ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 14, Issue 1, 2021

Online - 2455-3891
Print - 0974-2441

Research Article

FACTORS ASSOCIATED WITH BODY MASS INDEX IN CHILDREN – A COMMUNITY-BASED STUDY

NIKHILA PALADUGU[1], RAMAKRISHNA RAYITI[1], SIDDHARTHA NUTAKKI[1], RAJASREE GADDE[1], SAILAJA K[2], VIJAYA KUMAR GHANTA[1], VISWA SRUJANI KANAGALA[1]*

[1]Department of Pharmacy Practice, KVSR Siddhartha College of Pharmaceutical Sciences, Vijayawada, Andhra Pradesh, India. [2]Department of Pediatrics, Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, Krishna, Andhra Pradesh, India. Email: kvsrujani@gmail.com

Received: 23 November 2020, Revised and Accepted: 25 December 2020

ABSTRACT

Objectives: The increasing prevalence of overweight, obesity, and underweight in children has implications for their future health and it is vital to understand the modifiable factors that contribute to it. The study's main objective is to determine the factors associated with the body mass index in children.

Methods: A cross-sectional study was conducted among 346 school children over a period of 6 months. Data were collected using self-administered questionnaire. Physical measurements such as height and weight were obtained from parents. BMI (Body Mass Index) was calculated using kg/m^2. Children were categorized as overweight, obese, normal, and underweight using their body mass index scores and the factors associated with BMI in children were estimated.

Results: The prevalence of overweight, obesity, normal, and underweight among children was 10.40%, 17.92%, 24.28%, and 41.67%, respectively. Intake of fast food, sweetened beverages, junk food, and consumption of food while watching television, media time indicated a significant relationship with body mass index.

Conclusion: Health care professionals should educate parents and children regarding healthy nutrition and regular physical activity. The implications of obesity, overweight, and underweight should be well explained to make desirable lifestyle modifications for a better future.

Keywords: Body mass index, Obesity, Overweight, Underweight, Children, Factors.

 DOI: http://dx.doi.org/10.22159/ajpcr.2021v14i1.40318. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

The rising preponderance of overweight and obesity in childhood has leading inferences for their present and future health. An energy imbalance between calories consumed and calories expended is the well-known cause of overweight and obesity in children [1]. However, increasing evidence indicates that the notion of calorie imbalance may not be enough to handle and reverse the epidemic of obesity [2]. Complications of underweight and overweight can influence the physical growth and psychological development of children. Similarly, those children have high risks of hypertension, type-2 diabetes mellitus, metabolic, and mental disorders [3]. Consumption of high-fat foods is not only a reason for increased BMI, but lack of physical activity will also play a key role in the energy balance equation. Nowadays, children have more addictions to television, video games, and social websites than to exercise or play outdoors at their leisure [4]. Childhood obesity can be tackled through education, prevention, and viable interventions related to healthy dietary practices and promotion of physical activity at a population level.

To be reliable, these preventive tactics require effective tools to determine parameters such as the cutoff value or weight category to be considered for early diagnosis [5]. BMI is a simple and extensively used screening tool for child and adult obesity [6]. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2) [7]. BMI is not only used as an outcome measure for determining obesity but also as a useful anthropometric index for cardiovascular risk [5]. Exercise regimens alone will not work without food modification, as higher energy expenditure is likely to match higher energy intakes [8].

Poor nutritional choices, which include high soft drinks, sweets, snacks, takeaway foods, and large portions of food, were associated with increased BMI in adults, children, and adolescents [9]. The range of factors involved in the body mass index should be fully characterized and investigated to address this global problem [10].

Increasing fast food prices and decreasing healthy food prices can encourage healthy food consumption [11]. Sweetened beverages add calories and sugar but no nutritional value. Increased calorie intake is a major contributor to the recent increase in obesity [12]. Some studies suggest that the recommendation for consumption of fruit and vegetables can be justified but should not be based on a desirable weight regulation effect [13].

If society focuses on the causes, the rising problem of childhood obesity can be slowed down. Many variables play into obesity in the adolescence, some of which are more crucial than others. Focusing on these causes can alleviate childhood obesity over time and yield to a healthier society as a whole [14].

This study aimed to determine the association of some well-known factors such as fast food, sweetened beverages, television viewing, media time, physical activity, and sleep with body mass index in children.

METHODS

This is a cross-sectional study investigating the prevalence and the factors associated with the body mass index in children. Data were collected through the self-administered questionnaire with in the

period of 6 months in children from the age group of 6–12 years. The questionnaire contains the information about child's demographics, food habits, physical activity status, and health and lifestyle information. The children's questionnaires were completed by their parents after obtaining the consent.

To calculate the BMI, parents were asked to report the height and weight of their children. For some children height and weight were measured objectively, although there were no standardized instructions for this. BMI was calculated (weight [kg]/height [m]^2). According to the WHO, normal BMI was 18.5–24.9 kg/m^2 and less than 18.5 kg/m^2 are said to be underweight, within the range of 25–30 kg/m^2 are said to be overweight, greater than 30 kg/m^2 are said to be obese [7]. After refining the collected data, 346 children were included in the study and 54 were excluded from the study due to insufficient information provided and also ambiguous answers for some questions.

Statistical analysis

In the descriptive statistical analysis, the categorical variables were expressed by percentages. The univariate analysis was done using Chi-square test to determine the strength of association between factors and BMI, and the odds ratio was calculated and presented. For all analyses, $p<0.05$ was regarded as statistically significant. Data were analyzed using statistical tools like Epi-info 7.0 and GraphPad prism version 5.0.

Ethical consideration

The study protocol has been approved by Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation's Institutional Ethics Committee. Before initiating the study, all participants were informed and consent was obtained.

RESULTS

Characteristics of study participants

Table 1 shows the characteristics of children who participated in the study. A total of 346 children were included and in that 17.9% were found to be obese, 10.4% were overweight, 47.4% were underweight, and the remaining had normal BMI (24.2%).

When compared to boys the percentage of girls who were overweight and obese (58.3% vs. 41.6% and 67.7% vs. 32.2%) was greater. Whereas in the case of children who were underweight or had normal BMI 50% were boys and 50% were girls. About 32% of the children who participated in the study were 6–7 years old, 34.6% were from the age group 8–9 years, 28.6% were from 10 to 11 years age group, and 4.6% were 12 years old.

The BMI values of the children who participated in the study, classified in accordance with age, are given in Table 1; here, it can be observed that majority of the children from 6–7, 8–9, and 10–11 age groups were underweight (n=54, 51, 54) when compared to other categories, that is, overweight (n=8, 13, 12), obese (n=26, 28, 8), and normal (n=22, 28, 26), respectively. On the other hand, normal BMI (n=8) was found to be greater among 12-year-old children when compared to underweight (n=5) and overweight (n=3).

Factors associated with obesity, overweight, and underweight in children aged 6–12 years

Fast (processed) food

From Table 2, consumption of fast food is highly significant (with increasing servings/week) among obese children {more than 3 times/week ([p<0.0001], OR 133, 95% CI=12.7–1391); 1–2 times/week ([p=0.0002], OR 31.6, 95% CI=3.3–301); and occasional ([p=0.0081], OR 10.1, 95% CI=1.29–71.8)}. In children, classified as overweight according to their BMI, fast food consumption is found to be significant {more than 3 times/week ([p=0.01], OR 7.91, 95% CI=1.3–47.5); 1–2 times/week ([p=0.0003], OR 11.8, 95% CI=2.8–49.8)}. Occasional fast food consumption is found to have no significant association with overweight. Consumption of fast-food 1–2 times/week is highly significant among underweight children.

Sweetened beverages

From Table 2, consumption of sweetened beverages is highly significant among obese children{more than 3 times/week ([p<0.0001], OR 32.0, 95% CI=8.0–128); 1–2 times/week ([p<0.0001], OR 13.3, 95% CI=3.37–52.7); and occasional ([p<0.0001], OR 14.04, 95% CI=3.70–53.1)}. Drinking sweetened beverages occasionally (or) 1–2 times/week is found to be significant among the overweight {occasional ([p=0.0002], OR 7.57, 95% CI=2.4–23.5); 1–2 times/week ([p=0.0024], OR 5.86, 95% CI=1.7–19.7)}. Similar significant associations are observed among the children who belong to the underweight category {occasional ([p<0.0001], OR 7.48, 95% CI=3.74–14.9); 1–2 times/week ([p=0.004], OR 3.06, 95% CI=1.39–6.7)}.

Junk (unhealthy) food

From Table 2, consumption of junk food is found to be highly significant among underweight children {occasional ([p<0.0001], OR 39.0, 95% CI=4.4–341.7); 1–2 times/week ([p<0.0001], OR 35.0, 95% CI=4.1–292.1); more than 3 times/week ([p=0.0024], OR 13.2, 95% CI=1.6–107.4)} Significant associations are observed between consumption of junk food and obesity {occasional ([p=0.01], OR 5.0, 95% CI=1.2–20); 1–2 times/week ([p=0.03], OR 3.88, 95% CI=1.05–14.3)} as well as overweight {occasional ([p=0.01], OR 18.7, 95% CI=1.0–345.3)}.

Vegetables

Consumption of vegetables more than 3 times/week reduces the risk of children becoming obese. {(p=0.004), OR 0.34, 95% CI=0.16–0.73}.

Fruits

Consumption of fruits more than 3 times/week reduces the risk of obesity in children {(p=0.0003), OR 0.28, 95% CI=0.14–0.57}.

Nuts and pulses

Consumption of nuts and pulses more than 3 times/week {(p=0.0028, OR 0.13, 95% CI=0.03–0.5} or at least 1–2 times/week {(p=0.0017, OR 0.12, 95% CI=0.03–0.5} reduces the risk of children becoming obese.

Table 1: Characteristics of children participated in study. Data were divided into four groups based on the BMI of children and their frequencies are calculated using Epi info software

Characteristics	n (%)	Normal – n (%)	Obese – n (%)	Over weight – n (%)	Under weight – n (%)
Age (years)					
6–7	111 (32)	22 (26.1)	26 (41.9)	8 (22.2)	54 (32.9)
8–9	120 (34.6)	28 (33.3)	28 (45.1)	13 (36.1)	51 (31.1)
10–11	99 (28.6)	26 (30.9)	8 (12.9)	12 (33.3)	54 (32.9)
12	16 (4.6)	8 (9.5)	0 (0)	3 (8.3)	5 (3.05)
Sex					
Boys	159 (45.9)	42 (50)	20 (32.2)	15 (41.6)	82 (50)
Girls	187 (54)	42 (50)	42 (67.7)	21 (58.3)	82 (50)
BMI					
Frequency		84 (24.2)	62 (17.9)	36 (10.4)	164 (47.4)
Total (346)		84	62	36	164

Table 2: Factors associated with obesity, overweight, and underweight in children aged 6–12 years

Factors	Normal	Obese				Overweight				Underweight			
	n (%)	n (%)	OR	95% CI	p	n (%)	OR	95% CI	p	n (%)	OR	95% CI	p
Fast (processed) food/week													
More than 3 times	3 (3.57)	21 (33.8)	133	(12.7–1391)	<0.0001	5 (13.8)	7.91	(1.3–47.5)	0.01	11 (6.7)	3.16	(0.76–13)	0.1004
1–2 times	6 (7.14)	10 (16.1)	31.6	(3.3–301)	0.0002	15 (41.6)	11.8	(2.8–49.8)	0.0003	50 (30.4)	7.19	(2.52–20.4)	<0.0001
Occasional	56 (66.6)	30 (48.3)	10.1	(1.29–79.8)	0.0081	12 (33.3)	1.0	(0.2–3.5)	0.9778	81 (49.3)	1.24	(0.61–2.5)	0.53
Never	19 (22.6)	1 (1.61)			Ref	4 (11.11)			Ref	22 (13.41)			Ref
Sweetened beverages/week													
More than 3 times	10 (11.9)	24 (38.7)	32.0	(8.0–128)	<0.0001	2 (5.56)	1.60	(0.2 – 9.4)	0.6024	10 (6.1)	1.48	(0.54–4.0)	0.44
1–2 times	15 (17.8)	15 (24.1)	13.3	(3.37–52.7)	<0.0001	11 (30.5)	5.86	(1.7–19.7)	0.0024	31 (18.9)	3.06	(1.39–6.7)	0.004
Occasional	19 (22.6)	20 (32.2)	14.04	(3.70–53.1)	<0.0001	18 (50)	7.57	(2.4-23.5)	0.0002	96 (58.5)	7.48	(3.74–14.9)	<0.0001
Never	40 (47.6)	3 (4.84)			Ref	5 (13.8)			Ref	27 (16.4)			Ref
Junk food/week													
More than 3 times	46 (54.7)	10 (16.1)	0.54	(0.14–2.0)	0.37	13 (36.1)	6.09	(0.3–111)	0.09	61 (37.2)	13.2	(1.6–107.4)	0.0024
1–2 times	18 (21.4)	28 (45.1)	3.88	(1.05–14.3)	0.03	16 (44.4)	18.7	(1.0–345.3)	0.006	63 (38.4)	35.0	(4.1–292.1)	<0.0001
Occasional	10 (11.9)	20 (32.2)	5.0	(1.2–20)	0.01	7 (19.4)	15.0	(0.7–297.8)	0.01	39 (23.7)	39.0	(4.4–341.7)	<0.0001
Never	10 (11.9)	4 (6.45)			Ref	0 (0)			Ref	1 (0.6)			Ref
Vegetables/week													
More than 3 times	68 (80.9)	37 (59.6)	0.34	(0.16–0.73)	0.004	28 (77.7)	0.82	(0.3–2.1)	0.69	140 (85.3)	1.37	(0.6–2.7)	0.371
1–2 times	16 (19.5)	25(40.3)			Ref	8 (22.2)			Ref	24 (14.6)			Ref
Fruits/week													
More than 3 times	60 (71.4)	26 (41.9)	0.28	(0.14–0.57)	0.0003	19 (52.7)	0.447	(0.193- 1.0)	0.0484	100 (60.9)	0.62	(0.35-1.1)	0.1035
1–2 times	24 (28.5)	36 (58.0)			Ref	17 (47.2)			Ref	64 (39.03)			Ref
Nuts and pulses													
More than 3 times	35 (41.6)	16 (25.8)	0.13	(0.03–0.5)	0.0028	14 (38.8)	0.3	(0.05–1.5)	0.130	82 (50)	0.70	(0.1–2.7)	0.60
1–2 times	36 (42.8)	15 (24.1)	0.12	(0.03–0.5)	0.0017	15 (41.6)	0.31	(0.06–1.5)	0.142	51 (31.1)	0.42	(0.1–1.6)	0.20
Occasional	10 (11.9)	21 (33.8)	0.63	(0.1–2.8)	0.54	3 (8.3)	0.22	(0.03–1.6)	0.127	21 (12.8)	0.63	(0.1–2.8)	0.54
Never	3 (3.5)	10 (16.1)			Ref	4 (11.1)			Ref	10 (6.1)			Ref
Exercise and games													
More than 3 h/day	53 (63.1)	5 (8.6)	0.009	(0.00099–0.08)	<0.0001	0 (0)	0.009	(0.0002–0.3)	<0.0001	17 (10.3)	0.02	(0.003–0.20)	<0.0001
1–2 h/day	24 (28.5)	15 (24.1)	0.06	(0.007–0.5)	0.0021	30 (83.3)	1.25	(0.07–21.0)	0.87	114 (69.5)	0.36	(0.04–2.9)	0.324
Occasional	6 (7.1)	32 (51.6)	0.5	(0.05–4.9)	0.5761	5 (13.8)	0.83	(0.04–17)	0.90	20 (12.2)	0.25	(0.02–2.3)	0.205
Never	1 (1.1)	10 (16.1)			Ref	1 (2.7)			Ref	13 (7.93)			Ref

Bold numbers refer to p<0.05, Normal values are compared with other groups to calculate the p-value, odd's ratio, 95% confidence interval. These values are calculated using GraphPad prism

Table 3: Factors associated with obesity, overweight, and underweight in children aged 6–12 years (continued)

Factors	Normal	Obese				Overweight				Underweight (continued)			
	n (%)	n (%)	OR	95% CI	p	n (%)	OR	95% CI	p	n (%)	OR	95% CI	p
Watching TV													
More than 3 h/day	12 (14.2)	28 (45.1)	3.50	(0.51–23.7)	0.179	5 (13.8)	0.62	(0.07–4.9)	0.65	22 (13.4)	1.37	(0.26–7.19)	0.70
1–2 h/day	63 (75)	30 (48.3)	0.71	(0.11–4.5)	0.719	25 (69.4)	0.59	(0.09–3.7)	0.57	121 (73.7)	1.44	(0.31–6.63)	0.63
Occasional	6 (7.1)	2 (3.2)	0.50	(0.04–5.1)	0.568	4 (11.1)	1.0	(0.11–8.9)	1.0	17 (10.3)	2.12	(0.36–12.)	0.39
Never	3 (3.5)	2 (3.2)			Ref	2 (5.5)			Ref	4 (2.44)			Ref
Media time													
More than 3 h/day	8 (9.2)	10 (16.1)	4.37	(1.02–18.6)	0.04	0 (0)	0.13	(0.006 – 2.6)	0.08	11 (6.7)	0.96	(0.30–3.0)	0.94
1–2 h/day	18 (21.4)	22 (35.4)	4.27	(1.19–15.3)	0.02	13 (36.1)	1.68	(0.26–3.4)	0.38	20 (12.2)	2.83	(1.2–6.6)	0.014
Occasional	44 (52.3)	26 (41.9)	2.06	(0.61–6.9)	0.23	17 (47.2)	0.9	(0.29–2.73)	0.85	60 (36.9)	0.95	(0.43–2.0)	0.907
Never	14 (16.6)	4 (6.4)			Ref	6 (16.6)			Ref	73 (44.5)			Ref
Food during watching TV													
Yes	59 (70.2)	58 (93.5)	6.14	(2.0–18.7)	0.0005	26 (72.2)	1.10	(0.46–2.6)	0.826	124 (75.6)	1.31	(0.72–2.3)	0.362
No	25 (29.7)	4 (6.45)			Ref	10 (27.7)			Ref	40 (24.3)			Ref
Sleeping hours													
8–10 h/day	37 (44.0)	30 (48.3)	5.69	(0.28–114)	0.125	20 (55.5)	0.81	(0.12–5.2)	0.82	74 (45.1)	1.00	(0.23–4.2)	1.0
6–8 h/day	44 (52.3)	32 (51.6)	5.11	(0.25–102)	0.145	14 (38.8)	0.47	(0.07–3.1)	0.43	84 (51.2)	0.95	(0.22–4.0)	0.94
Less than 6 h/day	3 (3.5)	0 (0)			Ref	2 (5.56)			Ref	6 (3.66)			Ref
Birth weight													
Between 2–3 kg	36 (42.8)	20 (32.2)	1.66	(0.30–9.04)	0.55	13 (36.11)	2.16	(0.23–19.7)	0.48	77 (46.9)	1.28	(0.43–3.8)	0.65
Between 3–4 kg	42 (50.)	38 (61.2)	2.71	(0.51–14.2)	0.22	22 (61.11)	3.14	(0.35–27.7)	0.28	74 (45.1)	1.05	(0.35–3.1)	0.91
More than 4 kg	0 (0)	2 (3.2)	13.00	(0.44–377.8)	0.05	0 (0)	0.0	(0)	0	3 (1.83)	4.33	(0.19–98.2)	0.19
Less than 2 kg	6 (7.1)	2 (3.2)			Ref	1 (2.78)			Ref	10 (6.1)			Ref
Father education													
Educated	68 (80.9)	54 (87.1)	1.58	(0.63–3.9)	0.32	33 (91.6)	2.58	(0.7–9.5)	0.14	144 (87.8)	1.69	(0.82–3.4)	0.14
Uneducated	16 (19.05)	8 (12.9)			Ref	3 (8.33)			Ref	20 (12.20)			Ref
Father health conditions													
Disease	17 (20.2)	10 (16.1)	0.75	(0.32–1.79)	0.5273	9 (25.00)	1.31	(0.52–3.30)	0.56	20 (12.2)	0.54	(0.26–1.1)	0.09
Normal	67 (79.7)	52 (83.8)			Ref	27 (75.00)			Ref	144 (87.8)			Ref
Mother health (in period of pregnancy)													
Disease	6 (7.1)	4 (6.4)	0.89	(0.24–3.3)	0.87	3 (8.33)	1.18	(0.27–5.0)	0.82	24 (14.6)	2.2	(0.87–5.68)	0.08
Normal	78 (92.8)	58 (93.5)			Ref	33 (91.6)			Ref	140 (85.3)			Ref

Bold numbers refer to p<0.05, Normal values are compared with other groups to calculate the p-value, odd's ratio, 95% confidence interval. These values are calculated using GraphPad prism

Exercise and games

Exercising and playing games more than 3 h/day {(p<0.0001), OR 0.009, 95% CI=0.00099–0.08} or at least 1–2 h/day {(p=0.0021), OR 0.06, 95% CI=0.007–0.5} reduces the risk of obesity in children.

Similarly, daily exercise and games for more than 3 h are found to reduce the risk of children becoming overweight {(p<0.0001), OR 0.009, 95% CI=0.0002–0.3} and underweight {(p<0.0001, OR 0.02, 95% CI=0.003–0.20}.

Media time

From Table 3, time spent on digital or social media for more than 3 h/day {(p=0.04, OR 4.37, 95% CI=1.02–18.6} or even 1–2 h/day {(p=0.02), OR 4.27, 95% CI=1.19–15.3} is found to be significantly associated with obesity in children. Furthermore, media time of 1–2 h/day was found to be significantly associated with underweight in children {(p=0.014, OR 2.83, 95% CI=1.2–6.6}. Interestingly, no association was found between watching TV and obesity, overweight or underweight in children.

Food during watching television

Although watching television alone has not produced any significant associations, taking food while watching television is found to be a significant risk factor associated with obesity among children. {(p=0.0005, OR 6.14, 95% CI=2.0–18.7}.

Factors such as sleeping hours, birth weight, father's education, father's health, and mother's health during pregnancy were not associated with either of obesity, overweight, and underweight in this study.

DISCUSSION

Our findings from this research are used to determine the effect of factors on the occurrence of obesity, overweight, and underweight in children.

In this study, the overall prevalence of obesity, overweight, and underweight was 17.92%, 10.40%, and 47.40%, respectively. The incidence of underweight children is highest in India in a study that estimated worldwide trends in mean body mass index [15].

Fast foods or processed foods typically contain high amounts of calories and fat and this contributes to the incidence of obesity and overweight. The present study confirms that consumption of fast food can influence the BMI in children. Similarly, an international study conducted by Braithwaite *et al.* reported that frequent and very frequent fast-food consumption is associated with a higher BMI in children [16]. An association between fast food consumption and underweight is observed in this study. Fast foods may also suppress the appetite for a balanced diet including vegetables and fruits. This can be the possible explanation for the above-mentioned finding. The availability of a wide variety of fruits and vegetables and/or fussy eating behavior of children needs to be studied further.

The present study confirms that taking sweetened beverages frequently have a high significant association with obesity in children. Sweetened beverages are found to increase the risk of overweight as well in children even when consumed occasionally. In a systematic-review undertaken by Malik *et al*., a positive association was observed between greater consumption of sugar sweetened beverages and weight gain and obesity in both children and adults. These findings were derived from large cross-sectional studies and prospective cohort studies with long periods of follow-up [17]. Interestingly, our study shows association between sweetened beverages and underweight in children. Another possible explanation is that sugary drinks make one feel full, thereby reducing the amount of food intake. Hence, disturbances in the regular diet and a decrease in the amount of nutrition are observed.

Junk food consumption is significantly associated with malnutrition or low BMI among adolescents [18]. This result is consistent with the findings of the present study, in which children who ate junk food are at increased risk of having low BMI. Nowadays, low cost and ease of availability make junk food a leading risk factor associated with BMI in children.

In a study conducted by Wall *et al*., an inverse association was observed between BMI and consumption of vegetables, fruits, nuts, and pulses [19]. In the present study, we can see that vegetables, fruits, pulses, and nuts consumption reduce the risk of obesity in children. Taking fruits more than thrice/week also reduce the risk of overweight significantly.

In a study conducted by Klein-Platat *et al*., inverse association between structured physical activity and BMI was observed but significantly only for girls (p<0.01) in 12-year-old French adolescents [20]. The present study confirms that children who are involved in exercise and games daily have a reduced risk of obesity and overweight dues to the inverse association as is clearly shown. Furthermore, in our study exercise and games are found to be inversely related to underweight in children. By contrast, underweight in children was significantly related to their physical activity (p=0.006), such as playing outdoors in a study conducted by Syahrul *et al*. [3].

The findings of this study did not show any significant association between watching television and BMI in children but time spent on media (digital or social media) has significant impact in the case of obesity in children. Some studies reported significance w.r.t screen time and electronic media [21,22].

In our study, consumption of food while watching television was associated with BMI in obese children. Similarly, a study conducted by Matheson *et al*., supports our findings. Avoiding television viewing while eating meals was associated with lower odds of obesity and overweight [23]. Besides, a few other studies also concluded that the children watching television while eating were prone to obesity/overweight [24,25]. Measures should be taken to reduce the food consumption during TV viewing as it may lead to unconsciousness intake of more calories and high-fat food.

Mother's education does not reflect any association with BMI in children in this study. Whereas, Syahrul *et al*. observed overweight to be prevalent among children whose mothers were highly educated in their study findings [3]. The present study has no association between sleeping hours of children and their BMI. A study conducted by Wang *et al*. reports sleep duration and later bed time as risk factors for obesity in childhood independently [26].

Weight at the time of birth is not associated with BMI in our study. However, a study undertaken in Istanbul, Turkey, by Vehapoglu *et al*. found that increased birth weight and maternal BMI as significant risk factors for obesity in children [27]. Factors such as father's education, father's health conditions, and mother's health conditions do not show any significant relation with BMI in children and further research is needed to support major public interventions.

CONCLUSION

The epidemic of obesity, overweight, and underweight is a serious public health issue in urban areas and rural areas. To prevent overweight and obesity, a population level approach should be adopted. From the factors, we opted to explore in this study; fast food, sweetened beverages, junk food, and consumption of food while watching television, media time indicated a significant relationship with body mass index. Vegetables, fruits, nuts, and pulses, exercise, and games showed inverse associations with obesity and underweight in children. Health care professionals should educate parents and children regarding healthy nutrition and regular physical activity. The implications of obesity, overweight, and underweight should be well explained to make desirable lifestyle modifications for a better future.

ACKNOWLEDGMENT

We thank the Head of the Department and Department of Pharmacy Practice staff for the suggestions and we would like to express our sincere

gratitude to the principal of KVSR Siddhartha College of Pharmaceutical Sciences, Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation's Institutional Ethics Committee for suggestions and support for completion of this work.

AUTHORS' CONTRIBUTIONS

All the authors contributed equally.

CONFLICTS OF INTEREST

None.

FUNDING

Nil.

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