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Association Between Overweight and Central Obesity in Women of Reproductive Age and Overweight in Children Under Five Years of Age

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SUMMARY

Objective: Childhood obesity is becoming an emerging public health issue as it is associated with increased morbidity and premature deaths. Determinants like the child's household characteristics, maternal weight before the preconception stage, and maternal weight in childhood are studied. This study aims to understand the relationship between overweight women of reproductive age and overweight children under the age of five to inform future intervention strategies.
Methods: The data for the study were collected from the India's National Family Health Survey- 5 (NFHS-5). This study is based on publicly available, anonymized secondary data. It has been sub-grouped into urban and rural categories. The percentage of women with high-risk Waist-Hip-Ratio (WHR) and the percentage of overweight women were independent variables whereas the percentage of overweight under-five children was the dependent variable. Spearman rank correlation coefficient, simple linear regression, and multiple linear regression analysis were used to analyze the collected data. Descriptive analysis was done for mean, median, and mode.
Results: Study shows the percentage of overweight women has increased by 4.1%, and the percentage of overweight children has increased by 2% during the NFHS5 (2019-21) compared to NFHS4 (2015-16). The Spearman's rank correlation coefficient (rs) values are 0.4032 for urban, 0.6867 for rural, and 0.5835 for the total population of women with high-risk WHR and overweight children under five years of age whereas the analysis for the percentage of overweight women and percentage of overweight children under five years of age has shown rs=0.389 for rural and rs=0.03893 for total population. Multiple linear regression analysis was done for the total population at a significance level of 0.05 for the independent variables percentage of overweight women, the percentage of women with high risk WHR, and the dependent variable, the percentage of overweight children under five years of age. The results indicated (b0=-3.0448, b1=-0.0202, and b2=0.1397). Simple linear regression of the total population for the independent variable overweight women and dependent variable overweight children under five years of age shows (R=0.0344, Rsquare=0.0012, p-value=0.8421, and b=0.0099) and for the overweight children under five years of age and high-risk WHR women (R=0.5662, Rsquare=0.3205, p-value=0.0003, and b=0.1366).
Conclusions: Central obesity or high-risk WHR in women is more common than being overweight. The number of overweight women as well as children under five years is increasing. Central obesity in women shows a moderate positive relation with overweight in children under five years. It shows when the number of women with high-risk WHR increases, there will be an increase in the number of overweight children under five years of age.

Keywords: Child health; overweight; WHO; obesity; NFHS5; waist-hip ratio.

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INTRODUCTION

According to the World Health Organization (WHO), 37 million children under five were overweight in 2022. The data further says the share of children under five years who are defined as obese is increasing from 4.9% in 1995, 5.3% in 2000, and 5.6% in 2022. Overweight is the condition of excessive fat deposits. It is weight for height greater than 2 standard deviations above WHO child growth standards median [1]. Childhood obesity affects physical and psychological health with consequences like non-insulin-dependent diabetes, hypertension, Gastroesophageal Reflux Disease (GERD), cardiovascular problems, hepatic steatosis, bronchial asthma, Obstructive Sleep Apnea (OSA), etc [2].

The studies show family size, maternal health, unhealthy food practices, poor diet, poverty, and physical inactivity are some of the determinants of being overweight in children under five [3]. A study shows that the determining factors are household wealth, a child's dietary diversity, maternal Body Mass Index (BMI), and education [4]. Earlier studies are mainly based on the household characteristics of the child and their association with being overweight.

Studies are also available where the positive association of overweight children with maternal weight in the preconception stage and maternal weight during childhood is observed [5]. There is no study available to understand the association between overweight women of reproductive age and children under five years of age. This study has been designed to find out overweight and central obesity in women of reproductive age (15-49 years) and overweight in children under five years of age.

Among the obesity anthropometric indices, the waist-hip ratio (WHR) is considered superior to BMI in predicting obesity-related diseases [6]. Abdominal obesity showing high WHR has been proven to predict diseases such as hypertension, coronary heart disease, non-insulin-dependent diabetes, and stroke [7]. Hence the WHR is considered a parameter for this study.

The aim of this study is to investigate the association between overweight women of reproductive age, including those with a high-risk WHR, and overweight children under the age of five.

METHODS

Type of the study

Secondary data analysis

Study population

This study covered a population of 724,115 women in the 15-49 age group and children under five. Women and children under five were divided into two sub-samples, urban and rural.

Database used for study

The study data was obtained from the National Family Health Survey-5 (NFHS-5) from the Ministry of Health and Family Welfare (MoHFW), Government of India. The NFHS data for rounds 1-5 are openly available with (MoHFW), India [8].

The NFHS-5 is the fifth in the NFHS series which provides state-wise information on population, health, and nutrition for India. The contents of NFHS-5 are similar to NFHS-4 to allow comparisons over time. But NFHS-5 has included some new topics like preschool education, disability, access to a toilet facility, death registration, bathing practices during menstruation, and methods and reasons for abortion. The anthropometric parameters like the measurement of waist and hip circumferences are included in NFHS5 which were not there in NFHS4.

This national-level survey was carried out in two phases- the first phase was for 17 states and 5 Union territories from 17 June 2019 to 30 January 2020, and the second phase has been completed in 11 States and 3 UTs from 2 January 2020 to 30 April 2021.

Study approval

This study is based on the publicly available data of NFHS5 on the Ministry of Health and Family Welfare website, in India. No identifiable information on the participants is given. As per the data provided, the ethical approval for the NFHS-5 surveys is obtained from the ethics review board of the International Institute for Population Sciences, Mumbai, India. These surveys are reviewed and approved by the ICF Institutional Review Board, USA. Informed written consent for participation in this survey is obtained from the respondents during the survey. Each individual's approval is sought before the patient interview, as per the consistent methodology followed in these national surveys.

Study variables

The primary outcome variable or dependent variable in this study is the percentage of under-five overweight children. Whereas the independent variables or explanatory variables are the percentage of overweight women and the percentage of women with high-risk WHR. The waist and hip circumference measurements were taken using Gulick tapes to measure abdominal obesity. The WHO set cut-offs for women with high-risk WHR (≥0.85 cm) have been used for this study.

Statistical analysis

The collected data on overweight children under five years of age, overweight women, and high-risk WHR women were provided in percentage (%). Descriptive statistical analysis, mean, median, and mode were calculated for the collected data. The mean, median, and mode are calculated for these percentages reported for each state and Union territory of the country, as well as for urban and rural areas of these states and Union Territories. The mean, median, and mode represent the central or typical values in a distribution hence to understand measures of central tendency in such a large sample size these descriptive tests were done.

Spearman rank correlation coefficient, Simple linear regression, and Multiple linear regression were done to understand the relation between the dependent variable (Y)- the percentage of overweight children under five years of age, and independent variables (X)- the percentage of overweight women and percentage of women with high-risk WHR. Linear regression analysis was done to predict and understand the nature of the relationship between the study variables whereas the Spearman rank correlation coefficient is used to measure the strength of an association and direction of the relationship between these variables. Online statistical software Stats.Blue (https://stats.blue/) was used for all the above-said statistical analysis.

RESULTS

Descriptive analysis shows, that compared to NFHS4 (23.6%), the percentage of women who are overweight has increased in NFHS5 (27.7%). Similarly, the percentage of overweight children has increased from 2.9% to 4.9% in NFHS4 to NFHS5 (Table 1).

Table 1. State & Union Territories wise data on study parameters

	Overweight Women (%)				Women with high risk WHR (%)				Overweight children (%)			
State	**U***	**R‡**	**T5ϕ**	**T4¥**	**U***	**R‡**	**T5ϕ**	**T4¥**	**U***	**R‡**	**T5‡**	**T4¥**
Jammu & Kashmir	33.4	27.9	29.3	29.3	89.2	87.3	87.8	–	10.8	9.3	9.6	5.7
Himachal Pradesh	38.3	29.2	30.4	28.6	60.3	62.1	61.9	–	5.4	5.7	5.7	1.9
Punjab	44.3	38.8	40.8	31.3	73.0	72.6	72.8	–	4.4	4.0	4.1	2.3
Uttarakhand	39.1	25.4	29.7	20.4	62.8	63.0	62.9	–	4.4	3.9	4.1	3.5
Haryana	37.5	30.9	33.1	21.0	64.6	61.7	62.6	–	3.3	3.3	3.3	3.1
Delhi	41.2	44.6	41.3	33.5	67.6	69.0	67.7	–	4.0	4.5	4.0	1.2
Uttar Pradesh	30.6	18.3	21.3	16.5	61.7	55.2	56.8	–	3.6	2.9	3.1	1.5
Chandigarh	43.9	–	44.0	41.5	60.4	–	60.7	–	1.9	–	1.9	1.1
Ladakh	28.5	28.2	28.3	16.3	88.6	85.8	86.3	–	17.0	12.4	13.4	4.0
Andhra Pradesh	44.4	32.6	36.3	33.2	52.7	47.2	48.9	–	3.0	2.6	2.7	1.2
Karnataka	37.1	25.6	30.1	23.3	46.8	43.9	45.1	–	3.8	2.9	3.2	2.6
Kerala	40.4	36.0	38.1	32.4	71.1	70.2	70.7	–	3.8	4.2	4.0	3.4
Tamil Nadu	46.1	35.4	40.4	30.9	58.3	53.8	55.9	–	5.1	3.7	4.3	5.0
Telangana	41.7	23.8	30.1	28.6	47.5	42.3	44.1	–	4.2	3.0	3.4	0.7
Puducherry	47.6	43.2	46.2	36.7	55.4	52.0	54.3	–	2.7	6.5	3.8	2.2
Andaman & Nicobar	41.7	35.7	38.1	31.8	72.2	80.7	77.3	–	5.7	5.2	5.4	3.0
Lakshwadeep	34.2	31.0	33.5	40.6	69.1	66.2	68.4	–	10.0	11.8	10.5	1.6
Bihar	25.2	14.2	15.9	11.7	68.4	58.8	60.3	–	2.2	2.4	2.4	1.2
Jharkhand	21.6	8.6	11.9	10.3	66.4	56.2	58.7	–	2.8	2.8	2.8	1.5
Odisha	40.1	19.2	23.0	16.5	70.7	61.3	63.0	–	5.5	3.2	3.5	2.6
West Bengal	27.9	20.3	22.7	19.9	80.1	72.1	74.7	–	6.0	3.6	4.3	2.1
Rajasthan	20.6	10.5	12.9	14.1	62.1	58.1	59.0	–	3.9	3.1	3.3	2.1
Maharashtra	29.6	18.3	23.4	23.4	51.5	38.6	44.5	–	5.2	3.4	4.1	1.9

Gujrat	30.4	17.0	22.6	23.7	47.2	41.2	43.7	–	4.6	3.5	3.9	1.9
Goa	38.1	33.1	36.1	33.5	51.1	51.0	51.1	–	2.2	3.6	2.8	3.7
Dadara, Nagar Haveli, Diu & Daman	34.0	20.3	26.8	23.3	46.2	44.7	45.4	–	1.2	2.5	1.9	3.9
Chattisgarh	23.1	11.3	14.1	11.9	64.5	52.5	55.4	–	5.7	3.6	4.0	2.9
Madhya Pradesh	26.0	13.0	16.6	13.6	42.0	39.9	40.5	–	1.8	2.1	2.0	1.7
Arunachal Pradesh	28.9	22.9	23.9	18.8	66.6	69.4	68.9	–	9.6	9.7	9.7	4.9
Assam	23.8	13.6	15.2	13.2	66.6	67.3	67.2	–	8.0	4.5	4.9	2.3
Manipur	39.0	31.0	34.1	26.0	69.7	63.1	65.7	–	2.9	3.6	3.4	3.1
Meghalaya	17.9	9.7	11.5	12.2	55.7	61.9	60.6	–	4.2	4.0	4.0	3.9
Mizoram	29.7	16.9	24.2	21.0	47.8	47.3	47.6	–	12.1	8.1	10.0	4.2
Nagaland	17.1	13.0	14.4	16.2	59.6	63.4	62.0	–	4.8	4.9	4.9	3.8
Sikkim	41.0	30.8	34.7	26.7	71.9	78.0	75.6	–	3.5	12.2	9.6	8.6
Tripura	29.2	18.4	21.5	16.0	67.7	60.4	62.5	–	9.3	7.8	8.2	3.0
Mean	**33.7**	**23.6**	**27.7**	**23.6**	**62.7**	**58.3**	**60.9**	**--**	**5.2**	**4.8**	**4.9**	**2.9**
Median	**34.1**	**23.4**	**28.8**	**23.3**	**63.7**	**60.9**	**61.3**	**--**	**4.3**	**3.7**	**4.0**	**2.6**
Mode	**41.7**	**18.3**	**30.1**	**28.6**	**66.6**	**87.3**	**87.8**	**--**	**4.4**	**3.6**	**4.0**	**1.9**

**U-Urban; ǂR-Rural; ϕT5-Total NFHS5 (2019-21); ¥T4-Total NFHS4 (2015-16)*

When the mean values are compared for urban-rural difference for percentage of overweight women, percentage of women with central obesity, and percentage of overweight children; all the variables had higher values in urban areas compared to rural ones (Fig 1).

The Spearman rank correlation coefficient analysis shows a significant large positive correlation between the percentage of women with high-risk WHR and the percentage of overweight children under five years of age (Table 2).

The Spearman's rank correlation coefficient (rs) values are 0.4032 for urban, 0.6867 for rural, and 0.5835 for total population. It shows when the number of women with high-risk WHR increases there will be an increase in the number of overweight children

Figure 1. Average of national-level values for overweight women and children

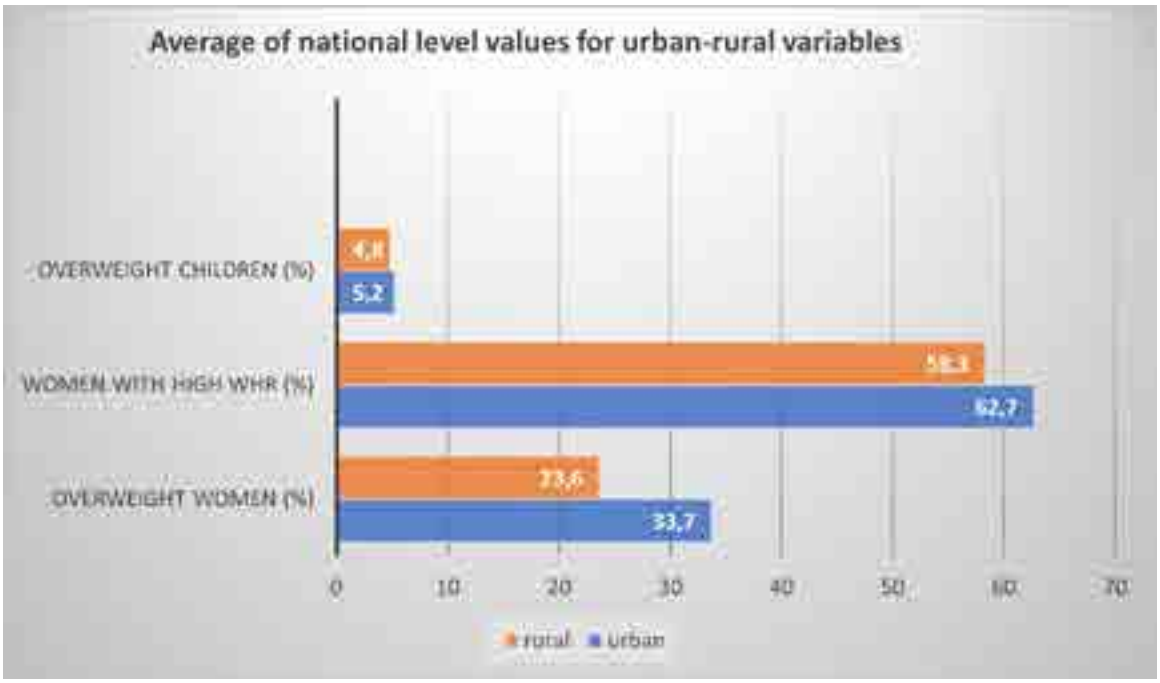

Table 2. Inference table for Spearman's rank correlation coefficient Analysis

Independent variable (X)	Dependent Variable (Y)	Population	Spearman's rank correlation coefficient (r_s)	p-value	Co-variance	Statistic	Results
Overweight women	Overweight children	Urban	-0.2225	0.1922	-24.6857	-1.3306	Non-significant, small, negative relationship
		Rural	0.389	0.01902	43.1357	2.4624	Significant, medium, positive relationship
		Total	0.03893	0.8217	4.3143	0.2271	Non-significant, very small, positive relationship
Women with High-risk WHR	Overweight children	Urban	0.4032	0.01474	44.7429	2.5695	Significant, medium, positive relationship
		Rural	0.6867	0.000003	76.1571	5.5078	Significant, large, positive relationship
		Total	0.5835	0.00018	64.6857	4.19	Significant, large, positive relationship

under five years of age. When the analysis was carried out for the relationship between the percentage of overweight women and the percentage of overweight children under five years of age, it showed a very small positive relationship in rural (rs= 0.389) and total population (rs= 0.03893) whereas a non-significant small negative relationship was observed for urban population (rs= - 0.2225).

Multiple linear regression analysis was done for the total population at a significance level of 0.05 (Table 3).

The independent variables were the percentage of overweight women (X1) and the percentage of women with high-risk WHR (X2) and the dependent variable (Y)-the percentage of overweight children under five years of age. The results indicated that there was a moderate collective significant effect between the percentage of overweight women (X1), the percentage of women with high-risk WHR (X2), and the dependent variable (Y)- the percentage of overweight children under five years of age.

Table 3. Inference table of multiple linear regression analysis for total population

Independent variables (X)	Dependent variable (Y)	Coefficient	α	p-value	Results
Overweight women (X1)	Overweight children	b/b0=-3.0448	0.05	0.1896	Moderate collective significant effect between variables
Women with High-risk WHR (X2)		X1/b1=-0.0202	0.05	0.6331	
		X2/b2=0.1397	0.05	0.0004	
Summary of overall regression-R-square=0.3253 p-value=0.0015					
Regression equation- percentage of overweight children = -3.0448-0.0202. percentage of overweight women + 0.1397. percentage of women with central obesity.					

Simple linear regression of the total population for the independent variable overweight women and dependent variable overweight children under five years of age shows (R= 0.0344, Rsquare= 0.0012, p-value= 0.8421, and b= 0.0099) very weak direct relationship (Table 4).

Simple linear regression for the dependent variable overweight children under five years of age and independent variable central obesity in women (R= 0.5662, Rsquare= 0.3205, p-value= 0.0003, and b= 0.1366) shows a moderate direct relationship. This means when the percentage of women with high-risk WHR will increase by 1 percentage then the percentage of overweight children under five years of age will increase by 0.1366. It shows High-risk WHR in women has more effect than obesity or overweight in children under five years of age.

DISCUSSION

This study shows a significant moderate positive correlation between women with high-risk WHR and overweight children under five years of age. If compared, the WHR in women has a significant relationship with the obesity of the children under five years of age more than the overweight of the women.

Factors like maternal employment [9], family structure [10], childhood daycare and education centres [11], and their effect on the weight of children are studied earlier. At the same time, the earlier studies on the relationship between a parent's obesity and a child's overweight show a positive relation [12]. This study is different as the percentage of women with overweight and high-risk WHR, along with the rate of overweight children is studied. Our findings suggest that with an increasing percentage of women with high-risk WHR, the percentage of overweight children below five will increase.

Our study shows that more urban women are overweight than rural ones, similar to earlier works [13]. A survey of the Nigerian women population shows 35.5% overweight women in urban areas, compared to 21.1% in rural areas. This study shows characteristics of women like household wealth, employment, old age, higher education, marital status, number of children, and contraceptive use are the determinants behind the urban-rural divide of overweight women in reproductive age [14,15].

A similar study was conducted on Bangladeshi women to know the urban-rural obesity trend. This study highlighted the increasing obesity trend in cities is due to rapid urbanization, modern transport, fast and processed food, and a sedentary lifestyle [16].

Urbanization is the most important contributor to being overweight due to access to unhealthy food and less physical activity [17]. The study carried out in Indian urban women of reproductive age for the period 2005-2021 also states the prevalence of obesity has increased in urban India from 23% in 2005-06 to 33% in 2019-21 [18].

As per our study, compared to NFHS4, the percentage of overweight women is increasing at the country level. Similar observations were seen in analyses conducted in Tanzania [19], Kenya [20], and Sub-Saharan African countries like Eswatini, Mauritania, South Africa, Gabon, Lesotho, and Ghana [21].

Overweight children under five years of age are not an urban phenomenon, it is seen in rural also. Maternal factors like age at the time of marriage, BMI, education, and media exposure are considered factors associated with under-five overweight children. Along with these factors, dietary diversity score, sex, age, birth weight, birth rank, and number of children are also the determining factors of childhood overweight [22].

Compared to NFHS4 data, the percentage of overweight children is increasing. A study was carried out on Chinese children to understand the urban-rural trend of childhood overweight for 29 years. It shows childhood obesity has been increasing continuously over the years in the country and though the percentage of overweight children is more in urban than rural, the gap between urban and rural is getting narrower [23]. Our study is important from a future point of view. Policies and interventions should be designed considering the rural children too.

This study shows high-risk waist-to-hip ratio in women is a mixed phenomenon observed in urban and rural women. The overall prevalence of central obesity was observed at 55% when five Indian cities were studied for central obesity in the urban women population [24]. The data analysis of our study shows an increasing trend of central obesity where 62.7% of urban women have high-risk WHR whereas 58.3% of rural women have high-risk WHR. A study carried out

Table 4. Inference table of simple linear regression analysis for total population

Independent variable (X)	Dependent variable (Y)	p-value	α	R	R^2	b	Results
Overweight women	Overweight children	0.8421	0.05	0.0344	0.0012	0.0099	Very weak direct relationship
Women with High-risk WHR	Overweight children	0.0003	0.05	0.5662	0.3205	0.1366	Moderate direct relationship

in the rural population of Meerut, India, has supportive evidence for our finding that high-risk WHR is also a rural phenomenon [25].

Our study shows the percentage of overweight women and overweight children is growing over the period. An analysis carried out to study the prevalence of overweight in adults and children between 1990 to 2015 for 195 countries shows a rising trend of obesity. In more than 70 countries, this trend has doubled [26].

The analysis of our data shows the percentage of women with central obesity is far higher compared to the percentage of overweight women. This is seen in urban as well as rural women population. Overweight or obesity is an important determinant of cardiovascular disease (CVD) and cardiometabolic disease (CMD). High-risk WHR has a positive correlation with the risk of infertility [27] and CVD risk [28]. Our findings highlight the importance of maintaining abdominal fat to maintain healthy WHR levels in women mainly of younger age.

Limitations of study

The strength of this study is a large sample size covering geographically and socio-culturally diverse areas. However, there are some limitations of the study. No data are available for NFHS4 for high-risk WHR, so we could not compare it with the values of NFHS5. This study is based on secondary data, so all the limitations of secondary data apply to it.

Research highlights

a. This study shows a moderate positive correlation between central obesity in women and overweight in under-five children.
b. More urban women are overweight as compared to rural ones. Overweight in children is a mixed phenomenon.
c. Compared to NFHS4, the percentage of overweight women and the percentage of overweight under-five children is increasing.
d. High-risk Waist-Hip-Ratio is seen in urban as well as in rural women.

CONCLUSION

In the present study, we examined the percentage of increase in the overweight of children under five years of age and women in the reproductive age of 15-49 years. Overweight is showing an increasing trend. There is a moderate positive correlation between central obesity in women and overweight in children under five years of age. The study found that the WHR but not overweight in women is an independent risk factor for overweight children under five years of age. However, no significant association was observed in women with overweight and overweight children under five years of age. Further research will help to understand the environmental and biological factors which are responsible for this association.

Overweight in women and children is becoming a public health issue. The study highlights the importance of managing abdominal fat. To prevent overweight, women should focus on healthy diets and physical activity. Curbing the high-risk WHR not only demands changes in diet and lifestyle at an individual level but also changes in policy, physical, and social environment, and cultural norms. Strategically designed awareness programs preferably in regional languages may help to reduce the risk. Policymakers should consider gender-specific risk factors related to women while developing preventive and therapeutic interventions for reducing high-risk WHR.

AUTHOR CONTRIBUTIONS

Both authors contributed to the paper's conception and writing. The first draft of the manuscript was mostly written by JS and CS commented and extended the argument in all versions of the draft. Both authors read and approved the final manuscript.

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The authors declare that this study has no funding.

ETHIC APPROVAL

This article does not contain any studies involving animals performed by any authors. This article does not contain any studies involving human participants performed by any author. This study is based on publicly available, anonymized secondary data of NFHS-5, so ethical approval is not applicable.

DATA AVAILABILITY

NFHS-5 data is freely available on the Ministry of Health and Family Welfare, India website.

CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

INFORMED CONSENT

Informed written consent is not applicable.

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