

Article

Prevalence and Determinants of Excessive Screen Viewing Time in Children and its Effects on Physical Activity, Sleep, Eye Symptoms and Headache

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Abstract: Screen viewing time is the total time spent by a child on any digital/electronic device. The objective of the present study was to determine the incidence and predictors of excessive screen viewing time in children in Ujjain, India. This cross-sectional, community-based study was conducted through house-to-house survey by using the three-stage cluster sampling method in 36 urban wards and 36 villages of Ujjain district, India. Excessive screen viewing time was defined as screen viewing for > 2 h/day. The prevalence of excessive screen viewing time was 17.83%. Risk factors identified using the multivariate logistic regression model were: age (OR: 1.5, $P < 0.001$); mobile phone use before bedtime (OR: 3.17, $P = 0.008$); parents' perception about the child habituated to screen (OR: 14.03, $P < 0.001$); television in bedroom (OR: 48.69, $P < 0.001$); morning mobile screen viewing time (OR: 9.27, $P < 0.001$); not reading books other than textbooks (OR: 9.71, $P < 0.001$); and lack of outdoor play for >2 h (OR: 4.20, $P < 0.001$). Presence of eye pain was a protective factor for excessive screen viewing time (OR: 0.12, $P = 0.011$). The study identified multiple modifiable risk factors for excessive screen viewing time.

Keywords: screen view time, children, risk factors, India

1. Introduction

Screen viewing time (SVT) or digital/screen exposure is the total time spent by an individual in viewing or using any digital or electronic device such as television (TV), smart phones, tablets, or computers [1]. According to the American Academy of Pediatrics (AAP) guidelines, children aged less than 2 years should not have any SVT, and SVT of ≥ 1 h/day is considered excessive among children aged 2–5 years [2]. Recent data suggests that children begin using online platforms at an early age in high-income settings [1, 2]. The effects of prolonged SVT and its physical, psychosocial, behavioral, and long-term outcomes are gradually becoming apparent [3–6]. The most studied effect of prolonged SVT is the reduced physical activity (PA) (lower than the recommended limit) of children and adolescents. The World Health Organization (WHO) has recommended at least 2 h of PA per day for children and adolescents [7]. In many high-income countries such as the United States of America (USA) and Japan, the recommended limit set by the WHO on PA per day has not been achieved. Long SVT is associated with low PA and long sedentary periods [4], all of which are associated with obesity [4]. In USA, most preschool children spend at least 4 h in screen viewing daily. Almost all school-going children watch TV, and one thirds of young children play games

on computers or electronic devices. Increased SVT is associated with adult-onset diseases associated with sedentary lifestyle in high-income countries [8-10]. TV watching and use of smart phones and tablets have been shown to significantly reduce PA, cause dry eyes, and reduce school performance [11, 12]. A systematic review of screen time and sleep among school-age children and adolescents in 90% of published studies indicated that increased SVT is associated with adverse sleep outcomes [13]. Sitting for lengthy time periods in a fixed posture in front of any electronic device such as computer terminals may result in neck pain and headache [14].

India is the largest and fastest growing market for digital consumers, with 560 million internet subscribers and 1.2 billion mobile phone subscriptions in 2018 [15]. Despite an increase in exposure to digital screens in India, no recommendations are currently available on screen viewing and its effects. Moreover, none of the studies have comprehensively evaluated the known risk factors for excessive SVT. Therefore, the objective of the present study was to determine the incidence and predictors of excessive SVT in children and its effect on physical/outdoor activity, sleep, and prevalence of eye symptoms and headache in children in Ujjain district, Madhya Pradesh, India.

2. Materials and Methods

This cross-sectional study using house-to-house survey was conducted from May to August 2021 in 36 urban wards and 36 villages of Ujjain district. Ethical approval of the study was obtained from the Institutional Ethics Committee of RD Gardi Medical College, Ujjain (Approval Number-95/2019). Children aged 3–15 years were identified during house-to-house visits. Excessive SVT was defined as the screen activity of >2 h/day on any device, including TV screen, computers (desktop computer and laptops), tablets like iPads or Samsung Galaxy tabs, and mobile phones.

2.1 Sample size calculation

The modified WHO cluster sampling method was used for sample size calculation [16]. Prior to sampling, children were stratified according to age into three groups, namely 3–6 years, >6–10 years, and >10–15 years. In a study in Karamsad, Gujrat, India, 17% children had SVT [17]. According to the 2014 National Family Health Survey data for Ujjain district [18], the prevalence of appropriate duration of screen time is 17%, the conservative design effect is 2, the nonresponse rate is 10%, the estimated number of households needed to find eligible children is 0.59, the number of children per cluster is 7, and the minimum estimated sample size is 550. The estimated minimum number of households needed to visit per age stratum was 110, with 24 clusters per stratum and 5 households per cluster. Thus, the survey comprised 72 clusters (36 urban and 36 rural).

2.2 Sampling procedure

To select the clusters, Ujjain tehsil of Ujjain district, Madhya Pradesh, India, was considered the sampling frame. The clusters were defined in urban area (Ujjain city) at the ward and village levels in rural areas. In total, Ujjain city has 54 wards, and Ujjain tehsil has 132 villages. A total of 36 urban wards and 36 villages were randomly selected from the list of wards and villages.

We conducted a cross-sectional, community-based survey and selected participants at the household level by using the three-stage cluster sampling method. First, all residential clusters within a radius of 0.5 km from the selected clusters were identified and numbered sequentially. Then, a census of households was conducted to identify households with children aged 3–15 years. In the second stage, 5 eligible households were

randomly selected from each urban and rural cluster-urban wards and villages. As the number of eligible households were already identified the interviewers received the tables that indicated the households to enroll. In the third stage, all eligible children of selected households were identified, and one of them was selected randomly. Additional inclusion criteria for both clusters were: (1) providing informed consent, (2) being a resident of the selected cluster for at least 6 months, and (3) being mentally capable of responding to the questionnaire. The sampling procedure is shown in **Figure 1**.

A questionnaire was developed through a review of literature and by two subject experts. The questionnaire was designed in both English and Hindi languages. The parent/child was free to choose the language of the questionnaire. The questionnaire comprised questions on socio-demographic features of parents. The questions about screen timing and related physical, social, emotional and behavioral domains were also included. Parents were asked to self-report the average time their child spent watching TV, playing on smartphone or tablet, using computers, playing videogames, playing outdoors, and reading on a typical weekday (Monday–Friday) and a typical weekend (Saturday and Sunday), separately. Parents were handed over the questionnaire during the first household visit. Informed consent was obtained from one of the parents, and assent to participate was obtained from children aged >7 years. In case the parents were not sure of their child's screen time, they were provided additional time to observe the screen time for one week before self-filling the questionnaire. In the subsequent household visit, the filled-in questionnaires were collected by research assistants of nonmedical background having 10 years of research experience (**Supplementary Materials Table 1- Questionnaire in English**). Research assistants interviewed the parent and/or the child to fill-in incomplete questionnaires.

2.3 Statistical method

Descriptive statistics was used to calculate the incidence of screen time for TV, smart devices, and computers. Differences in the screen time exposure between weekdays and weekends were assessed using paired two-tailed t tests. The outcome variable was SVT greater than 2 hour per day. The bivariate logistic regression analysis was used to assess the association of risk factors with the outcome variable. Multivariate logistic regression was used to examine the association of covariates with screen time after adjusting for other covariates such as age and sex. The effect of SVT on sleep, eating habits, and outdoor play was determined using bivariate logistic regression analysis.

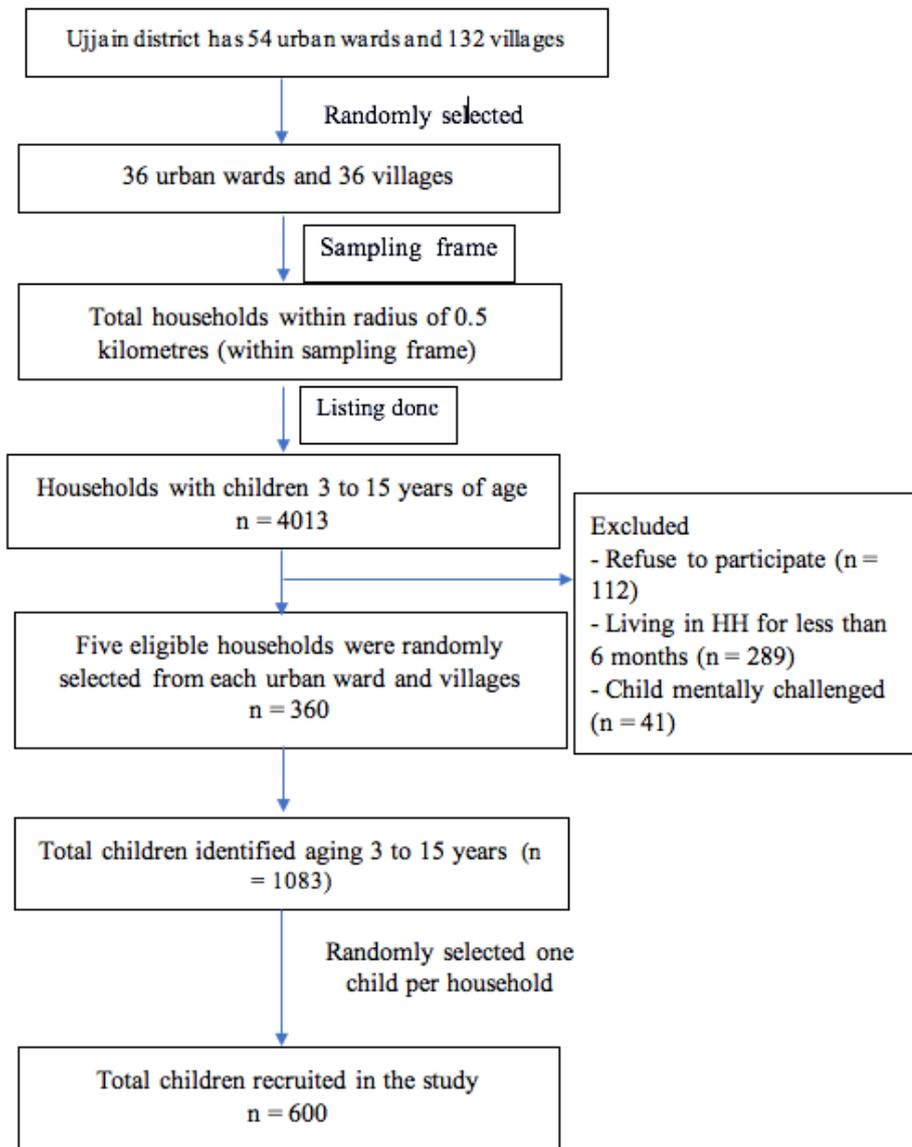


Figure 1 Sampling procedure followed in the study.

Fig-

3. Results

A total of 600 children including 314 (52%) girls and 286 (48%) boys were included, with the age range of 3–15 years. An equal number of urban and rural children was included. The prevalence of excessive SVT (>2 hours) was 17.83% (95% CI: 17.79%–18.52%). Socio-demographic risk factors for excessive SVT are presented in **Table 1**.

Table 1 Bivariate analysis of socio-demographic factors associated with excess screen viewing time (>2 hour/ day) in 600 children included in the study

Variable	Total n = 600	Screen viewing time (<2 hours/day)		OR	95% CI	P value
		Yes (n = 108)	No (n = 492)			
Gender						
Girls	314	68 (22)	246 (78)	R	R	-
Boys	286	40 (14)	246 (86)	1.7	1.10 - 2.60	0.015
Place of residence						
Urban	307	59 (19)	248 (81)	R	R	-
Rural	293	49 (17)	244 (83)	1.18	0.77 - 1.79	0.427
Age in years						
3 – 6	171	79 (46)	92 (54)	R	R	-
> 6 – 10	260	24 (9)	236 (91)	8.44	5.03 - 14.15	<0.001
> 10 – 15	169	5 (3)	164 (97)	28.16	11.01 - 72.04	<0.001
Type of family						
Joint	196	28 (14)	168 (86)	Ref	Ref	-
Nuclear	404	80 (20)	324 (80)	0.67	0.42 – 1.07	0.1
Number of family members						
3 – 5	452	85 (19)	367 (81)	Ref	Ref	-
> 5 – 9	116	19 (16)	97 (84)	1.18	0.68 - 2.03	0.547
> 10	32	4 (13)	28 (87)	1.62	0.55 - 4.74	0.378
Overcrowding						
Yes	226	31 (14)	195 (86)	Ref	Ref	-
No	374	77 (21)	297 (79)	0.61	0.38 – 0.96	0.035
Mother's education						
Uneducated / primary	251	53 (21)	198 (79)	Ref	Ref	-
Up to high school	141	21 (15)	120 (85)	1.52	0.87 - 2.66	0.133
Graduate / PG	208	34 (16)	174 (84)	1.36	0.85 - 2.20	0.193
Mother's occupation						
Unemployed	296	61 (21)	235 (79)	Ref	Ref	-
Labourer	169	21 (12)	148 (88)	1.80	1.06 - 3.12	0.027
Salaried job	135	26 (16)	109 (81)	1.08	0.65 - 1.81	0.746
Father's education						
Uneducated / primary	91	15 (16)	76 (84)	Ref	Ref	-
Up to high school	318	65 (20)	253 (80)	0.76	0.41 - 1.42	0.402
Graduate / PG	191	28 (15)	163 (85)	1.14	0.57 - 2.27	0.691
Father's occupation						
Unemployed	27	6 (22)	21 (78)	Ref	Ref	-
Self employed	196	36 (18)	160 (82)	1.21	0.47 - 3.37	0.48
Labourer	203	33 (16)	170 (84)	1.47	0.55 - 3.92	0.77
Salaried job	174	33 (19)	141 (81)	1.22	0.45 – 3.26	0.40

The bivariate analysis results for the association of excessive SVT with the type of screen, its duration, and child-related health factors are presented in **Table 2**.

Table 2 Bivariate analysis of association of type of screen time, its duration, child related health factors with excess screen view time (>2 hours/day) in the 600 children included in the study.

Variable	Total n = 600	Screen viewing time (<2 hours/day)		OR	95% CI	P value
		Yes (n = 108)	No (n = 492)			
Night-sleep time						
≥ 6 hours	537 (90)	101 (19)	436 (81)	R	R	-
< 6 hours	63 (10)	6 (10)	57 (90)	2.20	0.92 - 5.24	0.075
Mobile phone at bed time						
No	218 (36)	78 (36)	140 (64)	R	R	-
Yes	382 (64)	29 (8)	353 (92)	6.78	4.24 – 10.84	<0.001
TV in bed room						
No	187 (31)	97 (52)	90 (48)	R	R	-
Yes	413 (69)	10 (2)	403 (98)	43.43	21.78 – 86.58	<0.001
Morning mobile screen time						
No	203 (34)	74 (36)	129 (64)	R	R	-
Yes	397 (66)	33 (8)	364 (92)	6.32	4.00 – 9.99	<0.001
Child habituated to screen						
No	293 (49)	95 (32)	198 (68)	R	R	-
Yes	307 (51)	12 (4)	295 (96)	11.79	6.30 – 22.07	<0.001
Child reads books						
Yes	332 (55)	87 (26)	245 (74)	R	R	-
No	268 (45)	20 (7)	248 (93)	4.40	2.62 – 7.88	<0.001
Story telling by parents						
Yes	237 (40)	70 (30)	167 (70)	R	R	-
No	363 (60)	37 (10)	326 (90)	3.69	2.37 – 5.73	<0.001
Outdoor play						
Yes	430 (72)	88 (20)	342 (80)	R	R	-
No	170 (28)	19 (11)	151 (89)	2.04	1.20 – 3.47	<0.001
Outdoor play ≥ 2 hours						
Yes	244 (41)	72 (30)	172 (70)	R	R	-
No	356 (59)	35 (10)	321 (90)	3.83	2.40 – 5.98	<0.001
Headache						
No	483 (81)	99 (21)	384 (79)	R	R	-
Yes	117 (19)	8 (7)	109 (93)	3.51	1.65 – 7.44	<0.001
Eye pain						
No	478	96	382	R	R	-

Yes	122	11	111	2.53	1.31-4.90	0.006
Eye itching						
No	417 (70)	103 (25)	314 (75)	R	R	-
Yes	183 (30)	4 (2)	171(98)	14.67	5.31-40.52	<0.001

Table 3 shows the results of the multivariate logistic regression model.

Table 3 Multivariate analysis of factors associated with screen viewing time (>2 hours / day) in 600 children included in the study with adjusted odds ratios (a OR)

Variable	a OR	95% CI	P value
Girls vs boys	1.27	0.54 - 2.95	0.572
Age	1.57	1.34 - 1.84	<0.001
Mobile phone use at bedtime	3.17	1.35 - 7.45	0.008
Child habituated to screen according to parent's perception	14.03	4.14 - 47.49	<0.001
TV in bedroom	48.69	16.56 - 143.16	<0.001
Morning mobile screen time	9.27	3.76 - 22.83	<0.001
Child not reading books other than textbooks	9.71	3.34 - 28.18	<0.001
Lack of outdoor play for >2 hours	4.20	1.80 - 9.77	<0.001
Eye pain present	0.12	0.02 - 0.61	0.011

The factors identified to have a significant association with SVT by using the multivariate logistic regression model were: age (OR: 1.5, CI: 1.34–1.84; $P < 0.001$); mobile phone use at bedtime (OR: 3.17, CI: 1.35–7.45; $P = 0.008$); parent's perception about child habituated to screen viewing (OR: 14.03, $P < 0.001$); availability of TV in bedroom (OR: 48.69, CI: 16.56–143.16; $P < 0.001$); morning mobile screen viewing time (OR: 9.27, CI: 3.76–22.83; $P < 0.001$); child not reading books other than textbooks (OR: 9.71, CI: 3.34–28.18; $P < 0.001$); lack of outdoor play for more than 2 h (OR: 4.20, CI: 1.80–9.77; $P < 0.001$). Presence of eye pain was identified as a protective factor for excessive SVT (OR: 0.12, CI: 0.02–0.61; $P = 0.011$).

4. Discussion

In the present study, the bivariate analysis showed that boys had 1.7 times higher odds than girls for excessive SVT. However, the differences were not found to be statistically significant in the multivariate analysis. The results of the present study differ from those of a study conducted in New Delhi, India, which found that boys have longer SVT than girls, with boys having 1.36 times greater odds than girls [19]. According to a study from Democratic Republic of China, the prevalence of excessive SVT was 14.7% in boys and

8.9% in girls [20]. A Malaysian study reported the SVT for girls and boys to be 2.8 h/day and 3.3 h/day, respectively [21].

Age was found to be significantly correlated with excessive SVT (OR: 1.57, 95% CI: 1.34–1.84; $P < 0.001$) in the present study. The results are similar to those of a study conducted in rural western India, which showed that the odds of excessive SVT is 1.3 and 1.9 times greater in children aged 3–5 years and 5–6 years, respectively, than those in children aged 2–3 years [17]. A study in China also reported that the SVT among junior high school children was higher than that among elementary school children, and it decreased after 15 years of age (senior high school). The decreased SVT in Chinese senior high school children might be because of the pressure of studying and preparing for college entrance examinations, which may compel students to pay more attention and devote more time on study-related behavior, resulting in a “crowding-out effect” [20].

In a study in Turkey, 55% (183/333) of the children aged < 2 years were reported to watch TV for less than 2 h; whereas 59% (196/333) of these children were reported to use iPad/tablets for approximately 1 h [22]. In comparison, 46% children aged between 3 and 6 years in our study had SVT of more than 2 h. A study in United Kingdom also showed that the time spent on watching TV increased with age, and a period of accelerated increase was observed between 12 and 30 months, with an average estimated daily TV-time of 55 min at 6 months increasing to 124 min at 36 months [1]. In the present study, we could not document the increase in SVT over time because of observational design of the study, warranting further longitudinal studies.

In our study, excessive SVT in children was not found to have any statistically significant correlation with the type of family, overcrowding, and mother’s education and occupation (Table 1). A study used a social ecological model to explain the factors associated with digital media exposure among children [23]. Another study in Southern India reported that excessive SVT in children was not correlated with the socioeconomic status, place of residence, or mother’s education level [24]. However, a study conducted in Finland showed that the parents’ socioeconomic status is a risk factor for media screen exposure only among adolescent girls [25]. In another study in Canada, a linear regression analysis showed that parental education, parental income, and parental self-efficacy are the negative predictors of SVT [26].

In the present study, the use of mobile device before bedtime exhibited a statistically significant association with excessive SVT. A study in Tokyo, Japan, reported that the children not having screen time before bedtime were more likely to have normal body weight (OR: 0.73, 95% CI: 0.60–0.90), no dry eyes (OR: 1.31, 95% CI: 1.15–1.50), better understanding of the material presented in their classes, and better academic performance (1 h to < 3 h, OR: 1.67, 95% CI: 1.41–1.98; < 1 h, OR: 2.40, 95% CI: 1.95–2.96) than those who had screen time before bedtime [27].

A study from China indicated a J-shaped (positive nonlinear) association between TV viewing time and the risk of sleep disorder, with a threshold of 1 h/day. For each 1 h/day increment in TV viewing time over the threshold, the risk of sleep disorder increased by 12.35% (95% CI: 1.87–23.92%) [6]. The association between reduced night time sleep and excessive SVT may be partially explained through the displacement hypothesis [28]. Spending longer time in screen time behaviors reduces the time spent on other activities such as sleep. Furthermore, the use of screen-based devices (particularly at night) exposes children to blue light, which delays sleep onset and reduces sleep quality [28].

For children having TV sets in their bedroom, the odds of SVT of > 2 h was statistically significantly associated with excessive SVT. The American Academy of Sleep Medicine guidelines—endorsed by the AAP—recommends that children’s bedrooms should be free of any screen-based device and that children should not have access to any screen-

based device 30 min before bedtime [29]. Bedroom media also pose the risk of obesity and video game addiction [29]. Children with bedroom media are also likely to be exposed to media violence [30]. A study in Sweden reported that less sleep duration was associated with having a TV set in the bedroom, spending more than 2 h/day watching TV or using computer, being tired in school, and having difficulties both in waking up and in sleeping (OR: 1.25; P = 0.011) [31].

We believe that the children who read books other than textbooks have lesser SVT than those who do not read such books. Two studies in USA reported that long SVT distracts students from academic activities such as studying and doing homework, which can lead to learning and attention deficits and negative attitudes toward attending school [32-33]. Children who did not play outdoors for more than 2 hours per day exhibited excessive SVT in the present study. Children having long SVT spend less time in outdoor activities or playing and have sedentary lifestyle, which can lead to childhood obesity [34].

Headache is significantly associated with mobile phone usage. A study reported the associations between computer use and health problems in students and found that the prevalence of headache was 51% among girls and 24% among boys [35]. Children watching TV for more than 3 h reported having headache more frequently than those watching TV for less than 2 h [35]. Excessive use of mobile phones is considered a risk factor particularly for the development of migraine [36]. Another study reported an association of computer use with headache and neck pain among adolescent school students in a resource-poor country [37].

Digital device use has been associated with symptoms of dry eyes and tear film instability. The tear film instability increases with electronic device use during focused SVT, which leads to an increased interblink interval, leading to eye fatigue and tear film instability [4, 11, 14]. Blue light emitted from smart mobile device screens is also associated with eye fatigue and poor sleep quality [12]. Late-night screen viewing activity leads to increased sympathetic activity, which leads to decreased tear formation and secretion. [11, 12]. The increased sympathetic activity and decreased tear formation also affect sleep quality [11, 12]. We speculate that eye pain had a negative effect on SVT in our study. Dry eye symptoms such as eye fatigue or dry eye sensation have a negative effect on daily life activities among adults [38].

The present study has some limitations. The study was conducted after the COVID-19 pandemic first wave, and most children were receiving online education during this period, which might have provided greater opportunities to children to use online platforms for noneducational activities. Additionally, all data were self-reported, which might have introduced various biases. Finally, we could not collect anthropometric measurement data of the children, which would have provided more robust evidence for the correlation of SVT with obesity.

5. Conclusions

Nearly 20% of the children included in the study equally from urban and rural regions of Ujjain district had excess SVT. Thus, excessive screen viewing is a significant public health problem in India that can affect physical health of children. Many modifiable risk factors, including mobile phone use before bedtime and in early morning, presence of TV in bedroom, and disinterest in reading books other than textbooks, were identified in the study. Further interventional studies are warranted to mitigate the identified risk factors.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: Data collection form/questionnaire

Author Contributions: Conceptualization, A.P. and AM; methodology, A.P.; software, A.P.; validation, A.P., A.M. and S.J.; formal analysis, S.J. and A.M.; investigation, S.J., S.S., A.M. and A.P.; resources, A.P.; data curation, S.J., A.M. and A.P.; writing—original draft preparation, S.J. and A.P.; writing—review and editing, S.J., S.S., A.M. and A.P.; visualization, S.J., S.S., A.M. and A.P.; supervision, S.S., A.M. and A.P.; project administration, A.M. and A.P.; funding acquisition, A.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by RD Gardi Institutional Funds, grant number 10/2019

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Ethics Committee of RD Gardi Medical College, Ujjain, India (protocol code 95/2019 and 12/12/2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. Please mention Shilpa_SVT_dataset while requesting for the same. The data are not publicly available due to sensitive nature of data perceived by the parents.

Acknowledgments: The authors thank the Dean, RD Gardi Medical College Dr and Medical Director Dr VK Mahadik for administrative support for the project.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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