

1 **Physical activity and screen time in children who survived cancer – A report**  
2 **from the Swiss Childhood Cancer Survivor Study**

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40 Abbreviation table:

41 AAP                      American Academy of Pediatrics

42 BMI                      Body mass index

43 CCS                      Childhood cancer survivor

44 CI                        Confidence Interval

45 ICCC-3                International Classification of Childhood Cancer, third edition

46	IQR	Interquartile range
47	MICE	Multivariate imputation by chained equations
48	OR	Odds ratio
49	TBI	Total body irradiation
50	WHO	World Health Organization

51

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57

58 **ABSTRACT (249/250)**

59 **Background:** Physical activity (PA) can reduce the risk of chronic adverse health  
60 conditions in childhood cancer survivors. We examined physical activity and  
61 sedentary screen time behavior in a nationwide study in Switzerland.

62 **Procedures:** The Swiss Childhood Cancer Survivor Study sent questionnaires to  
63 parents of all Swiss resident  $\geq 5$  year-survivors diagnosed 1995–2010. We assessed  
64 physical activity including compulsory school sport, recreational sport, commuting to  
65 school, and time spent with screen media in those aged 5–15 years, and compared  
66 results to international recommendations.

67 **Results:** We included 766 survivors with a median age at diagnosis of 2.8  
68 (interquartile range 1.4–5.0) years and a median age at study of 12.5 (10.0–14.3)  
69 years. Median PA time was 7.3 (4.8–10.0) hours/week and median screen time 1.4  
70 (0.8–2.0) hours/day. Compulsory school sport hours and walking or cycling to school  
71 contributed significantly to total PA. 55% of survivors met PA and 68% screen time  
72 recommendations. PA was lower for children living in regions of Switzerland  
73 speaking French or Italian compared to German, and for those who had a relapse or  
74 musculoskeletal/neurological conditions. Screen time was higher in males, and  
75 children with lower parental education and a migration background.

76 **Conclusions:** PA and sedentary screen watching were associated with social factors  
77 and PA also with clinical risk factors. Structural preventions that afford active  
78 commuting to school and sufficient school sport are essential, as is counselling  
79 vulnerable survivor groups such as those with musculoskeletal and neurological  
80 problems, and those who have had a relapse.

81 **Introduction**

82 Adult childhood cancer survivors have an elevated risk of poor health<sup>1,2</sup> and early  
83 death<sup>3</sup>: almost 75% suffer from a chronic adverse health condition<sup>2</sup> and their  
84 cumulative mortality reaches nearly 10% 30 years after cancer diagnosis<sup>3</sup>. Physical  
85 activity can reduce the risk of cancer and inhibit chronic health conditions like  
86 diabetes and hypertension in the general population<sup>4</sup>, while among adult childhood  
87 cancer survivors (CCS) physical activity has been associated with reduced risk  
88 factors for cardiovascular disease<sup>5</sup> and cardiovascular disease itself<sup>6</sup>, and with lower  
89 overall mortality<sup>7</sup>. Yet while physical activity can mitigate many health hazards<sup>6,7</sup>, only  
90 half of adult CCS meet physical activity recommendations<sup>8-10</sup>.

91 An active lifestyle might be even more important for young children and  
92 teenage survivors, but only a few studies, usually at single centers or with low  
93 participant numbers, have been performed in this age group<sup>11-14</sup>. Their results vary,  
94 with 31 to 74% meeting recommendations for physical activity<sup>11-15</sup> and 28 to 46%  
95 meeting those for screen time behavior<sup>11,14</sup>. Research also has neither distinguished  
96 between different types of physical activities nor described how school sports or an  
97 active daily commute to school might contribute to overall physical activity. Better  
98 knowledge of screen time behavior and physical activity and the factors influencing  
99 both could inform recommendations for structured prevention and identify risk groups  
100 that could profit from counselling or focused interventions.

101 This nationwide, population-based prospective cohort study in Switzerland  
102 investigated activities in the daily life of young CCS and the factors associated with  
103 physical activity and screen time.

104

105

106

107 **Methods**

108 *The Swiss Childhood Cancer Survivor Study*

109 The Swiss Childhood Cancer Survivor Study is a population-based, long-term cohort  
110 study of all children registered in the Swiss Childhood Cancer Registry who have  
111 been diagnosed since 1976, survived  $\geq 5$  years after initial diagnosis, and were alive  
112 at the time of the study<sup>16</sup>. The registry includes all patients in Switzerland who were  
113 diagnosed at age  $< 21$  years with leukemia, lymphoma, central nervous system  
114 tumors, malignant solid tumors, or Langerhans cell histiocytosis<sup>17</sup>. Recent estimates  
115 indicate that the registry includes 95% of those diagnosed below age 16 since 1995  
116 in Switzerland<sup>18</sup>. We included survivors aged 5–15 years at survey who had been  
117 diagnosed between 1995 and 2010. From 2010 to 2016, we traced addresses and  
118 sent a questionnaire to parents. We mailed the questionnaire a second time to those  
119 who did not respond, and further lack of response included an attempt to reach  
120 parents by phone. Among 1068 survivors whose parents were contacted, we  
121 received responses from parents of 766 (72%) (Supporting Information TABLE S1,  
122 FIGURE S1).

123 Ethics approval was granted by the Ethics Committee of the Canton of Bern,  
124 Switzerland, to the Swiss Childhood Cancer Registry and the Swiss Childhood  
125 Cancer Survivor Study (KeK-BE: 166/2014), and the Swiss Childhood Cancer  
126 Survivor Study is registered at ClinicalTrials.gov (identifier: NCT03297034).

127

128 *Outcomes: physical activity and screen time*

129 We examined physical activity as compulsory school sport, recreational sport, and  
130 commuting to school. We derived the time for compulsory school sport, 2.3  
131 hours/week (3 x 45 minutes), from the Swiss school curriculum. Information on  
132 recreational sport activities and the commute to school were obtained via

133 questionnaire. Parents were asked about types of recreational sports and how many  
134 hours per week CCS devoted to each (Supporting Information FIGURE S2, question  
135 1), and we categorized answers into 16 different types of sports. We also asked how  
136 the child usually went to school: on foot or by bike/kickboard, by bus/streetcar, or by  
137 car), and the time required (<10 minutes, 10–20 minutes, or >20 minutes);  
138 Supporting Information FIGURE S2, questions 2–3); the durations observed in the  
139 analysis were 5, 15, and 30 minutes. We considered only transit by foot or  
140 bike/kickboard as active. To obtain weekly estimates, we multiplied the times  
141 reported for one way to school by 15 to account for five school days per week, and  
142 an average of three trips to school per day because there are 2–4 afternoon school  
143 sessions per week at Swiss schools, with most children going home for lunch.

144 We used the World Health Organization (WHO) recommendations to  
145 characterize whether a child had sufficient physical activity ( $\geq 7$  hours/week or  $\geq 60$   
146 minutes/day of any physical activity for children aged 5–17 years)<sup>19</sup>. We created the  
147 binary outcome of those who had “sufficient” physical activity and those who did not.

148 Screen time was assessed by asking parents how much time their child spent  
149 on average each day interacting with screen media including television, computer  
150 games, game boys, PlayStation, or Nintendo (Supporting Information FIGURE S2,  
151 question 4). We used the American Academy of Pediatrics (AAP) recommendations  
152 for screen-based media exposure to determine acceptable screen time, less than two  
153 hours per day<sup>20</sup>. We created the binary outcome of those who had media exposure  
154 that was “acceptable” screen time and those who those who did not.

155

### 156 *Clinical characteristics*

157 We extracted the following clinical characteristics from the cancer registry: age at  
158 cancer diagnosis, cancer diagnosis, year of cancer diagnosis, treatment protocol,

159 chemotherapy, radiotherapy, surgery, and hematopoietic stem cell transplantation.  
160 We classified cancer diagnoses in terms of 12 main groups and Langerhans cell  
161 histiocytosis according to the International Classification of Childhood Cancer, third  
162 edition (ICCC-3)<sup>21</sup>. We assessed whether children had been treated with  
163 anthracyclines. Thoracic radiation included the mantle field, mediastinum, thoracic  
164 spine, and total body irradiation (TBI); abdominal radiation included the pelvis, testis,  
165 and TBI; and radiation to the head/neck included TBI. We went back to medical  
166 records when registry treatment information was incomplete. The questionnaire  
167 collected information on chronic health conditions involving the cardiopulmonary and  
168 endocrine systems, problems affecting ears and eyes, and  
169 musculoskeletal/neurological conditions (Supporting Information TABLE S2).

170

#### 171 *Demographic, socioeconomic, and lifestyle characteristics*

172 The questionnaire included demographic (sex, age at study, Swiss language region),  
173 socioeconomic (migration background, parental education), and lifestyle  
174 characteristics (children's body mass index [BMI], maternal BMI). We used self-  
175 reported weight and heights and calculated children's BMI and corresponding z-  
176 scores<sup>22</sup>. BMI z-scores lower than -2 were classified as underweight, -2 to 1 as  
177 normal weight, >1 to 2 as overweight, and >2 as obese<sup>23</sup>. Self-reported maternal  
178 BMI was calculated and categorized according to the National Institutes of Health<sup>24</sup>.

179

#### 180 *Statistical analyses*

181 We compared characteristics of participating survivors and those in families from  
182 whom we received no response using chi-square tests. We used multivariate  
183 imputation by chained equations (MICE) to complete missing values in the outcome  
184 variables and demographic, socioeconomic, lifestyle, and clinical variables. Missing



185 values for hours of recreational sport were predicted by corresponding description of  
186 recreational sport. All other variables with missing values were imputed by using all  
187 other variables with the exception of the outcome variables (Supporting Information  
188 text). In an alternative approach, we determined physical activity and screen times  
189 using the original data before MICE (Supporting Information TABLE S3). Using  
190 multivariable logistic regression, we explored the association between the two binary  
191 outcomes, sufficient physical activity (meeting the WHO recommendations) and  
192 acceptable screen time (according to AAP recommendations), and demographic,  
193 socioeconomic, lifestyle, and clinical characteristics using an a priori selection of  
194 clinically important variables. We also investigated the correlation between physical  
195 activity and screen time using the pooled Spearman correlation coefficient. We used  
196 STATA software (Version 15.1, Stata Corporation, Austin, TX) and R (Version 3.5.2;  
197 R Foundation for Statistical Computing, Vienna, Austria)<sup>25</sup>.

198

199

## 200 **Results**

### 201 *Study population*

202 The median age at diagnosis of the study population of 766 children (428 were male)  
203 was 2.8 years (interquartile range [IQR] 1.4–5.1), median age at survey 12.5 years  
204 (10.1–14.3), and median time since diagnosis 9.0 years (7.5–10.8) (TABLE 1). The  
205 two most frequent diagnoses were leukemia (37%) and central nervous system  
206 tumor (16%), and 51% received anthracyclines and 16% any radiation. Overall, 54%  
207 of children reported one or more adverse chronic health condition. At survey, the  
208 median BMI z-score in children was 0.08 (–0.7–0.9), and 59% of survivors were  
209 normal weight. Full demographic, socioeconomic, and clinical characteristics of CCS

210 are given in Table 1. Participants were comparable to surviving nonparticipants in  
211 most characteristics (Supporting Information TABLE S1).

212

### 213 *Physical activity*

214 Overall, the median time devoted to physical activity was 7.3 hours/week, with  
215 recreational sport contributing 3.0 hours/week (TABLE 2, FIGURE 1, Supporting  
216 Information FIGURE S3). The most common recreational sports were soccer (13%),  
217 gymnastics (12%), swimming (11%), cycling/driving a scooter (10%), and free  
218 outdoor/indoor play (10%). For male survivors, soccer (21%), scooter (11%), and free  
219 indoor/outdoor play (10%) were most relevant, and for female survivors, gymnastics  
220 (17%), swimming (13%), and dancing (12%) (FIGURE 2). Over one-half of CCS  
221 (55%) had sufficient physical activity according to the WHO recommendations. We  
222 found no important difference using the alternative analysis approach that assessed  
223 physical activity time and meeting the WHO recommendations using the original data  
224 before MICE (Supporting Information TABLE S3).

225

### 226 *Screen time*

227 Median screen time was 91 minutes/day, and 68% of children had acceptable screen  
228 time in accordance with AAP recommendations (TABLE 2, FIGURE 1). We found no  
229 important difference in the alternative analysis approach that assessed screen time  
230 and meeting AAP recommendations using the original data before MICE (TABLE  
231 S3).

232

### 233 *Predictors for physical activity and screen time*

234 Physical activity was lower for children who lived in the French and Italian language  
235 regions than it was in the German-speaking region of Switzerland. It also was lower

236 for those who had had a relapse or suffered from musculoskeletal/neurological  
237 conditions (TABLE 3, FIGURE 3). We observed no association between physical  
238 activity and sex, age at study, BMI of survivors and mothers, cancer diagnoses,  
239 cardiopulmonary conditions, and treatment exposures. Screen time was higher in  
240 male survivors and children with lower parental education and migration background  
241 (TABLE 3, FIGURE 3), but not associated with sex, age at study, parental education,  
242 endocrine and musculoskeletal/neurological problems, and all other clinical  
243 characteristics.

244

#### 245 *Correlation between low physical activity and high screen times*

246 We found no correlation between physical activity and screen time in survivors  
247 (pooled Spearman correlation coefficient  $-0.05$ ), and no correlation between time  
248 spent for recreational sports and an active way to school (pooled Spearman  
249 correlation coefficient  $0.157$ ) (Supporting Information FIGURE S4).

250

251

## 252 **Discussion**

253 This comprehensive survey of physical activity and screen time in children and  
254 adolescents who have survived cancer found that half of young survivors met the  
255 recommendation for physical activity and two-thirds did not exceed the maximum  
256 recommended for screen time. Having an active way to get to school and compulsory  
257 school sport greatly contributed to overall hours of physical activity.

258 Our results for physical activity are superior compared to those of a cohort  
259 study that included 1300 Swiss children and adolescents between 6–16 years of age,  
260 among whom only 39% of children aged 12-13 years met or exceeded physical  
261 activity recommendations assessed by accelerometer<sup>26</sup>. Also in that study, children

262 who lived in the French and Italian linguistic regions of Switzerland were less active  
263 than those living in the German-speaking region<sup>26</sup>. Young survivors in our study  
264 preferred recreational sports including soccer for males, and gymnastics, swimming,  
265 and dancing for females, and these preferences are similar to those of other school  
266 children<sup>27</sup>. A study of screen time in healthy adolescent school children in  
267 Switzerland found higher median screen times of 122 minutes per day (compared to  
268 82 minutes per day in our population), though screen time was assessed differently  
269 and focused on internet use<sup>28</sup>.

270 Studies of physical activity and screen time in children after cancer are few  
271 and report variable results. A 2012 Australian study assessed 40 children in two  
272 centers after hematopoietic stem cell transplantation at a mean age of 12.5 years by  
273 questionnaire; 48% of the children met the physical activity recommendation and  
274 28% that for screen time<sup>11</sup>. Another single-center Australian study that used a three-  
275 day diary assessed 74 young survivors with a mean age of 15.0 years between 2012  
276 and 2014 and reported that 74% adhered to physical activity and 46% to screen time  
277 recommendations<sup>14</sup>. Gilliam and colleagues performed phone interviews between  
278 2010 and 2011 in 105 North American survivors aged 11.1 years who reported a  
279 mean physical activity time of 6.7 hours per week, which is lower than the mean 8.0  
280 hours we observed<sup>12</sup>, but times since diagnosis differed between the two cohorts (9.0  
281 years in our study versus 4.6 years in the North American study). Another study from  
282 two North American centers reported a mean physical activity time of 47 minutes per  
283 day for 319 survivors aged 14.6 years, which corresponds to 5.5 hours per week and  
284 again is lower than in our cohort<sup>15</sup>. But that study used questionnaires that focused  
285 on past-year leisure-time physical activity, whereas our questionnaire also included  
286 the way to school and school sport. This could explain the difference.

287            Important predictors for physical activity in young survivors in other studies are  
288            social support from family and peers<sup>12</sup>. Additional predictors reported for adolescent  
289            and adult survivors include female sex<sup>8,9</sup>, low parental<sup>8</sup> or survivor education<sup>9,13,29</sup>,  
290            cranial radiation<sup>8,9,29</sup>, overweight and obesity<sup>9,29</sup>, physical limitations<sup>8,29</sup>, and a  
291            diagnosis of central nervous system tumors and sarcomas<sup>29,30</sup>. We also found that  
292            musculoskeletal/neurological problems are a predictor for physical activity and we  
293            also saw a trend for parental education, central nervous system tumors, and  
294            endocrine conditions.

295            Among our study's limitations is the reliance of the outcome variables physical  
296            activity and screen time on parental reporting. Parents might have overestimated  
297            physical activity and underestimated screen time because of both social desirability  
298            and recall biases. A second problem involves the questionnaire's having inquired  
299            about structured physical activities even though young children in particular are  
300            active mainly in an unstructured way with free inside and outside play<sup>26</sup>. This  
301            differential misclassification bias could have led to underestimation of activity in  
302            younger survivors. However, parents did mention free outdoor and indoor play in  
303            10% of boys and 9% of girls (FIGURE 2). Accelerometers and pedometers may  
304            overcome this problem<sup>26,31</sup>, though worn only for study purposes and short periods  
305            their data might not be representative of daily life. A third limitation is that physical  
306            activity in Swiss school children differs between winter and summer<sup>26</sup>, but we did not  
307            account for the season when parents filled out the questionnaire. Fourth, screen time  
308            questions assessed traditional screen activities such as watching television and  
309            computer games, and not use of social media and mobile phones; the average  
310            screen time we observed might be an underestimate. Finally, our study had no  
311            control group because too few siblings met our inclusion criteria.

312 This study is the first nationwide, population-based study of physical activity  
313 and screen time in children who survived cancer. Among its strengths is its relatively  
314 high response rate, 72%, which makes us confident that the results are  
315 representative for Swiss CCS. Also, being nested in the Swiss Childhood Cancer  
316 Registry provided us with important, comprehensive data on demographic,  
317 socioeconomic, lifestyle, and clinical characteristics.

318 Our results indicate that structural support via compulsory school sport and an  
319 active daily commute to school are important contributors to physical activity. Public  
320 health policy should at least preserve if not increase support for both compulsory and  
321 voluntary school sport. Further research should inquire into why physical activity is  
322 lower in the parts of Switzerland speaking French and Italian than in the German-  
323 speaking part, and how physical activity levels might be increased in all three. Also, it  
324 goes without saying that family and community support for actively commuting to  
325 school should be maintained or increased.

326 For individual prevention, clinicians should counsel young survivors and their  
327 families to pursue active lives. In a German study, only 25% of 83 young survivors  
328 with a median age of 14 years and 3.8 years after cancer diagnosis participated in  
329 school sport, and medical advisories against sports participation were frequent<sup>32</sup>.  
330 Parents also might overprotect their children during and after completion of cancer  
331 therapy. Physical activity not only is safe both during and after cancer therapy, it may  
332 positively influence evolving chronic health conditions. Pediatric oncologists therefore  
333 can and should assure families that physical activity is of particular importance to  
334 CCS and encourage participation in compulsory and voluntary school sports, and  
335 keep medical restrictions on activity to a minimum. Further research should include  
336 interventions that include social support as an important contributor to children's  
337 physical activity<sup>12</sup>.

338           In summary, we found that half of young cancer survivors are not active  
339 enough and one-third devote too much time to sedentary screen viewing.  
340 Compulsory school sport and an active commute to school are important  
341 components of an active lifestyle. Therefore, we need both individual-based  
342 prevention such as better counselling of survivors and families, and structural  
343 prevention addressed to all children in Switzerland, such as promotion of active  
344 commuting to school and extended school sport lessons.

345 **Conflict of Interest statement**

346 The commercial funders of the Swiss Childhood Cancer Registry support the daily  
347 running of the registry and have not had and will not have any role in the design,  
348 conduct, interpretation or publication of the Swiss Childhood Cancer Registry itself as  
349 well as the related research projects.

350

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371

## 372 **Data availability statement**

373 The Swiss Childhood Cancer Registry and Swiss Childhood Cancer Survivor Study  
374 are a collaborative project of the Swiss Pediatric Oncology Group (SPOG) and the  
375 Institute of Social and Preventive Medicine, University of Bern, Switzerland. Our  
376 homepage displays detailed information in methods, results and publications  
377 (www.childhoodcancerregistry.ch). Researchers interested in collaborative work can  
378 contact the corresponding author (Claudia Kuehni; claudia.kuehni@ispm.unibe.ch) to  
379 discuss planned projects or analyses of existing data. The final decision will be made  
380 upon presentation of the project to the Scientific Council of the Swiss Pediatric  
381 Oncology Group<sup>16</sup>.

382

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463 **Legends**

464 **TABLE 1** Demographic, socioeconomic, lifestyle, and clinical characteristics of  
465 childhood cancer survivors included in the study, N=766

466 **TABLE 2** Compulsory school sport, recreational sport, active way to school, total  
467 physical activity, screen time, and adherence to WHO/AAP recommendations in  
468 childhood cancer survivors, N=766, 56% males, median age 12.5 years

469 **TABLE 3** Factors associated with a) sufficient physical activity (WHO  
470 recommendation) and b) acceptable screen time (AAP recommendation) in childhood  
471 cancer survivors, N=766, 56% males, median age 12.5 years

472 **FIGURE 1** A, box plot and histogram of total physical activity in hours/week; B, box  
473 plot and histogram of screen time in minutes/day; reported in childhood cancer  
474 survivors (N=766, 56% males, median age 12.5 years)

475 **FIGURE 2** Frequencies of the 16 different recreational sports in childhood cancer  
476 survivors (N=766, 56% males, median age 12.5 years), stratified by sex; there can be  
477 multiple (1-5) different recreational sports per child

478 **FIGURE 3** Factors associated with A) sufficient physical activity, and B) acceptable  
479 screen time in childhood cancer survivors (N=766, 56% males, median age 12.5  
480 years). Pooled odds ratios from multivariable logistic regression adjusted for  
481 demographic, socioeconomic, lifestyle, and clinical characteristics. CI, confidence  
482 interval. CNS, central nervous system

483

484 **Supporting Information**

485 **TABLE S1** Demographic, socioeconomic, and clinical characteristics of responding  
486 and nonresponding childhood cancer survivors (N=1068)

487 **TABLE S2** Selected chronic health conditions asked in the Swiss Childhood Cancer  
488 Survivor Study for survivors aged 5–15 years and included in this study

489 **TABLE S3** Compulsory school sport, recreational sport, active way to school, total  
490 physical activity, screen time, and adherence to WHO and AAP recommendations in  
491 childhood cancer survivors, N=766, 56% males, median age 12.5 years; original data  
492 before multivariate imputation by chained equations (MICE)

493 **FIGURE S1** Population tree of Swiss childhood cancer survivors eligible for the  
494 study, contacted and responding to the questionnaire of the Swiss Childhood Cancer  
495 Survivor Study

496 **FIGURE S2** Physical activity and screen time, asked in the Swiss Childhood Cancer  
497 Survivor Study questionnaire: recreational sport (question 1), the way to school  
498 (questions 2 and 3), and screen time (question 4)

499 **FIGURE S3** Pooled means of recreational sport, compulsory school sport, and active  
500 way to school by foot, bike/kickboard contributing to the total physical activity in  
501 hours/week in childhood cancer survivors (N=766, 56% males, median age at study  
502 12.5 years)

503 **FIGURE S4** Scatterplots of A) total physical activity and screen time, and B)  
504 recreational sport and active way to school, evaluated in childhood cancer survivors,  
505 N=766, 56% males, median age at study 12.5 years; no correlation between  
506 variables (pooled Spearman correlation coefficient for total physical activity and  
507 screen time -0.05; pooled Spearman correlation coefficient for recreational sport and  
508 active way to school 0.157)

509 **Supporting information text S1:** Description of number of missing values

510

**TABLE 1** Demographic, socioeconomic, lifestyle, and clinical characteristics of childhood cancer survivors included in the study, N=766

	N = 766	
	n	% <sup>a</sup>
<b>Demographic and socioeconomic characteristics</b>		
Male sex	428	56
Age at survey, years		
5–7	65	8
8–10	196	26
11–13	282	37
14–15	223	29
Language region		
German	535	70
French	197	26
Italian	34	4
Migration background <sup>b</sup>	212	28
Parental education <sup>c</sup>		
Primary education	61	8
Secondary education	462	60
Tertiary education	219	29
<b>Lifestyle characteristics</b>		
Child`s BMI (kg/m <sup>2</sup> ) z-scores		
Underweight	124	16
Normal	456	59
Overweight	89	12
Obese	23	3
Mother`s BMI (kg/m <sup>2</sup> )		
Underweight	29	4
Normal	486	64
Overweight	156	20
Obese	66	8
<b>Clinical characteristics</b>		
Age at diagnosis, years		
<1	149	20
1–4	423	55
5–10	194	25
Time since diagnosis, years		
5–10	607	79
11–15	159	21
ICCC3 cancer diagnoses		
I Leukemia	286	37
II Lymphoma	52	7
III Central nervous system tumor	125	16
IV Neuroblastoma	73	10
V Retinoblastoma	48	6
VI Renal tumor	61	8
VII Hepatic tumor	13	2
VIII Bone tumor	12	2
IX Soft tissue sarcoma	49	6
X Germ cell tumor	19	3
XI&XII Other rare tumors <sup>d</sup>	28	3
History of relapse	100	13
Time era of treatment		
1995–2000	147	19
2001–2005	319	42
2006–2010	300	39
Any chemotherapy	624	82
Anthracyclines	388	51
Any radiation	122	16

Thoracic <sup>e</sup>	30	4	N a n d , n u m b e
Abdominal <sup>f</sup>	30	4	
Cranial and neck <sup>g</sup>	76	11	
Bone marrow transplantation	55	7	
Chronic health conditions			
Cardiopulmonary	72	9	
Endocrine	82	11	
Hearing and vision	210	27	
Musculoskeletal/neurological	275	36	
Number of chronic health conditions			
None	354	46	
1	239	31	
≥2	173	23	

r; BMI, body mass index.

<sup>a</sup> Column percentages are given.

<sup>b</sup> Migration background: survivors who were not Swiss citizens at birth, not born in Switzerland, or had at least one parent who was not a Swiss citizen were defined as having a migration background.

<sup>c</sup> Parental education categorized by three categories: primary education (compulsory schooling only [ $\leq 9$  years]), secondary education (vocational training [10–13 years]), and tertiary education (higher vocational training, college, or university degree). If parents achieved different levels of education, we selected the parent with the highest education.

<sup>d</sup> Including Langerhans cell histiocytosis; other malignant epithelial neoplasms, malignant melanomas, and other or unspecified malignant neoplasms.

<sup>e</sup> Thoracic radiation included mantle field, mediastinum, thoracic spine, and total body irradiation.

<sup>f</sup> Abdominal radiation included the pelvis, testes, and total body irradiation.

<sup>g</sup> Cranial/neck radiation included total body irradiation.

**TABLE 2** Compulsory school sport, recreational sport, active way to school, total physical activity, screen time, and adherence to WHO/AAP recommendations in childhood cancer survivors, N=766, 56% males, median age 12.5 years

	N=766				
	Median <sup>a</sup> , IQR	Mean <sup>b</sup> , SD	10 <sup>th</sup> –90 <sup>th</sup> percentile	Range	Adherence <sup>c</sup> to WHO/AAP
Compulsory school sport (hours/week) <sup>d</sup>	2.3, NA	2.3, NA	NA	NA	
Recreational sport (hours/week) <sup>e</sup>	3.0, 1.0–5.0	3.7, 3.9	0–8.0	0–32	
Active way to school (hours/week) <sup>f</sup>	1.3, 0–3.8	2.0, 1.9	0–3.8	0–7.5	
Total physical activity (hours/week) <sup>g</sup>	7.3, 4.8–10.0	8.0, 4.5	3.3–13.5	2.3–35.5	55%
Screen time (minutes/day) <sup>h</sup>	82, 45–120	91, 66	15–180	0–480	68%

WHO, World Health Organization (recommending  $\geq 7$  hours of physical activity per week); AAP, American Academy of Pediatrics, (recommending  $< 120$  minutes screen time per day); N, number; IQR, interquartile range; SD, standard deviation; NA, not applicable.

<sup>a</sup> Pooled median over the complete imputed dataset.

<sup>b</sup> Pooled mean over the complete imputed dataset.

<sup>c</sup> Percent of adherence refers to the pooled medians.

<sup>d</sup> Compulsory school sport defined as  $3 \times 0.75$  hours/week=2.3 hours/week.

<sup>e</sup> Recreational sport as asked in the questionnaire (question 1, FIGURE S2): Which types of sport does your child perform?

<sup>f</sup> Active way to school by foot or bike/kickboard as asked in the questionnaire (questions 2 and 3, FIGURE S2): How does your child usually go to the kindergarten or to school? How long is your child's way to the kindergarten or school?

<sup>g</sup> Total physical activity consisting of compulsory school sport, recreational sport, and an active way to school. Please indicate, how often your child performs different types of sports (hours per week).

<sup>h</sup> Screen time as asked in the questionnaire (question 4, FIGURE S2): How much time does your child spend on average with the following activities per day? Watching television, computer games, game boy, PlayStation, Nintendo.



**TABLE 3** Factors associated with a) sufficient physical activity (WHO recommendation) and b) acceptable screen time (AAP recommendation) in childhood cancer survivors, N=766, 56% males, median age 12.5 years

	Multivariable logistic regression							
	a) Sufficient physical activity				b) Acceptable screen time			
	% <sup>a</sup>	Odds Ratio <sup>b</sup>	95% CI	p-value <sup>c</sup>	% <sup>a</sup>	Odds Ratio <sup>d</sup>	95% CI	p-value <sup>c</sup>
<b>Demographic characteristics</b>								
Sex								
Female	50	1.0			72	1.0		
Male	60	1.3	0.9-1.8	0.113	64	0.6	0.4-0.9	0.007
Age at study, years								
5–7	48	1.4	0.4–4.4		88	14.5	1.1–18.0	0.074
8–10	55	1.5	0.7–3.3		78	2.9	1.2–6.9	
11–13	60	1.6	1.0–2.6	0.306	68	2.0	1.1–3.4	
14–15	51	1.0			52	1.0		
Language region								
German	59	1.0			68	1.0		
French/Italian	48	0.6	0.4-0.9	0.005	65	0.8	0.6-1.2	0.354
<b>Socioeconomic characteristics</b>								
Migration background								
No	57	1.0			71	1.0		
Yes	51	0.9	0.6–1.3	0.473	59	0.6	0.4–0.9	0.018
Parental education								
Tertiary education	60	1.0			77	1.0		
Secondary education	54	0.8	0.6–1.1	0.218	65	0.5	0.3–0.8	0.004
Primary education	48	0.6	0.3–1.1		50	0.4	0.2–0.8	
<b>Lifestyle characteristics</b>								
Child's BMI (kg/m <sup>2</sup> ) z-scores								
Normal weight	43	1.0			66	1.0		
Underweight	50	0.8	0.5–1.2	0.409	74	1.2	0.7–2.1	0.803
Overweight/Obesity	45	1.0	0.7–1.7		64	0.8	0.6–1.6	
Maternal BMI (kg/m <sup>2</sup> ) (continuous)	NA	1.0	0.9–1.0	0.381	NA	1.0	0.9–1.0	0.247
<b>Clinical characteristics</b>								
Cancer diagnoses								
Leukemia	59	1.0			61	1.0		
Lymphoma	60	1.1	0.6–2.1	0.588	73	1.8	0.8–3.8	0.111
CNS tumor	46	0.7	0.4–1.3		71	2.2	1.1–4.7	

Other tumor	55	0.9	0.6–1.4		71	1.3	0.8–2.1	
Relapse								
No	58	1.0			67	1.0		
Yes	40	0.6	0.4–1.0	0.030	67	1.0	0.6–1.8	0.975
Cardiopulmonary conditions								
No	55	1.0			67	1.0		
Yes	56	1.1	0.7–1.9	0.642	68	1.1	0.6–1.9	0.805
Endocrine conditions								
No	57	1.0			68	1.0		
Yes	42	0.6	0.4–1.1	0.112	59	0.8	0.4–1.4	0.360
Hearing/vision chronic conditions								
No	56	1.0			66	1.0		
Yes	54	1.3	0.9–1.9	0.195	70	1.0	0.7–1.6	0.887
Musculoskeletal/neurological conditions								
No	59	1.0			67	1.0		
Yes	49	0.7	0.5–0.9	0.017	69	1.0	0.7–1.5	0.936
Anthracyclines								
No	53	1.0			68	1.0		
Yes	57	0.9	0.6–1.3	0.506	67	1.2	0.7–1.9	0.492
Radiotherapy								
No	55	1.0			68	1.0		
Yes	59	1.2	0.8–1.9	0.410	66	1.1	0.7–1.9	0.654
Stem cell transplantation								
No	55	1.0			68	1.0		
Yes	55	1.2	0.5–1.5	0.543	59	0.7	0.3–1.4	0.300

WHO, World Health Organization; AAP, American Academy of Pediatrics; N, number; CI, confidence interval; BMI, body mass index; NA, not applicable; CNS, central nervous system

<sup>a</sup> Column percentages are given.

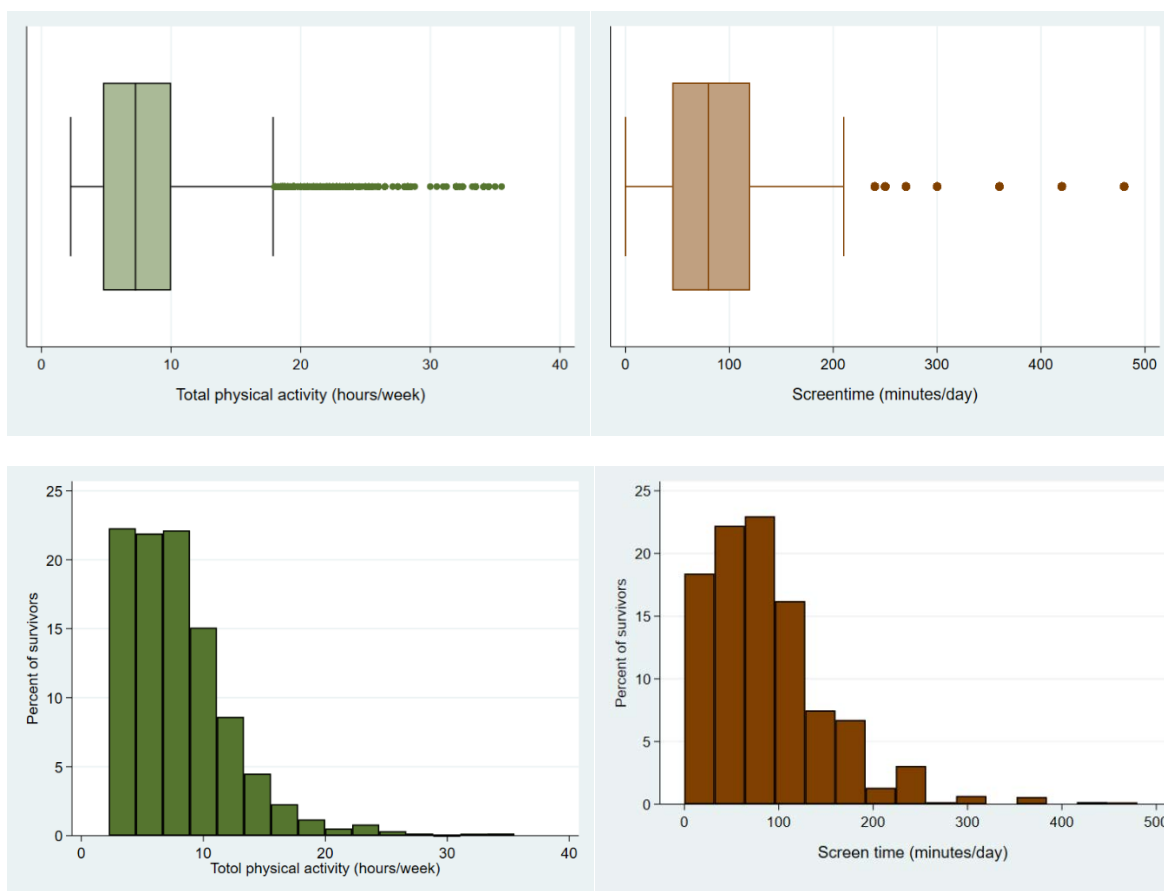
<sup>b</sup> Pooled odds ratios comparing those with high physical activity to those with low physical activity, adjusted for sociodemographic, socioeconomic, and cancer characteristics.

<sup>c</sup> p-value from likelihood ratio tests.

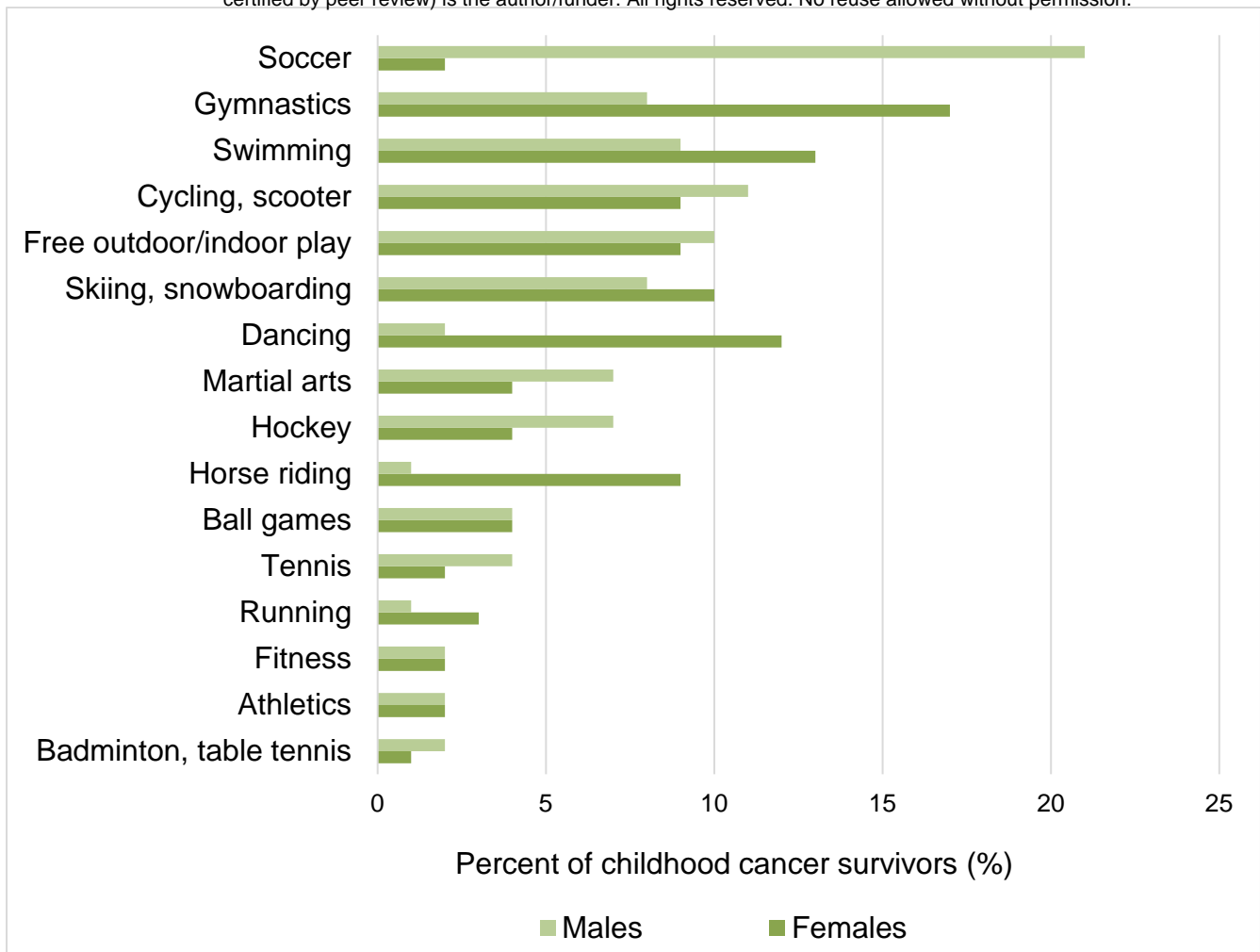
<sup>d</sup> Pooled odds ratios comparing those with low screen time to those with high screen time, adjusted for sociodemographic, socioeconomic, and cancer characteristics.

A)

B)



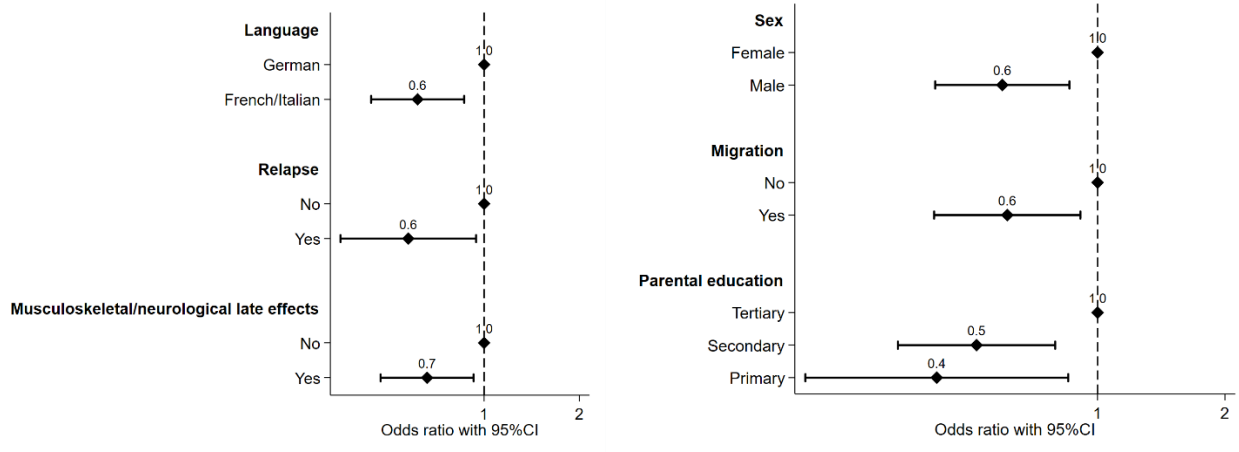
**FIGURE 1** A, box plot and histogram of total physical activity in hours/week; B, box plot and histogram of screen time in minutes/day; reported in childhood cancer survivors (N=766, 56% males, median age 12.5 years)



**FIGURE 2** Frequencies of the 16 different recreational sports in childhood cancer survivors (N=766, 56% males, median age 12.5 years), stratified by sex; there can be multiple (1-5) different recreational sports per child

**A) Sufficient physical activity**

**B) Acceptable screen time**



**FIGURE 3** Factors associated with A) sufficient physical activity, and B) acceptable screen time in childhood cancer survivors (N=766, 56% males, median age 12.5 years). Pooled odds ratios from multivariable logistic regression adjusted for demographic, socioeconomic, lifestyle, and clinical characteristics. CI, confidence interval. CNS, central nervous system