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# Relationship between leisure time screen activity and aggressive and violent behaviour in Iranian children and adolescents: the CASPIAN-IV Study

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**Background:** This study aimed to assess the relationship between leisure time spent watching television (TV) and at a computer and aggressive and violent behaviour in children and adolescents.

**Methods:** In this nationwide study, 14,880 school students, aged 6–18 years, were selected by cluster and stratified multi-stage sampling method from 30 provinces in Iran. The World Health Organization Global School-based Health Survey questionnaire (WHO-GSHS) was used.

**Results:** Overall, 13,486 children and adolescents (50.8% boys, 75.6% urban residents) completed the study (participation rate 90.6%). The risk of physical fighting and quarrels increased by 29% (OR 1.29, 95% CI 1.19–1.40) with watching TV for >2 hr/day, by 38% (OR 1.38, 95% CI 1.21–1.57) with leisure time computer work of >2 hr/day, and by 42% (OR 1.42, 95% CI 1.28–1.58) with the total screen time of >2 hr/day. Watching TV or leisure time spent on a computer or total screen time of >2 hr/day increased the risk of bullying by 30% (OR 1.30, 95% CI 1.18–1.43), 57% (1.57, 95% CI 1.34–1.85) and 62% (OR 1.62, 95% CI 1.43–1.83). Spending >2 hr/day watching TV and total screen time increased the risk of being bullied by 12% (OR 1.12, 95% CI 1.02–1.22) and 15% (OR 1.15, 95% CI 1.02–1.28), respectively. This relationship was not statistically significant for leisure time spent on a computer (OR 1.10, 95% CI 0.9–1.27).

**Conclusions:** Prolonged leisure time spent on screen activities is associated with violent and aggressive behaviour in children and adolescents. In addition to the duration of screen time, the association is likely to be explained also by the media content.

**Keywords:** Aggression, Violence, Television, Computer, Children and adolescents

## Introduction

The widespread use of visual media including television (TV) and video has provided a new arena for raising the level of public information and for children and adolescents to learn different skills.<sup>1</sup> In recent years, increased use of computers, including the use of computer games, has made them the second largest children's entertainment after TV. However, whilst playing computer games, children are in an active state, and it remains controversial whether this therefore reduces the effect on children's health.<sup>2</sup> Children

and adolescents spend a large proportion of their leisure time watching TV or working with a computer, which can be associated with long-term negative effects.<sup>3</sup> Improper and prolonged use of visual media may have a negative effect, including increased expression of anger and aggression, anti-social behaviour or isolation and physical effects such as obesity resulting from a sedentary lifestyle.<sup>4,5</sup>

The effects of the media on behaviour differ according to content: violent video games increase aggressive tendencies, as confirmed by a meta-analysis,<sup>6</sup> while prosocial media content may have beneficial effects.<sup>7</sup>

Moreover, some studies have shown that watching TV, videos or computer games for more than 2 hours a day, as recommended by the American Academy of

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Pediatrics,<sup>8</sup> might have a direct relationship with the development of anti-social behaviour and aggression.<sup>9–15</sup> Some believe that watching violent programmes and playing violent computer games can increase the risk of violent behavior in children and adolescents because they gradually lose their sensitivity to violence.<sup>16,17</sup> A birth cohort followed up for 26 years showed that excessive television viewing in those aged 5–15 years is associated with increased antisocial behaviour in early adulthood.<sup>18</sup>

However, the association between time spent on screen activities and anti-social behaviour remains to be determined. Some previous studies have limitations owing to small sample size and the study of specific groups of children and adolescents. The results of the majority of these studies indicate that time spent watching TV and playing computer games in childhood has a direct relationship with violent behaviour in children, adolescents and adults.<sup>10,19</sup> A longitudinal study demonstrated that time spent watching TV in adolescence and young adulthood increased the risk of subsequent aggressive behaviour. This correlation was independent of previous aggressive behaviour, income, neighborhood violence and some other risk factors.<sup>20</sup> Another study found an association between aggression and watching violence on TV, but after adjustment for prior aggressive tendencies, the association was no longer significant.<sup>21</sup>

Almost all previous large-scale studies have been conducted in western countries; because of the increasing use of TV, computers and computer games by children and adolescents in various parts of the world, surveys with large sample sizes in different populations are required.

This study aimed to investigate the relationship between watching TV and leisure time spent with computers with violent and aggressive behaviour in a nationally representative sample of Iranian children and adolescents.

## Methods

This nationwide study was conducted in 2011–2012 as the fourth national survey of a school-based surveillance programme entitled ‘the Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease (CASPIAN-IV)’ study. The methodology of the study has been reported previously<sup>22</sup> and is briefly explained below.

### *Study population and sampling framework*

The study population was elementary, secondary and high-school pupils from urban and rural parts of Iran. They were selected by multi-stage, cluster-sampling from 30 provinces. Stratification was performed in each province according to whether the location was urban or rural and the school grade (elementary/

secondary/high school) proportional to size and with equal gender ratio, i.e. the number of boys and girls selected from each province were the same, and the ratios in urban and rural areas were proportionate to the population of urban and rural students. In this way, the number of samples in rural/urban areas and in each school grade was allocated proportionally to the population of students in each grade. Cluster sampling with equal clusters was used in each province to reach the required sample size. The clusters were determined according to the type of school, and included ten samples in each cluster. Sample size was estimated according to a cluster sampling method, and to achieve a good estimation of the main risk factors of interest such as diet, overweight and obesity, and physical inactivity. The maximum sample size for a good estimate of all risk factors of interest was selected and was calculated to be 480 subjects in each province: 48 clusters of ten subjects in each province. In total, 14,880 students were selected by multi-stage (cluster and stratified) sampling from 30 provinces in cooperation with 45 universities of medical science. Trained health-care providers conducted interviews separately with each participant in a calm and quiet environment, and completed the questionnaire. Participants were assured that their responses would remain anonymous and confidential. All questions were read for the students in a simple, friendly and clear manner.

### *Questionnaire-completion procedure*

The WHO-GSHS questionnaire was used to collect data. It has been translated by experts and its validity and reliability have been confirmed. There were five possible responses to questions relating to aggressive and violent behaviour, from reporting none to displaying such behaviour at least four times. If a participant reported that he/she had never experienced such behaviour, he/she was considered not to have behaved aggressively; if other options were chosen, they were considered to have displayed aggressive behaviour. There were four possible responses to questions relating to watching TV and spending leisure time on a computer, from less than 1 hour a day to 4 or more hours a day. The questionnaire also included demographic information including age, gender, educational level, type of housing, physical activity, sleep time, family size and other information related to aggressive behaviour. Some questions, such as those related to socio-economic status (SES), were put to parents.<sup>22,23</sup>

### *Statistical analysis*

Data regarding the number of hours spent watching TV were categorized into two groups:  $\leq 2$  hours a day, and  $> 2$  hours a day, and this was also applied to the amount of leisure time spent on a computer. The mean total hours of watching TV and computer

Table 1 Frequency of violent behaviour in children and adolescents according to socio-demographic characteristics: the CASPIAN-IV Study

	Physical fighting?				Bullying?				Been bullied?			
	Yes		No		Yes		No		Yes		No	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	P-value
Age, mean (SD), yrs	12.6 (0.9)	12.4 (0.1)	12.9 (0.1)	12.4 (0.9)	<0.001	12.2 (0.1)	12.5 (0.9)	0.002				
Living area	4025 (29.1)	6101 (45.0)	1767 (13)	8328 (61.9)	0.6	2786 (20.6)	7348 (54.4)	0.6				
	1327 (9.8)	1948 (14.4)	580 (4.2)	2688 (19.9)		884 (6.5)	2394 (17.7)					
Gender	3295 (24.4)	3508 (25.9)	1405 (10.4)	5376 (39.8)	<0.001	2006 (21.5)	4804 (35.5)	<0.001				
	2057 (15.2)	4541 (33.6)	942 (6.9)	5640 (41.6)		1664 (12.2)	4938 (36.4)					
School level	2393 (17.7)	3766 (27.8)	925 (6.8)	5211 (39.1)	<0.001	1751 (12.9)	4413 (32.5)	<0.001				
	1557 (11.5)	1912 (14.1)	735 (5.4)	2721 (20.5)		1037 (7.6)	2432 (18.0)					
SES*	1402 (10.3)	2371 (17.5)	687 (5)	3084 (22.7)	0.16	882 (6.5)	2897 (21.3)	0.74				
	1669 (12.3)	2562 (18.9)	693 (5.1)	3425 (25.3)		1126 (8.3)	3004 (30.0)					
	1670 (12.3)	2403 (18.7)	753 (5.6)	3317 (24.5)		1141 (8.4)	2939 (29.7)					
Physical activity	1565 (11.5)	2447 (18.8)	709 (5.2)	3394 (25.1)	<0.001	1120 (8.2)	2996 (29.9)	0.90				
	1737 (12.8)	2796 (20.7)	823 (6)	3707 (27.2)		1234 (9.1)	3310 (24.5)					
	1917 (14.1)	2980 (22.0)	807 (5.8)	4075 (30.0)		1348 (9.9)	3549 (26.2)					
	1668 (12.3)	2212 (16.3)	702 (5.2)	3162 (23.3)		1070 (7.8)	2809 (20.7)					
Sleep duration	41 (0.3)	45 (0.3)	20 (0.1)	66 (0.4)	0.21	28 (0.2)	59 (0.4)	0.49				
	1202 (8.9)	1813 (13.4)	552 (4.4)	2452 (18.1)		809 (6.0)	2208 (16.3)					
	4077 (30.2)	6129 (45.4)	1758 (13)	8420 (62.1)		2808 (30.1)	7404 (54.5)					
Family size	2566 (19.0)	3888 (28.0)	1135 (8.4)	5306 (39.8)	0.71	1829 (13.5)	4630 (34.1)	0.1				
	2701 (20.0)	4035 (29.8)	1167 (8.7)	5550 (41.1)		1788 (13.2)	4954 (36.2)					
Weight status	623 (4.6)	959 (7.1)	258 (1.9)	1346 (9.9)	0.04	420 (3.0)	1194 (8.9)	0.09				
	3458 (25.5)	5326 (39.4)	1527 (11.3)	7233 (41.1)		2407 (17.8)	6384 (46.8)					
	498 (3.6)	776 (5.7)	226 (1.6)	1051 (7.2)		329 (2.4)	950 (6.5)					
	680 (4.7)	894 (6.6)	309 (2.2)	1257 (9.3)		465 (3.2)	1106 (8.0)					

SES, socio-economic status

**Table 2 Frequency of violent behaviour in children and adolescents according to time spent on screen activities**

	Physical fighting?			Bullying?			Been bullied?		
	Yes (%)	No (%)	P-value	Yes (%)	No (%)	P-value	Yes (%)	No (%)	P-value
Watching TV	2391 (17.7)	4176 (30.9)	<0.001	1001 (7.3)	5551 (40.9)	<0.001	1728 (12.7)	4839 (35.7)	0.01
	2918 (21.6)	3818 (28.2)		1327 (9.7)	5390 (39.7)		1912 (14.1)	4835 (35.7)	
Using a computer	4579 (33.9)	7206 (53.3)	<0.001	1942 (14.3)	9813 (72.3)	<0.001	3193 (23.5)	8600 (63.4)	0.14
	621 (4.6)	639 (4.7)		335 (2.4)	922 (0.6)		366 (2.6)	893 (6.6)	
Screen activity*	4128 (30.5)	6737 (49.9)	<0.001	1713 (12.6)	9125 (67.2)	<0.001	2919 (21.6)	7955 (58.6)	0.01
	1202 (9.5)	1284 (9.5)		623 (4.5)	1853 (13.6)		732 (5.3)	1756 (12.9)	

\* Including mean leisure time working on a computer and watching TV

(screen) time was also categorized into two groups of  $\leq 2$  hours and  $> 2$  hours a day.

Quantitative variables are reported as mean (SD) and qualitative variables as frequency and percentage. Differences of means and of categorized variables were assessed by the *t*-test and Pearson's  $\chi^2$  test, respectively. The association between screen activities and violent behaviour was assessed using various models of logistic regression analysis, in which the independent variable, i.e. screen time activities, were considered as continuous and binary variables. Before running models, outliers were excluded and collinearity between variables was tested, and, after confirming the lack of collinearity, the models were run.

In Model I, the crude associations between screen time and violent behaviour were assessed. In Model II, the associations were further adjusted for age, gender and living area (urban/rural), and in Model III, SES, physical activity, sleep hours, family size and body mass index were adjusted accordingly.

Results of the logistic regression are presented as odds ratio (OR) and 95% confidence interval (CI). In all analyses, the cluster sampling design was considered. Data were analysed using survey data analysis methods in the STATA Corp 2011 package (Stata Statistical Software, Release 12. College Station, TX: StataCorp).  $P < 0.05$  was considered to be statistically significant.

### Results

The survey included 13,486 students (50.8% boys, 75.6% urban). Mean (SD) age was 12.47 (3.36) years, with no significant difference between boys [12.36 (3.40)] and girls [12.58 (3.32)].

Table 1 shows the frequency of violent behaviour (physical fights, bullying) and being bullied in participants according to socio-demographic characteristics. Physical fighting, bullying and being bullied occurred significantly more frequent ly in boys than in girls, and in elementary school students than in middle- and high-school students. No significant difference was documented in the frequency of violent behaviour according to living area (urban vs rural) and in students' amount of sleep. Physical fighting was more frequent in those of low SES ( $P = 0.03$ ) and in those with medium levels of physical activity ( $P < 0.001$ ). However, the corresponding figure was not statistically significant for bullying and being bullied. Physical fighting was more common amongst students of normal weight than in other weight groups ( $P = 0.04$ ), but the difference was not statistically significant for bullying and being bullied.

The frequency of violent behaviour according to time spent on various screen time activities is presented in Table 2. Physical fighting and bullying was significantly more common in participants who spent

**Table 3 Odds ratios (95% CI) for violent behaviour by category of leisure time screen activity**

	Physical fighting?	Bullying?	Been bullied?
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Watching TV per day (>2 hrs/≤2 hrs)			
Model I	1.33 (1.23–1.43)*	1.36 (1.24–1.50)*	1.10 (1.01–1.20)*
Model II	1.32 (1.23–1.43)*	1.31 (1.19–1.44)*	1.12 (1.03–1.22)*
F-adjusted GOF ( <i>P</i> -value)	4.01 (<0.001)	1.80 (0.06)	1.02 (0.42)
Model III	1.29 (1.19–1.40)*	1.30 (1.18–1.43)*	1.12 (1.02–1.22)*
F-adjusted GOF ( <i>P</i> -value)	1.386 (0.138)	1.53 (0.135)	0.620 (0.796)
Working with computer (>2 hrs/≤2 hrs)			
Model I	1.52 (1.36–1.71)*	1.83 (1.59–2.11)*	1.10(0.9–1.26)
Model II	1.36 (1.21–1.53)*	1.62 (1.40–1.88)*	1.12(0.9–1.28)
F-adjusted GOF ( <i>P</i> -value)	3.97 (<0.001)	2.14 (0.045)	1.15 (0.32)
Model III	1.38 (1.21–1.57)*	1.57 (1.34–1.85)*	1.10(0.9–1.27)
F-adjusted GOF ( <i>P</i> -value)	0.37 (0.94)	1.79 (0.06)	1.663 (0.09)
Screen time (>2 hrs/≤2 hrs)			
Model I	1.52 (1.38–1.67)*	1.79 (1.60–1.99)*	1.13 (1.02–1.25)*
Model II	1.42 (1.29–1.56)*	1.64 (1.46–1.84)*	1.15 (1.03–1.28)*
F-adjusted GOF ( <i>P</i> -value)	2.44 (0.001)	1.41 (0.325)	1.85 (0.05)
Model III	1.42 (1.28–1.58)*	1.62 (1.43–1.83)*	1.15 (1.02–1.28)*
F-adjusted GOF ( <i>P</i> -value)	0.37 (0.94)	1.15 (0.36)	0.53 (0.85)

GOF, goodness of fit. Model I: without adjustment (crude models); Model II: adjusted for age, gender, living place; Model III: additionally adjusted for other characteristics including socio-economic status, physical activity, sleep hours, family size and body mass index.

\* *P* < 0.05

more than 2 hours of leisure time a day on computers and watching TV (*P* < 0.001). Being bullied was significantly more common for those who spent more than 2 hours a day watching TV and/or using a computer (*P* < 0.01). However, the figure was not significant for being bullied and spending more than 2 hours leisure time only on a computer.

After fitting the logistic regression model taking the survey sampling design into account, the F-adjusted mean residual goodness-of-fit (GOF) test was applied, and results of the adjusted models (Model II and III)

are presented in Tables 3 and 4. As shown in both tables, the last model (Model III) was the best fit (*P* < 0.05).

Table 3 shows the association between screen time (as binary variables) and types of violence. In the final model, i.e. after adjustment for confounding factors, watching TV for >2 hours per day increased the risk of physical fighting and quarrels by 29% (OR 1.29, 95% CI 1.19–1.40), leisure time spent on computers for >2 hours per day increased it by 38% (OR 1.38, 95% CI 1.21–1.57), and mean screen time of >2 hours per

**Table 4 Odds ratios (95% CI) for violent behaviour by hours spent on leisure time screen activity**

	Physical fighting?	Bullying?	Been bullied?
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Watching TV per day, hrs			
Model I	1.16 (1.12–1.20)*	1.23 (1.10–1.37)*	1.07 (1.03–1.11)*
Model II	1.16 (1.13–1.20)*	1.22 (1.11–1.34)*	1.08 (1.04–1.12)*
F-adjusted GOF ( <i>P</i> -value)	1.88 (0.05)	2.18 (0.02)	0.64 (0.75)
Model III	1.15 (1.10–1.19)*	1.22 (1.09–1.35)*	1.08 (1.04–1.13)*
F-adjusted GOF ( <i>P</i> -value)	0.96 (0.46)	1.53 (0.13)	1.08 (0.37)
Working with computer, hrs			
Model I	1.16 (1.12–1.21)*	1.34 (1.29–1.39)*	1.03 (0.99–1.08)
Model II	1.11 (1.07–1.16)*	1.32 (1.27–1.40)*	1.04 (1.00–1.08)*
F-adjusted GOF ( <i>P</i> -value)	3.47 (<0.001)	1.27 (0.12)	1.10 (0.35)
Model III	1.13 (1.09–1.19)*	1.32 (1.28–1.37)*	1.04 (0.99–1.09)
F-adjusted GOF ( <i>P</i> -value)	1.09 (0.36)	1.32 (0.16)	1.48 (0.14)
Screen time, hrs			
Model I	1.13 (1.10–1.16)*	1.34 (1.30–1.40)*	1.05 (1.02–1.08)*
Model II	1.12 (1.09–1.14)*	1.34 (1.28–1.41)*	1.06 (1.03–1.08)*
F-adjusted GOF ( <i>P</i> -value)	1.12 (0.34)	1.79 (0.06)	0.24 (0.98)
Model III	1.12 (1.09–1.15)*	1.33 (1.27–1.39)*	1.06 (1.03–1.09)*
F-adjusted GOF( <i>P</i> -value)	0.79 (0.62)	1.29 (0.24)	0.56 (0.83)

GOF, goodness of fit; Model I: without adjustment (raw models); Model II: adjusted for age, gender, living place; Model III: additionally adjusted for other characteristics including socio-economic status, physical activity, sleep hours, family size and body mass index;

\* *P* < 0.05

day increased it by 42% (OR 1.42, 95% CI 1.28–1.58). Spending >2 hours a day watching TV, on a computer for pleasure or on total screen time increased the risk of bullying by 30% (OR 1.30, 95% CI 1.18–1.43), 57% (OR 1.57, 95% CI 1.34–1.85) and 62% (OR 1.62, 95% CI 1.43–1.83), respectively.

Spending >2 hours a day watching TV or on total screen time increased the risk of being bullied by 12% (OR 1.12, 95% CI 1.02–1.22) and 15% (OR 1.15, 95% CI 1.02–1.28), respectively. However, this relationship was not statistically significant for leisure time spent on a computer (OR 1.10, 95% CI 0.9–1.27).

Table 4 shows the relationship between time spent on screen activity (as quantitative variables) and types of violence. Results of various logistic regression models showed that, similar to the binary variables in the final model, the number of hours spent watching TV, on a computer and total screen time (as quantitative variables) were significantly related to physical fighting and bullying. In the final model, physical fighting and quarrels increased by 15% (OR 1.15, 95% CI 1.10–1.19) in those watching TV for >2 hours per day, by 13% (OR 1.13, 95% CI 1.09–1.19) in those who spent >2 hours of daily leisure time on a computer, and by 12% (OR 1.12, 95% CI 1.09–1.15) in those who spent >2 hours a day on screen activity.

Watching TV, working on a computer for pleasure or total screen time of >2 hours a day increased the risk of bullying by 22% (OR 1.22, 95% CI 1.09–1.35), 32% (OR 1.32, 95% CI 1.38–1.37) and 33% (OR 1.33, 95% CI 1.27–1.39), respectively.

Being bullied was significantly related to watching TV (OR 1.08, 95% CI 1.04–1.13) and total screen time (OR 1.06, 95% CI 1.03–1.09) of >2 hours (as quantitative variables). It was not significantly related to leisure time spent on a computers for >2 hours a day (OR 1.04, 95% CI 0.99–1.09).

## Discussion

The findings of this study are novel in that they present information from a non-western community. They suggest that spending >2 hours a day watching TV and using a computer for pleasure, either alone or together (screen time), is associated with violent and aggressive behaviour in the paediatric age group. Prolonged time spent watching TV or using a computer for pleasure may increase violent behaviour such as physical fights and bullying, as well as the risk of being bullied. It should be noted that working with a computer for >2 hours a day also increased the incidence of violent behaviour. The findings are consistent with previous studies which found a direct association between prolonged time spent watching TV or using computer games and violent behaviour in children and adolescents.<sup>16,18</sup> Other studies, however, did not find a significant relationship

between screen time and violence. The difference might be owing to differences in culture, research methods and the age of participants in the various studies. Moreover, some studies showed that the content of media programmes is likely to be important in causing violent behaviour.<sup>19,24</sup> It has been shown that the aggressive lyrics of songs can be associated with the development of an aggressive personality.<sup>24</sup>

A recent meta-analysis of 98 studies with 36,965 participants confirmed that exposure to video games has social outcomes with short- and long-term effects.<sup>25</sup> It demonstrated that violent video games increase aggression and decrease prosocial consequences, whereas prosocial video games have the opposite effect.<sup>25</sup>

A study that considered the amount of media use and their violent content as separate predictors showed that violent content directly predicts aggressive behaviour but the overall amount of media use does not.<sup>26</sup> It is reported that adolescents who spend greater amounts of time playing video games with a violent content are more hostile and more likely to be involved in physical fights.<sup>27</sup>

Although media exposure contributes to children's socialisation;<sup>28</sup> exposure to media violence predicts more aggressive and less prosocial behavior,<sup>29</sup> whereas prosocial media content may decrease aggression.<sup>30</sup>

Other studies suggest that exceeding the time limit for screen time can diminish the relationship between children and adolescents and their parents and friends, and ultimately may reduce social interaction and the development of social and academic skills, and it may increase their isolation and violent behaviour.<sup>18,31–34</sup> Some studies have shown that every extra hour per day spent watching TV beyond the recommended 2 hours<sup>8</sup> increases the risk of violent behaviour by 20–30%.<sup>10,18,35</sup> The findings in this study are consistent with these studies. It is therefore recommended that parents, health-care providers, teachers and students should pay more attention to the disadvantages of prolonged TV viewing and time spent on computers for pleasure.

The most important limitation of this study is that the content of the media used by participants was not determined and therefore it was not possible to compare the effects of violent versus non-violent media content; only the amount of time spent on leisure time screen activity was evaluated. The other limitations are its cross-sectional design and the fact that students' answers were self-reported.

The main strength of the study is its novelty in reporting on a non-western community, including a large nationwide sample of participants, and adjustment of analyses too include other variables such as gender, SES, body mass index, physical activity and

family size. It was therefore possible to investigate the independent relationship between duration of screen time and violent and aggressive behaviour. In addition, the study evaluated more extreme forms of aggressive behaviour such as fighting and bullying which were not included in most other studies.

This study of a non-western population presents findings which show that spending prolonged leisure time on screen activities is associated with violent and aggressive behaviour in children and adolescents. In addition to the time spent on screen activity, this association is likely to be owing to the media content, which was not assessed in the current study.

### Disclaimer statements

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**Conflicts of interest** None.

**Ethics approval** The study was approved by ethical committees of all contributing organizations; informed written consent was obtained from students' parents.

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