



Reciprocal Longitudinal Associations Between Adolescents' Media Consumption and Psychological Health

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ABSTRACT

OBJECTIVE: This study investigated reciprocal longitudinal associations between media use/physical activity and adolescents' psychological health.

METHODS: Data were collected between 2011 and 2017 in the LIFE Child study in Germany. The sample included 814 10- to 17-year-old adolescents. The participants provided information on their media use per day (hours of television/video, computer/Internet, and mobile phone use), physical activity (frequency of organized and non-organized physical activity per week), behavioral difficulties (emotional problems, conduct problems, hyperactivity/inattention, peer relationship problems), and quality of life (physical and psychological well-being; satisfaction with parents, peers, and school) at 2 time points 12 months apart. Multiple regressions were applied to analyze reciprocal longitudinal associations between media use/physical activity and behavioral difficulties/quality of life.

RESULTS: Frequent use of computers/Internet at baseline was associated with an increase in internalizing behavioral difficulties (emotional problems and peer relationship problems) at follow-up. Additionally, a high frequency of computer/Internet and mobile phone use was related to a decrease in psychological well-being, whereas a high frequency of organized physical activity was linked to improved physical well-being. The analyses also revealed a link between more behavioral difficulties at baseline and increased television consumption at follow-up.

CONCLUSION: This study suggests mutual dependencies between electronic media use and psychological health over time.

KEYWORDS: adolescents; longitudinal; media; physical activity; psychological health

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WHAT'S NEW

This study investigated reciprocal longitudinal associations between adolescents' media use/physical activity and their psychological health. Frequent active media use predicted a decrease in psychological health 12 months later, whereas poorer psychological health predicted an increase in passive media use.

ELECTRONIC MEDIA USE and physical activity (PA) represent two major leisure activities for today's youth. Adolescents' use of electronic media has increased considerably in the last years.^{1,2} Older adolescents and adolescents with a lower social background have been shown to be especially prone to the consumption of electronic media.^{1,3} Regarding PA, previous time trend analyses suggest a slight increase in the last decades⁴; however, the majority of adolescents, particularly girls and adolescents

from lower social milieus, spend less than the recommended 60 minutes per day in moderate to vigorous PA.⁵

The central aim of this study was to investigate reciprocal longitudinal relations between adolescents' leisure activities (media usage and PA) and their psychological health. We examined various media (television, computer, mobile phone), physical activities (organized and non-organized), and indicators of psychological health (behavioral difficulties and quality of life/well-being) in a large sample of German adolescents.

Previous cross-sectional studies showed negative relations between the consumption of electronic media and mental health/well-being and positive associations between PA and mental health/well-being during adolescence.^{6–9} Longitudinal studies revealed negative associations between adolescents' PA and the development of mental health problems (eg, symptoms of depression).^{10–12} Regarding adolescents' media usage, previous longitudinal studies suggest that the evolution of depression can be

predicted by a high frequency of television consumption¹³ and Internet usage.^{14,15} At the same time, there is some evidence for the effects of mental diseases, especially emotional problems and depression, on Internet usage,¹⁵ television consumption, and video gaming.¹⁶

Most of the previous longitudinal studies investigated either adolescents' media usage or their PA; however, given the possible interplay of media usage and PA,¹⁷ it is important to investigate them simultaneously. In this study, both leisure activities were considered as factors that might be related to adolescents' psychological health. A further strength of this study is the exploration of reciprocal associations between media use/PA and psychological health. Most of the existing prospective studies focused on possible effects of media use or PA on mental health while ignoring the possibility that mental health might also affect media use or PA. Based on previous study findings, we expected to observe mutual longitudinal dependencies between adolescents' leisure activities and their psychological health. We hypothesized that we would find positive associations between PA and psychological health but negative associations between electronic media use and psychological health.

METHODS

PARTICIPANTS

All data were collected between 2011 and 2017 in the LIFE Child study in Leipzig, Germany. The LIFE Child study is a longitudinal child cohort study aiming to monitor healthy child development and the development of lifestyle diseases.¹⁸ The study was designed under the supervision of the Ethics Committee of the University of Leipzig (Reg. No. 264-10-19042010). Participants were mainly recruited via advertisements at hospitals, public health centers, and schools and by media such as radio, Internet, or television.¹⁸

Both an age between 10 and 18 years and participation in 2 subsequent study visits—a baseline visit and a follow-up visit—were criteria for being included in the study. Furthermore, complete information on media use, PA, behavioral difficulties, and quality of life had to be available at both baseline and follow-up. These criteria were met by 814 10- to 18-year-old children (399 boys, 415 girls; mean age at baseline = 12.33). The average time between baseline and follow-up was 12.24 months (standard deviation = 1.16 months). Informed written consent was obtained from all parents. Additionally, adolescents who were 12 years or older consented themselves.

MEASURES

ELECTRONIC MEDIA CONSUMPTION AND PHYSICAL ACTIVITY

Adolescents' use of electronic media was assessed by asking how much time per day they usually spent using television/video, computers/Internet, and mobile phones. Answers were given using a 5-step scale: "never," "approximately 30 minutes," "approximately 1 to 2 hours,"

"approximately 3 to 4 hours," and "more than 4 hours." For further analysis, the consumption times for the different media were categorized as "normal" or "high." The categorization was based on the media consumption times reported at baseline (see Table 1). The consumption time selected by most of the study participants and all shorter consumption times were considered to be normal, whereas all longer consumption times were considered to be high. For television/video, a consumption period of 1 to 2 hours per day or less was considered to be normal, whereas consumption times of 3 to 4 hours per day or more were considered high. For computer/Internet and mobile phone use, daily consumption times of 0.5 hours or less were judged to be normal, and consumption times of 1 to 2 hours or longer were considered high.

Adolescents' PA was assessed by asking how often per week they were doing sports in sports clubs (in the following referred to as organized PA) or outside sports clubs (in the following referred to as non-organized PA). Both organized PA and non-organized PA refer to activities outside of the school context. In Germany, school finishes early in the afternoon; therefore, other activities, such as PA or playing an instrument, are organized by the families themselves and take place after school. Whereas organized PA (eg, participation in a football or gymnastics club) is usually well structured and performed in groups, non-organized PA (eg, biking, inline skating, jogging) may be performed less systematically and more individually. The frequency of PA was identified by choosing the most appropriate of 5 answer categories: "never," "less often than once per week," "1 to 2 times per week," "3 to 5 times per week," and "almost every day." For further analysis, the times spent on organized or non-organized PA were categorized as "normal" or "high" based on the responses given at baseline (see Table 1). The frequency of PA that was chosen by most of the study participants and all lower frequencies were considered to be normal, and all exceeding frequencies were considered to be high. For both organized and non-organized PA, frequencies of 1 to 2 times per week or fewer were considered normal, and frequencies of 3 to 5 times per week or more were considered high.

The questionnaires on adolescents' media consumption and PA were based on instruments used in the KiGGS study, a nationwide survey on the health of children and adolescents growing up in Germany.^{19,20} Their validity was tested on a sample of 502 participants in the LIFE Child study (50% boys; mean age = 13.5, range = 5.6–20.3) who, in addition to completion of the questionnaires, had also worn a BodyMedia's SenseWear accelerometer for 1 week. As assessed by Spearman correlations, children who reported longer screen times (combination of television/video, computer/Internet, and mobile phone use) on the questionnaire spent more hours per day in a sedentary position (according to the accelerometer) than children who reported shorter screen times ($\rho = .42$, $P < .001$). Children who reported a higher

Table 1. Sociodemographic Characteristics, Behavioral Difficulties, Quality of Life, Media Usage, and Physical Activity of Study Participants at Baseline (Data Collected 2011–2016)

Characteristics	Study Sample (N = 814)
Sociodemographic	
Gender, n (%)	
Male	399 (49)
Female	415 (51)
Age, mean (SD)	12.33 (1.67)
SES, n (%)	
Low	104 (13)
Middle	505 (62)
High	205 (25)
Behavioral difficulties, mean (SD)	
Emotional problems	2.43 (2.04)
Conduct problems	1.85 (1.39)
Hyperactivity/inattention	3.70 (2.13)
Peer relationship problems	2.27 (1.68)
Quality of life, mean (SD)	
Physical well-being	19.32 (3.50)
Psychological well-being	29.19 (4.25)
Autonomy/parents	28.80 (4.32)
Peers/social support	16.40 (3.10)
School environment	15.96 (2.64)
Media usage, n (%)	
Television/video	
Never	39 (5%)
0.5 h/d	227 (28%)
1–2 h/d	404 (50%)
3–4 h/d	97 (12%)
>4 h/d	44 (5%)
Computer/Internet	
Never	132 (16%)
0.5 h/d	304 (37%)
1–2 h/d	256 (32%)
3–4 h/d	84 (10%)
>4 h/d	36 (5%)
Mobile phone	
Never	238 (29%)
0.5 h/d	304 (38%)
1–2 h/d	135 (17%)
3–4 h/d	68 (8%)
>4 h/d	65 (8%)
PA, n (%)	
Organized PA	
Never	190 (23%)
<1 time/wk	55 (7%)
1–2 times/wk	360 (45%)
3–5 times/wk	155 (19%)
Almost every day	50 (6%)
Non-organized PA	
Never	82 (10%)
<1 time/wk	186 (23%)
1–2 times/wk	275 (34%)
3–5 times/wk	111 (14%)
Almost every day	156 (19%)

SD indicates standard deviation; SES, socioeconomic status; PA, physical activity.

PA (combination of organized and non-organized PA) on the questionnaire spent more hours per day in moderate to vigorous PA (according to the accelerometer) than children who reported a lower PA ($\rho = .29$, $P < .001$).

PSYCHOLOGICAL HEALTH (BEHAVIORAL DIFFICULTIES AND QUALITY OF LIFE)

Adolescents' behavioral difficulties were assessed by the Strengths and Difficulties Questionnaire (SDQ), a standard instrument measuring behavioral problems and strengths of children and adolescents.²¹ It consists of 5 scales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior), each represented by 5 items. Answers are given on a 3-point Likert scale (0, not true; 1, somewhat true; 2, certainly true); consequently, the scores on each scale range from 0 to 10, with higher scores indicating more behavioral difficulties. In our analysis, only the problem scales of the SDQ (all scales except prosocial behavior) were considered. Furthermore, a total difficulties score was derived by summing up the scores of these problem scales.

Information on the participants' quality of life was derived from the KIDSCREEN-27.²² The 27 items of this screening questionnaire assess 5 aspects of children's and adolescents' health-related quality of life: physical well-being (5 items), psychological well-being (7 items), satisfaction with autonomy and parent relationship (7 items), satisfaction with peers and social support (4 items), and success in school/satisfaction with school environment (4 items). Answers are given on a 5-point Likert scale ranging from 1 (never/not at all) to 5 (always/extremely). The scores on each scale range between 1 and a maximum of 35, with higher scores indicating a higher quality of life. These scores can be summed up to a total quality of life score.

COVARIATES

In this study, age, gender, socioeconomic status (SES), and the year of data acquisition were considered to be covariates. Information on a family's SES was provided by the parents of the participating children. This information was reflected by an index considering the education (graduation and professional education) and occupational status of mothers and fathers, as well as monthly family net income.²³ This index varied between 3 and 21, with higher values indicating a higher SES. Furthermore, based on this index and on an appropriate categorization algorithm,²³ children could be assigned to the lower social milieu (index between 3 and 8.4), the middle social milieu (index between 8.5 and 15.4), or the high social milieu (index between 15.5 and 21).

ANALYTIC STRATEGY

To assess reciprocal longitudinal associations of electronic media use and PA with behavioral difficulties and quality of life, 2 analyses were performed. The first analysis investigated associations of media consumption and PA at baseline with behavioral difficulties and quality of life at follow-up. A basic inquiry established associations of the consumption times of the different media (normal vs high) and the frequencies of organized and non-organized PA (normal vs high) at baseline (independent

variables) with the total difficulties score and the total quality of life score at follow-up (dependent variables). Multiple linear regressions were performed. In the case of significant associations, a more detailed analysis was conducted. This analysis investigated the specific areas of behavioral difficulties and/or quality of life that were related to media consumption and/or PA. For this purpose, the regression models included the scores on the single subscales of the SDQ or KIDSCREEN-27 as dependent variables.

The second analysis assessed associations of behavioral difficulties and quality of life at baseline with media consumption and PA at follow-up. A basic inquiry investigated associations of the total difficulties score and the total quality of life score at baseline (independent variables) with the consumption times of the different media and the frequencies of organized and non-organized PA at follow-up (dependent variables). Multiple logistic regressions were performed. In the case of significant associations, a more detailed analysis (including the scores on the different scales of SDQ or KIDSCREEN-27 as independent variables) was conducted.

All associations were controlled for the covariates and the dependent variables at baseline; consequently, each association reflected how the dependent variables changed between baseline and follow-up as a function of the independent variables.

RESULTS

DESCRIPTIVE STATISTICS

Information on the sociodemographic characteristics, media consumption, PA, behavioral difficulties, and the quality of life of the study participants is summarized in Table 1. The SES was rather high, with 13% of participants belonging to the lower social milieu, 62% to the middle social milieu, and 25% to the high social milieu. Regarding media consumption, most adolescents (50%) reported watching television/video between 1 and 2 hours per day. Computers/Internet and mobile phones were used less frequently, with most adolescents (37%–38%) reporting usages of approximately 30 minutes per day. Concerning PA, most adolescents (45%) participated in organized PA once or twice per week. Similarly, most participants (34%) reported performing non-organized PA once or twice per week. The low average scores on the different problem scales of the SDQ and the rather high scores on the different scales of the KIDSCREEN-27 questionnaire suggest good psychological health among the participating adolescents (see Table 1).

Please note that the drop-out rate between baseline and follow-up was 34% (ie, out of an original pool of 1230 adolescents, 416 provided information at baseline but not at follow-up). Compared to these drop-outs, adolescents considered in our analyses were younger, had a higher SES, and reported slightly fewer behavioral problems, a higher quality of life, shorter media consumption times, and higher frequencies of PA.

ASSOCIATIONS OF MEDIA USE AND PHYSICAL ACTIVITY AT BASELINE WITH BEHAVIORAL DIFFICULTIES AND QUALITY OF LIFE AT FOLLOW-UP

The associations of media consumption/PA at baseline with behavioral difficulties at follow-up are displayed in Table 2. As revealed by the basic analysis, high daily consumption of computers/Internet at baseline was significantly associated with an increase in the total behavioral difficulties score at follow-up ($\beta = .07, P = .019$). The detailed analysis showed significant relations between a high consumption of computers/Internet and an increase in emotional problems ($\beta = .08, P = .019$) and peer relationship problems ($\beta = .15, P < .001$).

Table 3 summarizes the associations of media consumption and PA at baseline with the quality of life at follow-up. The basic analysis showed a significant association between high consumption of computers/Internet at baseline and a decrease in the total quality of life score at follow-up ($\beta = -.09, P = .003$). The detailed analysis revealed that high usage of computers/Internet was related to reduced physical well-being ($\beta = -.12, P < .001$), a decline in psychological well-being ($\beta = -.09, P = .004$), decreased satisfaction with peers and social support ($\beta = -.09, P = .015$), and reduced success in school/satisfaction with school environment ($\beta = -.08, P = .027$). The detailed analysis also revealed relations between the participants' usage of mobile phones and aspects of their quality of life. Adolescents showing high consumption of mobile phones at baseline reported a decline in psychological well-being ($\beta = -.07, P = .032$), as well as decreased satisfaction with the school environment at follow-up ($\beta = -.07, P = .045$). Furthermore, the detailed analyses showed a significant association between high frequencies of organized PA at baseline and an increase in physical well-being at follow-up ($\beta = .06, P = .045$).

ASSOCIATIONS OF BEHAVIORAL DIFFICULTIES AND QUALITY OF LIFE AT BASELINE WITH MEDIA USE AND PHYSICAL ACTIVITY AT FOLLOW-UP

The associations of behavioral difficulties and quality of life at baseline with media consumption/PA at follow-up are displayed in Table 4. The basic inquiry showed that higher total difficulties scores at baseline significantly increased the likelihood of showing high consumption of television/video at follow-up (odds ratio = 1.05, $P = .028$). However, the more detailed analysis revealed no significant associations between single domains of behavioral difficulties (emotional problems, conduct problems, hyperactivity/inattention, peer relationship problems) and the likelihood of high consumption of television/video (all $P > .149$).

DISCUSSION

The objective of this study was to investigate electronic media use and PA in 10- to 17-year-old German adolescents, with a particular interest in reciprocal longitudinal associations between both leisure activities and psychological health.

Table 2. Associations of Long Media Consumption Times and Frequent Physical Activity at Baseline with Behavioral Difficulties at Follow-up: Basic and Detailed Analysis

Independent Variable at Baseline	Dependent Variable at Follow-up									
	Basic Analysis			Detailed Analysis						
	Total Difficulties Score	Emotional Problems	Conduct Problems	Hyperactivity/Inattention	Peer Relationship Problems	P				
	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P				
Television/video*	-.01 (-.06-.05)	.854	-.01 (-.07-.05)	.766	.01 (-.05-.07)	.793	.03 (-.03-.08)	.342	-.03 (-.09-.03)	.376
Computer/Internet†	.07 (.01-.13)	.019	.08 (.01-.14)	.019	.02 (-.04-.09)	.512	-.01 (-.07-.05)	.633	.15 (.08-.21)	<.001
Mobile phone‡	.00 (-.06-.06)	.973	.02 (-.05-.08)	.626	.00 (-.06-.07)	.917	.02 (-.04-.08)	.490	-.03 (-.09-.03)	.306
Organized PA‡	-.04 (-.09-.02)	.161	-.03 (-.08-.03)	.357	-.02 (-.08-.04)	.430	-.03 (-.09-.03)	.314	-.04 (-.10-.02)	.154
Non-organized PA‡	-.01 (-.06-.05)	.812	-.02 (-.08-.03)	.397	.01 (-.05-.07)	.747	.01 (-.05-.06)	.752	-.01 (-.07-.04)	.667
Dependent variable	.63 (.57-.68)	<.001	.53 (.47-.59)	<.001	.51 (.45-.57)	<.001	.62 (.57-.68)	<.001	.54 (.48-.60)	<.001

β indicates standardized regression coefficient; CI, confidence interval; PA, physical activity.

All associations are adjusted for gender, age, socioeconomic status (as continuous variable ranging between 3 and 21, with higher scores indicating higher socioeconomic status), and all other independent variables.

*Reference = normal usage (≤ 2 h/d).

†Reference = normal usage (< 1 h/d).

‡Reference = normal PA (≤ 2 times/wk).

The media consumption times reported in this study were comparable with the consumption times reported in another large population-based German cohort study conducted between 2003 and 2006.¹⁹ Only the frequency of mobile phone usage was higher in our study, a difference that might reflect the rapid increase in the use of mobile media devices.¹ With respect to PA, the results of our study show that nearly 80% of adolescents are active in sports clubs and that 90% are engaging in individual physical activities other than in sports clubs.

ASSOCIATIONS BETWEEN MEDIA CONSUMPTION AT BASELINE AND PSYCHOLOGICAL HEALTH AT FOLLOW-UP

The central aim of this study was to investigate associations of electronic media use and PA with the evolution of behavioral difficulties and the quality of life within 1 year. The analysis revealed that high consumption of computers/Internet (≥ 1 h/d) is associated with an increase in emotional problems and peer relationship problems, independent of the adolescents' PA. These findings are in line with longitudinal studies that show associations between Internet usage and the development of depression^{14,15} and suggest a negative impact of long computer/Internet consumption times on internalizing behavioral difficulties. This suggestion is confirmed by our finding that frequent computer usage among adolescents is associated with decreased levels of physical and psychological well-being and a decline in satisfaction with peers. Similar to the consumption of computers/Internet, long mobile phone consumption times (≥ 1 h/d) were also associated with a decline in psychological well-being. Taken together, our findings may suggest that the active use of media (eg, gaming, Internet surfing, social networking via computer and/or mobile phone) plays an especially important role in the evolution of internalizing behavior difficulties and well-being. In contrast, the finding that the consumption of television (a type of passive media use) was not related to either behavioral difficulties or the quality of life suggests that passive forms of electronic media use might play only a minor role.

A possible reason for the associations between active media use and psychological health is that the consumption of electronic media displaces time that could be spent on more social or creative activities.²⁴ This lack of social or creative activities might, in turn, trigger emotional problems, peer relationship problems, and reduced well-being.²⁵ The potentially violent, sexual, or age-inappropriate content of Internet sites or the experience of peer victimization on social networking sites represent further factors that might explain the negative relationship between extensive media usage and decreasing psychological health. This suggestion is in line with several studies showing relations between Internet use and behavioral difficulties^{26,27} and between the experience of online peer victimization and (emotional) well-being in adolescence.^{28,29} Furthermore, the adolescents' personalities might influence the relationship between long computer/Internet and/or mobile phone consumption times and

Table 3. Associations of Long Media Consumption Times and Frequent Physical Activity at Baseline with Quality of Life at Follow-up: Basic and Detailed Analysis

Independent Variable at Baseline	Dependent Variable at Follow-up											
	Basic Analysis				Detailed Analysis							
	Total Quality of Life Score		Physical Well-being		Psychological Well-being		Autonomy/Parents		Peers/Social Support		School Environment	
	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P
TV/video*	.04 (-.02-.09)	.202	.03 (-.03-.09)	.352	.02 (-.04-.08)	.526	.02 (-.05-.08)	.606	.02 (-.05-.08)	.656	.04 (-.02-.10)	.231
Computer/Internet†	-.09 (-.15 to -.03)	.003	-.12 (-.18 to -.05)	<.001	-.09 (-.16 to -.03)	.004	-.03 (-.09 to -.04)	.389	-.09 (-.16 to -.02)	.015	-.08 (-.15 to -.01)	.027
Mobile phone‡	-.04 (-.10-.02)	.230	-.03 (-.09-.04)	.404	-.07 (-.13 to -.01)	.032	-.01 (-.07-.06)	.817	.05 (-.02-.12)	.194	-.07 (-.14 to -.00)	.045
Organized PA‡	-.00 (-.06-.05)	.895	.06 (.01-.12)	.045	-.00 (-.06-.05)	.885	-.02 (-.08-.04)	.494	-.01 (-.08-.05)	.672	-.00 (-.06-.06)	.997
Non-organized PA‡	-.02 (-.08-.04)	.490	-.01 (-.06-.05)	.820	-.01 (-.07-.05)	.798	-.03 (-.09-.03)	.299	.02 (-.04-.09)	.477	.02 (-.04-.09)	.454
Dependent variable	.58 (.53-.64)	<.001	.51 (.45-.58)	<.001	.48 (.42-.54)	<.001	.56 (.49-.62)	<.001	.33 (.27-.40)	<.001	.45 (.39-.51)	<.001

β indicates standardized regression coefficient; CI, confidence interval; PA, physical activity.

All associations are adjusted for gender, age, socioeconomic status (as continuous variable ranging between 3 and 21, with higher scores indicating higher socioeconomic status), and all other independent variables.

*Reference = normal usage (≤ 2 h/d).

†Reference = normal usage (< 1 h/d).

‡Reference = normal PA (≤ 2 times/wk).

psychological well-being. As revealed by a cross-sectional study, adolescents with Internet addiction disorders reported not only more internalizing behavioral problems but also higher degrees of introversion and psychoticism than adolescents without Internet addiction.³⁰

In addition to the relationship between the consumption of computers/Internet and mobile phones with internalizing behavior and a decline in well-being, our analyses revealed associations between frequent usages of these types of media and a decrease in adolescents' success in school/satisfaction with the school environment. These findings might be explained by decreased levels of concentration due to the intensive use of computers/Internet or mobile phones.³¹ Furthermore, spending much time with computers/Internet and mobile phones might distract adolescents from more academic activities such as reading, which, in turn, might result in poorer school performance.³²

In summary, our analyses suggest that especially the active usage of electronic media has a detrimental effect on adolescents' psychological health. However, the effects were rather small, indicating that there exist other, probably more important, factors that affect the psychological health of children.

ASSOCIATIONS BETWEEN PSYCHOLOGICAL HEALTH AT BASELINE AND MEDIA CONSUMPTION AT FOLLOW-UP

This study assessed not only associations between baseline media use/PA and psychological health later in life but also associations between baseline psychological health and later media consumption/PA. These analyses revealed a significant relationship between the number of behavioral difficulties at baseline and the likelihood of showing long television consumption times (> 2 h/d) 1 year later. This finding contradicts previous longitudinal studies in children and adolescents indicating that frequent television viewing is associated with an elevated risk for subsequent attention problems (and not vice versa).^{33,34}

Watching television represents a passive (ie, inactive) form of media consumption; therefore, our findings suggest that children with more behavioral difficulties might tend to neglect themselves and become inactive. However, it should be noted that the association between behavioral difficulties and later television consumption was weak (though significant). Furthermore, a more detailed analysis on which specific domains of behavioral difficulties (emotional problems, conduct problems, hyperactivity/inattention, peer relationship problems) are related to an increased likelihood of showing long television consumption times revealed no significant associations. Therefore, the relation between behavioral difficulties and later television consumption should be interpreted with caution. Future studies might investigate the possible relationship between behavioral difficulties and later media consumption (especially the consumption of passive media) in more detail.

Table 4. Likelihood of Showing Long Media Consumption Times and Frequent Physical Activity at Follow-up Depending on Behavioral Difficulties and Quality of Life at Baseline: Basic Analysis

Independent Variable at Baseline	Dependent Variable at Follow-up									
	TV/Video*		Computer/Internet†		Mobile Phone‡		Organized PA‡		Non-organized PA‡	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Total difficulties score	1.05 (1.01–1.11)	.028	1.02 (0.98–1.07)	.229	1.00 (0.97–1.04)	.853	0.98 (0.94–1.03)	.422	1.01 (0.97–1.05)	.782
Total quality of life score	0.99 (0.97–1.01)	.348	1.00 (0.98–1.01)	.823	0.99 (0.98–1.01)	.392	1.02 (0.99–1.03)	.079	1.01 (0.99–1.03)	.168
Dependent variable	7.77 (5.02–12.02)	<.001	6.32 (4.45–8.97)	<.001	6.32 (4.29–9.32)	<.001	7.12 (4.92–10.28)	<.001	4.14 (2.95–5.82)	<.001

OR indicates odds ratio; CI, confidence interval; PA, physical activity. All associations are adjusted for gender, age, socioeconomic status (as continuous variable ranging between 3 and 21, with higher scores indicating higher socioeconomic status), and all other independent variables.

*High usage = > 2 h/d.

†High usage = ≥ 1 h/d.

‡High PA = > 2 times/wk.

RECIPROCAL LONGITUDINAL ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND PSYCHOLOGICAL HEALTH

Our analyses revealed a weak but significant association between frequent engagement in organized PA (ie, activity in sports clubs) and an increase in physical well-being. PA might improve adolescents’ fitness³⁵ and, therefore, increase their physical well-being. In contrast to non-organized PA, activity in sports clubs might, furthermore, involve social contact with peers. This social contact might strengthen the positive effect of PA on adolescents’ well-being.³⁶

In contrast to physical well-being, the psychological aspects of well-being as well as behavioral difficulties were not related to adolescents’ PA. This finding contradicts previous longitudinal studies showing positive associations of PA with mental health later in life^{10–12} and suggests that differences in PA are not necessarily associated with psychological health. However, we cannot rule out that possible effects of physical activity on psychological health had already occurred earlier (ie, before children participated in the study).

LIMITATIONS

The simultaneous consideration of electronic media use and PA in one study and the assessment of reciprocal longitudinal associations between these leisure activities and adolescents’ psychological health represent strengths of this study. The limitations mainly concern the survey methods. The questions on the participants’ media consumption did not differentiate between media use with or without surfing the Internet; thus, it is not possible to tell if online versus offline activities differ in their effect on psychological health. Also, the different purposes of individual media usage (eg, chatting, e-mailing, social networking, gaming, searching for information, doing homework) were not distinguished. The effects of school-related versus entertaining purposes of media use on well-being, especially on school-related quality of life and success at school, might differ substantially. With respect to PA, neither intensity nor specific durations were assessed. Future research might combine subjective and objective measures of leisure time activities and investigate them in more detail, such as by assessing the time spent on different activities along with their purpose and features. This strategy might allow drawing clearer conclusions regarding which aspects of media use or PA can affect psychological health.

A further limitation concerns the differences between the study participants and children who dropped out between baseline and follow-up. Those children who were considered for analyses grew up in families with a higher SES and reported lower media consumption and better psychological health than children who dropped out. The study sample, therefore, represents a positive selection of adolescents. This circumstance might limit the generalizability of our findings for adolescents in general.

CONCLUSION

This study showed that active forms of media usage are associated with an increase in behavioral difficulties and a decline in the quality of life, independent of the social background and PA. At the same time, the findings suggest that behavioral difficulties may increase adolescents' passive media consumption. These findings show the complex interplay of media use and psychological health, and they emphasize that both high media consumption and signs of behavioral difficulties should be taken seriously and be countered immediately.

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