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Association Between Obesity and Periodontitis among Undergraduate Students of Hyderabad - A Cross Sectional Study

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Abstract

Background: Obesity, ranked sixth by WHO for its global health impact, leads to chronic inflammation through adipokines released from fat tissues. These compounds influence metabolism and contribute to systemic inflammation, exacerbating periodontal diseases by raising CRP levels.

Objectives: The present study aimed to investigate the correlation between indicators of obesity (Body mass index and waist circumference) and periodontal health status among undergraduate students.

Materials and Methods: A single examiner recorded the demographic data and oral health status of 1000 systemically healthy males and females aged 18 - 25 years in Hyderabad. Obesity of the study subjects was determined by calculating body mass index (BMI) and waist circumference (WC). Gingival index and the periodontitis severity and grading system adopted from the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions were used to determine the condition of periodontal health. Periodontal probing depth (PPD) and clinical attachment level (CAL) were measured. $P < 0.05$ is considered statistically significant.

Results: The overall mean BMI and WC among the study subjects was 25 ± 7.46 kg/m^2 and 79.7 ± 15.05 cm respectively. Gingivitis prevalence significantly differed by BMI ($p = 0.000$) and WC; older underweight individuals had mild gingivitis, while younger normal and obese subjects had moderate gingivitis. Stage 2 periodontitis was prevalent in overweight ($p = 0.005$) and obese ($p = 0.065$) subjects. Spearman correlation showed a significant, positive, and moderate to high correlation of BMI with WC, gingivitis, and periodontitis.

Conclusion: Both BMI and WC were significantly associated with periodontal status among undergraduate students in Hyderabad. Overweight and obese individuals exhibited a higher prevalence of periodontitis, highlighting the importance of oral health awareness and obesity prevention strategies.

Keywords: *Obesity; Body Mass Index; Waist Circumference; Periodontitis*

Abbreviations

BMI: Body Mass Index; WC: Waist Circumference; WHO: World Health Organization; PPD: Periodontal Probing Depth; CAL: Clinical Attachment Level

Introduction

Periodontitis, often called pyorrhea, is an inflammatory condition that damages the bone that supports the teeth, alters the composition of the subgingival plaque, and speeds up the loss of alveolar tissue. It has been ranked as the tenth most widespread condition in the world and found to be a significant public health issue that impacts countries developed and developing [1]. As a complex entity, the clinical progression of periodontitis is greatly influenced by several local and systemic risk factors, such as aging, bad habits, dental hygiene practices, socioeconomic status, genetic vulnerability, gender, and psychological stress. The fact that periodontitis is associated with systemic diseases shows that the condition is not just caused by plaque build-up but also involves a variety of host variables that may change its outcomes [2]. For example, recent study conducted by Arumuganainar., *et al.* revealed that for those with type 2 diabetes mellitus, CD44 may have a negative role in the development of periodontal condition [3].

According to the World Health Organization (WHO), obesity is a major public health concern as it is the sixth detrimental factor that reduces life expectancy and causes illnesses worldwide [4]. Obesity triggers chronic inflammation and immune dysfunction, characterized by the release of adipokines and inflammatory cytokines from adipose tissue. These molecules, including TNF, inflammatory cytokines (IL-6, IL-8), and plasminogen activator inhibitor, act on hypothalamic neurons, influencing metabolism and contributing to systemic inflammation. An increase in C reactive protein (CRP) levels further exacerbates periodontal disease progression. The adipogenic differentiation of bone marrow stem cells (BMSCs) and the interruption of haematopoiesis are linked to bone marrow obesity. These outcomes result in a decrease in osteoblasts and lymphoid precursors and an increase in monocyte differentiation. Hypermetabolism in obesity accelerates BMSC senescence, while gut microbial dysbiosis and genetic factors exacerbate osteoporosis risk. Additionally, saturated fatty acids in the diet independently promote bone loss. These mechanisms collectively impact local periodontal defense, microbial composition, and bone remodeling, emphasizing the intricate link between obesity, inflammation, and periodontitis progression [5,6]. The systemic inflammation can be reduced by increased mucosal concentration of interleukin-1β caused by the treatment with ghrelin which is a polypeptide obtained from the gut [7]. Obesity not only causes periodontitis but also worsens disease severity among those affected and less favourable outcomes after undergoing periodontal treatment [8].

Numerous observational studies have discovered a correlation, ranging from low to somewhat significant, between obesity and periodontitis. In certain studies, obesity was measured using body mass index (BMI), but BMI only considers overall body weight and overlooks body composition and fat distribution. Therefore, for accurate adiposity assessment, waist circumference (WC) also should be taken into account. WC is a crucial measure of central adiposity and reliably indicates the risk of periodontal disease [9]. In this study, we have used both BMI and WC to measure obesity. Some clinical trials are been done regarding the relationship between obesity and periodontitis Nilsen., *et al*. [10] proved that the association between metabolic syndrome and periodontitis may become less significant at a certain BMI level, possibly due to the overriding influence of obesity-related factors, which may overshadow the effects of other systemic factors.

Dogan., *et al*. [11] revealed that obesity influences periodontal health by elevating IL-6 in saliva and correlating negatively with IL-10 levels and gingival index. Skrypnk., *et al*. [12] observed that obese individuals exhibited poorer oral hygiene and higher gingivitis severity, even with satisfactory oral hygiene.

The literature examining the direct relationship between body composition and periodontal disease appears to be sparse, even though only a few numbers of research [13-17] in India have revealed a substantial relation/association between obesity and oral health. No

study has been conducted so far that has assessed relationship between BMI and periodontal health, WC and periodontal health, and assessment of correlation between all three parameters in younger adults. Considering these points, the present study aims to determine the relation between periodontal health status, body mass index (BMI), and waist circumference (WC) among undergraduate students of Hyderabad.

Materials and Methods

A cross-sectional study was conducted among all undergraduate students from Hyderabad, India, who were visiting Army College of Dental Sciences, Secunderabad, between February 2022 and September 2022. The Institutional Review Board (ACDS/IC/71/Jan 2021) provided approval and ethical clearance. Each participant gave signed, informed consent to participate after being told about the objectives and procedures of the study. This study was not registered with in Clinical trials registry.

Study population

To determine the feasibility of the study and to estimate the size of the final sample, a pilot study involving 30 undergraduate students was carried out. The final study sample did not include the students who took part in the pilot study. With a Cronbach's alpha of 0.832, internal reliability and validity were assessed and judged to be good. The sample size was estimated at 996, having a 95% confidence interval and 5% precision level.

Thus, the study included 1000 participants between the ages of 18 and 25 depending on the selection criteria. Participation was voluntary and respondents' identities and confidentially was respected.

Inclusion criteria

- All Undergraduate students of Hyderabad visiting Army College of Dental Sciences, Secunderabad.
- Those making their first visit to the dental hospital.
- Those who provided written consent forms and ready to participate in the study.

Exclusion criteria

- Physically and mentally handicapped individuals.
- Subjects on antibiotic therapy.
- Subjects with systemic illnesses like diabetes, hypertension, hypothyroidism, etc.
- Subjects have undergone any dental treatment in the last three months.

Determination of BMI, WC

The demographic data (age, gender, education) were collected. Quetelet or the body mass index (BMI), which is calculated as the ratio of weight (kg) to height squared, was used to estimate the degree of obesity among the study participants. The patient was instructed to remove any additional weights, such as overcoats, wallets, keys, mobile phones, etc. before having their weight measured on a conventional digital scale. The participant was measured for height while standing straight up against the wall with their feet together using a stadiometer (WS 021). The WHO Guidelines served as the foundation for the BMI cut-off [18]. Based on this cut-off the study population was classified as underweight (≤ 18 kg/m^2); normal weight (18.5 - 24.9 kg/m^2); Overweight (25 - 29.9 kg/m^2); Obese (≥ 30 kg/m^2). The waist circumference (WC), which is the thinnest between the umbilicus and the rib cage, was measured using stretch-resistant tape. Obese individuals were classified as males with a WC of ≥ 102 cm (40) and females with a WC of ≥ 88 cm (35) [19].

Clinical evaluation

Clinical examination including the assessment of gingival and periodontal status was performed by a single examiner. Using the gingival index developed by Loe H. and Silness J [20] in 1963, the gingival status was evaluated. Based on the multidimensional staging and grading approach adopted from the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, the severity, complexity, extent, and distribution of periodontitis were categorized into four stages [21]. Using the William probe, periodontal probing depth (PPD) and CAL were measured in all 6 sites: disto-facial, mi-facial, mesio-facial, disto-facial, mid-facial, and mesio-lingual. Radiographs were used to determine the amount of bone loss and the type of bone defect.

Statistical analysis

Statistical Package for Social Sciences (SPSS) package version 20.0 was used to analyze the data. For gender and age comparison among the study population by body mass index (BMI), waist circumference (WC), and periodontal status; Mann-Whitney-U-test and Kruskal Wallis test were used. Comparison of mean scores of all variables based on gender and age was assessed by the Chi-square test. To correlate obesity indicators with periodontal disease indicators Spearman's Correlation was used. Statistical significance was set at $p < 0.05$.

Results

The study includes a sample of 1000 participants who gave their consent. Nearly equal numbers of men (51.9%) and women (48.1%) were included in the sample. Most of the study subjects were aged between 18 - 21 years (54.2%) while only 45.8% of subjects were in the age group of 22 - 25 years.

Body Mass Index (BMI) results showed that 25% of the participants were obese, followed by underweight (25%), overweight (25%), and normal (25%). Comparison based on age revealed that a higher percentage of younger subjects (18 - 21) were underweight (79.2%) and the older subjects (22 - 25 years) were overweight (61.2% and obese (52.8%). Most of the females were underweight (61.6%) and overweight (52.8%), while males were obese (70%). Regarding Waist Circumference (WC), a higher number of subjects were reported to be non-obese (84.7%) and only 15.3 were obese. Amongst the non-obese population, male subjects and younger subjects were in higher percentages (54.1%, and 57.6% respectively).

The overall mean BMI and WC among the study subjects was 25 ± 7.46 and 79.7 ± 15.05 respectively. The mean BMI and WC were comparable and significantly higher among older subjects (27.3 ± 5.79, 86.6 ± 14.1 respectively) in comparison to younger subjects (23.03 ± 8.11, $p = 0.000$; 73.9 ± 13.2, $p = 0.000$). Likewise, comparison based on gender revealed significant differences with higher means among males (26.8 ± 8.4, 83.1 ± 16.3 respectively = 0.000).

Based on the gingival status, a comparable percentage of subjects had mild (47.2%) and moderate gingivitis (43.6%), with only 9.2% having severe gingivitis. A significant difference in the prevalence of gingivitis with BMI was observed ($p = 0.000$). Mild gingivitis is more prevalent among subjects who had normal BMI (85.2%) and who were underweight (76.4%), while moderate and severe gingivitis is most prevalent among overweight (72%, 9.6% respectively) and obese subjects (64.4%, 26.8% respectively). with regards to WC, moderate gingivitis is most prevalent among Obese subjects (71.9%) and mild among non-obese subjects (54%).

Comparison based on age revealed significant differences among underweight, normal, and obese ($p = 0.021$, 0.026 respectively) subjects, wherein mild gingivitis is most common among older underweight subjects and younger normal and obese subjects. On the other hand, moderate gingivitis among younger underweight and obese subjects. When WC was considered, a significant association between age and gingivitis was seen only among non-obese subjects, where in moderate and severe gingivitis are most prevalent among older subjects (45.1%, and 14.8% respectively) (Table 1).

Obesity parameters		Age Mild n (%)	Gingival Index (GI)			Chi Square value	P value
			Moderate	Severe			
			n (%)	n (%)			
BMI	Underweight	18-21	14 (73.2)	53 (26.8)	0 (0)	5.298	0.021
		21-25	46 (88.5)	6 (11.5)	0 (0)		
	Normal	18-21	152 (89.4)	18 (10.6)	0 (0)	8.591	0.014
		21-25	61 (76.3)	18 (22.5)	1 (1.3)		
	Overweight	18-21	12 (12.4)	78 (80.4)	7 (7.2)	5.627	0.060
		21-25	34 (22.2)	102 (66.7)	17 (11.1)		
	Obese	18-21	7 (9.1)	58 (75.3)	12 (15.6)	7.296	0.026
		21-25	15 (8.7)	103 (59.5)	55 (31.8)		
WC	Non - obese	18-21	313 (64.1)	164 (33.6)	11 (2.3)	72.097	0.000
		21-25	144 (40.1)	162 (45.1)	53 (14.8)		
	Obese	18-21	3 (5.6)	43 (79.6)	8 (14.8)	2.785	0.248
		21-25	12 (12.1)	67 (67.7)	20 (20.2)		

Table 1: *Distribution and comparison of GI among group based on age.*

Similarly, comparison based on gender revealed a significant difference only in underweight (p = 0.038) and obese subjects (p = 0.003), wherein mild and moderate gingivitis is seen mostly among females (80.5% and 80% respectively). Based on WC, both mild and moderate gingivitis are significantly higher among both obese and non-obese females (Table 2).

Obesity parameters		Age Mild n (%)	Gingival Index (GI)			Chi Square value	P value
			Moderate	Severe			
			n (%)	n (%)			
BMI	Underweight	Male	67 (69.8)	29 (30.2)	0 (0)	3.775	0.038
		Female	124 (80.5)	30 (19.5)	0 (0)		
	Normal	Male	112 (86.2)	18 (13.8)	0 (0)	1.170	0.557
		Female	101 (84.2)	18 (15)	1 (0.8)		
	Overweight	Male	28 (23.7)	80 (67.8)	10 (8.4)	4.292	0.117
		Female	18 (13.6)	100 (75.8)	14 (10.6)		
	Obese	Male	17 (9.7)	101 (57.7)	57 (32.6)	11.853	0.003
		Female	5 (6.7)	60 (80)	10 (13.3)		
WC	Non-obese	Male	224 (48.9)	182 (39.7)	52 (11.4)	24.146	0.000
		Female	233 (59.9)	144 (37)	12 (3.1)		
	Obese	Male	0 (0)	46 (75.4)	15 (24.6)	12.313	0.002
		Female	15 (16.3)	64 (69.6)	13 (14.1)		

Table 2: *Distribution and comparison of GI among groups based on gender.*

Based on the grading and staging of periodontitis, the majority of the subjects were healthy (63%), while 32.4% had stage 1, 4.3% had stage 2, 1.3% had stage 3 and none of the subjects had stage 4 periodontitis. A significant association was seen when BMI and WC were compared with the periodontal status. According to BMI, most of the underweight and normal-weight subjects had healthy periodontium, while in the overweight and obese subjects; stage 2 periodontitis was more prevalent (51.2%, and 66.4% respectively). This high prevalence is significantly higher among younger subjects (p = 0.021, 0.001, 0.005 respectively), except in obese subjects. Likewise, according to WC, stage 2 periodontitis is more prevalent in obese individuals (68.6%) than non-obese (25.9%), especially among older subjects (72.7%) (Table 3).

Obesity parameters		Age 1 n (%)	Periodontal severity				Chi Square value	P value
			2	3	4			
			n (%)	n (%)	n (%)			
BMI	Underweight	18-21	192 (97)	6 (3)	0 (0)	0 (0)	6.524	0.021
		21-25	46 (88.5)	6 (11.5)	0 (0)	0 (0)		
	Normal	18-21	164 (96.5)	6 (3.5)	0 (0)	0 (0)	13.019	0.001
		21-25	67 (83.8)	12 (15)	1 (1.3)	0 (0)		
	Overweight	18-21	38 (39.2)	59 (60.8)	0 (0)	0 (0)	12.864	0.005
		21-25	69 (45.1)	69 (45.1)	14 (9.2)	1 (0.7)		
	Obese	18-21	23 (29.)	43 (55.8)	11 (14.3)	0 (0)	7.227	0.065
		21-25	31 (17.9)	123 (71.1)	17 (9.8)	2 (0.8)		
WC	Non-obese	18-21	406 (83.2)	81 (16.6)	1 (0.2)	0 (0)	87.21	0.000
		21-25	199 (55.4)	18 (38.4)	21 (5.8)	1 (0.3)		
	Obese	18-21	11 (20.4)	33 (61.6)	10 (18.5)	0 (0)	4.004	0.261
		21-25	14 (14.1)	72 (72.7)	11 (11.1)	2 (1.3)		

Table 3: *Distribution and comparison of periodontal severity among groups based on age.*

Periodontal severity is divided into 4 stages based on "periodontitis severity and grading system adopted from the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions".

Based on gender, a significant difference in periodontal status was seen among underweight, overweight, and obese individuals. All the males and most of the females (92.2%) underweight had healthy periodontitis (p = 0.004). Whereas stage 2 periodontitis was most significantly and highly prevalent among female overweight (56.8%; p = 0.002) and obese subjects (69.3, p = 0.004). Based on WC, significant stage 2 periodontitis is seen among male non-obese (30.1%) and female obese subjects (71.7%) (Table 4).

Spearman correlation showed a significant, positive, and moderate to high correlation between BMI and WC, gingivitis, and periodontitis, likewise, the correlation between WC, gingivitis, and periodontitis was significant and moderate (Table 5).

Obesity parameters		Age 1 n (%)	Periodontal severity				Chi Square value	P value
			2	3	4			
			n (%)	n (%)	n (%)			
BMI	Underweight	Male	96 (100)	0 (0)	0 (0)	0 (0)	7.858	0.004
		Female	142 (92.2)	12 (7.8)	0 (0)	0 (0)		
	Normal	Male	120 (92.3)	10 (7.7)	0 (0)	0 (0)	1.175	0.556
		Female	111 (92.5)	8 (6.7)	1 (0.8)	0 (0)		
	Overweight	Male	52 (44.1)	53 (44.9)	13 (11)	0 (0)	14.412	0.002
		Female	55 (41.7)	75 (56.8)	1 (0.8)	1 (0.8)		
	Obese	Male	32 (18.3)	114 (65.1)	27 (15.4)	2 (1.1)	13.275	0.004
		Female	22 (29.3)	52 (69.3)	1 (1.3)	0 (0)		
WC	Non-obese	Male	300 (65.5)	138 (30.1)	20 (4.4)	0 (0)	25.150	0.000
		Female	305 (78.4)	81 (20.8)	2 (0.5)	1 (0.3)		
	Obese	Male	0 (0)	39 (63.9)	20 (32.8)	2 (3.3)	46.772	0.000
		Female	25 (27.2)	66 (71.7)	1 (1.1)	0 (0)		

Table 4: *Distribution and comparison of periodontal severity among groups based on gender.*

Periodontal severity is divided into 4 stages based on "periodontitis severity and grading system adopted from the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions".

Correlation between		r value	P value
BMI	WC	0.821	0.000*
	Gingival index	0.590	0.000*
	Periodontal index	0.619	0.000*
WC	Gingival index	0.622	0.000*
	Periodontal index	0.651	0.000*

Table 5: *Correlation between BMI, WC and oral health parameters.*

Discussion

The "New Global Syndrome" of non-communicable diseases (NCDs), of which obesity is considered the first wave, has a significant impact on global socioeconomics and public health [22]. Obesity is one of the most significant public health issues of the present day as it is affected by 13% of people who are 18 years of age and older globally, according to the World Health Organization [23]. According to estimates, it is the sixth risk factor to potentially increase the overall burden of disability-adjusted life years lost (DALYs) [24].

Individuals aged 18 to 25 undergo a transitional phase from youth to adulthood. This period is recognized for its blend of social, psychological, and biological factors, which can render them susceptible to engaging in various forms of risk-taking behaviors [25]. In advanced nations, 18 to 25-year-olds are just recently being recognized as a "vulnerable demographic" for leading unhealthy lifestyles that lead to overweight and obesity [26,27]. As there isn't a lot of literature on this age group, the present study was carried out among undergraduate students between the ages of 18 and 25.

The BMI, also known as the Quetelet index, is used to estimate the risk of obesity-associated disorders in a range of populations and is closely related to fat mass, morbidity, and mortality [28]. Because visceral adipose tissue exhibits greater physiological activity and releases a higher amount of cytokines and hormones compared to subcutaneous adipose tissue, it is strongly associated with waist circumference [29]. A small number of studies have indicated that BMI is the best predictor, whereas an more small number of studies have found that waist circumference is a better predictor than BMI [30,31]. To eliminate any doubt when comparing the impact of central adiposity to overall adiposity on the risk of periodontal disease, both the anthropometric parameters (BMI and WC) were evaluated in the current investigation.

In the present study, based on BMI, 25% of the subjects were in the overweight and obese category respectively. However, when the WC was considered, 84.7% of them were non-obese subjects. Concerning both BMI (overweight and obese) and WC, more of the older subjects and males were obese. According to a study conducted among undergraduate students from 22 universities, 22% of young adults were overweight or obese, with men being more likely to be so (24.7%) than women (19.3%) [32]. In contrast; a study conducted by Doddamane., *et al*. [33] found that there was no difference observed in gender distribution between obese and non-obese groups. The prevalence of overweight and obesity, however, is higher among women than men, according to previous studies [13,14,34]. This gender difference might be due to differences in fat metabolism, lifestyle, preference for family, cultural beliefs/factors, or due to demographic variations.

As obesity is always associated with chronic subclinical inflammation, in the present study more than 70% of the overweight and obese as measured by both BMI and WC, had moderate to severe gingivitis. Similarly, Khan., *et al*. [35] observed 83% of subjects had sites with GBI > 30% and Hedge., *et al*. [36] observed high means of GI among non-obese adults. In the study by See and Ehizele, the binary logistic regression found that obesity was the most likely predictor of gingival bleeding [37]. The findings of Nascimento., *et al*. on the other hand, did not appear to link gingivitis to weight [38].

Although the underlying molecular mechanisms are still unknown, it is thought that adipose tissue releases adipocytokines, which are proinflammatory cytokines and hormones that cause oxidative stress problems and inflammation, resulting in diseases with comparable pathophysiologies [39]. The majority of the overweight and obese participants in the current study exhibited stage 2 periodontitis based on their periodontal health. While Gorman., *et al*. [40] found a correlation between periodontal disease and obesity but not overweight, some studies [41,42] found a direct link between periodontitis and overweight. Whereas Ekuni., *et al*. [43] found a direct link between weight gain and the onset of periodontitis.

In this investigation, the Waist Circumference (WC), a measure of body fat distribution, also revealed a substantial direct link with periodontitis, which was consistent with the findings of earlier literature [44-46], with periodontitis being more common in people with large waist circumferences. Also, a substantial correlation between WC and the prevalence of periodontal disease in the younger age group (18 - 34 years) was demonstrated by Al-Zahrani., *et al* [47]. Corresponding to this, Rees., *et al*. [48] reported that adolescents between the ages of 17 and 21 had a higher chance of developing the periodontal disease for every 1 cm increase in WC.

Also, the majority of obese older and female people had stage 2 periodontitis as determined by BMI and WC. This finding is similar to Kolte., *et al*. [49] where they found a significant increase in PPD and CAL among obese patients rather than non-obese. Nonetheless, young, obese, or overweight females had a higher chance of developing periodontitis than people with a normal BMI, according to Haffajee and Socransky [50]. On the other hand, Han., *et al*. [51] found that men had a larger connection between obesity and periodontitis than women. Furthermore, Amin., *et al*. [52] noted that men with larger waist circumferences were more likely to develop periodontitis. The variations in the results could be attributed to variations in oral hygiene practices, lifestyle factors, cultural norms, and sample characteristics. According to Palle., *et al*. [53] obesity has been linked to several diseases such as cardiovascular disease, diabetes, etc. According to Jagannathachary., *et al*. [54] periodontists should provide counseling to obese individuals regarding potential oral complications

associated with obesity, aiming to reduce morbidity. The current study acknowledges some limitations, the first of which is that the cross-sectional design of the study restricts the casual association between obesity and periodontal health. Secondly, other factors like oral hygiene behaviors and lifestyle factors which greatly influence obesity and periodontal status were not considered due to logical reasons.

Conclusion

In conclusion, our study highlights the significant association between obesity, as measured by both BMI and WC, and periodontal health among undergraduate students in Hyderabad. We observed a higher prevalence of gingivitis and stage 2 periodontitis among overweight and obese individuals, particularly in older age groups and males. The correlation between obesity indicators and periodontal disease underscores the importance of addressing obesity as a potential risk factor for periodontitis. These findings emphasize the need for comprehensive oral health interventions targeting obesity-related factors to mitigate the burden of periodontal disease in young adults.

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