Different types of screen time are associated with low life satisfaction in adolescents across 37 European and North American countries

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Different types of screen time are associated with low life satisfaction in adolescents across 37 European and North American countries

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Abstract

Aims: Prolonged screen time (ST) is a potential concern for poor wellbeing. This study aimed to examine the associations of different types of ST with life satisfaction among adolescents.

Methods: Data were from 380,446 adolescents (aged 11-15 years, 51% girls) across 37 European and North American countries who completed the 2010 and 2014 Health Behaviour in School-aged Children surveys. Participants reported hours/day during free time spent on television, electronic games, and computer/other devices. Life satisfaction was assessed using a 10-point scale (low life satisfaction ≤5).

Results: Generalized additive modelling showed nonlinear associations for each ST type, with low life satisfaction increasing monotonically for >1 hr/d of electronic gaming or computer/other device, and >2 hrs/d of television. Multilevel multivariable modelling showed that >4 hrs/d of television was associated with 26% higher odds for boys (OR 1.26; 95% CI:1.21-1.32) and 52% higher odds for girls (1.52; 1.46-1.59) of low life satisfaction than for ≤1 hr/d of television. Electronic gaming >4 hrs/d was associated with low life satisfaction with odds 42% higher in boys (1.42, 1.36-1.48) and 69% higher in girls (1.69, 1.61-1.76). A similar association was found for >4 hrs/d of computer/other device for boys (1.43, 1.37-1.49) and girls (1.71, 1.65-1.77).

Conclusions: Low levels of ST may be beneficial; however, prolonged periods are associated with low life satisfaction among adolescents, in particular among girls. Results support ≤2 hrs/d restriction of ST and highlight research is needed to understand underlying mechanisms of ST and wellbeing, which may not reflect active vs. passive content.

Keywords: computer use, electronic gaming, television, mentally active, mentally passive, sedentary behaviour, wellbeing, mental health.

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Introduction

Advances in technology availability, accessibility and applications in recent decades has increased adolescent screen time (ST).[1] One US study demonstrated the average adolescent in grade 12 spent more than twice as much time online in 2016 than in 2006.[2] There are concerns that prolonged ST has adverse psychological impacts in adolescents; however evidence is mixed.[3] One systematic review suggested moderate levels of ST has positive effects, but no ST and high ST has a small negative effect.[4] A recent study of 577,475 adolescents across Europe and North America reported a positive association between high ST and psychosomatic complaints.[5] Another study indicated adolescents with ST>5 hrs/d had higher odds of depressive symptoms and suicidal behaviours than those with ST≤2 hrs/d.[6]

Life satisfaction is an individualised subjective evaluation of life as a whole, and an established indicator of wellbeing.[7] High life satisfaction has a strong positive association with adaptive psychological functioning, and low rates of behavioural problems in adolescents.[8] A multi-country study during 2002-2018 indicated that adolescent girls reported lower life satisfaction than boys, and one-third of the 36 participating countries had decreases in life satisfaction.[9] This is a significant concern given continued increases in ST among young people[1, 2] and the potential link between prolonged ST and adverse psychological outcomes[6]. The mechanisms by which prolonged ST can be detrimental to adolescent wellbeing include sleep disturbance, disruption of face-to-face interactions and displacement of physical activity.[10] Earlier research has showed inverse associations of prolonged ST with various wellbeing indicators in adolescents such as depressive symptoms and quality of life, and examined wellbeing indicators such as behaviour problems, anxiety, hyperactivity and inattention, self-esteem, cognitive development and sleep outcomes.[11] However, little is known about associations between ST and life satisfaction in adolescents.

Given the increased and varied use of screens in education, social networks, and everyday life activities, it is important to develop a better understanding of how different types of ST may impact wellbeing. Mentally active ST is interactive and cognitively engaging (e.g., gaming, computer use for learning), and may provide mental and/or physical stimulation which is advantageous compared to mentally passive ST (e.g., watching television/movies/videos) which is typically more static and solitary.[12-14] The British Cohort Study reported no link between active ST (e.g., reading books, computer gaming) at age 16 years and psychological distress at age 42 years, but a significant positive association for passive ST.[15] Passive ST, but not active ST, has previously been associated with mood and anxiety disorders in adolescents.[14] Prolonged smartphone and social media use can adversely affect adolescents' wellbeing in terms of self-view and interpersonal relationships through unfavourable social comparison and cyberbullying, as well as via sleep deprivation, impaired cognitive control and altered socioemotional functioning.[16] However, many of these studies use non-representative small samples which may bias results.

More work is needed with large representative samples that differentiates between active and passive types of ST to improve knowledge on the adverse and dose-dependent impact on life satisfaction. This evidence can highlight how and to what extent specific types of ST are linked with wellbeing and inform intervention targets and behavioural recommendations. Given previously demonstrated gender differences in both ST and wellbeing[5, 9], gender-stratified analyses are also required. A recent large multi-country study reported that high levels of total ST were associated with low life satisfaction in adolescents but did not differentiate among types of ST.[5] The aim of this study, therefore, was to examine the associations between different types of ST, including mentally active and passive activities, with low life satisfaction among adolescents, and whether such associations vary across gender.

Methods

Health Behaviour in School-aged Children (HBSC) is a multinational study of adolescent health and wellbeing, with cross-sectional surveys repeated every four years in Europe and North America using a standardised protocol. The HBSC uses a stratified random cluster sampling where primary sampling units are classes within schools to obtain a nationally representative sample of 11-, 13-, and 15-year-old school-based children from each participating country. Respondents complete an anonymous standardised questionnaire with items developed by the HBSC study.[17] The current study used data from 2010 and 2014 HBSC surveys. Of the 427,675 participants across the two surveys, 380,446 cases across 37 countries had complete data on ST and life satisfaction and formed the analytical sample.

Outcome measure

Life satisfaction was assessed using the single item The Cantril ladder which has demonstrated reliability and convergent validity in adolescents.[18] Participants respond on a visual analogous scale ranging from the worst possible life (0 point) to the best possible life (10 points). The scale was dichotomised consistent with previous HBSC research (1 [low]: 0 to ≤5; 0: ≥6).[19] For sensitivity analyses, the scale was dichotomised using the median score (<8 as low).

Exposures

Respondents indicated time spent during weekdays and weekend days during their free time in each of three types of ST: (i) watching television, DVDs, other videos (e.g., YouTube); (ii) gaming using computers, gaming consoles, tablets (excluding moving/fitness games); and (iii) using computers or other electronic devices for other purposes (including social media, homework, email). There were nine response options: 0 hr/d, 0.5 hr/d, 1 hr/d, 2 hrs/d, 3 hrs/d, 4 hrs/d, 5 hrs/d, 6 hrs/d, and ≥7 hrs/d. These items have acceptable test-retest reliability.[20] ST

on weekdays and weekend days were combined to generate average ST in hrs/d, using (hours/weekday×5+hours/weekend day×2)/7. Each type of average ST was recoded into five categories: ≤1 hr/d, >1-to-2 hrs/d, >2-to-3 hrs/d, >3-to-4 hrs/d, and >4 hrs/d. For sensitivity analyses, each ST was grouped into six categories: ≤2 hrs/d, >2-to-3 hrs/d, >3-to-4 hrs/d, >4-to-5 hrs/d, >5-to-6 hrs/d and >6 hrs/d.

Covariates

A set of covariates were selected based on HBSC availability and a plausible connection to wellbeing indicators[21] and included age, cigarette smoking, having been drunk, Family Affluence Scale (FAS), body mass index (BMI) which was converted into BMI z-scores using the WHO Child Growth Standards, and number of days physically active for ≥60 mins/d in past week.

Statistical Analyses

To minimise bias due to missing data, which ranged from 0.8% for age to 18.2% for BMI (Table 1), multiple imputations by chained equations (MICE) were implemented. We used 20 imputations based on the rule that the number should be at least as large as the percentage of missing data. The imputed descriptive statistic values (e.g., mean, percentages) closely matched the observed values.

We used generalized additive models (GAMs) to examine the associations between each ST type and low life satisfaction, adjusted for the set of covariates. Smoking was excluded from the analyses due to its strong association with having been drunk. The GAM offers estimation of nonlinear relationships without specifying any functional form, which allows data driven reflection of relationships. The interaction between ST types and gender was significant ($p<0.001$), which supported the stratified analyses. We conducted multilevel multivariable logistic regression modelling to examine the associations of each ST type with

low life satisfaction, considering the nested structure of the data, adjusted for the same set of covariates. A separate model was constructed for each ST type to avoid multi-collinearity. We conducted multilevel analyses with binomial logit response models using the **runmlwin** command via Stata v17SE (StataCorp, USA). We conducted sensitivity analyses to investigate whether different categorisations of ST or life satisfaction had any differential effects on association estimates.

Results

Average age of participants was 13.6 (SD 1.63) years and 51.2% were girls (n=380,446, Table 1). Low life satisfaction was more common among girls (16.8%) than boys (12.1%). Country level descriptive statistics of the key variables are presented in Supplementary Table S1.

Patterns of associations between screen time and low life satisfaction

Smoothed functions estimated by the GAM of low life satisfaction as a function of ST type showed non-linear relationships (Chi-square tests of non-linearity: p<0·001) for boys and girls (Fig 1). Less than 1 hr/d of ST, irrespective of type, was inversely associated with low life satisfaction. In general, low life satisfaction increased monotonically after 2 hrs/d for all types of ST. A positive association between ST and low life satisfaction was observed for >1 hr/d for both electronic games or computer/other use among boys and girls. A positive association between watching television and low life satisfaction was seen for >1 hr/d in girls and >2 hrs/d in boys.

Adjusted association estimates between screen time and low life satisfaction

Multilevel multivariable logistic regression estimates of associations are presented in Table 2. Compared to ≤1 hr/d, watching television >1-3 hrs/d in boys and >1-2 hrs/d for girls was

positively associated with low life satisfaction. Among adolescents reporting >4 hrs/d of television, there was 26% higher odds for boys (OR 1.26; 95% CI:1.21-1.32) and 52% higher odds for girls (OR 1.52; 1.46-1.59) of low life satisfaction. Electronic gaming >4 hrs/d was associated with low life satisfaction with odds 42% higher in boys (OR 1.42, 1.36-1.48) and 69% higher in girls (OR 1.69, 1.61-1.76). The odds of low life satisfaction increased monotonically when computer/other use exceeded 2 hrs/d with 43% higher odds in boys (OR 1.43, 1.37-1.49) and 71% higher odds in girls (OR 1.71, 1.65-1.77) for >4 hrs/d. Additional analyses where each ST type analysis was mutually adjusted for the other ST types showed comparable results with mutual adjusted estimates (Table S2) slightly lower than the estimates obtained from analysing each type of ST separately (Table 2). The multilevel modelling showed that country and school random effects composed approximately 5-6% of the total residual variance across the different models.

Sensitivity analyses with six categories (≤2 hrs/d as reference) of each ST type produced similar results without meaningful changes (Table 3). The modelling supported the positive associations of each ST type with low life satisfaction, with the odds of low life satisfaction increasing monotonically with an increase in ST type, except for television time among boys. Additional sensitivity analyses, using the median as the cut-off for low life satisfaction, provided estimates (Table S3) which are comparable with the original estimates (Table 2).

Discussion

Our findings demonstrated non-linear relationships, with low life satisfaction increasing after 1 hr/d of either electronic games or computer/other device among both boys and girls, and for watching television for ≥1 hr/d among girls and for ≥2 hrs/d among boys. Odds of low life satisfaction increased for computer/other device after 2 hrs/d for both boys and girls, and for electronic games after 3 hrs/d for boys and after 1 hr/d for girls. The detrimental relationship

of watching television with low life satisfaction started after 4 hrs/d for boys and after 2 hrs/d for girls. Associations between prolonged ST and low life satisfaction were slightly stronger for active (gaming, computer/other use) than passive ST (television), and for adolescent girls than boys. These results contribute to the evidence on the adverse impact of prolonged ST on adolescent wellbeing and provide a more detailed understanding across different types of ST and by gender.

Our results demonstrated that prolonged ST (>2 hrs/d) of all types was associated with low life satisfaction in adolescents. A range of mechanisms may underlie this relationship. The displacement hypothesis is that ST negatively affects wellbeing because of replacing health-enhancing activities such as social involvement and exercise.[22] Social comparison explanations focus on ST content, with poor wellbeing seen as resulting from unfavourable evaluations.[23] Social media with upward comparison content (e.g., popularity) can impact adversely on self-esteem and precipitate depression and social anxiety.[24] Gaming may involve idealised images and life depictions which provide unfavourable comparisons. "Reinforcing spirals"[25] involve seeking out and engaging with ST (movies/games/online information) consistent with negative internal experiences, which are then reinforced. However, recent longitudinal research on ST and exercise has not supported the displacement hypothesis[26], and studies indicate a high proportion of people do gaming with a friend[27], as well as no difference between adolescent gamers and non-gamers in terms of the time spent interacting with family or friends[28]. More work is needed, therefore, to understand the mechanisms between ST and adolescent wellbeing, so that interventions can target the relevant mediators. If ST is reflecting specific interests and values among adolescents, then interventions that consider how these can be met in other ways may be more successful than simply constraining ST.

Our results contrast previous commentary and research suggesting mentally passive, but not active ST, is detrimental for wellbeing indicators such as depression and anxiety[12-14]. In our study, the odds of low life satisfaction were 42% and 69% higher in boys and girls for >4 hrs/d gaming (active ST), and 26% and 52% higher for watching television/DVD/movies (passive ST). Types of participants, exposure and outcome measure may contribute to cross study differences on ST and wellbeing. Some studies demonstrating benefits of active ST have focused on older adults[12, 13] who have different cognitive functioning, developmental needs, and life experience than adolescents. Some studies have examined active and passive sedentary *behaviour*, which is broader than our measure of ST and may include different activities relevant to wellbeing such as reading and doing problem solving puzzles. Active and passive ST may also have differential relationships with wellbeing according to outcome measure e.g., social connections, aggression, depression, problem solving.

Our research supports behavioural recommendations to limit recreational ST among adolescents to 2 hrs/d and indicates this should be irrespective of mentally active or passive pursuits. Parents can have a key role in limiting adolescent ST but may send mixed messages by modelling prolonged use. ST location (e.g., outside the bedroom) and cyber-safety discussions may reduce gaming. Autonomous motivation has been shown as a mechanism of ST change in parental[29] and school based interventions.[30] Effective strategies to reduce sedentary behaviour among young people include family involvement, behavioural components and electronic monitoring devices.[31] However, many studies have focussed on young children (6-10 years) and adolescents (<13 years). More intervention research is needed with older adolescents who are likely to engage with active and passive ST in different ways than those younger.

Associations between prolonged ST and low life satisfaction were stronger for adolescent girls than boys. ST>4 hrs/d increased the odds of low life satisfaction by 26%

among boys and 52% among girls for television/DVD/videos, by 42% among boys and 69% among girls for gaming, and by 43% among boys and 71% among girls for computer/other devices. Consistent with previous research[9, 32], our results also demonstrated that poor wellbeing was more common among adolescent girls than boys, with approximately one in six girls reporting low life satisfaction. Biophysical, intra-individual, environmental and sociocultural factors can increase vulnerability to poor wellbeing among adolescent girls, and the gender gap in adolescent mental health is most pronounced for life satisfaction[32]. Adolescent girls may engage with ST in ways which increase risk of poor wellbeing; girls are more likely than boys to do social networking and social comparisons, and to experience cyberbullying.[33] Interventions to reduce ST among adolescents may therefore benefit from considering gender differences in ST experiences which are specifically relevant to wellbeing, and tailoring accordingly.

In our study, *positive* life satisfaction was associated with watching television/DVD/videos for up to 3 hrs/d for boys and up to 2 hrs/d for girls, and with computer/other device (e.g., social media, homework) for up to 2 hrs/d among adolescent boys. These results suggest that limited amounts of both active and passive ST can offer positive experiences. Television and videos can provide a foundation for family interactions and other social connections, support empathy, demonstrate positive role models, and be a means of relaxation/distraction. Online computer activities can enhance knowledge, actualise interests, and enable social connections. Computer emails may also be a means of social connection and sharing information of interest. Electric gaming can provide mental stimulation, mastery experiences, help connect with others, and promote problem solving and persistence. It is important therefore, that interventions to manage ST for adolescent wellbeing do not vilify ST but instead adopt an "in moderation" philosophy. A key component of such interventions could be identifying warning signs of adverse impact e.g.,

excluding other recreation activities, negative emotions/mood, altered sleep patterns, aggression.

The strengths of this study include a large multi-country and nationally representative sample, assessment items with sound psychometric properties, novel analytic techniques (e.g., GAMs) and adjustment for multiple covariates, and stratified analyses to extend understanding of the associations across gender. However, data were self-reported so are susceptible to bias (e.g., social desirability, recall). Gaming and computer/other device use were conceptualised as active ST, and television/DVD/video as passive ST; however, the validity of this cannot be confirmed. We used life satisfaction as the indicator of adolescent wellbeing, however both constructs reflect a complex range of components and a different outcome measure (e.g., depression, social connections) may have demonstrated different associations with ST. Computer and other device use included a range of undifferentiated activities (e.g., homework, social media) which could have different associations with life satisfaction. Exploration of relationships by GAMs did not consider dependence in data. The non-linear relationship of positive effects with moderate screen use may also be an artefact of bias; the analyses were adjusted for a limited set of covariates available in the HBSC data, which can contribute to the shape of the relationship. Data are cross-sectional and cannot indicate the direction of ST and wellbeing relationships. Data were collected over the past decade and may not reflect changes in contemporary screen media landscape.

Conclusions

This study demonstrated non-linear associations between mentally active (i.e., computer/other device, gaming) and passive (i.e., television/DVDs/videos) ST and low life satisfaction among adolescents. Life satisfaction was *positive* for low levels of all ST types. Adverse associations between ST and life satisfaction began when watching television/movies/videos exceeded 2 hrs/d for girls and 4 hrs/d for boys, computer/other use

exceeded 2 hrs/d for both boys and girls, and gaming exceeded 3 hrs/d for boys and 1 hr/d for girls. Associations were slightly stronger for mentally active than passive ST, and for adolescent girls than boys. These results support behavioural recommendations to limit recreational ST to 2 hrs/d but highlight that some ST can be advantageous. More work is needed to understand the relationships between different types and content of ST and wellbeing specific to adolescents, as well as underlying mechanisms and moderators of change.

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Figure 1. Smoothed adjusted associations of various screen use with low life satisfaction by gender, using generalized additive models.

Table 1: Description of analytic sample from Health Behaviour in School Aged Children (HBSC) study across 37 countries, 2010-2014 (n=380,446).

Table 2: Multilevel logistic regression§ estimates of independent associations of watching television, electronic gaming, and computer/other use with low life satisfaction among adolescents across 37 countries, HBSC 2010-2014.

Table 3: Sensitivity analyses of examining associations§ of watching television, electronic gaming, and computer/other use (six categories) with low life satisfaction of adolescents across 37 countries, HBSC 2010-2014.

Table S1. Descriptive statistics for the study sample from 37 countries, HBSC 2010-2014.

Table S2: Multilevel logistic regression§ estimates of mutually adjusted associations of watching television, electronic gaming, and computer/other use with low life satisfaction among adolescents across 37 countries, HBSC 2010-2014.

Table S3: Sensitivity analyses of examining associations§ of watching television, electronic gaming, and computer/other use with low life satisfaction (median cut-off) of adolescents across 37 countries, HBSC 2010-2014.

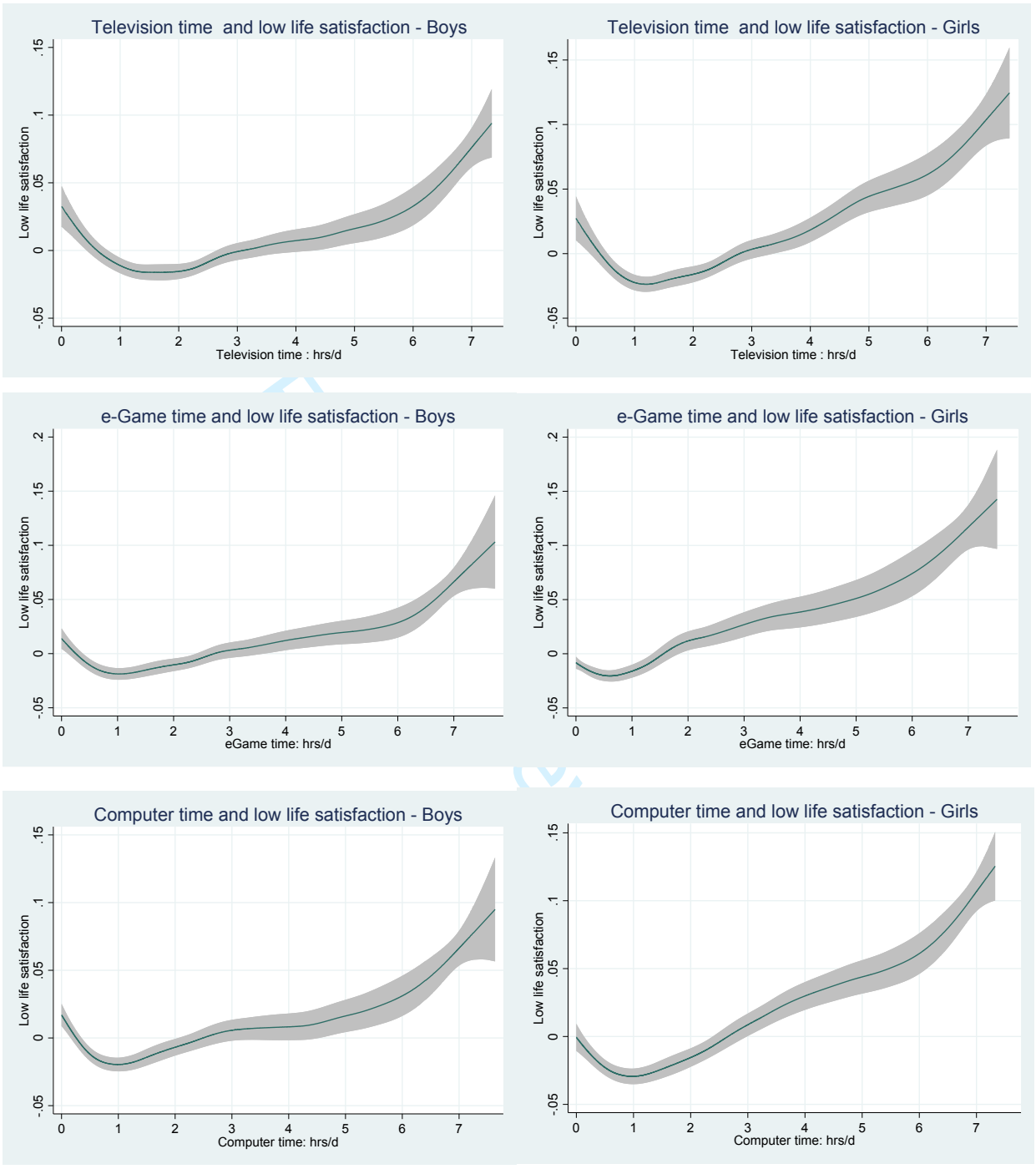

Figure 1. Smoothed adjusted associations of various screen use with low life satisfaction by gender, using generalized additive models§.

NB: Chi-square tests for non-linearity: p<0.001 for all

§ adjusted for age, BMI z-scores, having been drunk, physical activity, family affluence scale, and survey round.

Table 1: Description of analytic sample from Health Behaviour in School Aged Children (HBSC) study across 37 countries, 2010-2014 (n=380,446).

Characteristics	Boys	Girls
	Mean (SD)	
Age (years)[a]	13.58 (1.63)	13.56 (1.63)
Body Mass Index (BMI)[b]	19.79 (3.55)	19.38 (3.36)
Screen Time (hrs/d)		
Watching television[c]	2.52 (1.69)	2.38 (1.60)
Electronic gaming[d]	2.29 (1.87)	1.34 (1.65)
Computer use[e]	2.06 (1.89)	2.20 (1.92)
Physical activity (days/wk)[f]	4.43 (2.06)	3.80 (2.02)
	N (%)	
Total study participants	185,965	194,481
Age (years)		
11	53,505 (28.77)	56,562 (29.08)
13	65,243 (35.08)	68,043 (34.99)
15	67,085 (36.07)	9,781 (35.88)
Missing	132 (0.07)	95 (0.07)
Been drunk (days/month)		
Never	138,303 (74.37)	152,047 (78.18)
Once	17,811 (9.58)	16,527 (8.50)
Twice or more	23,337 (12.55)	20,080 (10.32)
Missing	6,514 (3.50)	5,827 (3.00)
Family affluence scale		
Q1	68,075 (36.61)	79,036 (40.64)
Q2	34,753 (18.69)	36,197 (18.61)
Q3	31,724 (17.06)	32,077 (16.49)
Q4	39,229 (21.09)	37,749 (19.41)
Missing	12,184 (6.55)	9,422 (4.84)
Low life satisfaction[g]	12.14 (11.99-12.29)	16.76 (16.59-16.93)

SD: Standard deviation;
Qi : i^{th} quartile
Missing values:
[a] Age: 0.8%
[b] BMI: 18.2%
[c] Television: 9.4%
[d] Electronic gaming: 9.6%
[e] Computer/other use: 9.4%
[f] $\geq$ 60 mins of PA: 2.0%
[g] <5 on scale of 1-10

Table 2: Multilevel logistic regression modelling§ estimates of independent associations of watching television, electronic gaming, and computer/other use with ***low life satisfaction*** among adolescents across 37 countries, HBSC 2010-2014.

	Low life satisfaction	
	Boys	**Girls**
	aOR (95% CI)	**aOR (95% CI)**
Watching Television		
≤1 hr/d[a]	1.0	1.0
>1-2 hrs/d	0.85 (0.81, 0.89)	0.95 (0.91, 0.98)
>2-3 hrs/d	0.91 (0.87, 0.95)	1.06 (1.02, 1.10)
>3-4 hrs/d	1.01 (0.96, 1.06)	1.15 (1.11, 1.20)
>4 hrs/d	1.26 (1.21, 1.32)	1.52 (1.46, 1.59)
Electronic gaming		
≤1 hr/d[a]	1.0	1.0
>1-2 hrs/d	0.96 (0.92, 1.00)	1.10 (1.06, 1.14)
>2-3 hrs/d	1.03 (0.98, 1.08)	1.23 (1.18, 1.28)
>3-4 hrs/d	1.14 (1.08, 1.20)	1.39 (1.32, 1.47)
>4 hrs/d	1.42 (1.36, 1.48)	1.69 (1.61, 1.76)
Computer/other use		
≤1 hr/d[a]	1.0	1.0
>1-2 hrs/d	0.95 (0.91, 0.98)	0.99 (0.96, 1.03)
>2-3 hrs/d	1.10 (1.05, 1.14)	1.16 (1.11, 1.20)
>3-4 hrs/d	1.17 (1.11, 1.23)	1.35 (1.29, 1.41)
>4 hrs/d	1.43 (1.37, 1.49)	1.71 (1.65, 1.77)

§ adjusted for age, BMI, been drunk, physical activity, family affluence scale and survey round.

aOR: adjusted odds ratios; CI: Confidence interval.

[a] reference category.

Table 3: Sensitivity analyses of examining associations[§] of watching television, electronic gaming, and computer/other use (six categories) with low life satisfaction of adolescents across 37 countries, HBSC 2010-2014.

	Low life satisfaction	
	Boys	**Girls**
	aOR (95% CI)	**aOR (95% CI)**
Watching television		
≤2 hrs/d[a]	1.0	1.0
>2-3 hrs/d	0.99 (0.95, 1.03)	1.09 (1.06, 1.13)
>3-4 hrs/d	1.10 (1.05, 1.15)	1.19 (1.14, 1.23)
>4-5 hrs/d	1.20 (1.14, 1.27)	1.44 (1.38, 1.51)
>5-6 hrs/d	1.29 (1.19, 1.38)	1.53 (1.44, 1.63)
>6 hrs/d	1.74 (1.64, 1.84)	1.89 (1.78, 2.01)
Electronic gaming		
≤2 hrs/d[a]	1.0	1.0
>2-3 hrs/d	1.05 (1.01, 1.09)	1.20 (1.15, 1.25)
>3-4 hrs/d	1.16 (1.11, 1.22)	1.36 (1.29, 1.44)
>4-5 hrs/d	1.29 (1.22, 1.36)	1.46 (1.37, 1.55)
>5-6 hrs/d	1.37 (1.27, 1.47)	1.54 (1.42, 1.68)
>6 hrs/d	1.70 (1.61, 1.80)	1.94 (1.83, 2.07)
Computer/other use		
≤2 hrs/d[a]	1.0	1.0
>2-3 hrs/d	1.12 (1.07, 1.16)	1.16 (1.12, 1.20)
>3-4 hrs/d	1.19 (1.13, 1.25)	1.35 (1.30, 1.41)
>4-5 hrs/d	1.24 (1.17, 1.32)	1.53 (1.46, 1.61)
>5-6 hrs/d	1.31 (1.21, 1.42)	1.58 (1.48, 1.67)
>6 hrs/d	1.75 (1.66, 1.85)	2.01 (1.92, 2.11)

[§] adjusted for age, BMI z-scores, been drunk, physical activity and family affluence score with six categories for each ST type.

aOR: adjusted odds ratio; CI: Confidence interval.

[a] reference category.

Table S1. Descriptive statistics for the study sample from 37 countries, HBSC 2010-2014

Country	N	Age		% Girls	% Low life satisfaction	Television[#]		Electronic game[#]		Computer use[#]	
		Mean	SD			Mean	SD	Mean	SD	Mean	SD
Armenia	5,943	13.26	1.64	53.9	8.65	2.75	1.73	1.58	1.68	1.60	1.72
Austria	8,326	13.46	1.66	51.95	12.89	2.25	1.58	1.67	1.75	1.85	1.75
Belgium Flemish	8,447	13.47	1.72	47.61	14.61	2.49	1.63	1.56	1.65	2.02	1.85
Belgium French	9,627	13.47	1.66	50.63	14.46	2.34	1.65	1.94	1.77	1.91	1.82
Canada	27,766	13.73	1.51	50.85	17.1	2.49	1.74	2.08	1.98	2.25	2.01
Croatia	11,778	13.65	1.66	51.05	14.28	2.67	1.70	1.62	1.72	2.06	1.87
Czech Republic	9,322	13.47	1.66	52.17	17.9	2.39	1.59	1.79	1.79	2.14	1.90
Denmark	8,151	13.61	1.65	52.63	12.92	2.57	1.61	2.08	1.90	2.15	1.81
England	8,569	13.54	1.64	51.69	15.38	2.64	1.67	1.95	1.91	2.54	1.98
Estonia	8,256	13.76	1.65	51.01	12.4	2.50	1.55	1.96	1.84	2.45	1.93
Finland	12,549	13.69	1.66	51.44	10.52	2.18	1.36	1.35	1.52	2.01	1.64
France	11,712	13.42	1.65	49.89	15.94	2.41	1.75	1.77	1.81	2.05	1.96
Germany	10,814	13.42	1.67	50.22	16.63	2.40	1.61	1.82	1.81	2.13	2.04
Greece	8,949	13.66	1.64	50.96	11.58	2.69	1.66	1.68	1.72	1.94	1.81
Greenland	1,973	13.55	1.64	52.81	17.13	2.38	1.75	1.17	1.51	1.02	1.33
Hungary	8,587	13.52	1.65	51.81	16.7	2.45	1.64	1.84	1.75	2.04	1.79
Iceland	21,133	13.55	1.65	49.81	11.05	2.03	1.41	1.59	1.83	2.14	1.84
Ireland	8,670	13.73	1.55	53.52	13.75	2.18	1.54	1.38	1.60	1.73	1.81
Israel	8,343	13.70	1.65	54.01	13.56	2.86	1.92	2.28	2.12	2.63	2.16
Italy	8,808	13.52	1.66	49.89	14.82	2.10	1.48	1.63	1.64	1.83	1.78
Latvia	9,653	13.56	1.65	52.39	15.22	2.58	1.57	1.73	1.69	2.01	1.67
Luxembourg	7,280	13.60	1.60	51.54	15.65	2.28	1.66	1.59	1.71	2.10	1.93
Macedonia	7,743	13.69	1.62	50.25	16.94	2.55	1.83	2.03	1.90	2.29	1.96
Netherlands	8,688	13.48	1.60	51.12	7.19	2.83	1.71	2.12	2.01	2.61	2.06
Norway	7,493	13.39	1.66	50.63	11.57	2.26	1.47	1.61	1.77	2.04	1.72
Poland	8,529	13.63	1.65	51.23	19.83	2.57	1.66	1.79	1.79	2.46	1.93
Portugal	8,719	13.57	1.60	52.99	16.41	2.70	1.73	1.67	1.69	2.03	1.74
Romania	9,161	13.23	1.66	51.81	18.28	2.90	1.87	2.37	2.03	2.13	2.02
Russia	9,256	13.45	1.63	53.33	17.71	2.63	1.78	1.98	1.89	2.45	2.05
Scotland	12,559	13.67	1.67	50.45	12.71	2.63	1.71	2.29	2.03	2.57	2.10
Slovakia	11,285	13.56	1.52	50.46	17.96	2.92	1.75	1.82	1.95	2.42	1.99
Slovenia	10,345	13.62	1.63	50.03	12.69	2.16	1.40	1.37	1.52	1.88	1.71
Spain	14,925	13.66	1.61	51.14	11.99	2.25	1.57	1.67	1.69	2.13	1.90
Sweden	13,908	13.52	1.69	50.39	14.64	2.50	1.57	2.05	1.89	2.39	1.97
Switzerland	12,985	13.53	1.57	50.23	12.2	1.82	1.39	1.25	1.38	1.61	1.59
Ukraine	10,057	13.67	1.67	52.93	18.05	2.74	1.55	1.45	1.59	1.23	1.56
Wales	10,137	13.64	1.61	49.22	16.78	2.68	1.69	2.15	1.95	2.55	2.00
Total	***380,446***	***13.57***	***1.63***	***51.12***	***14.5***	***2.45***	***1.65***	***1.80***	***1.82***	***2.13***	***1.92***

[#] *screen-time was assessed in hrs/d.*

Table S2: Multilevel logistic regression modelling§ estimates of mutually adjusted associations of watching television, electronic gaming, and computer/other use with ***low life satisfaction*** among adolescents across 37 countries, HBSC 2010-2014.

	Low life satisfaction	
	Boys	**Girls**
	aOR (95% CI)	**aOR (95% CI)**
Watching Television		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	0.84 (0.81, 0.88)	0.93 (0.89, 0.96)
2-3 hrs/d	0.88 (0.84, 0.93)	0.99 (0.95, 1.03)
3-4 hrs/d	0.94 (0.89, 0.99)	1.02 (0.97, 1.06)
>4 hrs/d	1.08 (1.03, 1.13)	1.23 (1.18, 1.29)
Electronic gaming		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	0.98 (0.94, 1.03)	1.09 (1.06, 1.13)
2-3 hrs/d	1.03 (0.98, 1.08)	1.15 (1.10, 1.20)
3-4 hrs/d	1.08 (1.03, 1.14)	1.21 (1.14, 1.28)
>4 hrs/d	1.24 (1.18, 1.30)	1.28 (1.23, 1.35)
Computer/other use		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	0.96 (0.92, 1.00)	0.97 (0.93, 1.01)
2-3 hrs/d	1.08 (1.03, 1.13)	1.09 (1.04, 1.13)
3-4 hrs/d	1.10 (1.04, 1.16)	1.23 (1.17, 1.29)
>4 hrs/d	1.22 (1.16, 1.28)	1.44 (1.38, 1.50)

§ adjusted for age, BMI, been drunk, physical activity, family affluence scale, survey round, and mutually for each other ST types.
aOR: adjusted odds ratios; CI: Confidence interval.
[a] reference category.

Table S3: Sensitivity analyses of examining associations[§] of watching television, electronic gaming, and computer/other use discretionary uses of screen time with ***low life satisfaction (median cut-off)*** [¥] among adolescents across 37 countries, HBSC 2010-2014.

	Low life satisfaction	
	Boys	**Girls**
	aOR (95% CI)	**aOR (95% CI)**
Watching Television		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	1.02 (0.98, 1.05)	1.08 (1.05, 1.11)
2-3 hrs/d	1.10 (1.07, 1.14)	1.20 (1.16, 1.23)
3-4 hrs/d	1.22 (1.18, 1.26)	1.34 (1.30, 1.39)
>4 hrs/d	1.28 (1.24, 1.32)	1.49 (1.44, 1.54)
Electronic gaming		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	1.10 (1.07, 1.13)	1.13 (1.10, 1.16)
2-3 hrs/d	1.19 (1.15, 1.22)	1.26 (1.22, 1.30)
3-4 hrs/d	1.32 (1.28, 1.37)	1.37 (1.31, 1.43)
>4 hrs/d	1.40 (1.36, 1.44)	1.51 (1.46, 1.57)
Computer/other use		
≤1 hr/d[a]	1.0	1.0
1-2 hrs/d	1.02 (0.98, 1.04)	1.11 (1.08, 1.14)
2-3 hrs/d	1.14 (1.11, 1.18)	1.29 (1.25, 1.33)
3-4 hrs/d	1.23 (1.18, 1.28)	1.44 (1.39, 1.49)
>4 hrs/d	1.29 (1.25, 1.33)	1.65 (1.60, 1.70)

[§] mutually adjusted for age, BMI, been drunk, physical activity, family affluence scale and survey round.

aOR: adjusted odds ratios; CI: Confidence interval.

[¥] using median cut-off of life satisfaction

[a] reference category.