

# Sleep Deprivation and Disruptors of Sleep among Secondary Schoolchildren and Adolescents from Mumbai City

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## ABSTRACT

**Aims and objectives:** Good sleep quality entails that it is continuous without any interruptions, characterized by early onset of sleep, fewer interruptions or disruptions, and fewer early awakenings. Studies indicate that younger adolescents are perhaps the most sleep-deprived and vulnerable to sleep disturbances. Therefore, the present study examined sleep disruption among Indian school children/adolescents.

**Materials and methods:** This cross-sectional study was conducted in two schools (purposively selected) catering to children from different socioeconomic backgrounds. Overall, 1,974 children aged 10–18 years were studied, 1,083 children belonging to a government-aided school (GAS) and the remaining 891 were from an international school (IS). Sleep quality was assessed using a detailed questionnaire containing questions based on the Pittsburgh Sleep Quality Index.

**Results:** Among the 1,974 participants, 38.5% ( $n = 759$ ) of children reported that they had disrupted sleep. Almost, one-third (33.9%,  $n = 125$ ) of the children, whose sleep was disrupted every night, slept for 6 hours or less. Sleep disruption was higher among the children attending the GAS (41.5%) compared to children who were from much better socioeconomic backgrounds and were attending the IS (34.7%). Overall, noise was a major disruptor for more 39.6% of the children, followed by the urge to go the bathroom (33.2%). Half the children (50.3%) with disrupted night sleep listened to music and 46.3% reported that they thought about/were worried about the next day. Thirty-five percent of the students reported that they watched television or used mobiles (34.1%) or played video games (33.1%).

**Conclusions:** The study results indicated that a fairly high percentage of urban students experience sleep disruption and their daily habits before going to bed, technological advancement, social chatting on mobiles as well as their economic background influenced their sleep pattern.

**Keywords:** Adolescents, Daytime sleepiness, Pittsburgh sleep quality index, Sleep deprivation, Sleep disruption.

*Indian Journal of Sleep Medicine* (2021): 10.5005/jp-journals-10069-0068

## INTRODUCTION

Sleep has a restorative role in maintaining physical, physiological health, and wellbeing. Sleep disturbances are associated with increased risk of absenteeism and accidents and have a negative impact on vitality, social functioning, physical and mental health, as well as quality of life.<sup>1,2</sup> Sleep quality is as important as is the duration of sleep, with uninterrupted good quality sleep being important. According to the National Sleep Foundation of the US, adolescents require about 9 hours of sleep every night to support optimum health and development. However, studies in different parts of the world indicate that the average duration is far less than the optimum recommended.<sup>3</sup> However, sleep duration is not the only indicator of sleep health. Good sleep quality implies that sleep is continuous without any interruptions and characterized by early onset of sleep, fewer interruptions or disruptions, and fewer early awakenings.<sup>3</sup> Yet, it has been observed that children and adolescents have problems with initiating and maintaining sleep. Adolescence is a crucial stage characterized by critical transitions in the life span, including rapid growth and developmental changes, second only to that of infancy.<sup>4</sup> It is a stage of increased independence and more socialization that affects the overall behavior including sleep which generally includes later bedtime hours but early waking up for school. Therefore, adolescent sleep patterns need particular attention.

Western data indicates that younger adolescents are perhaps the most sleep-deprived and are also vulnerable to sleep disturbances attributable to a variety of intrinsic and external factors.<sup>5</sup> There are many factors that impact sleep quality, including media use, screen time, noise, too much light, blue light, Wi-Fi, dietary

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**How to cite this article:** Desai SR, Vaidya RA, Udipi SA, *et al.* Sleep Deprivation and Disruptors of Sleep among Secondary Schoolchildren and Adolescents from Mumbai City. *J Sleep Med* 2021;16(2):33–39.

**Source of support:** Nil

**Conflict of interest:** None

choices, alcohol, and caffeine consumption as well as stress, health status, sleep apnea, and need to visit the bathroom. In contrast, tranquility has been reported to have positive health benefits.<sup>6</sup> Proper sleep maintains the inflammatory homeostasis through effects on several inflammatory mediators, such as cytokines, and therefore, prolonged sleep insufficiency can lead to inflammatory associated noncommunicable diseases like diabetes, hypertension, atherosclerosis, obesity, depression, heart attack, and stroke.<sup>7-9</sup> because of the chronic, systemic low-grade inflammation.<sup>10,11</sup> Our clinical experience with a group of patients with polycystic ovary syndrome indicated that there can be severe sleep deprivation, with some individuals having short-term insufficient sleep related to academic pressures and examinations.<sup>12</sup>

Nocturnal sleep awakenings are important to consider because they impair sleep consolidation and shorten sleep duration.<sup>13</sup> All these adversely impact daytime functioning and behavior, cognitive development including academic performance, predispose to accidents and injury as well as poor neuropsychological functioning in adolescence.<sup>14,15</sup> Even in adolescents who performed well academically, it was observed that a week of partial sleep deprivation affected their mood, cognitive functioning, and alertness in regular routine.<sup>16</sup> It has been reported that perhaps one-fifth of elementary schoolchildren has fragmented sleep.<sup>17</sup>

However, compared to duration, less work has been done on sleep disruptors or the problems with quality of sleep. In the Indian context, few studies are available in the reported literature on sleep quality and disruptors that could interfere with sleep. Therefore, the present study examined sleep disruption among schoolchildren / adolescents from different socioeconomic backgrounds. This was a part of a larger study on sleep in 1,974, 10–18-year-old children who were attending either a private school or a government-aided school (GAS), both located in neighboring suburbs within Mumbai city. We examined the prevalence of sleep disruption among these children and attempted to identify the disruptors and compared the different age-groups for sleep disruption.

## MATERIALS AND METHODS

Two schools catering to children from different socioeconomic backgrounds were purposively selected. One was an international school (IS) and the other was a GAS. These schools were selected because of the interest shown by the respective school authorities in the study and in order to determine whether different socioeconomic backgrounds affected their sleep. For both schools, permission was obtained from their respective managements and principals.

### Participants

A total of 1,974 children aged 10–18 years were studied, with 1,083 children belonging to the GAS and the remaining 891 were from the IS. Data were collected from all children in each standard/grade who were present on the day of the survey.

### Data Collection

Data were collected using a pretested questionnaire that had been finalized through a consultative process with the teachers from schools, as well as the school counselor and Parent Teacher Association representative and school physician.

Questions included in the survey form were based on the Pittsburgh Sleep Quality Questionnaire.<sup>18</sup> Time of going to bed and time at which each participant woke up on weekdays and weekends was recorded from which duration of sleep was calculated. Other information that was recorded included time taken to fall asleep, whether the students do any activity such as listening to music, playing games, listening to stories, etc., while waiting to fall asleep or what were the common sleep disruptors. Also, information was obtained about the use of mobile, computer, reading, and watching television. Students were also asked whether they felt sleepy during school hours.

Forms were filled by the students in the presence of their class teachers and the investigators. If they had any difficulty, the question was explained to enable them to answer the question. In the GAS, students were allowed to answer in Marathi or Gujarati or English as per their mediums of instruction. For students who studied in either Marathi or Gujarati medium, the forms were translated into these languages.

Forms were collected and checked for omissions and/or irrelevant answers. On a separate day, investigators worked with individual students to fill up the missing information or to obtain relevant answers to missing questions. The verification and completion of the forms were required for a total of 60 students from both schools.

### Statistical Analysis

Data were analyzed using SPSS software (version 20, SPSS Inc., Chicago, Illinois, USA). Descriptive statistics that included mean, standard deviation, and range values were computed for quantitative variables. Chi-square test was applied to examine associations and independent Student's *t*-test was used to determine whether there were differences between groups. A *p*-value less than 0.05 was considered statistically significant.

## RESULTS

### Overall Sleep Disruption

Only half (50.2%, *n* = 990) out of the 1,974 children reported that they never woke up at night and had a sound sleep. However, 38.5% (*n* = 759) of the children reported that they had disrupted sleep, with 18.7% (*n* = 369) having disrupted sleep regularly with the frequency of waking up almost every night. Further, 19.8% children (*n* = 390) woke up 2 to 3 times/week and another 11.4% (*n* = 224) woke up twice or thrice a month. Almost 15.5% of the children reported that if they woke up from sleep in the night, they were not able to fall asleep again immediately and it took them some time to go back to sleep.

There was not much difference between the two schools as 52.2% children from the IS and 48.4% from the GAS reported that they never wake up at night. However, 14.4% (*n* = 128) from the IS and 22.3% (*n* = 241) from the GAS reported that they wake up almost every night. Another 20.3% (*n* = 181) in the IS and 19.3% (*n* = 209) in the GAS woke up approximately 2 to 3 times/week. The highest percentage was among the GAS students aged 14 to 15 years. There was a significant association with gender only in the IS and not in the GAS school. A higher percentage of males (16.6%) woke up every night compared to 12.1% of the females (Table 1).

### Sleep Curtailment

Out of the 369 children who reported sleep disruption almost every night, one-third of the children (33.9%, *n* = 125) slept for 6 hours or less. More than 50% of these children slept after midnight/12 a.m. and woke up at 6 a.m. or even before. However, 29.0% (*n* = 107) of these children, slept for 7 hours and the remaining 37% (*n* = 137) slept for 8 hours or more. A similar trend was observed among children whose sleep was disrupted about 2–3 times/week (Table 2). A significant association was observed between the duration of sleep in hours and the time the children went to bed.

Daytime sleepiness was reported as being experienced "sometimes" by at least one-third of the children wherein, the percentage of children who experienced sleep disruption daily with less than 6 hours of sleep (44.0%) was higher as compared to children whose sleep was disrupted 2–3 times/week and slept for a similar duration (34.4%) (Table 2). Also, a higher percentage of children with regular sleep disruption felt sleepy "usually" in the daytime as compared to those with lesser frequency of sleep disruption.

**Table 1:** Frequency of sleep disruption among children

Sleep disruption		All children (n = 1,974) n%	IS (n = 891) n%	GAS (n = 1,083) n%
Boys	Every night	206 19.7%	75 16.6%	131 22.0%
	2-3 times/week	216 20.6%	92 20.3%	124 20.8%
	2-3 times/month	105 10.0%	46 10.2%	59 9.9%
	Never	521 49.7%	240 53.0%	281 47.2%
Girls	Every night	163 17.6%	53 12.1%	110 22.5%
	2-3 times/week	174 18.8%	89 20.3%	85 17.4%
	2-3 times/month	120 13.0%	70 16.0%	50 10.2%
	Never	469 50.6%	226 51.6%	243 49.8%
$\chi^2$	5.747	8.967	2.055	
<i>p</i>	0.125	0.030	0.561	

**Table 2:** Sleep curtailment and daytime sleepiness among young adolescents

Categories	All children (n = 1,974)	Sleep disruption								
		Every night (n = 369)				$\chi^2$ <i>p</i>	2-3 times/week (n = 390)			$\chi^2$ <i>p</i>
		≤6 hrs (n = 125)	7 hrs (n = 107)	≥8 hrs (n = 137)	≤6 hrs (n = 122)		7 hrs (n = 127)	≥8 hrs (n = 141)		
<b>Time to go to bed</b>										
Before 10 p.m.	256 (13.0%)	15 (12%)	15 (14.1%)	29 (21.1%)	166.967 0.000	0(0)	7 (5.5%)	42 (29.8%)	191.17 0.000	
10-12 p.m.	1,408 (71.3%)	46 (36.8%)	87 (81.3%)	107 (78.1%)		66 (54.1%)	119 (93.7%)	97 (68.8%)		
After 12 a.m.	310 (15.7%)	64 (51.2%)	5 (4.7%)	1 (0.7%)		56 (45.9%)	1 (0.8%)	2 (1.4%)		
<b>Time to wakeup</b>										
Before 7 a.m.	1,824 (92.4%)	122 (97.6%)	102 (95.3%)	110 (80.3%)	70.914 0.000	121 (99.2%)	125 (98.3%)	117 (82.9%)	87.857 0.000	
7-8 a.m.	53 (2.7%)	0 (0)	2 (1.9%)	5.8 (8%)		0(0)	0(0)	9 (6.4%)		
After 8 a.m.	97 (4.9%)	3 (2.4%)	3 (2.8%)	19 (13.9%)		1 (0.8)	2 (1.6%)	15 (10.7)		
<b>Daytime sleepiness</b>										
Never / rarely	1,155 (58.5%)	58 (46.4%)	60 (56%)	78 (56.9%)	20.481 0.000	72 (59.0%)	66 (51.9%)	85 (60.3%)	8.967 0.175	
Sometimes	627 (31.8%)	55 (44%)	27 (25.2%)	42 (30.7%)		42 (34.4%)	47 (37.0%)	39 (27.7%)		
Usually	192 (9.7%)	12 (9.6%)	20 (18.7%)	17 (12.4%)		8 (6.6%)	14 (11.0%)	17 (12.1%)		

**Factors for Sleep Disruption**

Sleep was disrupted due to various reasons, with noise being a major disruptor. Another important factor that disrupted sleep was urge to go the bathroom with a higher percentage of children in GASs. Dreams and light were also reported as disruptors by a higher percentage of the GAS children compared to IS (Table 3).

**Activities Done before Falling Asleep**

Children (n = 759) who either woke up every night (n = 369) and those who woke up 2-3 times/week (n = 390) were asked what they do after they go to bed before falling asleep. Half of the students (50.3%) listened to music, but 46.3% of the student reported that they thought about/were worried about the next

day (Table 4). Almost one-third of the students reported that they watched television (35.0%) or used mobiles (34.1%) or played video games (33.1%).

Among those whose sleep was disrupted every night, a significantly higher percentage of students from GAS played games on the mobile or reported that they thought about the next day or watched TV compared to the IS students (Table 4). However, the percentage of those who read, surfed net, chatted with someone in room was higher among the IS students.

Among those with sleep disruption 2–3 times/week, almost 50% among children from the GAS watched films at night or listened to music which was significantly higher than among the IS children (4.4%). However, a significantly higher percentage of IS students played games on mobile, read, surfed net, chatted with someone in the room, was on Whatsapp or Facebook (Table 4).

**DISCUSSION**

One of the first studies on reduction in habitual sleep duration of children was reported by Terman and Hocking.<sup>19</sup> Since then, there have been numerous studies on the sleep health of children. There are two fundamental dimensions of sleep adequacy—sleep quantity or total sleep time and sleep quality. Sleep time is affected by late bedtimes, sleep onset latency, getting up early, and sleep quality is determined by disturbances or disruptions in sleep as well as waking up at night, nightmares as well as irregular bedtimes.<sup>17</sup>

Sleep disruption is a major problem today and is of concern among school-going children and adolescents. A meta-analysis showed that the adverse effects of sleep deprivation in some individuals may be after a single night’s deprivation or after several nights.<sup>20</sup> While there has been a lot of attention paid to sleep health in Western countries, there has not been much focus on Indian children and adolescents, particularly on sleep disruptors and quality of sleep.

The present study, therefore, investigated the factors causing sleep disruption in school-going children and adolescents

aged 10–18 years. We observed that nearly 40% of the students experienced sleep disruption either on daily basis or twice or thrice a week. This percentage is higher than the percentages earlier reported which states about 20–30% of young children had some type of sleep problem which decreased to 18% children having fragmented sleep, as they entered primary school.<sup>21</sup> On examining the reasons for sleep disruption among school-going urban children in our study, it was observed that their daily habits before going to bed, technological advancement, social chatting on mobiles as well as economic background influenced their sleep. Factors such as bed-sharing, room-sharing, bedtime rituals, media use, as well as family and school environments can influence the children’s sleep-wake cycle and child’s routine and improve health and well-being.<sup>22</sup> In modern-day society, the above social factors tend to delay the beginning of sleep combined with early school timings; which may negatively affect health by causing sleep deprivation and sleep disturbances. In the present study, both schools started at 7.30 a.m. in the morning. This is because in the city of Mumbai, space availability is a constraint and most schools run in two shifts with secondary school students from the fifth standard onwards having the morning shift and the afternoon shift is for the primary students. Such early school hours are most likely to contribute to

**Table 3:** Common sleep disruptors among young adolescents

Sleep disruptors	All children (n = 1,974)	IS (n = 309)	GAS (n = 450)	$\chi^2$ p
Noise	272	146 (53.7%)	126 (46.3%)	29.522 0.000
Light	137	58 (42.3%)	79 (57.7%)	0.701 0.369
Dreams	191	76 (39.8%)	115 (60.2%)	0.799 0.416
Urge to use washroom	246	106 (43.1%)	140 (56.9%)	0.385 0.199

**Table 4:** Association of activities done by children before bedtime and sleep disruption

Activity	All children	Sleep disruption					
		IS (n = 309)		GAS (n = 450)		$\chi^2$ p	$\chi^2$ p
		Every night (n = 128)	Every night (n = 241)	2–3 times/week (n = 181)	2–3 times/week (n = 209)		
Play games on mobile	808 (40.8%)	37 (28.9%)	108 (44.8%)	8.868 0.003	76 (42.0%)	78 (37.3%)	0.885 0.347
Read	519 (26.3%)	45 (35.2%)	49 (20.3%)	9.677 0.002	80 (44.2%)	39 (18.7%)	29.838 0.000
Surf the net	370 (18.7%)	27 (21.1%)	24 (10.0%)	8.703 0.003	73 (40.3%)	12 (5.7%)	68.088 0.000
Chat with someone in the room	520 (26.3%)	42 (32.8%)	48 (19.9%)	7.538 0.006	74 (40.9%)	48 (23.0%)	14.486 0.000
Whatsapp/Facebook	706 (35.8%)	49 (38.3%)	76 (31.5%)	1.698 0.192	75 (41.4%)	69 (33.0%)	2.954 0.086
Listen to music (daily)	1,293 (65.5%)	63 (49.2%)	131 (54.4%)	7.066 0.132	74 (40.9%)	114 (54.5%)	10.952 0.027
Think about the next day (daily)	1,179 (59.7%)	21 (16.4%)	46 (19.1%)	10.870 0.028	30 (16.6%)	30 (14.4%)	15.163 0.004
Watch a film/movie (daily):	780 (39.5%)	49 (38.3%)	122 (50.6%)	34.610 0.000	75 (41.4%)	104 (49.8%)	31.632 0.000



sleep deprivation and disrupted sleep. It was observed that when school start time was delayed to 9 a.m., sleep onset time and wake-up time of the adolescents were also delayed, which caused a transient increase in sleep duration and also reduced the duration of weekend catch-up sleep in these adolescents.<sup>23</sup> The American Academy of Pediatrics (AAP) in 2014 pointed out the need to start school late by 8.30 a.m. in order for the adolescents to get a healthy night sleep.<sup>24</sup>

School children from lower socioeconomic status (SES) have been found to be more vulnerable to sleep impairments.<sup>25</sup> In the present study also, sleep disruption was higher among the children attending the GAS compared to children who were from much better socioeconomic backgrounds and were attending the IS. We observed that noise was a major sleep disruptor among both the school children. There are many sources of noise in cities like Mumbai, ranging from external sources such as aircraft, rail, road traffic, via loudspeakers.<sup>26</sup> In our study, the children from the IS and GAS stayed in a suburb that was fairly close to the airport as well as the highway, thus placing them at risk of more exposure to noise from aircraft as well as vehicular noise from cars, buses, and trucks. In addition, in typical low SES homes found in urban areas, most families live in single rooms that are relatively small. It is quite likely that for these GAS children noise within the home was also a source from talking among other family members and noise of television. The economically deprived groups face a double burden of low economic status and higher exposure to environmental noise.<sup>27</sup> This outside noise may affect children's sleep by threatening and producing presleep worries may vary greatly in terms of their intensity or potential health consequences and may also increase social health differences among children.<sup>28,29</sup> In adults, it was observed that when road traffic noise was high, symptoms of insomnia were significantly higher<sup>30</sup> and that exposure to aircraft noise was linked with disturbed sleep especially when the noise levels exceeded 55 decibels.<sup>31</sup>

Apart from noise, media has been found to lead to a loss in the total sleep time of adolescents. The increasing access to and availability of media formats such as web, e-mail, messaging, video games, particularly the location of television, video games, internet, and mobile phones in bedrooms could contribute to sleep disruption and sleep debt. In the present study, a higher percentage (41.3%) of GAS students played games on mobile or viewed television, whereas chatting on mobile, Whatsapp, Facebook, and surfing net was higher among IS students (32.4%). Access to mobile phones for children has increased partly due to their being sold at relatively low prices. The increased use of technology and media before sleeping may increase the activity level of the nervous system thereby causing alertness, physiological arousal, and difficulty in falling asleep.<sup>32</sup> Studies have reported that watching television late at night delayed bedtime and reduced the total sleep time, and children had difficulty in waking up whereas the violent nature of games and television programs might lead to anxiety and difficulty in falling asleep.<sup>33-35</sup> This kind of interactivity could also affect the ability of children to disengage from these after a desirable duration by themselves. It is likely to displace sleep and increase the risk of irregular bedtimes. Such behavior could possibly be linked to laxity on the part of parents or to the child having a health problem. However, both these aspects were not included in our study. Also, there is a two-way relationship between the use of media and poor sleep in that heavy use of media could be responsible for poor sleep or poor sleepers are more likely to use media.<sup>21</sup> This aspect warrants study in Indian children and

adolescents. Also, television watching and extensive use of media, i.e., computers and/or cell phones have been linked with obesity, poor eating habits, and poor sleep,<sup>36-38</sup> decreased physical activity and fitness and poor school performance.<sup>39-41</sup> Social jetlag which is the discordance between individuals' circadian rhythms and social rhythms can be a major contributor to childhood obesity and unhealthy weight gain in adolescents.<sup>42</sup> Therefore, family and parenting dynamics play an important role in determining the sleep environment and it would be worthwhile to sensitize and educate the parents on sleep disruption, sleep hygiene, and implementing different parenting styles as well as managing children's behavior by parents in order to improve children's sleep patterns and sleep health.<sup>43</sup>

Light pollution is another source of global environmental concern, particularly because it disrupts the rhythms of daily life and suppresses nocturnal melatonin production by the pineal gland, even if the exposure to light is of short duration and if the intensity of the light is low.<sup>44,45</sup> Presence of artificial lighting in the urban scenario, intensity, and timing/duration of light exposure has increased drastically. Light sources are not only within the household but also an important source for many families can be light filtering into the home from street lighting. In patients with primary sleep disorders, melatonin has been shown to decrease sleep onset latency, increase sleep time, and improve sleep quality overall.<sup>43</sup>

It was observed in American individuals that those who lived with greater outdoor nighttime lights had delayed bedtimes and wake-up times, as well as shorter sleep duration.<sup>46</sup> It is important to understand that along with maintaining sleep hygiene like bathing, meditating or listening to stories, etc., before bedtime, it is necessary to avoid exposure to light from mobiles or televisions in order to keep the mind peaceful and avoid disrupted sleep. The blue light emitted from these devices (mobile, TV, laptops) affects the circadian rhythm and may lead to poor and disrupted sleep.<sup>47,48</sup>

We also observed that many of the children needed to visit the bathroom at night and therefore was a sleep disruptor. It was reported that possibly two voids per night could be a critical threshold, but this aspect has not been focused on much in Indian children and needs attention.<sup>49</sup> Parental sleep habits are also likely to affect children's sleep. Irregular sleep habits of parents were found to be associated with increased sleep problems and daytime sleepiness of children and those children who had irregular sleep habits were found to doze more frequently in the daytime as well as tended to skip breakfast.<sup>50</sup> In our study also, daytime sleepiness being experienced "usually" was reported by one-tenth to almost one-fifth of the students. Further observational studies are required in Indian settings.

Thus, changes in sleep patterns may cause daytime sleepiness, inattentive behavior, and poor academic performance and might negatively affect the neurocognitive performance, mood, and health and even put adolescents at risk for accidents or injury.<sup>50</sup> The present findings may have important clinical and public health implications, most important being that the amount of time that adolescent children spend watching television, or on mobiles needs to be regulated. Some children in our study said their sleep was disrupted because they had nightmares or their thoughts about the next day. These issues could increase anxiety and stress and need to be addressed jointly by school authorities and parents by which adolescents may be able to reduce the likelihood that they will experience the onset of frequent sleep problems by early adulthood. Further, studying their daily lifestyle patterns

and activities before bedtime, the conduciveness of the home environment and the external sources of sleep disruption along with parents' sleep habits as well as measuring the stress levels in these children will help to obtain a holistic picture in order to help parents and teachers to address the current problem of sleep disruption at an early age.

## ACKNOWLEDGMENTS

We would like to thank the research scholars Ms. Fagun Gandhi and Ms. Nagma Nurany for their dedication. Also, we thank Mr. Vaidya, Principal of ND Bhuta School and Utpal Sanghvi School for their cooperation.

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