

Determinants and health-related consequences of screen time in children and adolescents: post-COVID-19 insights from a prospective cohort study

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Summary

AIMS: This study aims to provide age-specific prevalence of time spent on-screen among children and adolescents, to identify its sociodemographic and family-related determinants and to assess its impact on physical and psychosocial health outcomes.

METHODS: Data was drawn from the SEROCov-KIDS prospective cohort study, which includes randomly selected children living in Geneva, Switzerland. Daily screen time, sociodemographic and family characteristics were collected at baseline (December 2021 to June 2022). Physical and psychosocial health outcomes were measured at one-year follow-up.

RESULTS: Among 674 children (2–8 years old), 752 preadolescents (9–13 years old) and 434 adolescents (14–17 years old), median daily screen time was 0h29, 1h14 and 3h18, respectively. Lower parental education and poorer parenting practices were associated with higher screen time in all age groups. In children only, poor parental mental health (+14 minutes/day; 95% CI: 2–27) and work-family conflicts (+6 minutes/day; 95% CI: 2–10) were related to increased screen time. After adjustment, elevated screen time was associated with an increased likelihood of poor physical-, emotional- and school-related quality of life in preadolescents and adolescents and of social difficulties in adolescents one year later.

CONCLUSION: Almost all children engage with screens, but those from socially disadvantaged backgrounds and with strained families face a heightened risk of prolonged screen time. The health consequences we identified call for close monitoring.

Introduction

The prevalence of screen use has risen notably among children and adolescents over the past few decades [1]. Average recreational screen time of European adolescents rose from 4 to 6.5 hours a day between 2002 and 2014, while in Switzerland the proportion of adolescents spending more than 2 hours per day on-screen jumped from 61% to 81% over the same period [2]. In 2018, average weekend screen time of 11–15-year-olds living in Switzerland was as high as 8 hours per day [3]. The shift to many activities online during the COVID-19 pandemic likely contributed to an acceleration of this trend, as screen time increased globally during that period [4], including in Switzerland [5], and has remained elevated ever since [6, 7]. These patterns are alarming given that studies have uncovered adverse effects of screen time on the wellbeing of young individuals. Moreover, with the widespread adoption of mobile devices usable anywhere with limited adult supervision, screen use keeps evolving quickly [1, 8], and reports from ten years ago may already be outdated [1, 8].

Several sociodemographic and family characteristics have been related to screen time among children and adolescents, but findings are mixed across studies [9–12]. Older age seems to be a common predictor of higher screen time [9, 10]. Disadvantaged socioeconomic circumstances were shown to be associated with increased time spent on-screen in two systematic reviews [9, 11], while two others found inconsistent results [10, 12]. Family characteristics such as poor parental mental health or a lack of screen rules might also be related to higher screen time, but with conflicting results across reviews [9, 10, 12]. A previous report suggests that determinants of screen time vary depending on

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context and highlights the need for country-specific studies [13].

While screen use can offer learning and communication opportunities [1], elevated screen time has been linked to various adverse physical and psychosocial health outcomes in young populations [1]. Several meta-analyses reported an increased risk of excess weight and poor self-rated health among children and adolescents with higher screen time [14–16]. According to the displacement hypothesis, this could be attributed to the shift of time dedicated to health-promoting activities, such as exercise and sleep, towards screen use [17]. Moreover, a systematic review found moderate evidence linking screen time to depressive symptoms and diminished quality of life. It also found weaker evidence suggesting connections with behavioural issues, anxiety, poorer psychosocial health and lower educational achievements. [16]. These findings mirror those from a systematic review of longitudinal studies showing a small but significant effect of screen time on depressive symptoms among adolescents, but lacking evidence to support a relationship with other internalising problems [18]. The negative effect of screen time on young individuals' psychosocial wellbeing could be explained by the displacement of activities beneficial to health and by screen content if violent, age-inappropriate, triggering upward social comparison or exposing them to cyberbullying [19]. Importantly, these associations might be evolving along with the increasing diversity of screen uses including social interactions, gaming, information seeking and content creation [1].

Therefore, we aimed (1) to describe up-to-date post-pandemic prevalence of screen time and adherence to corresponding recommendations by age, (2) to identify sociodemographic and family determinants of screen time, and (3) to examine its effects on subsequent physical and psychosocial health outcomes.

Materials and methods

Study design

Data was extracted from the SEROCOVID-KIDS population-based prospective cohort study, which was designed to evaluate the direct and indirect impacts of the COVID-19 pandemic on the health of children and adolescents, in Geneva, Switzerland. Eligibility criteria were to be aged between 6 months and 17 years old and living in the canton of Geneva at baseline. Eligible children and adolescents were randomly selected from state registries either specifically for this study or for COVID-19 seroprevalence studies conducted in our unit [20–23]. The index registries were provided by the Swiss Federal Office of Statistics or the Geneva Cantonal Office for Population and Migration. Participants aged 2–17 years at enrollment were included in the present analysis and categorised as follows: children, aged 2–8 years; preadolescents, aged 9–13 years; and adolescents, aged 14–17 years (figure S1 in the appendix).

Data was collected at baseline between December 2021 and June 2022 and during two follow-up assessments conducted about 6 months apart (first follow-up, between September 2022 and February 2023; second follow-up, between May 2023 and September 2023). Online questionnaires were completed on the Specchio-Hub online plat-

form [24] by the referent parents (or legal guardian) on behalf of their participating children. Adolescents, aged 14 years or above, also completed their own questionnaires specifically tailored to their age group.

Measures

Adolescents self-reported screen time and health-related quality of life (HRQoL); all other measures were parent-reported (table S1 in the appendix).

Screen time

At baseline, participants were asked how many hours per weekday and weekend day they (or their child) spend on-screen (smartphone, computer, television, tablet, video game) for recreational purposes. Average screen time per day was calculated as $(\text{weekday} \times 5 + \text{weekend day} \times 2) / 7$. Non-adherence to recommendations was defined as spending more than one hour per day on-screen for children under five years according to the World Health Organization's (WHO) guidelines [25]. For older children, neither the WHO nor Swiss health authorities provide a threshold and we used the daily two hours limit proposed by Canadian and Australian guidelines [26, 27].

Determinants

Based on the literature, the following sociodemographic characteristics assessed at baseline were considered as potential determinants. The educational level attained by each parent was combined to obtain the parents' highest education (*lower than college vs college or higher*). The parents' birth country was grouped into *at least one born in Switzerland vs both born abroad*. Parents who stated that they were raising their child(ren) alone were defined as a single parent, in which case only their education and birth country was considered. The household financial situation was deemed *good* if its members could cover their needs and face unforeseen expenses and *average-to-poor* if they could hardly cover unforeseen expenses or could not meet current needs.

We additionally evaluated family determinants at baseline including having siblings (*yes vs no*) and referent parent's mental health (*good vs average-to-poor*), as well as the following family dynamics treated as continuous variables. Family adjustment, which refers to the within-family support and emotional resources to face challenges, was measured as the combination of the parental adjustment, family relationships and parental teamwork scales from the parenting and family adjustment scales (PAFAS) [28, 29]. Parenting practices were assessed by grouping the following PAFAS scales: parental consistency, coercive parenting, positive encouragement and parent-child relationship [28, 29]. The work-family conflict scale was additionally included [30]. Family dynamics were measured at the first follow-up, about eight months after the baseline assessment (mean: 39.2 weeks; standard deviation [SD]: 9.9). We did not expect these constructs to drastically change within this interval and decided to assess their effect on screen time along with the sociodemographic characteristics collected at baseline.

Health outcomes

Physical and psychosocial health outcomes were measured at baseline and at the second follow-up assessment, about 16 months later (mean: 71.8 weeks; SD: 9.9) and dichotomised with published thresholds corresponding to impaired health (table S1 in the appendix).

Body mass index (BMI) z-scores for age were calculated using the *anthro* [31] and *anthroplus* [32] R packages from the WHO. Excess weight was defined as a z-score above +2 SD for children aged below 5 years and above +1 SD for older children [33]. The physical, emotional, social and school health-related quality of life were assessed with the corresponding subscales of the Pediatric Quality of Life Inventory (PedsQL) Short Form [34]. A poor health-related quality of life was defined with thresholds provided by Varni et al. [35]. The Strengths and Difficulties Questionnaire (SDQ) was used to evaluate behavioural problems [36]. As recommended for community samples, internalising problems were assessed by combining the emotional and peer problems subscales, and externalising problems were computed by adding the conduct problems and hyperactivity subscales, while prosocial behaviours were separately analysed [37]. Behavioural problems were defined with clinical thresholds (90th percentile) based on United Kingdom norms available on <https://sdqinfo.org/>.

Covariates

The following variables were collected at baseline: age, sex, daily hours of physical activity, participation in extracurricular activities and number of close friends (only available for preadolescents and adolescents). For 2-year-old children, physical activity and extracurricular activities were measured at the second follow-up.

Statistical analyses

Median screen time and prevalence of non-adherence to recommendations were weighted according to the Geneva population's age and sex distribution [38]. Multivariate models were specified following hypothesised relationships between study variables (figure S2 in the appendix). Sociodemographic determinants of screen time in minutes, the primary outcome, were assessed together in age- and sex-adjusted models. Family determinants were separately evaluated in models adjusted for age, sex and sociodemographic variables to estimate their respective direct effect [39]. Adherence to screen recommendations and screen time in percentage difference (using log transformation) were examined as secondary outcomes with the same set of adjustments. The associations between screen time at baseline and each subsequent health outcome after one year were examined with three distinct models to evaluate the effect of different adjustments. The first model was adjusted for age, sex and sociodemographic variables and the second one was further adjusted for physical activity, extracurricular activity and the number of friends; the main model presented in the results further controlled for the baseline level of the examined health outcome. The month of screen time measurement was tested as a potential covariate but was not included in the final models as there was no association with screen time (p -value > 0.1). Generalised linear models taking the household clustering of da-

ta into account were performed using the R survey package [40]. Linear models following a Gaussian distribution were performed for continuous outcomes and robust Poisson models following a quasi-Poisson distribution were chosen for binary outcomes. The assumptions of the linear regression models were evaluated through visual inspection of the residuals and were deemed to be adequately met.

Missing data

Parent-reported information at the first and second follow-up was available for 1532/1860 (82.4%) and 1277 (68.7%) participants, respectively (figure S1 in the appendix). A total of 393/434 (90.5%) adolescents additionally completed a baseline questionnaire and 270 (62.2%) a second follow-up. Questionnaire non-response was more frequent among older participants with foreign origin, a disadvantaged financial background and a poor health-related quality of life (table S2 in the appendix). Following Seaman et al. [41], we opted for a cautious approach to handle missing data, which combines inverse probability weighting (IPW) for questionnaire non-response and multiple imputation (MI) for item non-response. Propensities to respond to the first and second follow-up questionnaires were separately quantified at the household level using generalised linear models. The inverse of the estimated propensity to respond was used to weight the main models. Missing items were imputed by chained equations with 10 imputed datasets and 1000 iterations using the R mice package [42].

All analyses were stratified by age group to account for the fact that the associations under study may vary depending on age. Estimations were performed with R 4.2.2, available under the GNU General Public License. The R tidyverse package was used for data management and visualisation [43]; codes are accessible to researchers upon request. A formal study protocol was not pre-registered.

Ethics approval and consent to participate

The Geneva Cantonal Commission for Research Ethics approved the study (ID: 2021-01973). All referent adults, as well as adolescents aged 14 years or older provided written consent to participate. Children gave oral assent to participate.

Results

A total of 1860 participants were included: 674 children (mean age: 5.5 years), 752 preadolescents (mean age: 10.9 years) and 434 adolescents (mean age: 15.4 years, table 1). Intraclass correlation at the household level ranged from 0.43 among adolescents to 0.89 among children.

When weighted according to the Geneva population's age and sex distribution, median screen time per day was 0h29 (quartile [Q] 1–Q3: 0h14–0h51), 1h14 (Q1–Q3: 0h47–1h48) and 3h18 (Q1–Q3: 2h11–4h43), respectively for children, preadolescents and adolescents (figure 1). Prevalence of non-adherence to screen recommendations increased from 7.0% among children to 20.7% among preadolescents and 78.7% among adolescents. Overall, 61 children (9.1%) were reported to have no screen time, while this was the case for 6 preadolescents (0.8%) and 2 adolescents (0.5%) only.

Table 1: Sociodemographic, family and health characteristics of children (2–8 years old), preadolescents (9–13 years old) and adolescents (14–17 years old) according to non-adherence to screen recommendations and screen time.

		Children (n = 672)			Preadolescents (n = 750)			Adolescents (n = 391)		
		Total	Non-adherence	Time (hours/day)	Total	Non-adherence	Time (hours/day)	Total	Non-adherence	Time (hours/day)
		n	n (%)	Median (Q1–Q3)	n	n (%)	Median (Q1–Q3)	n	n (%)	Median (Q1–Q3)
Determinants										
Age ^b		5.5 (1.9)	4.9 (1.9)	–	10.9 (1.4)	11.6 (1.4)	–	15.4 (1.1)	15.5 (1.1)	–
Sex	Male	333	21 (6.3%)	0h30 (0h15–0h49)	382	74 (19.4%)	1h17 (0h39–1h51)	187	147 (78.6%)	3h17 (2h15–4h54)
	Female	338	23 (6.8%)	0h30 (0h15–0h58)	367	76 (20.7%)	1h09 (0h39–1h56)	203	158 (77.8%)	3h04 (2h09–4h26)
	Other	1	0 (0.0%)	–	1	0 (0.0%)	–	1	1 (100.0%)	–
Parents' birth country	At least one in Switzerland	403	20 (5.0%)	0h28 (0h15–0h49)	465	84 (18.1%)	1h09 (0h39–1h47)	260	207 (79.6%)	3h09 (2h17–4h34)
	Abroad	269	24 (8.9%)	0h34 (0h17–1h00)	285	66 (23.2%)	1h17 (0h39–1h56)	131	99 (75.6%)	3h09 (2h06–4h34)
Parents' highest education	College or higher	583	32 (5.5%)	0h28 (0h15–0h47)	617	112 (18.2%)	1h09 (0h39–1h47)	325	247 (76.0%)	3h00 (2h09–4h17)
	Lower than college	89	12 (13.5%)	1h00 (0h34–1h26)	133	38 (28.6%)	1h30 (1h06–2h17)	66	59 (89.4%)	4h00 (3h52–6h04)
Household financial situation	Good	529	28 (5.3%)	0h28 (0h13–0h47)	563	112 (19.9%)	1h09 (0h39–1h56)	305	244 (80.0%)	3h04 (2h13–4h30)
	Average to poor	110	14 (12.7%)	0h39 (0h24–1h12)	136	31 (22.8%)	1h17 (0h51–1h49)	64	46 (71.9%)	3h26 (1h46–5h56)
	Missing ^c	33	2 (6.1%)	0h30 (0h17–0h47)	51	7 (13.7%)	0h56 (0h39–1h39)	22	16 (72.7%)	3h26 (1h57–4h13)
Single parenthood	No	607	41 (6.8%)	0h30 (0h15–0h56)	673	123 (18.3%)	1h13 (0h39–1h47)	348	272 (78.2%)	3h04 (2h09–4h31)
	Yes	27	1 (3.7%)	0h39 (0h17–1h04)	43	20 (46.5%)	1h56 (1h03–2h34)	23	19 (82.6%)	4h26 (2h51–5h15)
	Missing	38	2 (5.3%)	0h28 (0h17–0h56)	34	7 (20.6%)	1h08 (0h39–1h47)	20	15 (75.0%)	3h17 (2h05–4h00)
Siblings	Yes	600	38 (6.3%)	0h30 (0h15–0h56)	682	130 (19.1%)	1h16 (0h39–1h50)	362	287 (79.3%)	3h09 (2h17–4h30)
	No	72	6 (8.3%)	0h34 (0h09–1h00)	68	20 (29.4%)	1h17 (0h44–2h17)	29	19 (65.5%)	3h13 (1h47–5h26)
Referent parent mental health	Good	570	29 (5.1%)	0h30 (0h15–0h47)	656	127 (19.4%)	1h13 (0h39–1h47)	354	273 (77.1%)	3h09 (2h09–4h34)
	Average to poor	101	15 (14.9%)	0h39 (0h19–1h13)	94	23 (24.5%)	1h17 (0h46–2h00)	37	33 (89.2%)	3h17 (2h17–5h09)
	Missing	1	0 (0.0%)	–	–	–	–	–	–	–
Family adjustment ^{bd}		8.2 (5.0)	9.3 (5.1)	–	8.3 (4.9)	8.8 (5.1)	–	8.3 (4.8)	8.6 (4.9)	–
Parenting practices ^{bd}		12.2 (3.9)	13.3 (3.5)	–	12.4 (4.7)	13.7 (5.6)	–	13.0 (4.9)	13.3 (5.0)	–
Work-family conflict ^{bd}		2.0 (0.8)	2.2 (0.8)	–	2.0 (0.8)	2.0 (0.8)	–	1.9 (0.8)	2.0 (0.8)	–
Outcomes										
Weight status	Normal weight	382	19 (5.0%)	0h28 (0h13–0h47)	434	87 (20.0%)	1h13 (0h39–1h47)	233	185 (79.4%)	3h09 (2h09–4h34)
	Excess weight	72	7 (9.7%)	0h39 (0h19–1h07)	99	24 (24.2%)	1h34 (0h57–2h00)	22	19 (86.4%)	3h49 (2h35–5h04)
	Missing	218	18 (8.3%)	0h34 (0h17–1h00)	217	39 (18.0%)	1h09 (0h39–1h47)	136	102 (75.0%)	3h00 (2h06–4h26)
Physical health-related quality of life	Good	436	25 (5.7%)	0h28 (0h14–0h49)	503	98 (19.5%)	1h17 (0h39–1h51)	284	218 (76.8%)	3h00 (2h09–4h26)
	Poor	24	0 (0.0%)	0h32 (0h17–0h49)	31	13 (41.9%)	1h47 (1h08–2h43)	35	30 (85.7%)	4h17 (2h26–6h02)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	72	58 (80.6%)	3h17 (2h24–4h34)
Emotional health-related quality of life	Good	293	13 (4.4%)	0h28 (0h15–0h47)	393	76 (19.3%)	1h17 (0h39–1h51)	186	140 (75.3%)	2h58 (2h05–4h20)
	Poor	167	12 (7.2%)	0h28 (0h15–0h52)	141	35 (24.8%)	1h17 (0h47–2h00)	133	108 (81.2%)	3h34 (2h17–5h09)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	72	58 (80.6%)	3h17 (2h24–4h34)
Social health-related quality of life	Good	394	19 (4.8%)	0h28 (0h15–0h47)	455	94 (20.7%)	1h17 (0h39–1h56)	287	221 (77.0%)	3h00 (2h09–4h26)

	Poor	66	6 (9.1%)	0h26 (0h13–0h57)	79	17 (21.5%)	1h17 (0h47–1h56)	32	27 (84.4%)	4h21 (2h20–6h40)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	72	58 (80.6%)	3h17 (2h24–4h34)
School health-related quality of life	Good	397	22 (5.5%)	0h28 (0h13–0h47)	416	80 (19.2%)	1h13 (0h36–1h52)	181	134 (74.0%)	2h51 (2h00–4h00)
	Poor	63	3 (4.8%)	0h36 (0h17–1h00)	118	31 (26.3%)	1h21 (0h56–2h12)	138	114 (82.6%)	3h34 (2h17–5h29)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	72	58 (80.6%)	3h17 (2h24–4h34)
Internalising problems	No	446	24 (5.4%)	0h28 (0h15–0h49)	504	103 (20.4%)	1h17 (0h39–1h56)	234	187 (79.9%)	3h15 (2h14–4h34)
	Yes	14	1 (7.1%)	0h19 (0h10–0h36)	30	8 (26.7%)	1h17 (0h56–2h03)	21	17 (81.0%)	3h34 (2h21–4h39)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	136	102 (75.0%)	3h00 (2h06–4h26)
Externalising problems	No	431	23 (5.3%)	0h28 (0h15–0h49)	518	106 (20.5%)	1h17 (0h39–1h56)	252	201 (79.8%)	3h17 (2h12–4h35)
	Yes	29	2 (6.9%)	0h19 (0h13–0h39)	16	5 (31.2%)	1h32 (1h15–2h17)	3	3 (100.0%)	2h47 (2h45–3h30)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	136	102 (75.0%)	3h00 (2h06–4h26)
Antisocial behaviours	No	394	22 (5.6%)	0h28 (0h15–0h49)	456	89 (19.5%)	1h15 (0h39–1h48)	217	170 (78.3%)	3h09 (2h09–4h26)
	Yes	66	3 (4.5%)	0h22 (0h10–0h45)	78	22 (28.2%)	1h34 (0h47–2h17)	38	34 (89.5%)	4h17 (2h39–6h02)
	Missing	212	19 (9.0%)	0h34 (0h17–1h00)	216	39 (18.1%)	1h09 (0h39–1h47)	136	102 (75.0%)	3h00 (2h06–4h26)

^a 47 participants with missing screen time information are not included in the table.

^b Continuous variables expressed as mean (standard deviation).

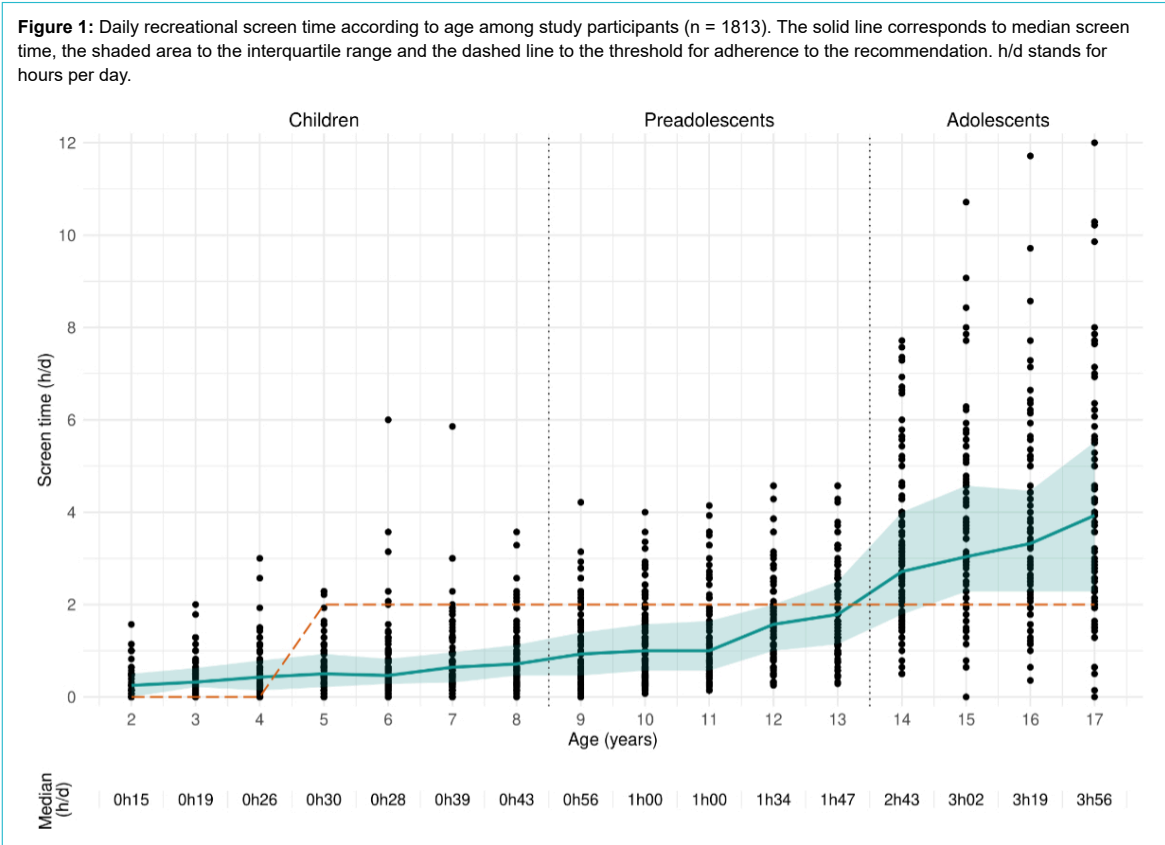
^c Among whom 105 participants preferred not to answer to this question.

^d Scores range 0–36 for family adjustment (n = 1230), 0–54 for parenting practices (n = 1483) and 1–4 for work-family conflicts (n = 1272); higher values indicate less favourable situations.

Determinants of recreational screen time

A lower parental education was associated with spending an additional 25 minutes per day (95% confidence interval

[CI]: 13–37) on-screen among children, 14 minutes (95% CI: 4–25) among preadolescents and 65 minutes (95% CI: 33–97) among adolescents (figure 2). Compared with children of highly educated parents, this represented a 95%



(95% CI: 53–149%), 29% (95% CI: 13–48%) and 42% (95% CI: 24–63%) higher screen time, respectively (table S3 in the appendix). On average, preadolescents living in single parent households had a 22-minute higher daily screen time (95% CI: 3–42) than their counterparts raised by two parents. There were no associations with other sociodemographic characteristics.

Family characteristics such as average-to-poor parental mental health (+14 minutes/day; 95% CI: 2–27) or higher work-family conflicts (+6 minutes/day; 95% CI: 2–10) were also determinants of higher screen time among children (figure 2, table S3 in the appendix). Furthermore, participants – whether children, preadolescents or adolescents – whose parents had less favourable parenting practices tended to spend more time on-screen. Having siblings was not associated with screen time.

Similar patterns were observed when examining determinants of adherence to screen time recommendations and of screen time in percent difference (table S3).

Association of recreational screen time with health outcomes one year later

Among preadolescents and adolescents, screen time was associated with an increased risk of several poor health outcomes after one year, such as a poor physical health-related quality of life (adjusted relative risk [aRR]: 1.46; 95% CI: 1.02–2.08 and aRR: 1.15; 95% CI: 0.99–1.35, re-

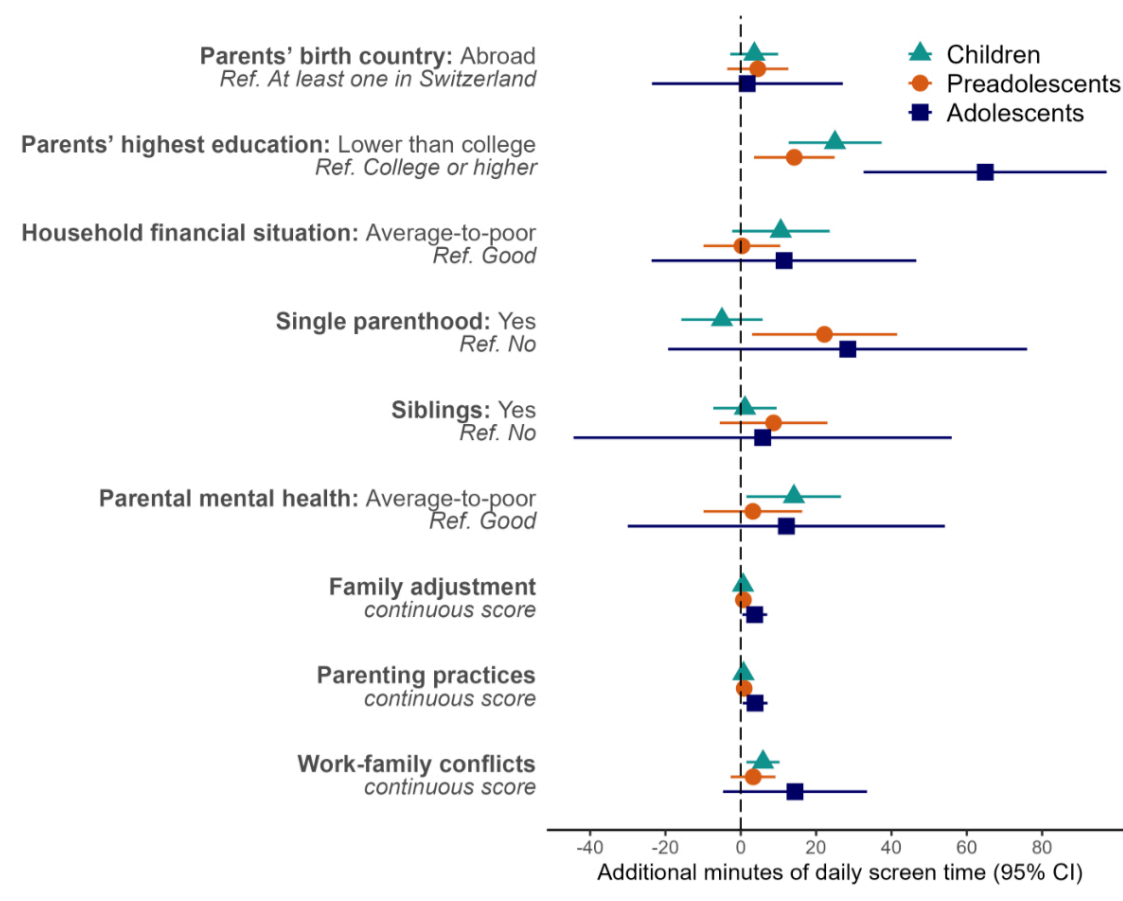
spectively), a poor emotional health-related quality of life (aRR: 1.18; 95% CI: 1.03–1.36 and aRR: 1.04; 95% CI: 0.98–1.10, respectively) and a poor school health-related quality of life (aRR: 1.14; 95% CI: 0.98–1.33 and aRR: 1.08; 95% CI: 1.02–1.13, respectively). Conversely, higher screen time seemed related to a good physical health-related quality of life among children (aRR: 0.56; 95% CI: 0.32–1.00). Each additional daily hour of screen time was also associated with an 18% (aRR: 1.18; 95% CI: 1.03–1.34) and 15% (aRR: 1.15; 95% CI: 1.02–1.29) increased risk of a poor social health-related quality of life and of antisocial behaviours among adolescents, respectively (figure 3).

Although not significant when adjusting for the baseline weight status, screen time was associated with a higher risk of excess weight among children (aRR: 1.43; 95% CI: 1.02–2.01) and preadolescents (aRR: 1.28; 95% CI: 1.06–1.54) even after adjustment for sociodemographic characteristics, physical and extracurricular activity (table S4 in the appendix). The associations between screen time and other health outcomes did not meaningfully change across models (table S4).

Discussion

Screen use was common across all age groups and strongly increased with age, spanning from a daily median of half an hour among children to over three hours among ado-

Figure 2: Sociodemographic and family determinants of screen time among children (2–8 years old, n = 674), preadolescents (9–13 years old, n = 752) and adolescents (14–17 years old, n = 434). Results are additional minutes of daily screen time with 95% confidence intervals (CI) from age-, sex- and sociodemographic-adjusted generalised linear models. Higher values of continuous scores indicate less favourable situations and coefficients correspond to the effect of a 1-point increase in the scores.



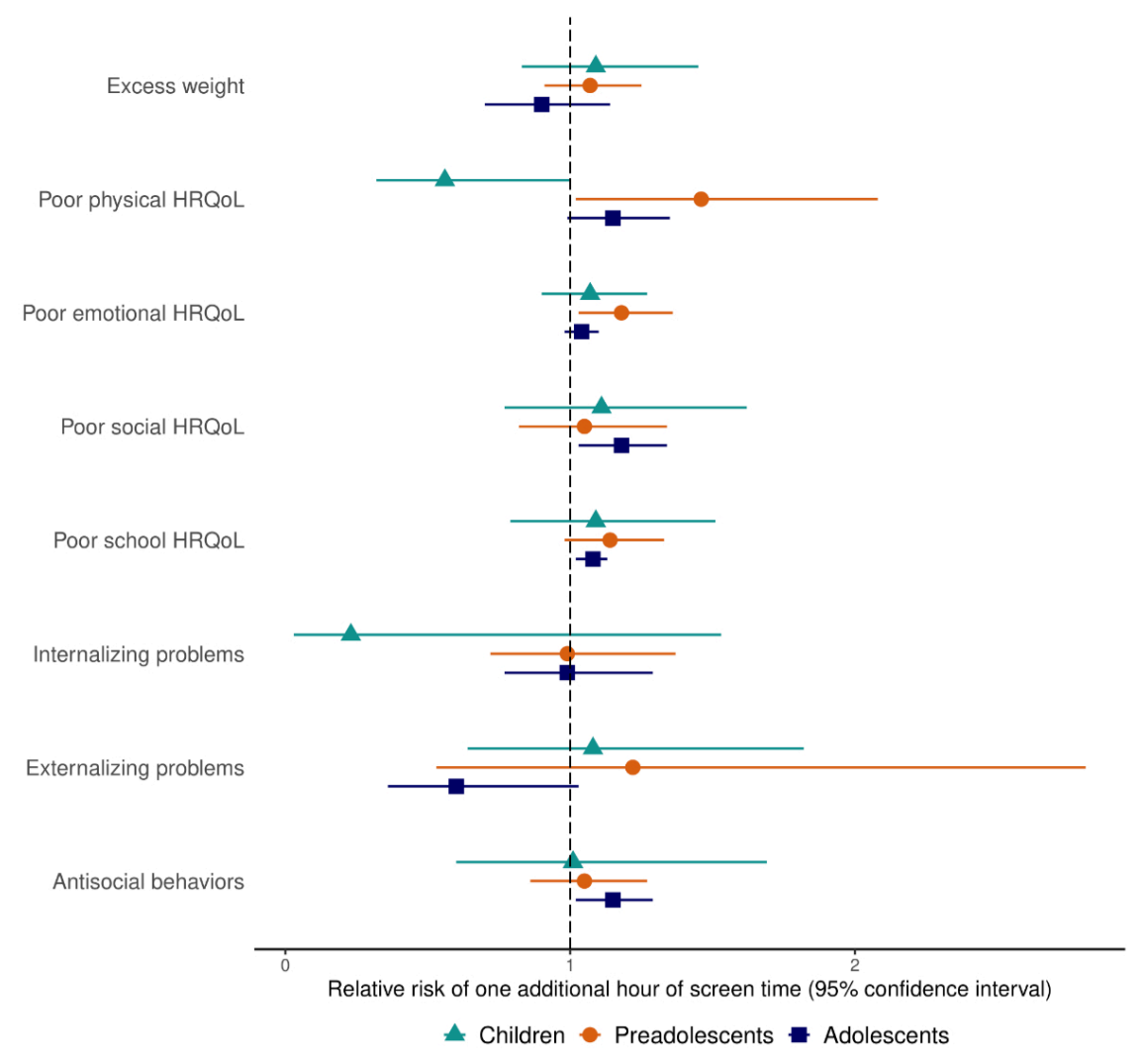
lescents. Determinants of screen time included a lower parental educational level and less optimal parenting practices in all age groups. Poorer parental mental health and work-family conflicts were associated with elevated screen time in children only, while single parenthood was a determinant in preadolescents only. In turn, higher screen time increased the risk of a poor physical-, emotional- and school-related quality of life one year later among preadolescents and adolescents, as well as subsequent social difficulties among adolescents. The present report expands current research by providing a comprehensive post-pandemic picture of screen time, related determinants and health consequences from early childhood to adolescence.

Consistent with pre-pandemic findings [2], screen time in 2022 was lower in our study taking place in Switzerland than in other European countries [6, 44]. The observed prevalence of children and preadolescents not meeting recommendations mirrored Swiss estimates from the second wave of the COVID-19 pandemic, in winter 2020/21 [5]. It suggests that screen use remained elevated even after all sanitary restrictions were lifted, as previously found in the

Netherlands [6] and in the United States [7]. On the contrary, the proportion of non-adherent adolescents was higher in our sample (78% vs 62%) [5]. It could be due to our study relying on adolescent-reported screen time, whereas in Peralta et al. [5], it was reported by parents who may have been less aware of the extent of their adolescents' screen time.

In line with prior research indicating an association between disadvantaged socioeconomic circumstances and increased screen time [9, 11], our study found parental education to be a consistent determinant. Interestingly, its influence was more pronounced than the household's financial situation, which did not show an independent effect. It suggests that young individuals' screen time may be more closely linked to family social norms and health literacy than purely economic factors. This aligns with the observation that parenting practices were associated with screen time in our study and various literature reviews [9, 12]. Parental education may also influence children's screen time through family structure and dynamics, which played an additional independent role in our study. As

Figure 3: Effects of screen time on physical and psychosocial health after one year among children (2–8 years old, $n = 674$), preadolescents (9–13 years old, $n = 752$) and adolescents (14–17 years old, $n = 434$). Results are from generalised linear models following a quasi-Poisson distribution adjusted for age, sex, sociodemographic characteristics, physical activity, extracurricular activities and the baseline level of each health outcome among all participants, and for the number of close friends among preadolescents and adolescents. HRQoL: health-related quality of life.



in previous findings, characteristics such as single parenthood, poor parental mental health and work-family conflicts were determinants of screen time among children and/or preadolescents [9]. It might be that they imply lower emotional- and time-availability of parents to supervise their children's screen use and engage in alternative activities with them [45]. Interestingly, these family characteristics were not related to adolescents' screen time. It could reflect the decreasing influence of parents in this age range, paralleled by a growing influence of other non-assessed determinants such as peer norms [46].

The present findings demonstrate that elevated screen time is associated with an increased likelihood of subsequent physical and psychosocial outcomes one year later. Those include diminished physical, emotional and school functioning among preadolescents and adolescents, as well as heightened social difficulties among adolescents. It echoes previous reports [16, 18] suggesting that screen time might affect youth's psychosocial wellbeing through the displacement of physical activity, face-to-face interactions and schoolwork, as well as because of problematic content, cyberbullying and excessive social comparison [19]. Additionally, as previously observed [14, 16], we found screen use to be related to an increased risk of excess weight among children and preadolescents. In our analysis, however, the association was no longer significant when controlling for the baseline weight status. It suggests that the processes at play might operate over a longer time frame than the one-year interval between our two measurements [47].

Screen time displayed different health impacts according to age, affecting psychosocial health in adolescents, excess weight in children and both in preadolescents. This variability could be attributed to differences in screen content and context across age groups, leading to differing health consequences. This finding is in line with a study among children aged 2 to 17 years, which reported the effect of screen time on psychological wellbeing to be larger in adolescents than children [48]. Proposed explanations included that mobile phone and internet use, which are more popular among adolescents than children, may be more detrimental to mental health than other screen activities [18]. As adolescents with high screen time may have had elevated use since childhood [49], the heightened effect on adolescents might also reflect the cumulative exposure to screens. Finally, adolescents are more likely to possess their own devices [50], which could increase the risk of problematic use. Also consistent with our results, another longitudinal study spanning over eight years found that screen time predicted BMI in children aged 6 to 10 years but not in adolescents, which could be due to a displacement of physical activity observed among children but not adolescents [49].

Our findings raise concerns for the current and future health of young individuals since carrying excess weight during childhood tends to persist into adulthood [51] and because adolescent psychological symptoms predict later episodes of mental disorder [52]. Strengthening parents' knowledge of screen guidelines and of the adverse effects of unhealthy use has been proposed as an effective way of limiting young people's screen time [53]. However, beyond awareness, parental barriers to successfully imple-

ment screen rules should also be considered [45]. For instance, parents frequently mentioned time constraints as a reason for resorting to screen use to occupy their young children while they attended to daily chores [54]. Parents of adolescents also expressed doubts about the practicality of adhering to recommendations they perceived as overly restrictive. Some admitted to abandoning screen time rules due to failure or conflicts [55]. Therefore, in line with the updated screen guidelines of the American Academy of Pediatrics [56], carefully reviewing content quality for children and promoting a moderate and safe screen use for adolescents might be a more pragmatic and acceptable approach for families than strictly limiting screen time. Structural measures proposing financially accessible and convenient alternatives to screen use, such as childcare or extracurricular activities, could also be effective while providing support to parents [45].

Findings from this analysis should be interpreted in light of their limitations. First, despite the random selection process, children with highly educated parents were more likely to participate in our study, as is frequently the case in epidemiological studies [57]. The observed prevalence of screen time may thus be underestimated, given its higher occurrence among children with less educated parents. Second, data reported by referent parents and adolescents could have been subject to measurement errors, especially for screen time [58]. Third, the one-year follow-up assessment may have been too short to observe more substantial effects of screen time on some health outcomes under study, particularly weight. Further follow-ups within the scope of this longitudinal study will provide more insights. Finally, statistical power was limited due to the age stratification, which reduces the certainty around some estimates, but does not impact the interpretation of observed associations. Strengths included the random selection of participants covering a large age range, the longitudinal design as well as the examination of multiple physical and psychosocial health outcomes measured with validated scales.

Conclusion

While almost all children engage with screens, those from socially disadvantaged backgrounds and with strained families seem to face a heightened risk of prolonged screen time. The implications for their physical and psychosocial wellbeing are concerning, highlighting the need for interventions to promote safe screen usage and for the provision of accessible alternatives. Finally, research and monitoring are essential to deepen our understanding of the mechanisms driving these health effects and to adapt to the evolving patterns of screen use.

Availability of data and materials

The dataset used during the current study is available from the corresponding author on reasonable request.

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Authors' contributions: All authors contributed to study conception and design. Material preparation and data collection were performed by Viviane Richard, Roxane Dumont, Elsa Lorthe, Andrea Loizeau,

Hélène Baysson, Maria-Eugenia Zaballa, Julien Lamour and Silvia Stringhini. Rémy P. Barbe, Klara M. Posfay-Barbe, Idris Guessous and Silvia Stringhini supervised the study. Analyses were performed by Viviane Richard who also wrote the first draft of the manuscript. All authors critically revised the previous versions of the manuscript. All authors read and approved the final manuscript.

Generative AI and AI-assisted technologies in the writing process:

During the preparation of this work, the authors used ChatGPT-3.5 in order to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

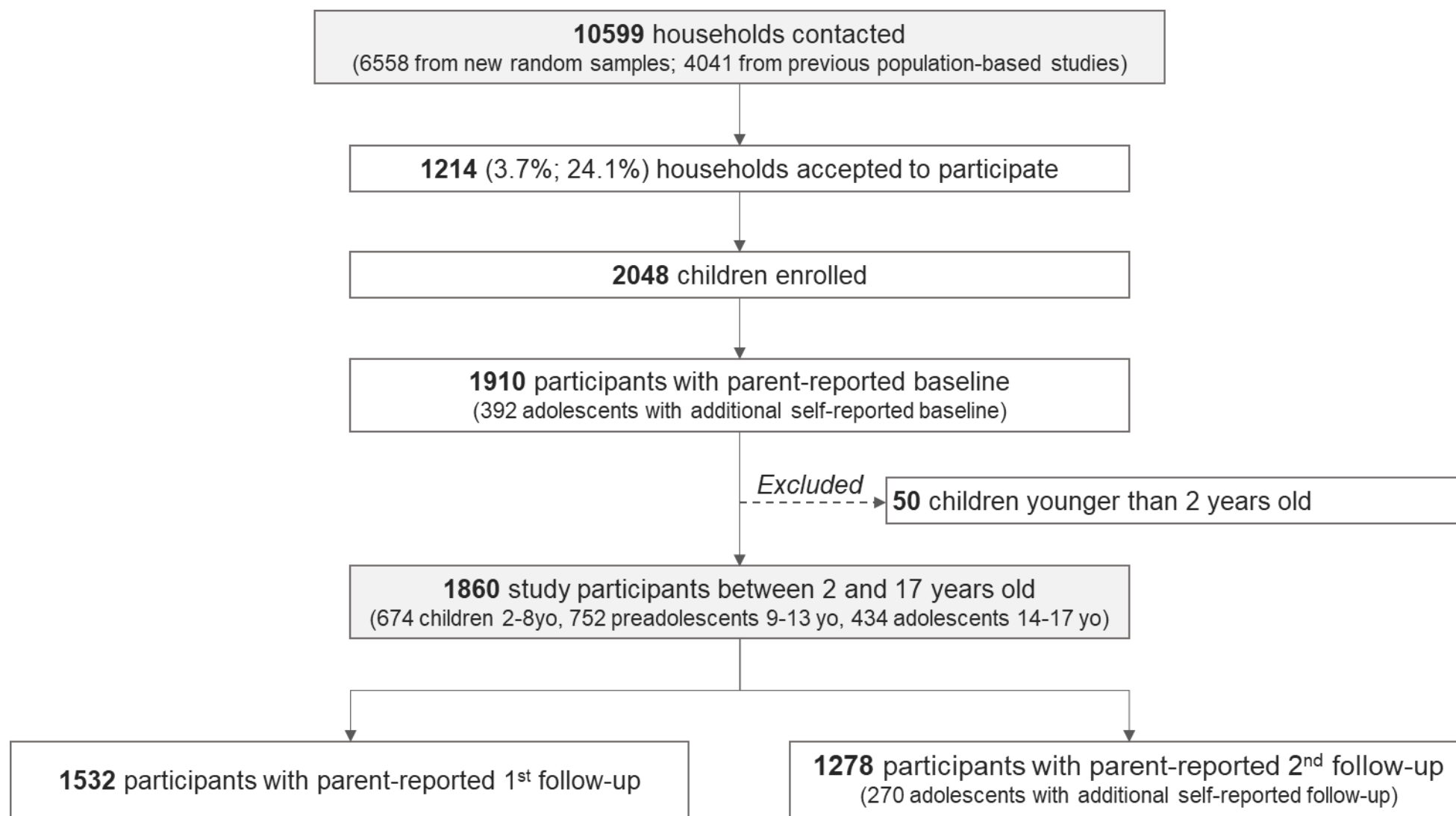
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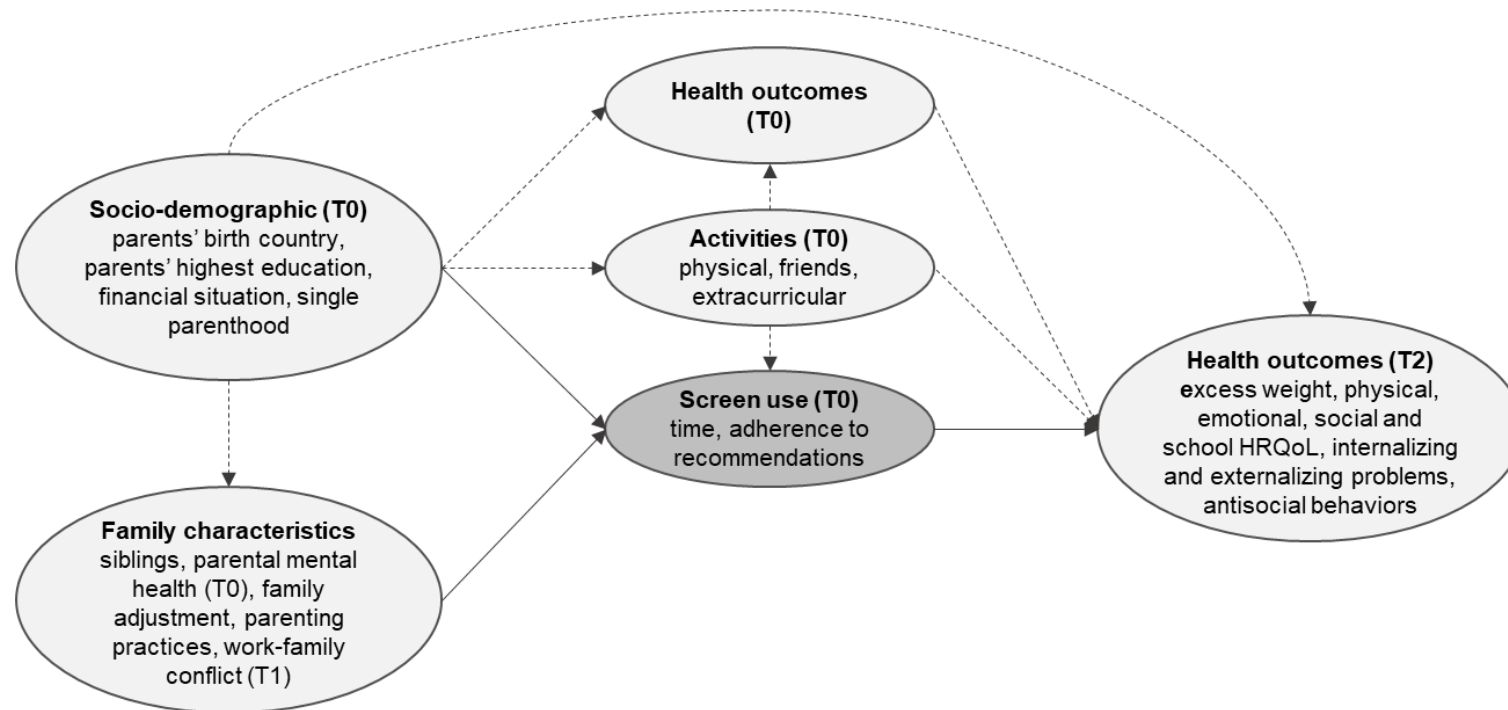
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Determinants and health-related consequences of screen time in children and adolescents: post-COVID-19 insights from a prospective cohort study

Supplementary material – Swiss Medical Weekly



Supplementary figure □□Flowchart of participants recruitment and questionnaires



Supplementary figure □□ Directed acyclic graph of studied variables. Plain lines correspond to the relationships of interest and dashed lines to adjustment pathways. Age and sex are thought to be effect modifiers of all relationships but are not drawn for readability. T0 stands for baseline assessment between December 2021 and July 2022, T1 for first follow-up between September 2022 and February 2023, and T2 for second follow-up between May and September 2023, HRQoL stands for health-related quality of life.

Supplementary table □□ Definition of study variables

Measure timepoint	Age	Details	Reported by
RECREATIONAL SCREEN TIME			
Screen time □hours/day□			
T0	2-13	(weekday x 5 + weekend day x 2) / 7	Parent
T0	14-17	(weekday x 5 + weekend day x 2) / 7	Adolescent
Adherence to screen time recommendations			
T0	2-4	Yes ($\leq 1\text{h/day}$) vs No ($> 1\text{h/day}$) ^a	Parent
T0	5-13	Yes ($\leq 2\text{h/day}$) vs No ($> 2\text{h/day}$) ^b	Parent
T0	14-17	Yes ($\leq 2\text{h/day}$) vs No ($> 2\text{h/day}$) ^b	Adolescent
SOCIO-DEMOGRAPHIC AND FAMILY DETERMINANTS			
Parents highest education			
T0	2-17	College or higher vs Lower than college	Parent
Parents birth country			
T0	2-17	At least one born in Switzerland vs Both born abroad	Parent
□ousehold financial situation			
T0	2-17	Good (can cover current and minor unforeseen expenses) vs Average-to-poor (could hardly cover unforeseen expenses or cannot cover current expenses)	Parent
Single parenthood			
T0	2-17	No vs Yes	Parent
Siblings			
T0	2-17	Yes vs No	Parent
Parental mental health			
T0	2-17	Good vs Average-to-poor	Parent
Family adjustment □score range □-□□			
T1	2-17	Combination of the PAFAS parental adjustment, family relationships and parental teamwork scales ^c	Parent
Parenting practices □score range □-□□			
T1	2-17	Combination of the PAFAS parental consistency, coercive parenting, positive encouragement, and parent-child relationship scales ^c	Parent
Family-work conflict □score range □-□□			
T1	2-17	Work-family conflict scale ^d	Parent
HEALTH OUTCOMES			
Excess weight			
T0 & T2	2-4	Yes (BMI z-score $> +2$ SD) vs No (-2 SD $\leq$ BMI z-score $\leq +2$ SD) ^e	Parent
T0 & T2	5-17	Yes (BMI z-score $> +1$ SD) vs No (-1 SD $\leq$ BMI z-score $\leq +1$ SD) ^e	Parent
Physical □R□o□			
T0 & T2	2-13	Poor (PedsQL score < 63.28) vs Good (PedsQL score ≥ 63.28) ^f	Parent
T0 & T2	14-17	Poor (PedsQL score < 72.98) vs Good (PedsQL score ≥ 72.98) ^f	Adolescent
Emotional □R□o□			
T0 & T2	2-13	Poor (PedsQL score < 63.29) vs Good (PedsQL score ≥ 63.29) ^f	Parent
T0 & T2	14-17	Poor (PedsQL score < 59.57) vs Good (PedsQL score ≥ 59.57) ^f	Adolescent
Social □R□o□			
T0 & T2	2-13	Poor (PedsQL score < 62.07) vs Good (PedsQL score ≥ 62.07) ^f	Parent
T0 & T2	14-17	Poor (PedsQL score < 66.61) vs Good (PedsQL score ≥ 66.61) ^f	Adolescent
School □R□o□			
T0 & T2	2-13	Poor (PedsQL score < 56.75) vs Good (PedsQL score ≥ 56.75) ^f	Parent
T0 & T2	14-17	Poor (PedsQL score < 62.99) vs Good (PedsQL score ≥ 62.99) ^f	Adolescent
Internalizing problems			
T0 & T2	2-3	Yes (SDQ emotional and peer problems scores ≥ 8) vs No (SDQ scores < 8) ^g	Parent
T0 & T2	4-17	Yes (SDQ emotional and peer problems scores ≥ 9) vs No (SDQ scores < 9) ^g	Parent
Externalizing problems			
T0 & T2	2-3	Yes (SDQ conduct problems and hyperactivity scores ≥ 12) vs No (SDQ scores < 12) ^g	Parent
T0 & T2	4-17	Yes (SDQ conduct problems and hyperactivity scores ≥ 11) vs No (SDQ scores < 11) ^g	Parent
Antisocial behaviors			
T0 & T2	2-3	Yes (SDQ prosocial score ≤ 6) vs No (SDQ scores > 6) ^g	Parent
T0 & T2	4-17	Yes (SDQ prosocial score ≤ 5) vs No (SDQ scores > 5) ^g	Parent

T0 (December 2021-July 2022), T1 (September 2022-February 2023) and T2 (May-September 2023) stand for the baseline assessment, 1st and 2nd follow-up questionnaires, respectively. BMI: body mass index, PAFAS: parenting and family adjustment scale, PedsQL: pediatrics quality of life inventory, SDQ: strengths and difficulties questionnaire.

^a World Health Organization 2019 (see reference n° 25; ^b Tremblay 2016; Australian Government Department of Health and Aged Care 2021 (see references n° 26,27; ^c Sanders et al. 2014 (see reference n° 28; ^d Breyer et Bluemke 2016 (see reference n° 30; ^e De Onis et Lobstein 2010 (see reference n° 33; ^f Varni et al. 2003 (see reference n° 35; ^g sdqinfo.org

Supplementary table □ Response patterns to the parent- and adolescent-reported follow-up questionnaires according to baseline study variables

Characteristic □ n total □ n adolescents □	All participants							Adolescents			
	□aseline December 2021-July 2022	□ st parent-reported follow-up September 2022-February 2023			□ nd parent-reported follow-up May-September 2023			□aseline December 2021-July 2022	□ nd adolescent-reported follow-up May-September 2023		
	□total	□es	□o	Chi [□]	□es	□o	Chi [□]	□total	□es	□o	Chi [□]
	n □□□□□	n □□□□□	n □□□□□	p	n □□□□□	n □□□□□	p	n □□□□□	n □□□□□	n □□□□□	p
Age □ Mean □ SD □ n □□□□□ □ n □□□□□	10.0 (4.1)	9.7 (3.9)	11.4 (4.5)	<0.001	9.9 (4.1)	10.1 (4.2)	0.271	15.4 (1.1)	15.4 (1.1)	15.3 (1.2)	0.814
Sex □ n □□□□□ □ n □□□□□											
Male	929 (49.9)	769 (50.2)	160 (48.8)	0.640	628 (49.1)	301 (51.7)	0.231	212 (48.8)	119 (44.1)	93 (56.7)	0.014
Female	928 (49.9)	760 (49.6)	168 (51.2)		649 (50.8)	279 (47.9)		221 (50.9)	151 (55.9)	70 (42.7)	
Other	3 (0.2)	3 (0.2)	0 (0.0)		1 (0.1)	2 (0.3)		1 (0.2)	0 (0.0)	1 (0.6)	
Parents' birth country (n=18 □□ □ n □□□□□)											
At least one in Switzerland	1152 (61.9)	967 (63.1)	185 (56.4)	0.027	832 (65.1)	320 (55.0)	<0.001	282 (65.0)	193 (71.5)	89 (54.3)	<0.001
Parents' highest education (n=18 □□ □ n □□□□□)											
College or higher	1557 (83.7)	1281 (83.6)	276 (84.1)	0.878	1081 (84.6)	476 (81.8)	0.148	355 (81.8)	226 (83.7)	129 (78.7)	0.233
Household financial situation □ n □□□□□ □ n □□□□□											
Good	1430 (81.7)	1203 (82.9)	227 (75.9)	0.006	1009 (82.9)	421 (79.0)	0.059	336 (82.4)	223 (85.1)	113 (77.4)	0.068
Single parenthood □ n □□□□□ □ n □□□□□											
No	1664 (94.3)	1385 (94.7)	279 (92.4)	0.141	1161 (94.7)	503 (93.5)	0.371	382 (92.9)	246 (94.3)	136 (90.7)	0.243
Siblings □ n □□□□□ □ n □□□□□											
Yes	1688 (90.8)	1376 (89.8)	312 (95.1)	0.004	1153 (90.2)	535 (91.9)	0.275	404 (93.1)	246 (91.1)	158 (96.3)	0.059
Parent mental health □ n □□□□□ □ n □□□□□											
Good	1622 (87.3)	1343 (87.7)	279 (85.1)	0.223	1115 (87.2)	507 (87.3)	1.000	392 (90.3)	245 (90.7)	147 (89.6)	0.833
Privacy^a □ n □□□□□ □ n □□□□□											
No	1709 (91.9)	1421 (92.8)	288 (87.8)	0.004	1191 (93.2)	518 (89.2)	0.004	388 (89.4)	250 (92.6)	138 (84.1)	0.009
Screen time □ mean h/d □ SD □ n □□□□□ □ n □□□□□	1.6 (1.6)	1.5 (1.5)	2.1 (2.0)	<0.001	1.6 (1.6)	1.6 (1.7)	0.417	3.6 (2.0)	3.5 (2.1)	3.7 (1.9)	0.421
Excess weight □ n □□□□□ □ n □□□□□											
No excess weight	1544 (83.9)	1270 (83.9)	274 (83.8)	1.000	1068 (84.4)	476 (82.6)	0.369	381 (88.0)	236 (87.4)	145 (89.0)	0.743
Physical □ R□o□ □ n □□□□□ □ n □□□□□											
Good	1707 (93.9)	1428 (95.1)	279 (88.3)	<0.001	1189 (94.8)	518 (91.8)	0.019	350 (89.1)	236 (90.1)	114 (87.0)	0.458
Emotional □ R□o□ □ n □□□□□ □ n □□□□□											
Good	1295 (71.2)	1078 (71.8)	217 (68.7)	0.299	902 (71.9)	393 (69.7)	0.356	272 (69.2)	180 (68.7)	92 (70.2)	0.847
Social □ R□o□ □ n □□□□□ □ n □□□□□											
Good	1644 (90.4)	1365 (90.9)	279 (88.3)	0.188	1144 (91.2)	500 (88.7)	0.101	364 (92.6)	240 (91.6)	124 (94.7)	0.375
School □ R□o□ □ n □□□□□ □ n □□□□□											
Good	1402 (77.1)	1198 (79.8)	204 (64.6)	<0.001	999 (79.7)	403 (71.5)	<0.001	239 (60.8)	174 (66.4)	65 (49.6)	0.002
Internalizing problems □ n □□□□□ □ n □□□□□											
No	1779 (95.7)	1467 (95.8)	312 (95.4)	0.898	1216 (95.2)	563 (96.7)	0.172	408 (94.0)	252 (93.3)	156 (95.1)	0.580
Externalizing problems □ n □□□□□ □ n □□□□□											
No	1769 (95.2)	1459 (95.2)	310 (94.8)	0.849	1219 (95.5)	550 (94.5)	0.439	416 (95.9)	266 (98.5)	150 (91.5)	0.001
Antisocial behaviours □ n □□□□□ □ n □□□□□											
No	1570 (84.5)	1295 (84.5)	275 (84.1)	0.911	1072 (83.9)	498 (85.6)	0.409	356 (82.0)	229 (84.8)	127 (77.4)	0.070

Number of observations without missing values reported next to variable names for all participants and adolescents. ^a Defined as not wanting to share information about their financial situation.

Supplementary table □□ Socio-demographic and family determinants of screen time and adherence to screen recommendations among children (2-8 years old), preadolescents (9-13 years old) and adolescents (14-17 years old).

	Children $\bar{n}$ □□□□		Preadolescents $\bar{n}$ □□□□		Adolescents $\bar{n}$ □□□□	
	Complete case	MI/IP□	Complete case	MI/IP□	Complete case	MI/IP□
DETERMINANTS OF SCREEN TIME IN MINUTES						
	min/d (95% CI)	min/d (95% CI)	min/d (95% CI)	min/d (95% CI)	min/d (95% CI)	min/d (95% CI)
Parents birth country: Abroad ^a	2.9 (-3.9-9.6)	3.6 (-2.8-9.9)	4.1 (-4.4- 12.6)	4.5 (-3.6- 12.6)	7.8 (-21.3- 36.8)	1.7 (-23.6- 27.1)
Parents highest education: Lower than college ^a	25.4 (10.9- 40.0)	25.0 (12.7- 37.4)	14.3 (2.8- 25.9)	14.2 (3.5- 24.9)	62.5 (26.7- 98.3)	64.9 (32.6- 97.1)
□ousehold financial situation: Average to poor ^a	13.4 (-1.2- 27.9)	10.6 (-2.3- 23.6)	3.5 (-6.7- 13.8)	0.3 (-9.9- 10.5)	19.7 (-22.1- 61.5)	11.5 (-23.7- 46.6)
Single parenthood: Yes ^a	-6.4 (-18.6-5.7)	-5.0 (-15.8- 5.8)	29.0 (11.4- 46.6)	22.2 (3.0- 41.5)	25.3 (-32.2- 82.8)	28.4 (-19.3- 76.0)
Siblings: No ^a	1.4 (-7.7- 10.5)	1.1 (-7.3- 9.5)	8.2 (-6.5- 22.9)	8.7 (-5.6- 23.0)	13.0 (-43.1- 69.1)	5.8 (-44.4- 56.0)
Parental mental health: Average to poor ^a	10.3 (-1.9- 22.5)	14.1 (1.5- 26.6)	3.1 (-10.6- 16.8)	3.2 (-9.9- 16.3)	7.5 (-39.8- 54.7)	12.1 (-30.0- 54.2)
Family ad ñstment ^b	0.5 (-0.1-1.2)	0.6 (-0.1-1.3)	0.6 (-0.5- 1.6)	0.7 (-0.3-1.6)	3.8 (0.1-7.5)	3.7 (0.4-7.0)
Parenting practices ^b	0.9 (0.1-1.7)	0.7 (0.0-1.5)	0.8 (-0.2- 1.8)	0.9 (0.0-1.8)	3.8 (0.5-7.2)	3.8 (0.5-7.1)
□ork-family conflicts ^b	6.1 (1.8- 10.4)	5.9 (1.5- 10.3)	2.6 (-3.4- 8.7)	3.3 (-2.7-9.2)	13.6 (-6.9- 34.0)	14.4 (-4.7- 33.5)
DETERMINANTS OF NON-ADHERENCE TO SCREEN TIME RECOMMENDATIONS						
	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)
Parents birth country: Abroad ^a	1.65 (0.87-3.12)	1.73 (0.94-3.19)	1.16 (0.84-1.59)	1.23 (0.91-1.66)	0.98 (0.86-1.11)	0.97 (0.87-1.09)
Parents highest education: Lower than college ^a	1.96 (0.82-4.65)	2.11 (0.96-4.66)	1.44 (0.98-2.12)	1.43 (0.99-2.07)	1.21 (1.07-1.36)	1.21 (1.09-1.36)
□ousehold financial situation: Average to poor ^a	2.17 (1.00-4.69)	1.87 (0.87-4.03)	0.94 (0.63-1.38)	0.90 (0.61-1.32)	0.85 (0.71-1.02)	0.86 (0.73-1.01)
Single parenthood: Yes ^a	0.38 (0.05-2.80)	0.39 (0.05-2.84)	2.25 (1.58-3.22)	2.00 (1.36-2.93)	1.02 (0.82-1.26)	1.07 (0.90-1.26)
Siblings: No ^a	1.20 (0.51-2.79)	1.09 (0.47-2.52)	1.37 (0.94-2.00)	1.32 (0.90-1.93)	0.89 (0.68-1.17)	0.83 (0.64-1.08)
Parental mental health: Average to poor ^a	1.97 (0.89-4.35)	2.50 (1.19-5.26)	1.10 (0.69-1.75)	1.12 (0.71-1.76)	1.15 (1.00-1.33)	1.16 (1.02-1.32)
Family ad ñstment ^b	1.04 (0.97-1.11)	1.05 (0.99-1.12)	1.00 (0.97-1.04)	1.02 (0.98-1.05)	1.01 (0.99-1.02)	1.01 (1.00-1.03)
Parenting practices ^b	1.07 (1.00-1.14)	1.05 (0.98-1.13)	1.04 (1.01-1.07)	1.04 (1.01-1.07)	1.01 (1.00-1.02)	1.01 (1.00-1.03)
□ork-family conflicts ^b	1.34 (0.89-2.03)	1.35 (0.91-2.00)	1.03 (0.83-1.29)	1.05 (0.87-1.28)	1.10 (1.02-1.19)	1.08 (1.00-1.16)
DETERMINANTS OF SCREEN TIME IN PERCENTAGE DIFFERENCE						
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Parents birth country: Abroad ^a	6.73 (-11.51- 28.74)	8.85 (-8.56- 29.57)	2.91 (-9.66- 17.22)	2.62 (-9.02- 15.75)	6.27 (-8.16- 22.97)	2.56 (-10.40- 17.41)
Parents highest education: Lower than college ^a	92.63 (46.79- 152.79)	94.85 (52.62- 148.77)	27.18 (9.86- 47.23)	29.26 (12.83- 48.07)	40.51 (20.47- 63.88)	42.12 (23.88- 63.05)
□ousehold financial situation: Average to poor ^a	26.83 (-3.15- 66.08)	17.94 (-8.26- 51.62)	6.84 (-7.59- 23.52)	2.68 (-10.88- 18.30)	0.61 (-17.31- 22.41)	-0.98 (-16.60- 17.57)
Single parenthood: Yes ^a	-2.96 (-31.35- 37.18)	2.81 (-25.35- 41.60)	41.84 (16.22- 73.11)	28.71 (2.16- 62.17)	12.27 (-13.52- 45.74)	15.99 (-6.49- 43.87)
Siblings: No ^a	-2.65 (-26.54- 29.00)	-4.41 (-26.94- 25.05)	6.13 (-13.29- 29.90)	7.72 (-10.93- 30.28)	7.41 (-16.90- 38.81)	2.34 (-19.04- 29.36)
Parental mental health: Average to poor ^a	23.39 (-4.95- 60.17)	29.86 (0.58- 67.66)	-6.03 (-24.37- 16.76)	-5.47 (-23.09- 16.20)	5.81 (-14.58- 31.08)	9.55 (-9.50- 32.62)
Family ad ñstment ^b	1.76 (-0.14- 3.69)	1.58 (-0.30- 3.49)	0.54 (-0.81- 1.90)	0.66 (-0.56- 1.89)	2.37 (0.32- 4.46)	2.23 (0.57- 3.92)
Parenting practices ^b	1.45 (-0.80- 3.74)	0.68 (-1.48- 2.89)	0.80 (-0.46- 2.07)	0.92 (-0.25- 2.10)	2.05 (0.33- 3.81)	2.12 (0.53- 3.74)
□ork-family conflicts ^b	15.59 (2.60- 30.22)	13.99 (1.57- 27.91)	0.84 (-7.75- 10.22)	1.72 (-6.46- 10.62)	14.82 (2.11- 29.10)	12.58 (1.97- 24.30)

Results are coefficients in minutes per day (min/d), adjusted prevalence ratio (aPR) or percentage difference (%) and 95% confidence intervals (CI) from age-, sex-, and socio-demographic-adjusted generalized linear models following a Gaussian distribution for screen time and a quasipoisson distribution for non-adherence to recommendations. MI/IPW combines multiple imputation (MI) for item non-response and inverse probability weighting (IPW) for questionnaire non-response.

^a Reference levels for parents birth country, parents highest education, household financial situation, single parenthood, siblings, and parental mental health are at least one in Switzerland, college or higher, good, no, yes, and good, respectively.

^b Continuous variables, higher values indicate less favourable situations and coefficients correspond to the effect of a one-point increase in the scores.

Supplementary table Effect of screen time on physical and psychosocial health at one year among children (2-8 years old), preadolescents (9-13 years old) and adolescents (14-17 years old)

	E _x cess weight		Poor physical ☐ R ☐ o ☐		Poor emotional ☐ R ☐ o ☐		Poor social ☐ R ☐ o ☐		Poor school ☐ R ☐ o ☐	
	Complete case	MIIP ☐	Complete case	MIIP ☐	Complete case	MIIP ☐	Complete case	MIIP ☐	Complete case	MIIP ☐
	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)	aRR (95% CI)
Children ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	1.46 (1.06-2.01)	1.37 (0.99- 1.88)	0.85 (0.50- 1.44)	0.78 (0.46-1.33)	1.07 (0.84-1.37)	1.17 (0.94-1.46)	0.95 (0.58-1.55)	1.14 (0.77-1.69)	0.99 (0.67-1.48)	1.09 (0.77-1.53)
Fully adjusted	1.58 (1.14-2.21)	1.43 (1.02- 2.01)	0.79 (0.47-1.33)	0.73 (0.43-1.25)	1.08 (0.85-1.38)	1.17 (0.94-1.46)	0.99 (0.61-1.60)	1.17 (0.79-1.73)	1.01 (0.68-1.52)	1.09 (0.77-1.55)
Baseline adjusted	1.22 (0.97- 1.54)	1.09 (0.83- 1.45)	0.61 (0.33- 1.10)	0.56 (0.32- 1.00)	1.02 (0.82-1.26)	1.07 (0.90-1.27)	0.94 (0.61-1.44)	1.11 (0.77-1.62)	1.01 (0.70-1.45)	1.09 (0.79-1.51)
Preadolescents ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	1.36 (1.12-1.65)	1.33 (1.10-1.60)	1.71 (1.29-2.28)	1.62 (1.19-2.21)	1.17 (0.99-1.38)	1.22 (1.04-1.42)	1.16 (0.93-1.46)	1.11 (0.89-1.39)	1.19 (1.00-1.42)	1.17 (0.98-1.38)
Fully adjusted	1.31 (1.08-1.59)	1.28 (1.06-1.54)	1.63 (1.20-2.21)	1.52 (1.09-2.10)	1.17 (0.99-1.38)	1.22 (1.04-1.43)	1.21 (0.94-1.55)	1.16 (0.91-1.49)	1.20 (1.01-1.43)	1.17 (0.99-1.39)
Baseline adjusted	1.09 (0.92- 1.29)	1.07 (0.91- 1.25)	1.58 (1.14- 2.19)	1.46 (1.02- 2.08)	1.14 (0.98-1.32)	1.18 (1.03-1.36)	1.07 (0.84-1.36)	1.05 (0.82-1.34)	1.18 (1.01-1.38)	1.14 (0.98-1.33)
Adolescents ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	1.04 (0.82- 1.32)	1.08 (0.88- 1.33)	1.26 (1.06- 1.49)	1.24 (1.09-1.41)	1.08 (1.01-1.15)	1.06 (1.00-1.12)	1.22 (1.05-1.42)	1.25 (1.08-1.43)	1.11 (1.05-1.17)	1.11 (1.06-1.17)
Fully adjusted	1.04 (0.82- 1.32)	1.09 (0.88- 1.34)	1.21 (1.00-1.48)	1.19 (1.02-1.39)	1.07 (1.01-1.14)	1.06 (1.00-1.12)	1.20 (1.03-1.39)	1.23 (1.07-1.41)	1.11 (1.05-1.17)	1.11 (1.06-1.17)
Baseline adjusted	0.82 (0.65-1.04)	0.90 (0.70- 1.14)	1.16 (0.97-1.40)	1.15 (0.99-1.35)	1.05 (0.98-1.11)	1.04 (0.98-1.10)	1.15 (0.99-1.32)	1.18 (1.03-1.34)	1.07 (1.01-1.13)	1.08 (1.02-1.13)
	Internalizing problems		E _x ternalizing problems		Antisocial behaviours					
Children ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	0.44 (0.08- 2.46)	0.23 (0.03- 1.89)	1.13 (0.49-2.60)	0.96 (0.39-2.37)	0.78 (0.40-1.53)	0.99 (0.54-1.81)				
Fully adjusted	0.42 (0.08- 2.34)	0.23 (0.04- 1.54)	1.14 (0.49-2.63)	0.95 (0.39-2.30)	0.77 (0.38-1.55)	0.98 (0.53-1.84)				
Baseline adjusted	0.42 (0.07- 2.38)	0.23 (0.03- 1.53)	1.16 (0.70- 1.92)	1.08 (0.64- 1.82)	0.85 (0.44-1.64)	1.01 (0.60-1.69)				
Preadolescents ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	1.25 (0.89-1.74)	1.24 (0.89-1.73)	1.54 (0.82-2.90)	1.66 (0.89-3.10)	1.24 (0.98-1.56)	1.17 (0.94-1.46)				
Fully adjusted	1.17 (0.80-1.70)	1.17 (0.82-1.67)	1.60 (0.87-2.93)	1.73 (0.96-3.14)	1.27 (1.01-1.60)	1.20 (0.96-1.50)				
Baseline adjusted	1.00 (0.70- 1.43)	0.99 (0.72- 1.37)	1.13 (0.49-2.61)	1.22 (0.53-2.81)	1.09 (0.89-1.33)	1.05 (0.86-1.27)				
Adolescents ☐ ☐ ☐ ☐ ☐										
Minim. adjusted.	1.09 (0.83-1.43)	1.06 (0.82-1.36)	0.69 (0.58-0.83)	0.70 (0.46-1.06)	1.28 (1.12-1.46)	1.22 (1.08-1.38)				
Fully adjusted	1.10 (0.88- 1.38)	1.07 (0.85-1.35)	0.63 (0.50-0.81)	0.60 (0.36- 0.99)	1.24 (1.09-1.42)	1.20 (1.06-1.35)				
Baseline adjusted	1.01 (0.75- 1.35)	0.99 (0.77- 1.29)	0.68 (0.51-0.90)	0.60 (0.36-1.03)	1.18 (1.03-1.35)	1.15 (1.02- 1.29)				

Results are adjusted relative risks (aRR) and 95% confidence intervals (CI) from generalized linear models following a quasipoisson distribution. HRQoL stands for health-related quality of life.

Minimally (minim.) adjusted models: adjusted for age, sex, parents' birth country, parents' highest education, household financial situation, and single parenthood.

Fully adjusted models: further adjusted for physical activity and extracurricular activities among all participants, and for the number of close friends among preadolescents and adolescents.

Baseline adjusted models: further adjusted for the baseline level of the health outcome