The proportion of overweight and obese children in urban and rural schools in the practice area of a teaching hospital

Dastagirsab Mamadapur[1], Mounesh Pattar[2], Sowndarya T A[3]
[1]Department of Pediatrics Shri B.M. Medical College Hospital and Research Centre, Vijayapura
[2]Department of Pediatrics, [3]Department of Community Medicine,
Shridevi Institute of Medical Science and Research Hospital, Tumkur, Karnataka, India

Abstract

Background: Childhood obesity, recognized by WHO as a major 21st-century public health challenge, is rising globally, including in India, with varying prevalence based on age, gender, geography, and socio-economic status. Linked to conditions like hypertension and diabetes, it results from genetic and environmental factors. BMI is a standard measure for assessing obesity. This study evaluates the prevalence of overweight and obesity among 6-18-year-olds in urban and rural schools of field practice area of teaching medical college and hospital, identifying associated risk factors.

Methods: In the study, 1060 children aged between 6 and 18 years, studying in urban and rural schools in the field practice area of Teaching Medical College and Tertiary care Hospital of South Karnataka were analyzed to estimate the proportion of overweight and obese children, and assess if an urban-rural difference exists. Towards this, the socio-demographic details and anthropometric characteristics of all students were collected. Students who had measured above the cut off in the IAP BMI growth charts were further thoroughly assessed clinically and promptly referred to the teaching hospital for further management depending on the indications.

Results: The study included equal proportions of urban and rural subjects, predominantly aged 6-10 years, with a male majority (59.1%). Urban-rural differences were observed in diet, socio-economic status, obesity awareness, and screen time. Nutritional assessment showed 82.1% had normal BMI, 7.2% were underweight, 9.3% overweight, and 1.4% obese. Overweight (12.7%) and obesity (1.8%) were more prevalent in urban areas than in rural areas (6.1% and 0.9%, respectively). Gender distribution differed significantly, with fewer rural females (19.8%) in the 15-18 age group continuing education compared to urban females (27.8%). Undernutrition was more common in rural areas, especially among females, while overnutrition was prevalent in urban areas, particularly among males. These findings emphasize the need for targeted interventions to address regional, nutritional, and educational disparities in children.

Conclusion: The proportion of overweight and obese children aged 6-18 years was 9.3% and 1.4% respectively. On analysis, the proportion was significantly higher in urban areas compared to rural areas.

Keywords: Childhood obesity, Overweight, Urban-Rural Schools, screen time, south India, south Karnataka

Introduction:

Obesity is characterized by excessive fat accumulation, with Body Mass Index (BMI) being the most widely accepted metric for defining obesity in children. BMI is calculated as weight (kg) divided by height squared (m^2). The International Obesity Task Force (IOTF) has established age- and gender-specific BMI cut-offs for overweight and obesity, with Asian thresholds set at 23 kg/m^2 and 27 kg/m^2, respectivel.[1]

Childhood obesity has emerged as a significant global health concern, with the World Health Organization (WHO) recognizing it as a major public health challenge. In 2015, approximately 10% of the world's 1.5 billion overweight individuals were children, with 75% residing in developing countries[1].

Address for Correspondence:

Dr. Sowndarya T A
Associate Professor, Department of Community Medicine,
Sridevi Institute of Medical Science and Research Hospital, Tumkur, Karnataka, India
Email: Sowndaya5bug@gmail.com

Raising obesity rates in children have been linked to an increased prevalence of hypertension, abnormal glucose tolerance, dyslipidemia, and lower quality of life. Obese children are more likely to remain obese into adulthood, predisposing them to early-onset diabetes and cardiovascular disease[2]. Genetic predisposition and environmental factors also play a crucial role in obesity risk[3].

Developed nations report higher childhood obesity prevalence compared to developing countries. WHO data indicate that global overweight prevalence among 5-19-year-olds increased from 4% in 1975 to over 18% in 2016, with similar trends in boys (19%) and girls (18%)[4]. In India, studies show overweight and obesity prevalence of 10-14% and 3-6%, respectively, with higher rates in urban affluent children. The IAP Revised Growth Charts define overweight at the 71st and 75th centiles for boys and girls, and obesity at the 90th and 95th centiles, respectively[1].

The COVID-19 pandemic has exacerbated childhood obesity due to lockdown-related physical inactivity, increased screen time, unhealthy diets, and stress-induced eating. A 2021 JAMA study reported a rise in obesity prevalence among children from 19.3% to 22.4% during the pandemic. The loss of structured school meal programs further contributed to unhealthy dietary habits[5].

Despite extensive studies on childhood obesity in southern India, urban-rural disparities remain underexplored. This study aims to estimate overweight and obesity prevalence among 6-18-year-old school children from both urban and rural schools within the institution's field practice area, and assess significant risk factors contributing to this growing public health challenge.

Methodology:

The present school-based cross-sectional study was conducted over duration of 24 months, from July 2022 to June 2024, at the Department of Pediatrics of Teaching Medical College and hospital of south Karnataka. Children in the age range from 6 to 18 years,were selected based on specific inclusion criteria, which encompassed school-going children who had been completely immunized as per the Universal Immunization Programme and whose parents provided informed consent for participation. Exclusion criteria included children with chronic illnesses such as asthma, chronic diarrhea, malabsorption, or recurrent respiratory tract infections. Additionally, children with dysmorphic features, suspected genetic disorders, or those whose parents did not provide consent were excluded from the study.

Prior to data collection, necessary approvals were obtained from the Institutional Ethics Committee. Permission was also sought and granted by the heads of participating schools, and local health and education authorities were informed of the study schedule. Each class was allocated one hour for the study, during which an introductory session was conducted to explain the study's objectives and the questionnaire. Informed consent forms, available in both English and the local vernacular, were distributed to students, who were instructed to have them signed by both parents and return them the following day. Only students with duly signed consent forms were included in the study.

Data collection involved the administration of a socio-demographic questionnaire by the principal investigator and the research team. All participants were interviewed by the same researcher to ensure consistency, and strict confidentiality was maintained throughout the process. The questionnaire, which required approximately 15-20 minutes to complete, was designed to avoid any discomfort for the participants. Following questionnaire completion, anthropometric measurements of all students were recorded in a private setting, with chaperones present as needed. Students whose measurements exceeded the cutoff values in the Indian Academy of Pediatrics (IAP) BMI growth charts underwent a thorough clinical assessment. Those requiring further evaluation were promptly referred to the teaching hospital based on clinical indications. Further the data was entered and analyzed using R-Software. Categorical data was presented as frequencies and proportions, while continuous data was expressed as mean and standard deviation. Appropriate statistical tests were employed and a p-value of less than 0.05 was considered statistically significant, ensuring robust analysis.

Results:

The study sample comprised an equal distribution of children from urban and rural areas, each contributing 50% (530 children).

Table 1: Demographic characteristics of children

Subjects (N=1060)		Frequency (N)	Percentage (%)
Locality	Urban	530	50.0%
	Rural	530	50.0%
Gender	Male	626	59.1%
	Female	434	40.9%
Age group	6 to 10 years	376	35.5%
	11 to 14 years	375	35.4%
	15 to 18 years	309	29.1%

A male predominance was noted, with boys constituting 59.1% (626) of the total population, while females accounted for 40.9% (434). Age distribution revealed a fairly even spread among the three age groups, with the highest proportion in the 6 to 10-year (35.5%) and 11 to 14-year (35.4%) categories, while the older adolescents (15 to 18 years) made up 29.1%.

The gender disparity in enrollment may indicate either a higher school-going rate among boys or sociocultural factors influencing participation. The balanced rural-urban representation ensures comparability in analyzing geographical variations in childhood obesity trends. (Table 1)

Among the 1060 children assessed, the majority (82.1%) had a normal BMI, reflecting a healthy weight distribution within the study population. However, a concerning 9.3% were overweight, and 1.4% were obese, together forming a notable 10.7% of children with excess weight.

Table 2: Distribution of the study subjects based on body mass index

Subjects (N=1060)	Frequency (N)	Percentage (%)
Underweight	76	7.2%
Normal	870	82.1%
Overweight	99	9.3%
Obese	15	1.4%

On the other end, 7.2% were underweight, which, while relatively lower than the overweight category, still necessitates attention to potential nutritional deficiencies. The predominance of normal BMI values is encouraging, but the presence of overweight and obese children highlights the urgent need for targeted interventions focusing on lifestyle modifications, dietary habits, and physical activity. (Table 2)

Table 3: Association of locality of children with important parameters

Subjects (N=1060) N		Urban (N=530)		Rural (N=530)		p-value#
		N	%	N	%	
Gender	Male (N=626)	293	55.3%	333	62.8%	0.012*
	Female (N=434)	237	44.7%	197	37.2%	
Age group	6 to 10 years (N=376)	178	33.6%	198	37.4%	0.418
	11 to 14 years (N=375)	191	35.8%	184	34.7%	
	15 to 18 years (N=309)	161	30.4%	148	27.9%	
BMI	Underweight (N=76)	27	5.1%	49	9.3%	<0.001*
	Normal (N=870)	426	80.4%	444	83.7%	
	Overweight (N=99)	67	12.7%	32	6.1%	
	Obese (N=15)	10	1.8%	5	0.9%	

The gender distribution across urban and rural settings showed a significantly higher proportion of boys in rural areas (62.8%) compared to urban settings (55.3%), with a p-value of 0.012, suggesting a potential gender preference or differing school enrollment patterns. Age group distribution did not show a significant difference (p=0.418), indicating a comparable age structure across localities. BMI analysis revealed significantly higher underweight prevalence in rural children (9.3% vs. 5.1%, p<0.001), whereas overweight and obesity were more prevalent in urban children (12.7% overweight vs. 6.1% in rural areas; 1.8% obese vs. 0.9% in rural areas). These findings reinforce the contrasting nutritional challenges: undernutrition in rural areas and rising childhood obesity in urban settings, necessitating tailored public health interventions. (Table 3)

Table 4: Association of gender wise locality of children with important parameters

Subjects (N=1060)		Urban (N=530)				Rural (N=530)				p-value#
	Male (N=293)		Female (N=237)		Male (N=333)		Female (N=197)			
	N	%	N	%	N	%	N	%		
Age group	6 to 10 years	90	30.7%	88	37.2%	106	31.8%	92	46.7%	0.003*
	11 to 14 years	108	36.9%	83	35.0%	118	35.4%	66	33.5%	
	15 to 18 years	95	32.4%	66	27.8%	109	32.8%	39	19.8%	
BMI	Underweight	11	3.7%	16	6.7%	27	8.1%	22	11.2%	<0.001*
	Normal	232	79.2%	194	81.9%	283	85.0%	161	81.7%	
	Overweight	44	15.0%	23	9.7%	19	5.7%	13	6.6%	
	Obese	6	2.1%	4	1.7%	4	1.2%	1	0.5%	

When stratified by gender, a significant age group variation was observed (p=0.003), with rural girls in the youngest age group (6 to 10 years) having a notably higher proportion (46.7%) compared to urban girls (37.2%), while the adolescent (15 to 18 years) representation was markedly lower among rural girls (19.8%) compared to urban girls (27.8%). BMI distribution also showed statistically significant variations (p<0.001), with underweight being more common among rural males (8.1%) and females (11.2%) than their urban counterparts (3.7% and 6.7%, respectively). Conversely, overweight and obesity were higher among urban children, particularly boys (15% overweight, 2.1% obese) compared to rural boys (5.7% overweight, 1.2% obese). These gender-specific and locality-based differences underscore the need for context-specific nutritional interventions, addressing both rural malnutrition and urban childhood obesity concerns. (Table 4)

In evaluating the nutritional status of children across different age groups and localities, the study found that the majority maintained a normal weight, ranging from 82.6% to 88.5% in both urban and rural settings. However, disparities emerged in undernutrition and overnutrition trends. Underweight prevalence was higher among rural children, affecting 8.6% of those aged 6 to 10 years and 12.5% of those aged 11 to 14 years, compared to 5.7% and 6.3% in urban counterparts, respectively. Conversely, overweight and obesity were more common in urban children, particularly in the 11 to 14 years age group, where 19.4% were overweight compared to 8.7% in rural areas. Obesity, although relatively low, was more prevalent in urban settings (1.1% to 2.5%) than in rural children, peaking at 2.0% among 15 to 18-year-olds. The chi-square test confirmed a statistically significant difference (p<0.001) in nutritional status between urban and rural children. These findings suggest the need for targeted interventions to address undernutrition in rural areas while mitigating rising overweight and obesity trends in urban settings.

Analyzing the age- and gender-wise distribution of nutritional status, urban males slightly outnumbered females in the 6 to 10 years and 11 to 14 years age groups, whereas the 15 to 18 years group had an equal gender distribution. Urban children predominantly maintained normal nutritional status, with overweight cases concentrated in the 11 to 14 years category, while obesity remained minimal. In contrast, rural children exhibited higher underweight prevalence, particularly among females aged 11 to 14 years. Overweight and obesity were significantly lower in rural areas. The statistically significant differences in nutritional status across urban and rural localities underscore the necessity of customized nutritional policies aimed at tackling undernutrition in rural populations and preventing obesity in urban children.

Dietary patterns varied significantly between urban and rural subjects (p<0.001). Vegetarianism was more prevalent in rural areas (33.6%) than in urban areas (20.4%), possibly influenced by cultural and economic factors. In contrast, a mixed diet was more common among urban children (79.6%) compared to 66.4% in rural areas. Junk food consumption patterns also differed, with urban children consuming junk food more frequently than their rural counterparts. Only 1.7% of urban children reported no junk food consumption, compared to 5.1% in rural areas. Weekly consumption was prevalent in both groups, but urban children had a higher proportion of frequent junk food intake, with 12.1% consuming it daily or thrice a week, compared to only 3.6% in rural areas. These findings highlight the need for nutritional education and intervention programs, particularly in urban settings, to promote healthier eating habits.

Socioeconomic status, categorized using the modified BG Prasad classification, revealed significant disparities across gender and locality (p<0.001). In urban areas, 12.7% of males and 8.1% of females belonged to the upper class, compared to only 1.5% and 1.3%, respectively, in rural areas. The upper middle class was more prevalent in urban settings (27.2% of males and 21.5% of females) than in rural regions (8.3% of males and 3.2% of females). Conversely, the lower middle and lower classes had a higher representation in rural areas, with 31.3% of males and 21.7% of females classified as lower middle class, while 19.2% of males and 13.4% of females belonged to the lower class. These socioeconomic disparities may influence dietary habits, healthcare access, and overall nutritional status.

The study also examined the influence of family history on overweight and obesity prevalence. A statistically significant difference (p<0.001) was observed between urban and rural children. In urban areas, 6.4% of males and 4.5% of females had a family history of overweight/obesity, compared to only 1.7% of males and 1.1% of females in rural areas. Awareness of family history was lower among rural children, with 16.0% of males and 11.1% of females reporting uncertainty, compared to 6.9% and 4.9% in urban children, respectively. These findings suggest a potential hereditary component to obesity and highlight the importance of family-based nutritional counseling.

Gender-wise physical activity patterns demonstrated significant variations between urban and rural children. Among those engaging in less than one hour of daily physical activity, urban males (55.1%) and females (52.1%) outnumbered their rural counterparts (44.9% and 47.9%, respectively). However, rural males (66.8%) were more likely to engage in moderate physical activity (1 to 3 hours daily) compared to urban males. Among those exercising for more than three hours daily, rural females had the highest proportion (83.3%) compared to urban females (16.7%). These differences underscore the need for strategies to enhance physical activity in urban children, potentially countering the rising obesity trends.

Screen time exceeding two hours daily was significantly more common among urban children ($p<0.001$). High screen time was reported by 36.6% of urban males and 23.9% of urban females, whereas only 12.5% of rural males and 10.2% of rural females exhibited similar habits. Conversely, lower screen time was more prevalent among rural children, with 48.3% of males and 29.1% of females spending less than two hours on digital devices. This disparity highlights differences in lifestyle, emphasizing the need for digital exposure management in urban populations.

Clinically, malnutrition indicators were examined, revealing a higher prevalence of pallor among rural children (3.4%) compared to urban children (1.3%). Acanthosis nigricans, associated with obesity, was observed more frequently in urban children (0.6%), while only one rural child (0.2%) exhibited this condition. Gender-specific trends showed that pallor was most prevalent among rural females (5.1%), whereas acanthosis nigricans was more common in urban males (0.7%). The observed patterns align with the general trend of undernutrition in rural settings and overnutrition in urban populations.

Dietary habits revealed that 2.5% of children consumed non-vegetarian food three times a week or daily, while 7.8% consumed junk food at a similar frequency. Sweets were consumed by 20.2% of children at least three times a week. Interestingly, 75.2% of children did not consume fruits daily, and 1.9% reported a dislike for vegetables. Regarding physical activity, 63.2% engaged for less than an hour daily, while 4.1% did not participate in outdoor activities. Inadequate sleep (<8 hours) was reported by 27.9% of children, while 41.6% exceeded two hours of screen time daily.

Family history assessment indicated that 6.9% of subjects had overweight or obese family members, and 12.9% had parents with comorbidities such as hypertension or diabetes mellitus. However, 10-15% of subjects were unaware of their familial medical history. Behavioral insights revealed that 5.8% of children perceived themselves as overweight or obese, while 14.2% reported weight gain during the COVID-19 lockdown. Awareness of weight-related health risks was evident in 37.1% of cases, while 17.5% recognized the need to reduce junk food intake. Parental influence played a crucial role, with 68.5% restricting screen time and 61.7% encouraging outdoor activities.

Discussion:

This study was conducted as a school-based, cross-sectional survey in the field practice area of the Teaching Medical College and Tertiary care hospital of south karnataka. The target population included children aged 6 to 18 years enrolled in both urban and rural schools. Inclusion criteria required children to be within this age range, fully immunized as per the Universal Immunization Programme, and with parental consent. Children with chronic illnesses, genetic disorders, or those lacking parental consent were excluded. Ethical clearance was obtained, and permissions were secured from school authorities. Data collection involved administering a socio-demographic questionnaire followed by anthropometric measurements conducted privately.

Locality-Based Nutritional Differences

A balanced urban and rural subject distribution allowed for a comparative assessment of nutritional outcomes. Prior studies indicate significant variations in obesity prevalence based on locality. Parekh A et al.[6] (14.6% urban vs. 12.8% rural) highlighted a higher prevalence of obesity among urban adolescents due to lifestyle and environmental factors. Conversely, Liu J et al.[7] (16.5% rural vs. 14.3% urban) found higher overweight rates in rural U.S. children, suggesting regional and cultural influences. Contreras DA et al.[8] and Kumar S et al.[9] examined affluent urban populations and reported a strong correlation between high socioeconomic status and obesity. Bishwajit G et al.[10] observed a higher prevalence of undernutrition in rural areas, reinforcing the urban-rural nutritional divide.

Gender-Based Obesity Trends

Obesity prevalence varies by gender and locality, with urban males consistently showing higher rates. This study observed a higher proportion of males, especially in urban settings, aligning with Parekh A et al.[6] who reported a significantly higher prevalence of obesity among urban males. Liu J et al.[7] found rural boys in the U.S. more likely to be overweight than urban boys, indicating geographic differences in gender-based obesity risk. Contreras DA et al.[8] and Kumar S et al.[9] reinforced that affluent urban males experience higher obesity rates. Bishwajit G et al.[10]

reported urban males were more prone to obesity, while rural males exhibited higher undernutrition rates, supporting findings from Parekh A et al.[6]

Interplay of Gender and Locality

Urban males face a higher obesity risk, whereas rural males are more likely to be undernourished. The present study found a similar pattern, where urban males exhibited greater obesity prevalence while rural males were more affected by undernutrition. Parekh A et al.[6] similarly identified higher obesity risk among urban males. However, Liu J et al.[7] found rural boys in the U.S. more likely to be overweight than urban boys, suggesting regional differences. Studies by Contreras DA et al.[8] and Kumar S et al.[9] showed that urban affluent males were at greater risk of obesity, reinforcing earlier findings. Bishwajit G et al.[10] concluded urbanization contributes to higher obesity rates in males, particularly in wealthier settings, while rural males remain more susceptible to undernutrition.

Age Distribution and Nutritional Trends

Age influences nutritional status, with obesity risks increasing as children grow older. The present study observed a majority of participants aged 6-10 years, with no significant age-related nutritional differences. However, Parekh A et al.[6] (14-16 years) found urban adolescents consistently had higher BMI across all age groups. Liu J et al.[7] reported overweight prevalence was higher among younger rural children (10-14 years), suggesting age-related trends vary between settings. Contreras DA et al.[8] and Kumar S et al.[9] highlighted that obesity risk in urban affluent children increases with age. Bishwajit G et al.[10] supported the association between aging and increasing obesity risk in urban settings, aligning with Parekh A et al.[6] and Contreras DA et al.[8]

Age and Locality-Based Nutritional Outcomes

Age-related obesity trends vary between urban and rural settings. Parekh A et al.[6] found that urban adolescents consistently exhibited higher BMI across all age groups. Liu J et al.[7] reported younger rural children were more prone to overweight, indicating different environmental influences. Contreras DA et al.[8] and Kumar S et al.[9] confirmed that obesity risk increases with age in urban affluent settings. Bishwajit G et al.[10] supported the notion that urban environments exacerbate obesity risk as children grow. Overall, age is a significant factor in obesity prevalence, particularly in urban populations, whereas rural settings show more variability.

Age, Gender, and Locality Interactions

Age, gender, and locality interact in complex ways to influence nutritional outcomes. The present study found that younger urban males were at greater risk of obesity. Parekh A et al.[6] similarly reported urban males aged 14-16 had the highest obesity rates. Liu J et al.[7] diverged, showing rural boys were more likely to be overweight, indicating regional differences. Contreras DA et al.[8] and Kumar S et al.[9] found older urban affluent males were most susceptible to obesity, aligning with Parekh A et al.[6] and the present study. Bishwajit G et al.[10] suggested urban males had a higher obesity risk, especially with age. The evidence highlights urban males, particularly older ones, face the highest obesity risks, whereas rural settings show greater variability.

Nutritional Status and BMI Distribution

Urban settings generally exhibit higher rates of overweight and obesity. The present study found most participants had a normal BMI, but obesity rates were higher in urban areas. Parekh A et al.[6] reported that urban adolescents had significantly higher BMI compared to rural adolescents. Liu J et al.[7] noted rural children had higher BMI Z scores than urban children, suggesting region-specific influences. Contreras DA et al.[8] and Kumar S et al.[9] found that urban affluent children had higher BMI, reinforcing the findings of Parekh A et al.[6] and the present study. Bishwajit G et al.[10] corroborated these findings, showing urban children had higher overweight prevalence.

Influence of Socioeconomic Status and Dietary Practices

Dietary habits significantly affect obesity prevalence, particularly in urban settings. The present study found urban children had more dietary diversity, which contributed to higher obesity rates. Parekh A et al.[6] suggested urban adolescents had greater access to calorie-dense foods. Liu J et al.[7] implied rural children's diets might have contributed to their overweight prevalence. Contreras DA et al.[8] and Kumar S et al.[9] found that urban affluent children's consumption of calorie-dense foods increased obesity rates. Bishwajit G et al.[10] supported this notion, reporting urban children had greater access to diverse but unhealthy diets.

Screen Time and Physical Activity Levels

Urban children had significantly higher screen time and lower physical activity, correlating with higher obesity rates. Parekh A et al.[6] found urban adolescents engaged in less physical activity, contributing to obesity. Liu J et al.[7] reported rural children were more active but still had higher overweight prevalence, suggesting other factors at play. Contreras DA et al.[8] and Kumar S et al.[9] confirmed that urban affluent children's sedentary lifestyles increased obesity risks. Bishwajit G et al.[10] indicated urban children's lower

activity levels and higher screen time contributed to their obesity risk.

Malnutrition Manifestations across Localities

Malnutrition presents differently in urban and rural settings, with urban children facing higher obesity rates while rural children are more likely to be undernourished. The present study found that pallor was more common among rural children, while obesity-related conditions were more prevalent in urban children. Parekh A et al.[6] focused primarily on urban obesity, while Liu J et al.[7] suggested rural children exhibited shifting nutritional patterns. Contreras DA et al.[8] and Kumar S et al.[9] reinforced the trend of obesity being more prevalent in urban affluent populations. Bishwajit G et al.[10] concluded that urbanization drives a shift from undernutrition to overnutrition.

Conclusion:

The study assessed the prevalence of overweight and obesity among children aged 6-18 years in urban and rural areas, highlighting key health and lifestyle differences. Males predominated, especially in rural areas, where educational disparities were noted. Under nutrition was more common in rural children, while over nutrition was higher in urban areas. Rural children had a higher vegetarian diet, whereas urban children consumed more junk food, engaged in less physical activity, and had greater screen time. Malnutrition indicators were prevalent in rural children, while urban children exhibited signs of overnutrition. The findings underscore the need for targeted nutritional and lifestyle interventions.

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