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Examining the association between maternal junk food consumption and obesity among children: evidence from a cross-sectional survey in India

Antaryami Dash[1], Shalem Balla[2], Shankar Das[3] and Srinivas Goli[4*]

Abstract

Background Childhood obesity is not only a concern for the immediate health of children but also imposes varied health implications throughout the life course and a significant burden on the healthcare system. Parental feeding attitudes and lifestyles, especially mothers', significantly influence the development of children's eating behaviours and nutritional outcomes. This study examines the relationship between 'maternal junk food consumption' and 'childhood obesity' in India.

Methods Using the 2021 round of the National Family Health Survey, we analysed data from 191,126 children aged 0–5 years across 36 states and Union Territories of India. The study measured childhood overweight/obesity through weight-for-height Z-scores (WHZ). Further, the study constructed a junk food consumption intensity score by creating a composite measure based on the intake frequency of aerated drinks and fried foods. We employed multiple binary logistic regression models and robustness checks to examine the association between 'maternal junk food consumption' and 'children with overweight/obesity' net of parental, household, and geographical characteristics.

Results Children of mothers with high junk food consumption exhibited a higher prevalence (4.01%) compared to those with moderate (3.29%) and no/low consumption (3.27%). The differences further increased when we adjusted the results for other covariates. Adjusted odds ratio shows that children of mothers with "high" and "moderate" junk food consumption have 1.390 ($p < 0.01$) times and 1.204 times ($p < 0.05$), respectively, higher odds of having children with overweight or obesity compared to those with "no/low" consumption. Further, the results are confirmed through multiple robustness checks.

Conclusions Interpreting these results in the context of existing evidence and policy suggests that tackling childhood obesity necessitates comprehensive, multi-level interventions - spanning individual, family, community and facility levels. These interventions should aim to enhance food and nutrition literacy, foster healthy dietary practices, and promote positive behaviours that minimise risks associated with all obesogenic factors among children and their families.

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Keywords Child nutrition, Childhood obesity, Junk food consumption, Maternal dietary intake behaviour, Home food environment, India

Introduction

Childhood obesity has emerged as a significant public health concern globally, with rising prevalence rates observed in many countries, including India. An estimated 14.4 million children under five are obese in India, the second highest rate in the world after China [1, 2]. Data from the fifth round of the National Family Health Survey (NFHS-5, 2021) reveal a 60% increase in the prevalence of childhood overweight in India compared to NFHS-4 (2015-16), with rates rising from 2.1 to 3.4% [3, 1]. This issue is alarming as it lays the foundation for various health complications, including type 2 diabetes, cardiovascular diseases and physiological issues in later life [4–7]. This surge poses a significant challenge to achieving Sustainable Development Goal 2.2, which aims to eradicate all forms of malnutrition, including childhood overweight, by 2030. Childhood obesity is not only a concern for the immediate health of children but also poses a significant burden on the healthcare system and national development [8].

Among the myriad of factors contributing to early childhood obesity, maternal nutrition and household eating practices, i.e. 'home food environment', stand out as critical influencers [9]. The home food environment encompasses the availability, accessibility, and types of food children are exposed to. It also includes parental attitudes and behaviours regarding food choices, which significantly shape children's eating habits [10]. Previous studies have shown that children are more likely to develop healthy eating patterns when supported by a buoyant home food environment, characterised by the availability of nutritious foods, family meals, and parental modelling of healthy eating behaviours [11].

Research indicates that a 'home food environment' rich in healthy food options, such as fruits, vegetables and pulses, is associated with better dietary quality and lower obesity rates among children [12]. Conversely, homes with high availability of energy-dense, nutrient-poor foods contribute to unhealthy eating patterns and increased risk of obesity [13]. For instance, recently, Singh and Colleagues and Athavale and colleagues have reported that junk food consumption, inactivity, and psychological stress are the main factors contributing to childhood obesity. Thus, children's obesity and high body mass index are directly correlated with consuming a lot of fried meals and beverages with added sugar [14, 15, 16, 17]. Moreover, the home food environment is not just about the food available but also the social and emotional contexts in which food is consumed. Parents often face challenges managing their children's food preferences, especially when unhealthy options are heavily marketed [18].

The relationship between maternal dietary practices and children's eating behaviours is a critical area of research, particularly in the context of rising childhood obesity rates. The systematic review by van der Horst and colleagues emphasises the importance of environmental factors in shaping dietary behaviours among children [19]. The review categorises these influences into micro and macro environments, highlighting that parental intake and household food availability are significant determinants of children's dietary choices. For instance, parental modelling of dietary behaviours, such as the consumption of fruits and vegetables, has been shown to influence children's eating habits positively [19, 20].

India, now the world's most populous country with over a billion people, faces a profound nutritional challenge, with an estimated 63–76% of the population not being able to afford a healthy diet [21]. NFHS-5 shows that between 2019 and 2021, only 13% of women reported consuming fruits daily; approximately half consumed vegetables, pulses, or dairy products, while less than 10% consumed other animal-source foods. Similarly, among young children, dietary diversity remains critically low—only 24% of those aged 6–23 months met the minimum dietary diversity (MDD) standard during the same period.

In many Indian households, traditional dietary practices are increasingly being replaced by processed and high-calorie foods, often due to growing exposure to urbanization and the influence of global food marketing through mass media or electronic media [22]. The percentage of school-aged children in India who are overweight increased from 9.7 to 13.9% due to high junk food intake [23]. This shift is particularly pronounced in urban, affluent families, where children are more likely to consume diets high in fats, sugars, and salt. Furthermore, there are very few nutrients in diets that contain high levels of junk food [24]. Furthermore, the prevalence of nutritional illiteracy among parents exacerbates the issue, as many are unaware of what constitutes a balanced diet [25]. Studies have shown that mothers who prioritise healthy eating are more likely to instill similar values in their children or children themselves socialize to similar behaviours [26, 27]. For example, maternal food responsiveness and enjoyment of food are positively associated with children's BMI, indicating that mothers' attitudes towards food and socialization can shape children's eating behaviours [27].

Parents create environments for children that may foster the development of healthy eating behaviours and weight gain, or that may promote overweight and aspects of disordered eating. Mothers are particularly interested in children's eating behaviour, as they have been shown to spend significantly more time than fathers in direct interactions with their children across several familial situations. Parental feeding attitudes and styles, especially for mothers, have a significant influence on the development of children's eating behaviours [28]. Maternal food intake is associated with infants' and toddlers' food intake, suggesting the need for early interventions to promote healthy eating [29].

Children's early experiences with food and eating behaviours are shaped within the home food environment, where parents play a crucial role in influencing their children's dietary behaviours. Parents establish the food environment, model eating behaviours, and make food choices that their children are likely to imitate. As such, it is plausible that parental behaviours and child-feeding practices, when combined with genetic predispositions, contribute to the development of problematic eating patterns or less nutritious food preferences in children [30, 31, 32]. This paper examines the relationship between maternal junk food consumption and childhood obesity net of other parental covariates in India, utilizing unit-level data from the fifth round of the National Family Health Survey.

Methods

Data

The study used data from the National Family Health Survey-5 (NFHS-5) round conducted in 2019 – 21.[34] This survey is part of the globally synonymous Demographic Health Survey (DHS) and collected data on population health, nutrition, and well-being. Among these diversified topics, the survey also covers indicators related to children and mothers' anthropometry and their dietary intake patterns, including 'junk foods'. This survey used a two-stage cluster sampling design for the selection of households. Detailed information regarding sampling methodology can be found in the report of NFHS-5th round [3].

Study population

In this round of NFHS, the information was collected from 636, 699 households, 724,115 women and 101,839 men. For this study, data on mothers and their children under the age of five were extracted from the Kids file of the NFHS-5 dataset. The NFHS-5 dataset contains information on 232,920 children aged 0–5 years across 36 states and Union Territories (UTs). After applying exclusion criteria (explained in Fig. 1), a final sample size of 191,126 was used in the analysis. To maintain representativeness, sampling weights provided by the NFHS were applied in all analyses to account for the complex survey design and non-response adjustments.

Variable

Outcome variable

The primary outcome variable in this study was childhood overweight/obesity, measured through weight-for-height Z-scores (WHZ). Children were classified as overweight/obese if their WHZ score was greater than two standard deviations above the median of the World Health Organization (WHO) growth standards [33].

Predictor variable

In NFHS-5, women were asked about the frequency of their consumption of fried foods and aerated drinks,

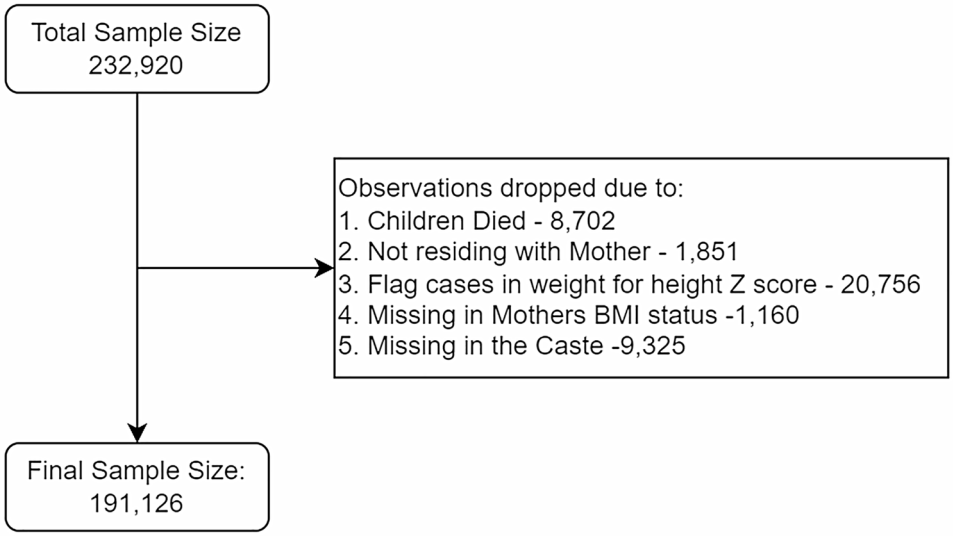

Fig. 1 Flow chart of the sample size

with a response option of "daily," "weekly," "occasionally," or "never." These responses were quantified by assigning values: 0 for "never," 1 for "occasionally," 2 for "weekly," and 3 for "daily." For this study, both fried food and aerated drinks were categorised as junk food. So, we have a total of two items (fried foods and aerated drinks) with a score ranging from 0 to 3, where 0 to 1 represent no or low junk food consumption, 2 is moderate, and 3 indicates high junk food consumption. We have constructed this junk food consumption intensity score by assigning a weight of 0.75 to fried food consumption and 0.25 to aerated drink consumption to reflect their relative contributions to overall junk food intake. We have given more weightage to fried foods because they are generally calorie-dense due to the fat absorbed during frying, while aerated drinks - particularly sugar-sweetened beverages - provide primarily "empty calories". For instance, a 12-oz serving of a usual soda can have about 150 calories, while a similar serving of French fries can have around 378 calories. This indicates that fried foods can deliver 2.5 to 3 times more calories per equivalent portion. Accordingly, the relative weights in our analysis were calibrated to reflect this disparity in energy contribution [34].

Control variables

We have reviewed previous literature to select relevant control variables for predicting childhood obesity in the Indian context. In India, the dietary practices are highly influenced by cultural factors and place of residence. For instance, Caste and Religious affiliations highly influence their food habits where Hindus and Upper castes less likely to eat non-veg foods compared to their counterparts [1, 35, 36, 37]. We have used Age of the Child (0–2 years & 2–5 years), Sex of the child (Male & Female), Education of the mother (No education, Below higher education & Higher and above), BMI status of Mother (Normal, Underweight, Overweight & Obese), Education of the Father (No education, Below higher education, Higher and above), Age of the Mother (15–19, 20–24, 25–29, 30–34, 35–39, 40–44 & 45–49), Household size (< = 5 & More than 5), Wealth Quintile (Poorest, Poor, Middle, Rich & Richest), Caste (SC, ST, OBC & Others), Religion (Hindu, Muslim & Others), and Residence (Urban & Rural) as control variables in this study [1, 36]. We checked our control variables for multicollinearity using Variation Inflation Factor (VIF) statistics. VIF less than 1 means no multicollinearity, while 1 to 5 is considered moderate multicollinearity and above 5 is considered high multicollinearity. Thus, the VIFs of 1.14 and 1.20 in our models indicate an acceptable level of multicollinearity.

Patient and public involvement

This study does not involve patients and members of the public. The research is entirely based on secondary data sources, which are available for free access at https://dhsprogram.com/Data/.

Empirical strategy

The study applies a two-stage empirical approach. First, descriptive and bivariate statistics were calculated to summarise the characteristics of the sample, including maternal and child demographic data, junk food consumption patterns, and child weight status. Also, bivariate differences in childhood obesity by junk food intake status of mothers. Since the outcome variable is bivariate in nature, in the second stage, logistic regression models were used to examine the net association between junk food consumption intensity and child overweight/obesity, adjusting for potential confounders such as maternal education, BMI status, socioeconomic status, and region of residence. The mathematical expression of the model can be presented as below:

$$\text{Logit}\ (\text{P}\ (\text{Y}=1)) = \text{b}_0 + \text{b}_1\,(\text{MJFCI}) + \text{b}_2\,(\text{MBMI}) + \text{b}_3\,(\text{SES}) + \text{b}_4\,(\text{RES}) + \text{b}_5\,(\text{RG})$$

Where $\text{P}\ (\text{Y}=1)$ is the probability of the child being overweight/obese; MJFCI is the Mother's Junk Food Consumption Intensity; MBMI is Maternal Body Mass Index; SES is Socio-Economic Status, which includes Education of the Mother, Education of the Father, Wealth Status, Caste, Religion, Household size and other variables; RES is Residence; RG is Region. Statistical significance was set at $p<0.05$. We have also checked for multicollinearity, and the correlation between any two variables does not exceed 0.43. Further, we used cluster fixed effects, additional control variables, and heterogeneous effect analyses as robustness checks to confirm the consistency of findings from our main models.All analyses were conducted using Stata-18 to account for the survey's complex design and ensure accurate variance estimation.

Results

Prevalence of obesity

Table 1 illustrates the unadjusted prevalence of overweight and obesity among children aged 0–59 months, stratified by various background characteristics. Overall, the prevalence of overweight and obesity was 3.39% among the 191,126 children sampled. Children of mothers with high junk food consumption exhibited a higher prevalence (4.01%) compared to those with moderate (3.29%) and no/low consumption (3.27%). Younger children aged 0–2 years had a significantly higher prevalence (4.97%) than those aged 2–5 years (2.37%). Boys showed

Table 1 Prevalence of overweight and obesity among children aged 0–59 months by background characteristics in India, 2019-21 (in%)

Variables	%	Sample Size (*N*) *
Junk Food Consumption Intensity by Mothers		
No/low	3.27	103,571
Moderate	3.29	54,202
High	4.01	33,353
Age of the Child		
0–2 years	4.97	74,297
2 to 5 years	2.37	116,829
Sex of the Child		
Male	3.49	98,492
Female	3.27	92,634
Education of the Mother		
No education	2.87	98,492
Below higher education	3.23	92,634
Higher and above	4.70	98,492
Education of the Father		
No education	3.18	4377
Below higher education	2.86	20,098
Higher and above	4.27	4653
Age of the mother		
15–19	3.18	4102
20–24	2.86	54,132
25–29	4.27	76,619
30–34	3.18	37,642
35–39	2.86	14,365
40–44	4.27	3355
45–49	3.18	911
BMI status of Mother		
Underweight	2.33	36,245
Normal	3.45	120,608
Overweight	3.88	26,801
Obese	5.62	7472
Household size		
<=5	3.47	86,749
More than 5	3.32	104,377
Wealth Quintile		
Poorest	2.61	51,281
Poor	2.88	44,612
Middle	3.41	37,474
Rich	3.74	32,446
Richest	4.84	25,313
Caste		
SC	3.08	41,022
ST	3.31	41,125
OBC	3.16	76,208
Others	4.33	32,771
Religion		
Hindu	3.30	144,289
Muslim	3.65	22,116
Others	4.17	24,721
Place of Residence		
Urban	4.21	38,173

Table 1 (continued)

Variables	%	Sample Size (*N*) *
Rural	3.10	152,953
Total	3.39	191,126

Note: *Unweighted

a slightly higher prevalence (3.49%) than girls (3.27%). Maternal education was strongly associated with childhood overweight and obesity, with the highest prevalence observed among children of mothers with higher education (4.70%) compared to those with no education (2.87%). Similarly, paternal education reflected a similar trend, with the highest prevalence seen among children of fathers with higher education (4.27%).

Maternal BMI was a significant determinant, for mothers with obesity showed the highest prevalence (5.62%) of their children with obesity. Socioeconomic status, indicated by the wealth index, demonstrated a gradient, with children from the richest households having the highest prevalence (4.84%), while those from the poorest households had the lowest (2.61%). Residence also played a role, with urban children exhibiting a higher prevalence (4.21%) than their rural counterparts (3.10%).

Association between childhood overweight or obesity and junk food consumption by mothers

To examine the association between junk food consumption intensity and the likelihood of being overweight or obese among children in India, logistic regression models were employed to estimate adjusted odds ratios (AORs). As shown in Table 2, two models were used: Model 1 included the core variables, controlled for the Age of the Child, Sex of the Child, Mother's Education, BMI status of the mother, Age of the mother, Household size, Wealth index, Caste, Religion, and Residence. Model 2 added additional covariates, such as the father's education. The reference category (was defined for each categorical variable to compare the effects of the different levels. The Variation Inflation Factor (VIF) for both models are 1.14 and 1.20, respectively. The results are presented as odds ratios with corresponding standard errors in parentheses, and asterisks indicate the level of significance.

The results from Model 2 (including all the factors accounted for in Model 1, and the father's education) reveal significant associations between junk food consumption intensity, maternal BMI status, and household wealth with the likelihood of children being overweight or obese in India. Children of mothers with "Moderate" junk food consumption have 1.204 times higher odds of being overweight or obese compared to those with "No/Low" consumption ($p < 0.05$), and those with "High" consumption have even greater odds, at 1.390 ($p < 0.01$).

Maternal BMI status is also a strong predictor. Mothers with underweight are associated with significantly lower odds of having a child with overweight or obesity (OR = 0.632, $p < 0.01$), whereas mothers with overweight (OR = 1.193, $p < 0.01$) and mothers with obesity (OR = 1.142, $p < 0.01$) are linked to significantly higher odds of child being overweight or obese.

The wealth status shows a clear economic gradient effect. Children from wealthier households are more likely to be overweight or obese, with those in the richest category having 1.648 times higher odds ($p < 0.01$) compared to the poorest households. This suggests that increasing wealth may contribute to a higher risk of childhood obesity, likely due to lifestyle and dietary changes associated with greater economic status.

Figure 2 illustrates the level of junk food consumption intensity among mothers, stratified by key background characteristics such as sex of the child, maternal education, maternal BMI, wealth status, and place of residence. Maternal education shows a clear gradient, with junk food consumption intensity increasing as education levels rise; 17.2% of mothers with higher education reported high consumption, compared to 12.4% among those without education. The intensity of junk food consumption also varied by maternal BMI status, with mothers with obesity exhibiting the highest levels of consumption (16.8%) and underweight mothers the lowest (13.1%). A similar pattern emerged with household wealth, where the proportion of high junk food consumption increased with wealth, from 14.6% among the poorest mothers to 17.7% among the richest. Lastly, urban mothers were more likely to report high junk food consumption (17.1%) than rural mothers (14.4%). These findings suggest that higher maternal education, greater wealth, urban residence, and higher maternal BMI are associated with increased junk food consumption intensity.

Figure 3 shows the heterogeneity in the results across regions, suggesting that the relationship between junk food consumption by mothers and childhood obesity may be influenced by regional factors owing to their varied cultural practices, or socioeconomic factors, which influence their dietary behaviour. There is a positive association between junk food consumption by mothers and child overweight/obesity seen in the North, Central, East, and South regions. The Northeast region exhibits a unique trend with negative associations, suggesting a lower likelihood of obesity with higher junk food consumption by mothers. The West region shows no significant association, with point estimates close to zero.

Table 2 Adjusted odds ratio estimates: Association of junk food consumption intensity and overweight or obese among children aged 0–5 years in India

Variables	Model-1	Model-2
Junk Food Consumption Intensity Score		
No/Low®		
Moderate	1.036	1.204**
	(0.98–1.1)	(1.04–1.39)
High	1.234***	1.390***
	(1.16–1.31)	(1.19–1.63)
Age of the Child		
0–2 years®		
2–5 years	0.471***	0.449***
	(0.45–0.49)	(0.4–0.51)
Sex of the Child		
Male®		
Female	0.944**	1.008
	(0.9–0.99)	(0.89–1.14)
Education of the mother		
No education®		
Below higher education	0.960	0.994
	(0.9–1.03)	(0.83–1.2)
Higher and above	1.082*	1.020
	(0.99–1.18)	(0.79–1.33)
BMI status of Mother		
Normal ®		
Underweight	0.665***	0.632***
	(0.62–0.72)	(0.52–0.77)
Overweight	1.123***	1.193***
	(1.05–1.2)	(1.01–1.41)
Obese	1.142***	1.142***
	(1.28–1.58)	(1.06–1.82)
Education of the Father		
No education®		
Below higher education		0.854
		(0.7–1.04)
Higher and above		0.940
		(0.72–1.22)
Age of the Mother		
15–19®		
20–24	0.803***	0.732*
	(0.7–0.92)	(0.51–1.06)
25–29	0.717***	0.692*
	(0.62–0.82)	(0.48–1)
30–34	0.801***	0.742
	(0.69–0.93)	(0.51–1.09)
35–39	0.841**	0.991
	(0.72–0.99)	(0.66–1.49)
40–44	0.887	0.527*
	(0.72–1.1)	(0.28–1.01)
45–49	0.982	0.662
	(0.7–1.38)	(0.25–1.75)
Household size		
<=5®		
More than 5	0.930***	0.925
	(0.89–0.98)	(0.82–1.05)

Table 2 (continued)

Variables	Model-1	Model-2
Wealth Quintile		
Poorest®		
Poor	1.120***	1.190*
	(1.04–1.2)	(0.98–1.44)
Middle	1.265***	1.342***
	(1.17–1.37)	(1.09–1.65)
Rich	1.255***	1.368***
	(1.15–1.37)	(1.09–1.72)
Richest	1.404***	1.648***
	(1.27–1.55)	(1.27–2.14)
Caste		
SC®		
ST	1.302***	1.540***
	(1.21–1.41)	(1.25–1.89)
OBC	0.890***	0.935
	(0.83–0.95)	(0.78–1.12)
Others	1.143***	1.202*
	(1.06–1.24)	(0.98–1.48)
Religion		
Hindu®		
Muslim	1.232***	1.187*
	(1.15–1.33)	(0.98–1.44)
Others	1.370***	1.305***
	(1.27–1.47)	(1.08–1.58)
Residence		
Urban®		
Rural	0.964	1.033
	(0.91–1.03)	(0.88–1.22)
Constant	0.0427***	0.0347***
	(0.05–0.08)	(0.04–0.09)
Pseudo R2	0.0307	0.0390
Prob > chi2	0.00	0.00
Akaike crit. (AIC)	61446.538	9021.686
Observations	191,126	29,128
Mean VIF	1.14	1.20

Note: 95% confidence intervals are in parentheses; Level of Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Further investigation would be needed to understand the reasons behind these regional differences.

Robustness checks

The principal findings of this study were subjected to a series of robustness checks to assess their consistency and credibility. Three distinct approaches were employed: (1) We controlled for maternal height to account for potential intergenerational transmission of anthropometric traits; (2) To address concerns of unobserved between-group heterogeneity and to enhance the precision of point estimates, we calculated cluster-adjusted standard errors, thereby accounting for intra-cluster correlation consistent with the sampling design of large-scale surveys such as the NFHS; and (3) We examined the heterogeneity of our main associations by stratifying analyses based on maternal BMI categories and the specific types of junk food consumed. The corresponding results are presented below.

Association between maternal junk food consumption and overweight or obesity among children after controlling for maternal height

After adjusting for maternal height, a proxy for genetic growth potential, children of mothers with high junk food consumption scores exhibited significantly higher odds of being overweight or obese in both Model 1 (OR = 1.240, $p < 0.01$) and Model 2 (OR = 1.401, $p < 0.01$). The inclusion of paternal education in Model 2 modestly amplified the association, underscoring the relevance of paternal educational attainment in shaping child health outcomes (Fig. 4 & Supplementary Table 3).

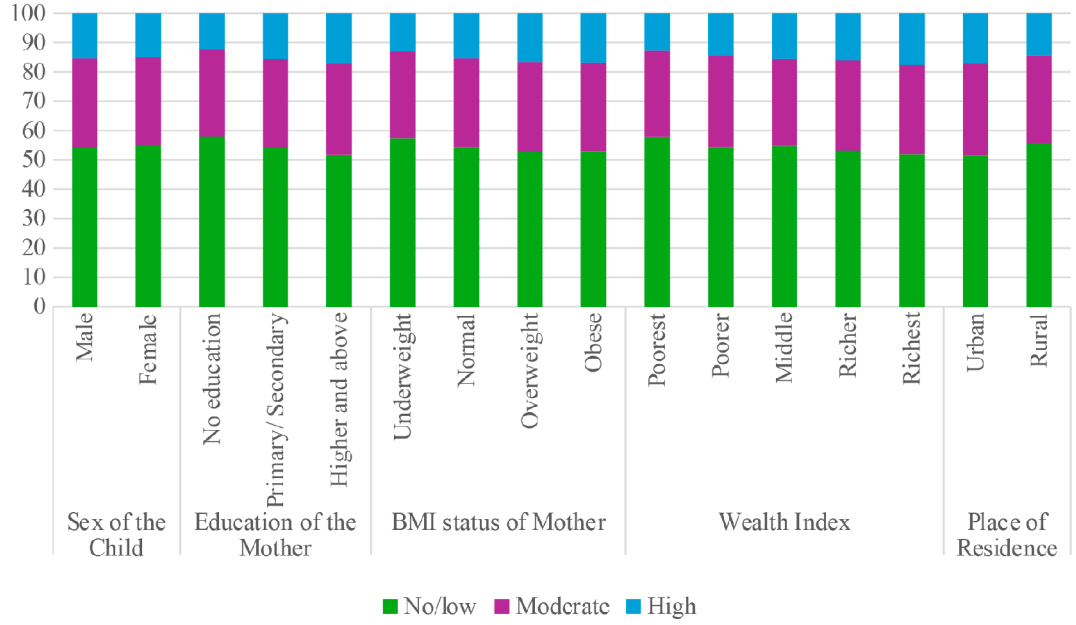

Fig. 2 Level of junk food consumption intensity of mothers by key background characteristics

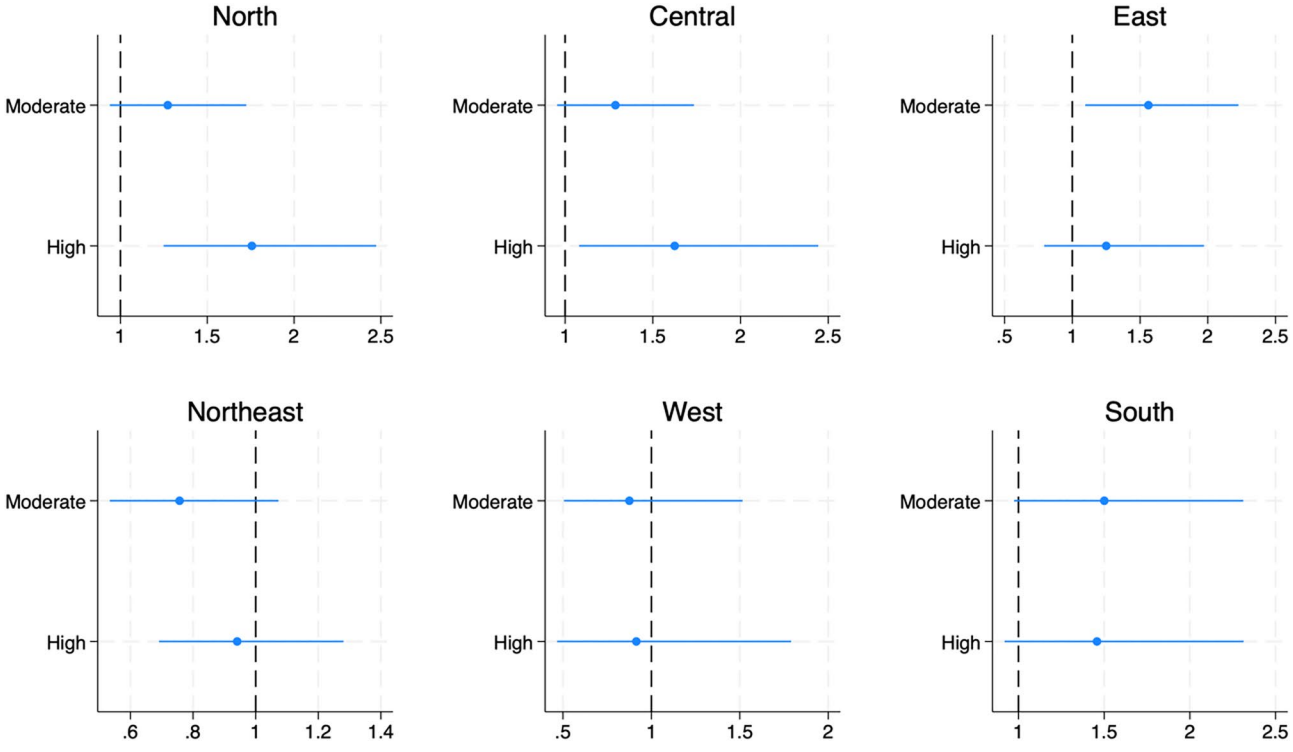

Fig. 3 Regional Heterogeneity Test: Association between maternal junk food Consumption and Overweight or Obesity among children by Regions of India. Note: All regression models are controlled for Age of the Child, Sex of the Child, Education of the mother, BMI status of Mother, Age of the Mother, Household size, Wealth index, Caste, Religion, Residence

Association between maternal junk food consumption and overweight or obesity among children with cluster fixed effects

Figure 5 shows the association between maternal junk food consumption and overweight or obesity among children after introducing cluster-level fixed effects accounting for unobserved heterogeneity at the cluster level. Results show that, in both models, children of mothers with a high junk food consumption score have

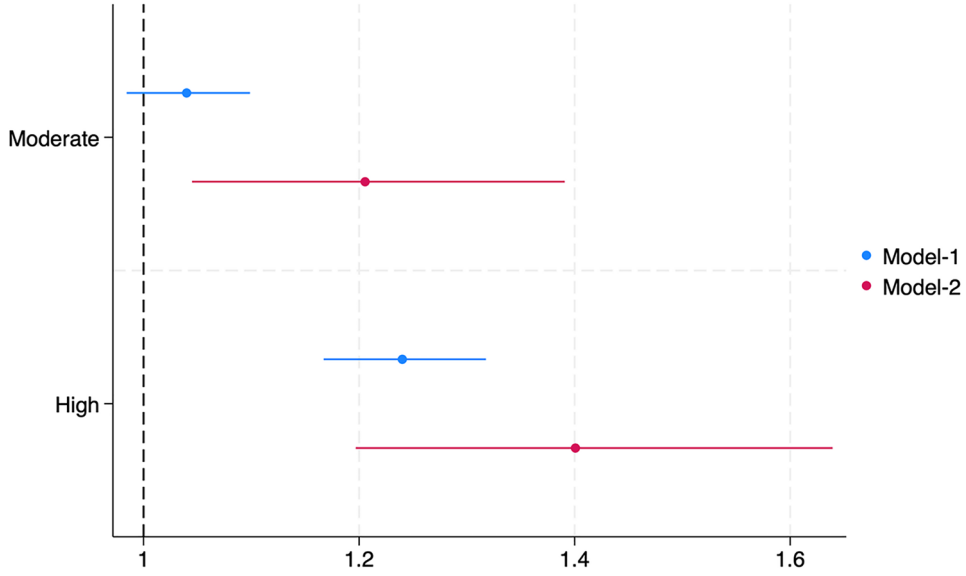

Fig. 4 Adjusted odds ratios: Association between maternal Junk food Consumption and Overweight or Obesity among children after controlling for maternal height. Note: Model-1 is controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Household size, Wealth index, Caste, Religion, Residence; Model-2 is controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Education of the father, Household size, Wealth index, Caste, Religion, Residence

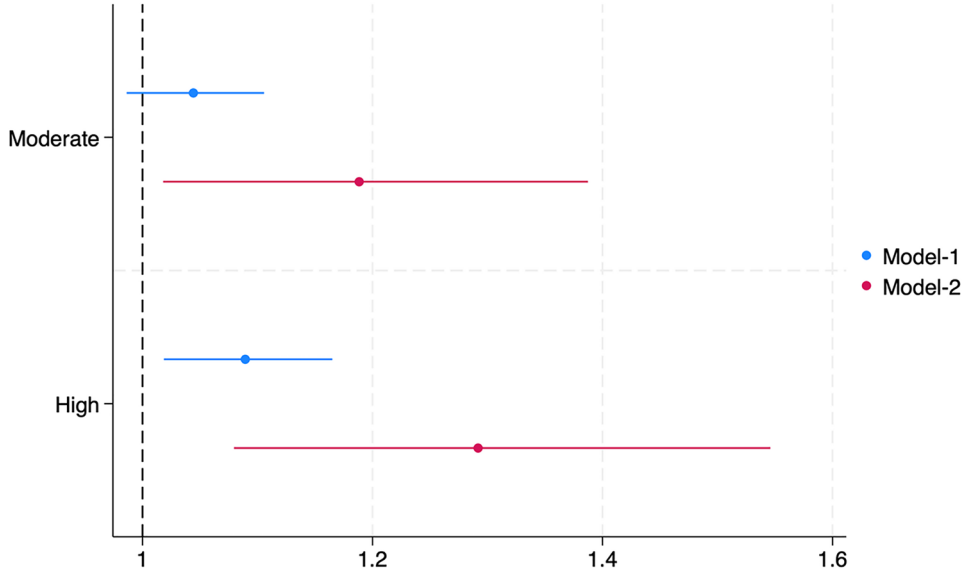

Fig. 5 Adjusted odds ratios: Association between maternal Junk food Consumption and Overweight or Obesity among children with cluster fixed effects. Note: Model-1 is controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Household size, Wealth index, Caste, Religion, Residence; Model-2 is controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Education of the father, Household size, Wealth index, Caste, Religion, Residence

higher odds of being overweight or obese (Model 1: OR = 1.089, $p < 0.05$ & Model 2: OR = 1.292, $p < 0.01$).

Heterogeneous effect analysis by BMI of mother and type of junk food consumption

The results indicate that children of mothers with a high junk food consumption scores have significantly higher odds of being overweight or obese across all maternal BMI categories: Underweight (OR = 1.240, $p < 0.01$); Normal (OR = 1.857, $p < 0.01$) and Overweight (OR = 1.344, $p < 0.01$). However, no clear gradient was observed across these BMI categories (Fig. 6 & Supplementary Table 5). Figure 7 and Supplementary Table 6 show the heterogeneity analysis by type of maternal junk food consumption. A positive association was observed between maternal junk food consumption scores and child overweight or

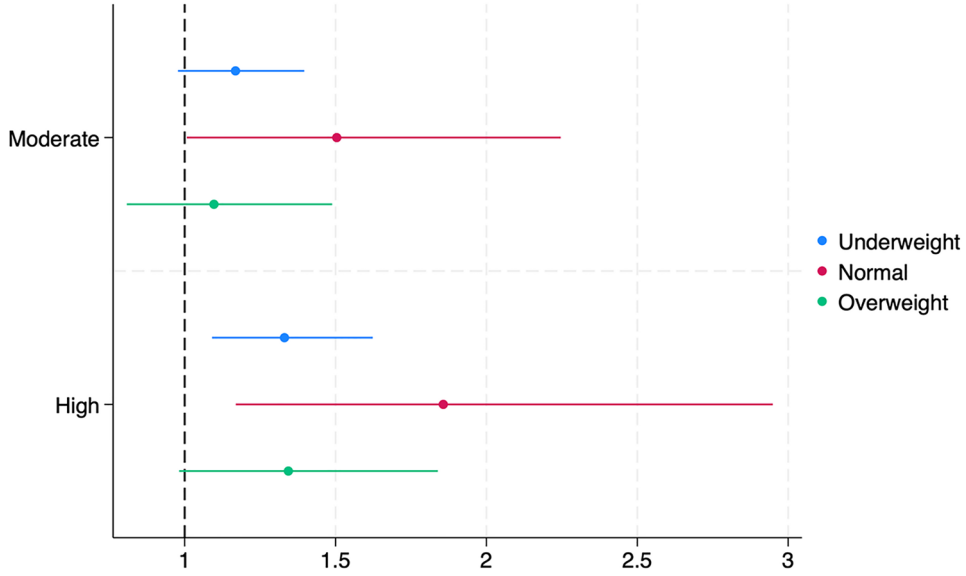

Fig. 6 Heterogeneous analysis by BMI status of mother: Association between maternal Junk food Consumption and Overweight or Obesity among children. Note: Models are controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Education of the father, Household size, Wealth index, Caste, Religion, Residence

obesity in both aerated drink consumption categories—never/occasionally and weekly/daily. The association was stronger among children whose mothers consumed aerated drinks on a weekly or daily basis. Comparable patterns were observed for maternal consumption of fried foods.

Discussion and conclusion

The findings of our study underscore the pressing issue of growing childhood obesity in India, which is currently at 3.4% among 0-59-month-old children and is a mounting public health concern with long-term health and socioeconomic implications. Our study highlights significant demographic disparities, demonstrating an association with maternal education, socioeconomic status, and maternal BMI. Importantly, we observe that maternal dietary behaviours show a strong association with child nutrition outcomes, aligning with global evidence on the influential role of maternal eating habits in shaping childhood nutrition outcomes [38–43]. Furthermore, the robustness of our findings is confirmed through multiple sensitivity analyses.

The significant association between maternal junk food consumption and the high prevalence of childhood obesity highlights the urgent need for targeted interventions. Our findings indicate that overweight/obesity among children of mothers with high junk food consumption is high compared to children of mothers with moderate or no/low consumption. These findings echo the study by Kumar (2023), which highlights that the maternal consumption of ultra-processed foods and sugar-sweetened beverages is a key driver of childhood obesity [44]. Further stratification revealed that this association persists across all maternal BMI categories—underweight, normal weight, and overweight—though no consistent gradient was observed. This association may indicate the potential connection between maternal employment and childhood obesity. Fertig and colleagues highlight that maternal employment can affect children's weight through mechanisms related to supervision and nutrition [45]. Two decades of meta-analysis by Singh et al. show that children of working women were found to be at a higher risk of obesity compared to children of non-working women [36]. Employed mothers may have less time to prepare healthy meals, leading to increased reliance on convenience foods [46]. This finding is particularly relevant in the Indian context, where working mothers often juggle multiple responsibilities, impacting their ability to foster healthy eating habits in their children [47].

The findings also show age and gender disparities where younger children (0–2 years) have a higher prevalence of obesity compared to those aged 2–5 years. This finding is consistent with Jansen and colleagues, who highlighted that early childhood is a critical period for developing obesity-related behaviours [26]. Additionally, some gender disparity in obesity, with boys showing a higher prevalence than girls, reflects trends observed in other studies, suggesting that boys may be more susceptible to obesity due to various behavioural and environmental factors. Also, boys may be exposed more to the outside home food environment due to a greater preference and freedom to go out and eat compared to girls [26, 36, 46].

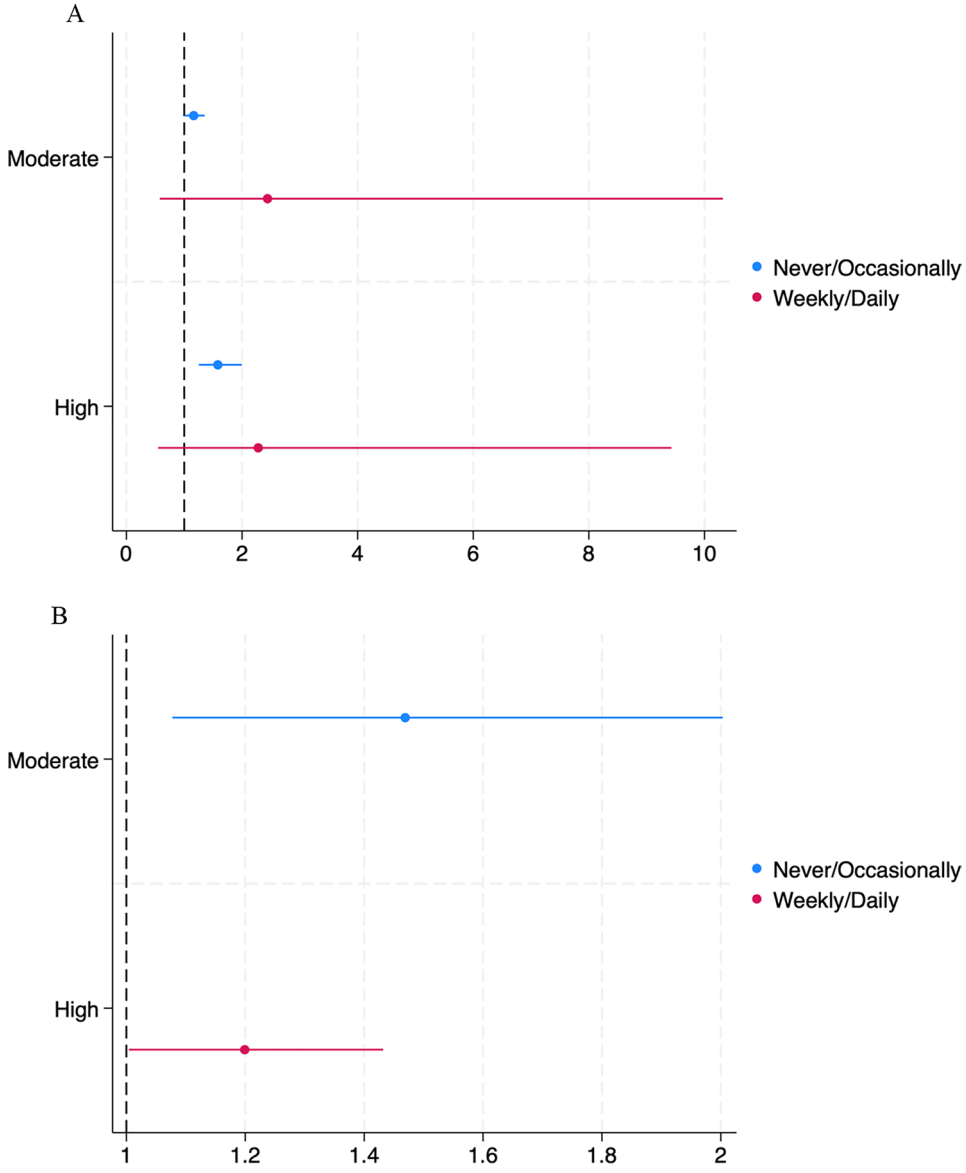

Fig. 7 Heterogeneous analysis by type of junk food: Association between maternal Junk food Consumption and Overweight or Obesity among children. Note: Models are controlled for Age of the Child, Sex of the Child, Height of the mother, Education of the mother, BMI status of Mother, Age of the Mother, Education of the father, Household size, Wealth index, Caste, Religion, Residence

The association between maternal education and childhood obesity is particularly striking, with children of mothers with higher education exhibiting a prevalence of obesity. This finding is supported by the systematic review conducted by Horst and colleagues, who emphasized the role of parental education in shaping dietary behaviours and weight outcomes in children [19]. Kumar and colleagues also opined that educated mothers may consume more ultra-processed foods, influenced by their socio-economic status and lifestyle choices. Also, highly educated women tend to enter more into full-time jobs, and in the absence of support from male partners in childcare, cooking and household activities, the family tend to eat more outside the home food environment [44].

Maternal BMI emerged as a significant determinant of obesity during childhood, with children of mothers with obesity showing the highest prevalence. This finding corroborates the results from the systematic review by Jansen and colleagues, who found a strong association between parental BMI and children's weight status [12, 26]. Our stratified analysis confirms that the association between maternal junk food consumption and childhood overweight/obesity is consistent across maternal BMI categories. The implications of these findings suggest that addressing maternal obesity through health education

and support could be a crucial strategy for preventing childhood obesity.

Wealth status demonstrated a clear gradient effect, with children from wealthier households having higher odds of being overweight or obese. The higher prevalence of childhood obesity in urban areas compared to rural areas further emphasizes the need for context-specific interventions that consider the unique challenges faced by urban populations, such as greater access to unhealthy food options and sedentary lifestyles [48]. This finding aligns with the research by Jambholkar and colleagues (2024), which noted that socioeconomic factors significantly contribute to the prevalence of childhood obesity in India [47]. The study findings corroborate with others regarding the disadvantage of affluence on childhood obesity [49].

The findings of this study highlight the multifactorial nature of childhood obesity in India, emphasising the complex interactions between maternal dietary practices, socio-economic factors, and broader environmental influences. Tackling childhood obesity will require comprehensive, multi-level interventions (state, school and family level) that address maternal nutrition, promote healthy family behaviours, and foster environments conducive to better dietary choices. Individual and family-level behaviour change would be supported by environment-level treatments such as obesity prevention programs targeting younger children should consider reducing food advertising to young children, increasing the availability of smaller portions, and offering substitutes for sugar-sweetened soft beverages. Our analysis reveals that children of mothers consuming aerated drinks or fried foods on a weekly or daily basis are at particularly higher odds of being overweight or obese, compared to children of mothers with occasional or no such consumption. Addressing maternal dietary patterns and enhancing parental awareness are crucial first steps in reversing these trends and fostering healthier futures for children. Given that food choices in India are ingrained in cultural roots, culturally tailored strategies that target these interrelated determinants are essential to curbing the rising prevalence of childhood obesity and ensuring healthier outcomes for children in India. The most crucial tactics for controlling childhood obesity are therapeutic lifestyle modifications and the maintenance of consistent physical activity through parental initiative and social support interventions. Additionally, countries like India require high-risk screening and efficient health and nutrition education initiatives.

Addressing this challenge requires a comprehensive approach, and lessons can be drawn from policies implemented in other countries to promote healthier eating practices. There is evidence of how a regulatory action influences consumer behaviours [50]. For example, Chile's Food Labelling and Advertising Law (FLAL), which regulates the marketing of unhealthy foods to children, has a significant change in the calories purchased [51]. Implementing clear and transparent labels in India could help mothers make informed dietary choices that benefit both their health and their children. Increasing taxation on sugar-sweetened beverages led to a decline in consumption in countries like Mexico and the United Kingdom [52, 53, 54, 55]. Similar policies could curb the consumption of junk food, especially among vulnerable populations.

School-based interventions like the Health, Hunger-free Kids Act (2010) in the United States of America introduced stricter nutritional standards for school meals, limiting access to junk food and increasing the availability of fruits, vegetables and whole grains [56].

Integrating counselling on the adverse effects of junk food into existing platforms—such as growth monitoring and counselling sessions at Integrated Child Development Services (ICDS) centers, the Mid-Day Meal (MDM) Scheme in schools, and Home-Based Care for Young Children—can strengthen maternal and child nutrition knowledge, thereby enhancing outreach and effectiveness.

Strengthening school-based initiatives like the 'Eat Right School Initiative' could improve nutrition education and promote healthy eating behaviours among children and their families. Furthermore, learning from countries implementing health taxes on food with High Fat, Sugar, and Salt (HFSS) can be adapted, where it's observed that unhealthy food taxation may be an effective tool to reduce unhealthy food intake [57].

Additionally, the development of maternal obesity prevention programs, including pre-conception and antenatal interventions, should be prioritized in India. This is particularly critical as the prevalence of overweight and obesity among women (BMI ≥ 25.0 kg/m^2) increased from 20.6% in 2015-16 to 24% in 2019-21, and findings of this study showed that it is significantly contributing to their children's overweight and obesity [3]. These efforts must be complemented by robust monitoring and evaluation systems to track progress and refine strategies to control junk food in Indian markets. Comprehensive strategies addressing these interconnected factors from households to markets are essential to promote healthier outcomes for children in India.

Our findings should be interpreted with consideration of the following limitations. The assessment of the frequency of junk food consumption "never," "occasionally," "weekly," and "daily" is a subjective matter. However, as we are reporting from the user perspective, the subjectivity of such reporting may not affect the policy relevance. The data was collected during 2019-21, which had some

effect of the COVID-19 pandemic that may affect the policy relevance.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41043-025-00937-9.

Supplementary Material 1

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None to declare.

Author contributions
SG and AD developed the concept of the study. SB acquired and managed the data. SG and SB analysed the data. AD and SB drafted the manuscript. AD, SG and SD critically revised the manuscript. All authors gave final approval and agreed to be accountable for all aspects of the work, ensuring integrity and accuracy.

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Data availability
The data is publicly available at The DHS Program: https://dhsprogram.com/Data/.

Declarations

Ethics approval and consent to participate
The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. The study used a secondary source of data available in the public domain. Thus, it doesn't require obtaining separate written or verbal consent from all the subjects.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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