein. This lack of dietary diversity, typified by a low intake of fruits, vegetables, protein-rich meals, and dairy, leads to nutritional inadequacies that hinder children's growth. Furthermore, cultural and economic variables continue to impact food choices. [9, 10]. Poverty limits access to nutritious food, and a lack of knowledge about balanced diets among caregivers heightens the problem. Targeted interventions include promoting awareness of proper feeding practices, improving access to affordable, nutritious foods, and enhancing government nutrition programs to reach underserved populations. Improving dietary practices is crucial in the fight against stunting and will lead to better health outcomes for children, especially in nutritionally vulnerable regions like Madhya Pradesh.

This study aims to analyse the role of household infrastructure and dietary practices in determining child stunting in Madhya Pradesh. It particularly focuses on the impact of dietary diversity and feeding practices on the prevalence of stunting, with identification of critical gaps in household infrastructure and nutrition practices that hamper progress toward zero stunting. Analyzing these aspects, the study digs out some major barriers to child nutrition and health. The findings will provide actionable recommendations that policymakers and stakeholders can implement to ensure targeted interventions, improvements in infrastructure, and better dietary practices, ultimately helping support healthy sustainability in Madhya Pradesh.

## 2. Data and Methodology

This study employs logistic regression analysis to explore the factors associated with child stunting in Madhya Pradesh, India. It examines how household infrastructure and dietary practices shape the occurrence of child stunting. It explores how household infrastructure and dietary practices influence the prevalence of child stunting. It applies data at the district level collected from NFHS-5 and draws rich insights on child health, household information, and other socioeconomic determinants. With a total of 16,280 observations, this dataset provides adequate statistical power for analyzing all aspects of child stunting.

Household infrastructure amenities such as better toilet facilities, drinking water supplies, and housing quality (flooring, wall, and roof materials) are significant independent variables. In addition, variables including the intake of grain foods, eggs, milk products, and fruits are used to examine dietary practices. Moreover, taken into account are socioeconomic factors such as the mother's education, BMI, place of delivery, caste, gender of the child, and wealth index. Logistic regression is used to estimate the likelihood of child stunting by using dietary practices as predictors while controlling for demographic factors. Future studies should include detailed assessments of protein and vegetable diet, since these parameters are important in child growth and stunting prevention. Due to data constraints, this study was unable to include such factors, limiting the breadth of the dietary analysis.

The dependent variable in this analysis is child stunting, which is measured as a binary outcome: 0 for non-stunted children and 1 for stunted children. Child stunting is determined using height-for-age z-scores, with stunting defined as a z-score of less than -2 standard deviations based on the WHO.

*Model Specification*

The logistic regression models can be specified as follows:

$$logit(p) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \epsilon$$

Where:

1) $P$ is the probability of sustainable livelihood success.
2) $x_1, x_2, \ldots, x_k$ are the independent variables.
3) $\beta_0$ is the intercept, $\beta_k$ are the regression coefficients, and $\epsilon$ is the error term.

### 2.1. Confidence Intervals and Statistical Significance

To evaluate each predictor's statistical significance and magnitude, the study computes odds ratios, standard errors, z-values, and 95% confidence intervals. A p-value threshold of 0.05 will be used to determine the statistical significance of the variables. Significant predictors are those for which the p-value is less than 0.05, indicating a robust relationship with child stunting.

### 2.2. Data Cleaning and Processing

Data were cleaned and prepared using STATA statistical software for missing values and to ensure consistency, as well as standardization of binary variables. Categorical variables, like caste and residence place, are encoded appropriately in logistic regression. This methodology allows for the reliability and validity of results and a detailed investigation into the Dietary Practices and infrastructural determinants of stunting in Madhya Pradesh.

***Table 1.*** *Socioeconomic Characteristics of Households in Madhya Pradesh.*

| Characteristics | Category | Freq. | Percent |
|---|---|---|---|
| Place of residence | Urban | 2,808 | 17.25 |
| | Rural | 13,472 | 82.75 |
| | Total | 16,280 | 100 |
| Belong to a caste | Schedule caste | 2,877 | 17.94 |
| | Schedule tribe | 4,428 | 27.61 |

| Characteristics | Category | Freq. | Percent |
|---|---|---|---|
| | Other Backward Caste | 6,734 | 41.98 |
| | None of them | 1,799 | 11.22 |
| | Don't know | 202 | 1.26 |
| | Total | 16,040 | 100 |
| Type of place of residence | Urban | 2,808 | 17.25 |
| | Rural | 13,472 | 82.75 |
| | Total | 16,280 | 100 |
| Wealth index | Poorest | 6,153 | 37.79 |
| | Poorer | 3,875 | 23.8 |
| | Middle | 2,582 | 15.86 |
| | Richer | 2,116 | 13 |
| | Richest | 1,554 | 9.55 |
| | Total | 16,280 | 100 |
| Type of toilet | Unimproved | 5,200 | 34.53 |
| | Improve | 9,858 | 65.47 |
| | Total | 15,058 | 100 |
| Source of drinking water | Unimproved | 13,334 | 87.71 |
| | Improve | 1,868 | 12.29 |
| | Total | 15,058 | 100 |

Source: National Family Health Survey (NFHS-5), India (2019-21)

Table 1 gives a socioeconomic characteristic of the households in Madhya Pradesh and indicates extreme disparities and challenges. Here, it can be noted that almost 82.75% of the households are rural and only 17.25% in the urban centers, focusing on the state's predominantly rural character. In terms of caste composition, most households belong to the Other Backward Classes 41.98%, followed by the Scheduled Tribes 27.61% and the Scheduled Castes 17.94%, while 11.22% do not identify with any of these categories, and 1.26% are uncertain. The wealth distribution skewed as 37.79% is the poorest of households, and poorer was 23.8% while richer and the richest combined comprised only 22.55%, clearly depicting that poverty exists across the state. Sanitation 65.47% are the households covered under improved toilets, and 34.53% rely upon UN-improved facilities. Access to safe drinking water is alarmingly not achieved, and 87.71% of households rely on unimproved water sources, while only 12.29% depend on improved water sources. The statistics clearly highlight the need for targeted policy interventions in addressing the disparities in wealth, sanitation, and water infrastructure, especially in rural areas.

***Table 2.*** *Dietary Characteristics of Households in Madhya Pradesh.*

| Characteristics | Category | Freq. | Percent |
|---|---|---|---|
| Gave child bread, noodles others made from grain | No | 5,097 | 53.51 |
| | Yes | 4,428 | 46.49 |
| | Total | 9,525 | 100 |
| Gave child egg | No | 8,901 | 93.45 |
| | Yes | 624 | 6.55 |
| | Total | 9,525 | 100 |
| Gave child fruit | No | 8,293 | 87.07 |
| | Yes | 1,232 | 12.93 |
| | Total | 9,525 | 100 |
| Gave child milk product | No | 8,688 | 91.21 |
| | Yes | 836 | 8.78 |
| | Don't know | 1 | 0.01 |
| | Total | 9,525 | 100 |

Source: National Family Health Survey (NFHS-5), India (2019-21)

Table 2 Dietary characteristics of the households in Madhya Pradesh are shown below with some notable child nutrition patterns. As shown in the table, of the surveyed households, 53.51% did not give the child bread, noodles, or other foods prepared from grain; 46.49% did. Egg consumption is relatively very low since 93.45% of households do not give eggs to children; only 6.55% include them in their diet. Similarly, fruit consumption is low, as 87.07% of households did not give fruits to their children, while 12.93% did. The consumption of milk products is also restricted, with 91.21% of households not providing milk products to children, 8.78% offering them, and a negligible 0.01% uncertain. These findings reflect a very inadequate intake and availability of nutritionally varied diets, which may have implications for the nutritional status of children as well as their health.

*Table 3. Summary Statistics of the Variables.*

| Variable | Obs. | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| Child stunting | 13,957 | 0.36 | 0.48 | 0 | 1 |
| Caste | 16,040 | 2.54 | 1.10 | 1 | 8 |
| Mother education | 16,280 | 1.50 | 0.93 | 0 | 3 |
| Child gender | 16,280 | 1.48 | 0.50 | 1 | 2 |
| Mother BMI | 15,616 | 20.94 | 3.75 | 7.49 | 69.25 |
| Place of delivery | 16,280 | 22.79 | 5.84 | 11 | 96 |
| Wealth index | 16,280 | 0.38 | 0.49 | 0 | 1 |
| Type of toilet facility | 16,280 | 23.99 | 20.06 | 11 | 97 |
| Source of drinking water | 16,280 | 24.22 | 19.94 | 11 | 97 |
| Gave child grain food | 9,525 | 0.46 | 0.50 | 0 | 1 |
| Gave child egg | 9,525 | 0.07 | 0.25 | 0 | 1 |
| Gave child milk product | 9,525 | 0.13 | 0.34 | 0 | 1 |
| Gave child fruits | 9,525 | 0.09 | 0.29 | 0 | 8 |

Source: National Family Health Survey (NFHS-5), India (2019-21)

## 3. Results and Discussion

*Table 4. Regression estimates of household infrastructure determinants on child stunting.*

| Child stunting | Unadjusted OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|
| Caste | 0.89(0.86, 0.92) | 0.00 | 0.95(0.92, 0.99) | 0.03 |
| Mother education | 0.79(0.76, 0.82) | 0.00 | 0.87(0.82, 0.91) | 0.00 |
| Child gender | 0.84(0.78, 0.90) | 0.00 | 0.85(0.79, 0.93) | 0.00 |
| Mother BMI | 0.95(0.94, 0.96) | 0.00 | 0.97(0.95, 0.98) | 0.00 |
| Place of delivery | 0.97(0.97, 0.98) | 0.00 | 0.99(0.98, 0.99) | 0.02 |
| Wealth index | 0.69(0.57, 0.66) | 0.00 | 0.80(0.70, 0.90) | 0.00 |
| Type of toilet facility | 1.00(1.00, 1.00) | 0.02 | 1.00(1.00, 1.01) | 0.00 |
| Source of drinking water | 0.99(0.99, 1.00) | 0.02 | 0.99(0.99, 0.99) | 0.01 |

Source: Author's estimations

Logistic regression analysis points to some important predictors of child stunting in Madhya Pradesh. The effect of caste is weak but statistically significant; children from specific castes had lower odds of stunting, adjusted odds ratio of 0.95, $p = 0.03$. Maternal education was very important for reducing the probability of child stunting. In this context, more education reduced the risks of stunting significantly adjusted odds ratio of 0.87, $p < 0.001$. The relationship between the level of a mother's formal education and child nutrition and growth has long been established in research literature [2, 5]. Generally, caregivers with higher levels of education tend to have better socioeconomic conditions, which positively influences the determinants of health and, either directly or indirectly, improves children's nutritional status [8]. However, various environmental factors shape the direction and strength of this relationship [14]. A study on the effects of parental education on child nutrition in 56 developing countries showed that the benefits from formal education

to nutrition were stronger when it positively impacts parents' nutritional knowledge [1]. Similarly, maternal BMI is critical as higher BMI has been shown to correlate with lower odds of stunting, adjusted odds ratio of 0.97, $p < 0.001$. Male children are significantly more likely to be stunted than females, with an adjusted odds ratio of 0.85, p-value < 0.001, and this could partly explain the inequality between genders. Institutional deliveries significantly reduce the proportion of stunted children, with an adjusted odds ratio being 0.99, p-value = 0.02, while the wealthier households tend to have children who are not stunted in significant proportions adjusted odds ratio is 0.80, p-value < 0.001.

Sanitation and clean drinking water availability reduce stunting significantly, with adjusted odds ratio of 1.00 ($p < 0.001$) for sanitation and 0.99 ($p = 0.01$) for water. The following observation points to the importance of sanitation and water quality for outcomes in child health. In Ethiopia, a study demonstrated an effect of WASH interventions for children; exposure to WASH-related interventions, like improved access to safe water and maternal hygiene education, reduced stunting [4]. In the present study, contaminated sources of unsafe water, such as hand pumps and tanks, have been linked to stunting due to their possible contamination and resulting diarrhea illnesses, including gastroenteritis and cholera [11]. Housing quality, specifically with regard to floor material, shows a small but significant effect with lower stunting (adjusted odds ratio of 0.99, $p = 0.01$). However, adjusted significance statistics do not show substantial impacts of wall and roof materials. These results suggest that some critical determinants, such as the education of mothers, health, wealth, sanitation, and clean water consumption, are key to child growth and stunting. Interventions on these determinants may thus be more significant in reducing child growth failures in Madhya Pradesh.

***Table 5.*** *Regression estimates of dietary practice determinants on child stunting.*

| Child stunting | Unadjusted OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|
| Gave child grain food | 1.22(1.12, 1.34) | 0.00 | 1.40(1.23, 1.60) | 0.00 |
| Gave child egg | 1.25(1.05, 1.50) | 0.01 | 1.35(1.03, 1.78) | 0.03 |
| Gave child milk product | 0.92(0.78, 1.07) | 0.28 | 1.21(0.99, 1.48) | 0.07 |
| Gave child fruits | 1.21(1.06, 1.38) | 0.04 | 0.72(0.57, 0.92) | 0.01 |
| Breastfeeding duration in month | 1.00(0.99, 1.00) | 0.08 | 0.99(0.99, 0.65) | 0.00 |

The relationship between dietary practices and child stunting was seen through regression analysis, which produced some significant and subtle findings. Intake of grain-based foods had increased odds of stunting with an adjusted odds ratio of 1.40 (95% CI: 1.23-1.60, $p < 0.001$), indicating that there might be nutritional imbalances or confounding factors in those foods. Egg consumption also has been found to be linked with increased stunting odds, adjusted odds ratio of 1.35, 95% CI: 1.03-1.78, $p = 0.03$, and may reflect the presence of other dietary or socioeconomic inequities. On the other hand, fruit intake appears to be protective and diminishes the stunting odds profoundly, adjusted odds ratio of 0.72, 95% CI: 0.57-0.92, $p = 0.01$, underlining the importance of dietary diversity and nutrient dense foods. The crude odds ratio for the consumption of milk product is 1.21, 95% CI: 0.99-1.48, $p = 0.07$ and not significant. However, prevalence of child stunting stands at 39.4% whereas households that consume nutrient-rich food groups such as dairy products 41%, poultry 65% that are smaller in number in comparison with others food groups, according to [7]. Dairy is a rich source of calcium that plays an essential role in the growth and development of bones. A case-control study conducted in Iran found a significantly lower average intake of dairy products in stunted children compared to the non-stunted counterparts [3]. However, in our study, we failed to establish any significant association of dairy products with child stunting.

Extended breastfeeding period shows a protective effect against stunting, with an adjusted odds ratio of 0.99 (95% CI: 0.99-0.65, $p < 0.001$), affirming the role of breastfeeding in achieving a decline risk of stunting. This result could be linked with studies that normally postulate that children who are breastfed for longer periods show less dietary diversity as reported in [13], which may influence their general growth and nutritional status. These findings establish the relationship of dietary practices with child nutrition; thus, possible ways to solve the issue of child stunting might include the promotion of dietary diversity and nutrient-dense foods combined with longer-lasting breastfeeding.

## 4. Conclusion and Suggestion

Children from specific castes had reduced odds of stunting (adjusted odds ratio of 0.95, $p = 0.03$), signifying a weak yet statistically significant caste effect. Maternal education substantially reduced the likelihood of stunting, evidenced by an adjusted odds ratio of 0.87 and a p-value of less than 0.001. A higher maternal BMI has been shown to be linked to a

lower risk of stunting, with an adjusted odds ratio of 0.97 ($p < 0.001$). There is a 0.85 adjusted odds ratio and a p-value of less than 0.001 that shows that boys are far more likely than girls to be stunted. Sanitation and access to clean drinking water markedly reduce stunting, exhibiting adjusted odds ratios of 1.00 ($p < 0.001$) for sanitation and 0.99 ($p = 0.01$) for water. Housing quality has a small but important effect on lowering stunting (adjusted odds ratio of 0.99, $p = 0.01$). These results show that some important things, like the mother's education, health, money, sanitation, and drinking clean water, are important for a child's growth and stunting. Regression research uncovered both pronounced and nuanced findings about the correlation between food choices and child stunting. An extended breastfeeding duration exhibits a protective effect against stunting, as indicated by an adjusted odds ratio of 0.99 (95% CI: 0.99-0.65, $p < 0.001$). Eating grain-based meals made it more likely that a child will be stunted, with an adjusted odds ratio of 1.40 (95% CI: 1.23-1.60, $p < 0.001$). This means that there may be nutritional imbalances or other factors that affect such foods. Eating eggs has also been associated with a higher risk of stunting, with an adjusted odds ratio of 1.35, a 95% confidence interval of 1.03-1.78, and a p-value of 0.03. This may be due to other dietary or socioeconomic inequalities. Conversely, fruit consumption seems to offer protection and significantly reduces the likelihood of stunting, with an adjusted odds ratio of 0.72 (95% CI: 0.57-0.92, $p = 0.01$), highlighting the significance of dietary diversification and nutrient-dense foods. The crude odds ratio for milk product intake is 1.21, with a 95% confidence interval of 0.99-1.48 and a p-value of 0.07, indicating insignificance. The incidence of child stunting is 39.4%, but households consuming nutrient-rich food categories, such as dairy products (41%) and poultry (65%), are fewer in number compared to other food groups.

Analysis of both socioeconomic and dietary factors brings in a much more significant meaning in understanding determinants of child stunting in Madhya Pradesh. Socioeconomic factors such as maternal education, wealth index, and access to improved sanitation and drinking water greatly contribute to reduced stunting levels, whereas maternal health and child gender are other significant factors for outcomes in stunting. Grain-based foods and egg consumption are related to increased stunting, while fruit consumption and prolonged breastfeeding are shown to have a protective effect. These results further indicate the complex nature of child stunting, wherein socioeconomic conditions and dietary behaviors tend to converge into child health outcomes.

Several key actions are recommended to address these issues. First, improvement in maternal education, especially in rural areas, can significantly reduce stunting since educated mothers are more likely to adopt better nutritional and healthcare practices. Second, access to clean sanitation and drinking water is a critical factor for reducing stunting, so investments in rural infrastructure must be prioritized. Nutritional awareness and dietary diversity will also be needed, as many households would not understand why balanced diets are recommended; therefore, such public health education should focus on the inclusion of nutrient-rich food types to ensure sufficient fruits, vegetables, and protein foods are provided. Continued breastfeeding is another necessary intervention, as it has been proven effective in preventing stunting. Finally, interventions targeting disadvantaged groups such as the Scheduled Castes and the Scheduled Tribes, and low-income households would be necessary to ensure equal access of all children to resources in which healthy growth can be derived. The stipulated factors would then be addressed, consequently reducing child stunting rates in Madhya Pradesh towards the augmentation of better child health and improvement in developmental outcomes.

## Abbreviations

| | |
|---|---|
| BMI | Body Mass Index |
| NFHS | National Family Health Survey |
| SDG | Sustainable Development Goal |
| UN | United Nation |
| WASH | Water, Sanitation, and Hygiene |
| WHO | World Health Organization |

## Author Contributions

**Ankit Singh:** Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Writing – original draft
**Shweta Sudele:** Writing – review & editing

## Conflicts of Interest

The authors declare no conflicts of interest.

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