Screen Time Associated with Health Behaviors and Outcomes in Adolescents

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Objectives: To study the associations of screen time (Internet / video games / television) with health-related behaviors and outcomes in adolescents. Methods: Regression analyses were performed to assess the associations of screen time with several health-related behaviors and outcomes in 2425 Dutch adolescents. Results: Screen time was associated with bullying, being bullied, less physical activity, skipping school, alcohol use and unhealthy eating habits. Compulsive and excessive screen times were associated respectively with several psychosocial problems and being overweight. Conclusions: Screen time was of significant importance to adolescent health. Behavioral interrelatedness caused significant confounding in the studied relations when behaviors were analyzed separately compared to a multi-behavioral approach, which speaks for more multi-behavioral analyses in future studies.

Key words: screen time, health behavior, overweight, psychosocial problems, adolescent

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With the advance of technology, time spent on television, Internet and video games is increasing among today’s youth.1-3 Television viewing, Internet use and video game playing are collectively called ‘Screen Time’. As early as 1983, it was claimed video game playing could become an addiction like any other behavioral addiction and the same was argued for excessive Internet use several years later.4,5 Although a formal medical diagnosis for video game addiction or Internet addiction is (still) lacking in current medical practice, discussions are on-going to add them to the future Diagnostic and Statistical Manual of Mental Disorders (DSM).2,5 In general, unhealthy screen time behavior is characterized by 2 aspects: (1) whether or not one spends an excessive amount of time on it; and (2) whether or not the behavior is considered “compulsive.”

The evidence increases that excessive and/or compulsive screen time behavior holds the potential to be harmful to one’s health;3,6,7 recent studies support for this belief, eg, in relation to obesity6,9 and several psychosocial and psychiatric problems, such as depression, lower self-efficacy and conduct disorder.10-12 In particular, self-efficacy is an aspect receiving increasing attention among interventions in the field of adolescent health promotion, because it is believed to be a mediating variable in the causal path of unhealthy behavior and psychosocial problems in adolescents.13,14

Furthermore, some literature suggests that unhealthy behaviors are associated with and influencing each other instead of existing independently. This raises interest for the probable associations of screen time behaviors in relation to each other and their possible associations with other unhealthy behaviors and health outcomes, which has relevance for future health promotion interventions.15-19

This study investigates how a range of known unhealthy behaviors and health outcomes are associated with several, relatively ‘new’ unhealthy screen time behaviors, in a sample of Dutch high school students. In this study these unhealthy behaviors consist of marijuana use, alcohol use, smoking, unsafe sex, skipping school, bullying, poor nutritional behavior and less physical exercise, in accordance with the Health Behavior in School-aged Children study (HBSC).20 The health outcomes consist of students’ psychosocial problems, being overweight, and General Self-Efficacy (GSE).21 To demonstrate the confounding effects of the interrelatedness of the screen time behaviors in their relations with other unhealthy behaviors and health outcomes, these associations are presented with and without correcting for (possible) confounding by the remaining screen time behavior variables.
Thus, we quantify the associations of different screen time behaviors with a range of unhealthy behaviors as well as the noted health outcomes, while preventing the introduction of bias due to the screen time behaviors’ interrelatedness and demonstrating the importance of multi-behavioral analyses in adolescent health behavior research.

**METHODS**

**Samples**
Data were collected from 5 Dutch high schools as part of the Utrecht Healthy School (UHS) study (N = 2425), the UHS pilot study school and its 4 sister schools from the UHS itself. These schools were part of a convenience sample of schools that were recruited for the UHS. All 5 schools participated in the study with the exception of one which participated only in the pilot study. These schools were part of a convenience sample of schools that were recruited for the UHS. All 5 schools participated in the study with the exception of one which participated only in the pilot study. All were all assisted with the questionnaire procedures by the research team. All are situated in suburban areas of middle-to-large cities in the Netherlands. Therefore, all 5 schools should be categorized as in-between rural and urban.

**Survey Procedures**
The UHS questionnaire was completed independently by participants in classroom settings at the start of the school year in September. Survey procedures allowed students to participate voluntarily and anonymously. Prior to the survey, students were informed of the questionnaire’s purpose and content by means of a newsletter. These points were repeated at the time of the survey by a message presented on the questionnaire and by the classroom teachers. The only students not completing the survey were ones not present at the time of the survey (due to conflicting course schedules, according to their teachers) or ones absent on the day of the survey; the surveys were unannounced, so this should have not been a source of bias. Taking into account these 2 reasons for being absent, the response rate was over 95%. Data cleaning was performed in such a way that when 50% or more of the data were missing the participant was deleted from the study; also, when answers were contradictory and/or unreliable on account of at least 3 main questionnaire topics (eg, nutrition, alcohol use, physical activity) the entire questionnaire was deleted from analyses. Data cleaning resulted in usable questionnaires of over 95% of the participants. No forms of data imputation were applied.

**Measures**

**Screen time.** Watching television, using the computer/Internet and playing video games will be referred to as “screen time behaviors.” Internet use was defined as use of Internet for non-school-related purposes. Video game playing was defined as (online) gaming on a game console such as the X-Box or PlayStation. Game use did not include games with monetary awards or gambling. Both the time spent on watching television, using the Internet or playing video games as well as the compulsiveness of these behaviors was measured.

Spending more than 2 hours/day on screen time behaviors was defined as “excessive” use, in accordance with current standards in the literature.

The compulsiveness of someone’s screen time behavior was measured by the Compulsive Internet Use Scale (CIUS) for compulsive Internet use and by the Videogame Addiction Test (VAT) for compulsive video game playing. Both the VAT and CIUS consist of 14 questions with a 5-point Likert scale, used to evaluate compulsive behavior, respectively for compulsive video game playing (CVP) and compulsive Internet use (CIU). A score higher than 3.0 indicates compulsive behavior. These binary measures for compulsive and excessive use were used in all presented analyses, because these are considered indicators of “problem behavior.”

**Definitions of the unhealthy behaviors and student demographics.** Questionnaire items and operationalization were largely similar to the Dutch HBSC questionnaire and covered several health outcomes and a range of different health behaviors and socio-demographics “Recent behavior” was defined as behavior in the month prior to completing the questionnaire. Questions on recent behavior were asked with regard to alcohol and marijuana use, smoking, bullying and unsafe sex. These measures dichotomous, ie, (0 = did not recently exert a behavior, 1 = did exert a behavior recently). These questions on unhealthy behaviors were posed as in the HBSC, which means that binge drinking was regarded as more than 5 alcoholic beverages on a single occasion, and skipping school as >3 hours of disallowed absence from school in the recent month.

Also measured, but not a standard part of the international HBSC survey, were questions regarding bullying and being bullied, based on the Olweus Bully Score and the Olweus Bully Victim Score. These scores distinguish bullies and bullied children from non-bullies and non-bullied children with a cut-off of “2 to 3 times a month” (0 = not bullied/bullying, 1 = bullied/bullying). In previous research Solberg and Olweus demonstrated these measures’ validity and reliability for adolescents. They stated that these scores allow for prevalence estimates of bullying and being bullied to be obtained conveniently, that they have a reasonably well-defined meaning, and that they are easily and unambiguously understood by users and researchers. Thereafter, Kyriakides, Kaloyirou and Lindsay assessed its validity and reliability, concluding it to be a psychometrically sound measure for bullying prevalence among adolescents.

Furthermore, healthy physical exercise patterns were defined as the following dichotomous measure: at least one hour of moderately intensive physical activity every day, where at least twice a week the activity is aimed at improving or maintaining physical fitness (0 = sufficing, 1 = not sufficing). This measure is commonly used in the...
Netherlands and is known as the Norm Healthy Physical Exercise. Finally, for healthy nutrition another commonly used composite measure was used, Norm Healthy Nutrition (0 = sufficing, 1 = not sufficing), defined as a composite score of having breakfast at least 5 times per week and eating fruits and vegetables at least 5 times per week.  

**Health outcomes.** Three indicators for adolescents’ physical and psychosocial well-being were used as health outcome measures. Firstly, psychosocial problems were measured by the Strengths and Difficulties Questionnaire (SDQ). This scale is comprised of 5 subscales (emotional problems, conduct problems, hyperactivity, peer problems, and pro-social behavior). The total SDQ score is the sum of the scores on the first 4 subscales (maximum score of 40). A problematic total SDQ score was defined as a score higher than 15, indicating more psychosocial problems; this dichotomous measure was used in the analyses to refer to students either having a ‘normal’ (= 0) or ‘potentially problematic’ SDQ score (= 1).

A dichotomous measure for healthy weight was used by means of the Body Mass Index (BMI), corrected for age and sex, with appropriate cut-off scores for adolescents, based on previous research. This means that a different cut-off score for a healthy BMI or being overweight was used based on age and sex.

Due to the importance of self-esteem, social anxiety, and assertiveness in adolescent development and psychosocial functioning, a composite measure of these concepts was integrated into the UHS survey. In the literature this concept was referred to as “General self-efficacy” (GSE). GSE has a broad definition without clear consensus. For this study, Schwarzer’s definition of GSE is applied to refer to the concept of how one describes beliefs in their capabilities to practice control over challenging demands and functioning across different psychological domains. The functional domains investigated in the current study are self-esteem, social anxiety and assertiveness, assessed by a survey consisting of a combination of the Rosenberg’s Self Esteem Scale and Schwarzer’s Generalized Self-Efficacy Scale. GSE is quantified here by a score based on a series of 11 questions on a 4-point Likert Scale to indicate one’s beliefs about capabilities to practice control over challenging demands and over their functioning across the aforementioned domains. The cut-off score for a low/reduced GSE was defined as one higher than 2.50, based on previous literature (0 = normal score, 1 = problematic score).

**Statistical Analyses**

To answer the first research question on how the unhealthy behaviors and health outcomes are associated with the relatively ‘new’ screen time behaviors, logistic regression analyses were conducted. The different screen time behaviors serve as independent variables whereas the other health behaviors are dependent variables. Odds ratios (ORs) are presented with confidence intervals (CIs) at the 95% level. In the analyses, collinearity tests were performed for the different independent variables and all were non-significant. All ORs were controlled for confounding by sex, age, school, year of school, educational level, ethnicity and socioeconomic status (SES). The ORs were checked for interaction by sex. When significant sex interactions were present the analyses were further performed on a sex-stratified sample.

To answer the second research question, both the so-called “single-screen time analyses” and a “multi-screen time analysis” were performed. In the single-screen time analyses the associations were analyzed with only one screen time behavior as the predicting variable together with the demographic factors. In the multi-screen time analysis the group of confounders in the regression analysis was expanded to include the remaining screen time behaviors. The differences between the effect sizes (and their significance) of the associations of the screen time behaviors and the other health behaviors and outcomes in the single-screen time behavior analyses versus those in the multi-screen time behavior analysis can be interpreted as the effect of the confounding due to the screen time behaviors’ clustering. All statistical analyses were performed with SPSS version 17.0.

**RESULTS**

Overall, 2425 students completed the questionnaire, a response rate of over 95%. Socio-demographic characteristics and screen time behaviors are listed in Table 1. Approximately 45% or participants were boys, 55% were girls and their average age was 14 years (range 11-18 years). Their educational level and ethnic composition is representative for a Dutch sample of adolescents. Students’ SES was reported to be somewhat higher than that of their peers in the Netherlands.

In the following section, several different models are presented by topic. First, the single-behavior regression analyses will be presented, comprised of individual screen time behavior and standard socio-demographic confounders per analysis. Second, these different single-behavior analyses are combined into a multi-screen time analysis.

**Screen Time Behaviors’ Associations with Other Unhealthy Behaviors**

Table 2 presents the ORs of the single-screen time behavior analyses. These analyses concern the influence of screen time behaviors (independent variable) on ‘classic’ unhealthy behaviors (dependent variables). Furthermore, in Table 3 the results of the multi-screen time behavior analyses are presented. In contrast to the results presented in Table 2, the Table 3 results are corrected for confounding with regard to these additional screen time behavior variables. Thus, the associations between a certain unhealthy behavior (eg, binge
drinking) with a certain screen time behavior (eg, excessive television watching), while correcting for the remaining screen time behaviors are shown in Table 3.

**Excessive television watching.** In the single-screen time analyses, excessive television watching was associated with recent marijuana use (OR 1.64, 95% CI 1.11-2.41), bullying (OR 1.51, 95% CI 1.09-2.09), poorer nutritional behaviors (OR 1.36, 95% CI 1.10-1.69) and being less physically active (OR 1.32, 95% CI 1.06-1.64). Watching television excessively also was associated with skipping school, but only for girls (OR 3.79, 95% CI 1.35-10.68); this association was not statistically significant for boys (Table 4). When combining the screen time behaviors into one multi-screen time analysis, thereby accounting for any confounding due to their interrelatedness, excessive television watching was only weakly associated with skipping school among girls (OR 4.14, 95% CI 0.96-17.82, .05 < p > .10); its previous associations with drug use, bullying, nutrition and physical exercise were no longer statistically significant (Table 5).

**Using the Internet/PC excessively.** Excessive Internet use was associated in the single-screen time analyses with recent alcohol use (OR 1.68, 95% CI 1.32-2.13), binge drinking (OR 1.46, 95% CI 1.13-1.89), regular smoking (OR 1.53, 95% CI 1.14-2.05), skipping school (OR 1.73, 95% CI 1.01-2.95), bullying (OR 2.33, 95% CI 1.74-3.13), poor-
er nutritional behaviors (in boys OR 1.36, 95% CI 1.00-1.86 and in girls OR 2.09, 95% CI 1.57-2.78) and less physical exercise (OR 1.61, 95% CI 1.31-1.99) (Table 2). In the multi-screen time analysis (Table 3) a variety of classic unhealthy behaviors were still associated with excessive Internet use; recent alcohol use (OR 1.51, 95% CI 1.09-2.09), bullying (OR 2.12, 95% CI 1.41-3.18) and less physical exercise (OR 1.77, 95% CI 1.34-2.34). For girls only, a significant association of excessive Internet use and poorer nutritional behaviors (OR 1.87, 95% CI 1.22-2.86) emerged. These findings were similar to those of the single-screen time analyses, despite slightly smaller effect sizes/regression slopes.

**Playing video games excessively.** Skipping school was the only behavior that was significantly associated with excessive video game playing (OR 3.30, 95% CI 1.06-10.27) (Table 2). This association was only significant among boys. This association remained virtually the same in the multi-screen time analysis (OR 3.69, 95% CI 1.09-12.54) (Table 3).

**Compulsive Internet use.** In the single-screen time analyses CIU was associated with binge drinking (OR 1.79, 95% CI 1.02-3.12), skipping school

### Table 2
**Odds Ratios of the Association of Screen Time Behaviors with Other Unhealthy Behaviors**

<table>
<thead>
<tr>
<th></th>
<th>Excessive watching TV (&gt;14h/week)</th>
<th>Excessive Internet use (&gt;14h/week)</th>
<th>Excessive video game playing (&gt;14h/week)</th>
<th>CIU *</th>
<th>CVP b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent marihuana use</td>
<td>1.64* (1.11-2.41)</td>
<td>1.40* (0.98-2.00)</td>
<td>N.S.</td>
<td>1.95* (0.96-3.95)</td>
<td>Boys: 3.12** (1.32-7.36)</td>
</tr>
<tr>
<td>Recent alcohol use</td>
<td>N.S.</td>
<td>1.68* (1.32-2.13)</td>
<td>N.S.</td>
<td>1.69* (0.99-2.86)</td>
<td>2.02* (1.00-4.08)</td>
</tr>
<tr>
<td>Binge drinking</td>
<td>N.S.</td>
<td>1.46* (1.13-1.89)</td>
<td>N.S.</td>
<td>1.79* (1.02-3.12)</td>
<td>2.44* (1.20-4.98)</td>
</tr>
<tr>
<td>Regular smoking</td>
<td>N.S.</td>
<td>1.53* (1.14-2.05)</td>
<td>N.S.</td>
<td>N.S.</td>
<td>1.96* (0.91-4.26)</td>
</tr>
<tr>
<td>Unsafe sex</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
</tr>
<tr>
<td>Skipping school</td>
<td>Girls: 3.79* (1.35-10.68)</td>
<td>1.73* (1.01-2.95)</td>
<td>Boys: 3.30* (1.06-10.27)</td>
<td>5.65** (2.64-12.08)</td>
<td>4.91** (2.01-12.00)</td>
</tr>
<tr>
<td>Boys: N.S.</td>
<td></td>
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<tr>
<td>Bullying</td>
<td>1.51* (1.09-2.09)</td>
<td>2.33** (1.74-3.13)</td>
<td>N.S.</td>
<td>2.95** (1.72-5.04)</td>
<td>4.27** (2.13-8.57)</td>
</tr>
<tr>
<td>Being bullied</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
<td>2.48** (1.36-4.53)</td>
<td>N.S.</td>
</tr>
<tr>
<td>Nutrition norm</td>
<td>1.36** (1.10-1.69)</td>
<td>Boys: 1.36* (1.00-1.86)</td>
<td>N.S.</td>
<td>5.35** (2.54-11.27)</td>
<td>6.64** (2.03-21.72)</td>
</tr>
<tr>
<td>Girls: 2.09** (1.57-2.78)</td>
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</tr>
<tr>
<td>Exercise norm</td>
<td>1.32* (1.06-1.64)</td>
<td>1.61** (1.31-1.99)</td>
<td>N.S.</td>
<td>1.51* (0.96-2.39)</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

**Note.**
All results were adjusted for sex, age, school, year of school, education level, ethnicity and socioeconomic status.

* CIU = Compulsive Internet Use Scale Score > 3.0, (range 0-4)
* CVP = Videogame Addiction Test Score > 3.0, (range 0-4)
* N.S. = Not Significant, p > .10
* Among drinkers
* Dutch Norm Healthy Physical Activity: “at least one hour of moderately intensive physical activity every day, where at least twice a week the activity is aimed at improving or maintaining physical fitness.”
* Dutch Norm Healthy Nutrition: at least having breakfast, eating fruits and vegetables 5 times per week.
* 10 > p > .05; *: p < .05; **: p < .01
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Compulsive videogame playing. Compulsive gamers were, in comparison to students that did not play videogames compulsively, more likely to report recent alcohol use (OR 2.02, 95% CI 1.00-4.08), binge drinking (OR 2.44, 95% CI 1.20-4.98), skipping school (OR 4.91, 95% CI 2.01-12.00), bullying (OR 4.27, 95% CI 2.13-8.57) and having poorer nutritional behaviors (OR 6.64, 95% CI 2.03-21.72). For boys also an association with recent marijuana use was significant (OR 3.12, 95% CI 1.32-7.36) (see Table 2). In the multi-screen

<table>
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<th>Table 3 Multivariate Regression Analysis: Odds Ratios of the Association of Screen Time Behaviors with Other Unhealthy Behaviors</th>
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<tr>
<td>Excessive watching TV (&gt;14 h/week)</td>
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<tr>
<td>Recent marijuana use</td>
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<td>Recent alcohol use</td>
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<tr>
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<tr>
<td>Regular smoking</td>
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<tr>
<td>Unsafe sex</td>
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<tr>
<td>Skipping school</td>
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<tr>
<td>Girls: 4.14* (0.96-17.82)</td>
</tr>
<tr>
<td>Bullying</td>
</tr>
<tr>
<td>Being bullied</td>
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<tr>
<td>Nutrition norm e</td>
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<tr>
<td>Girls: 1.87** (1.22-2.86)</td>
</tr>
<tr>
<td>Exercise norm f</td>
</tr>
</tbody>
</table>

Note.
All results were adjusted for sex, age, school, year of school, education level, ethnicity, socioeconomic status and the remaining screen time variables.

a CIUS = Compulsive Internet Use Scale Score > 3.0, (range 0-4)
b CVP = Videogame Addiction Test Score > 3.0, (range 0-4)
c N.S. = Not Significant, p > .10
d Among drinkers
e Dutch Norm Healthy Physical Activity: “at least one hour of moderately intensive physical activity every day, where at least twice a week the activity is aimed at improving or maintaining physical fitness.”
f Dutch Norm Healthy Nutrition: at least having breakfast, eating fruits and vegetables 5 times per week

Note: (OR 5.65, 95% CI 2.64-12.08), bullying (OR 2.95, 95% CI 1.72-5.04), being bullied (OR 2.48, 95% CI 1.36-4.53) and poorer nutritional behaviors (OR 5.35, 95% CI 2.54-11.27) (Table 2). Many of these associations were still present in the multi-screen time analysis. Here, CIUS was significantly associated with skipping school (OR 4.16, 95% CI 1.45-11.96), being bullied (OR 3.22, 95% CI 1.43-7.22) and having poorer nutritional behaviors (OR 5.79, 95% CI 2.01-16.70), although the effect sizes/regression slopes somewhat different (Table 3).
time analysis CVP was significantly associated with bullying (OR 2.90, 95% CI 1.22-6.89) and having poorer nutritional behaviors (OR 3.51, 95% CI 1.02-12.07) (Table 3).

**Screen Time Behaviors’ Associations with Health Outcomes**

In Table 4 the findings of the single-screen time behaviors’ associations with the health outcomes psychosocial problems, being overweight and GSE are shown and in Table 5 the multi-screen time analyses of the associations of different screen time behaviors with those health outcomes.

**Watching television excessively.** In the single-screen time analyses excessively watching television was the only screen time behavior that was associated with being overweight (OR 1.77, 95% CI 1.31-2.40). Furthermore, excessively watching television was also associated with peer problems (OR 1.31, 95% CI 1.02-1.68), a problematic total SDQ score (OR 1.30, 95% CI 1.00-1.68), and for girls also with conduct problems (OR 1.95, 95% CI 1.27-3.00) (Table 4). In the comprehensive multi-screen time analysis being overweight was still significantly associated with excessively watching television (OR 1.71, 95% CI 1.17-2.51) and a

**Table 4**

| Odds Ratios of the Association of Screen Time with Psychosocial Problems, Being Overweight and GSE |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Excessive watching TV (>14h/week) | Excessive Internet use (>14h/week) | Excessive video game playing (>14h/week) | CIU | CVP |
| Emotional problems | N.S. | Boys: N.S. | N.S. | 3.94** (2.40-6.48) | 6.90** (3.45-13.80) |
| | | Girls: 1.65** (1.15-2.37) | | | |
| Conduct problems | Boys: 1.38* (0.97-1.97) | Boys: 1.81** (1.30-2.53) | 2.33** (1.28-4.25) | 3.47** (2.15-5.60) | 3.47** (1.84-6.55) |
| | | Girls: 1.95** (1.01-2.38) | | | |
| Hyperactivity | N.S. | 1.97** (1.59-2.43) | N.S. | 2.64** (1.68-4.14) | 2.90** (1.55-5.41) |
| Peer problems | 1.31* (1.02-1.68) | N.S. | 1.71* (0.93-3.13) | Boys: 3.83** (2.00-7.32) | 4.09** (2.15-7.78) |
| | | | | Girls: 2.30* (1.13-4.70) | |
| Pro-social problems | N.S. | 1.48** (1.15-1.90) | 1.73* (0.94-3.17) | Boys: 2.29** (1.23-4.29) | 1.75* (0.91-3.37) |
| | | | | Girls: 2.48* (1.15-5.36) | |
| Problematic SDQd-score | 1.30* (1.00-1.68) | 1.77** (1.39-2.26) | N.S. | 5.06** (3.23-7.93) | 4.76** (2.54-8.93) |
| Overweight | 1.77** (1.31-2.40) | N.S. | N.S. | N.S. | N.S. |
| Low GSEe | N.S. | Boys: 1.85* (0.91-3.77) | N.S. | Boys: 3.35* (1.18-9.56) | 2.38* (0.87-6.49) |
| | | Girls: 1.86** (1.26-2.73) | | Girls: 4.81** (2.45-9.47) | |

Note. All results were adjusted for sex, age, school, year of school, education level, ethnicity and socioeconomic status.

a CIU = Compulsive Internet Use Scale Score> 3.0, (range 0-4)
b CVP = Videogame Addiction Test Score> 3.0, (range 0-4)
c N.S. = Not Significant, p > .10
d SDQ = Strengths and Difficulties Questionnaire
e GSE = General Self-Efficacy
* .10 > p > .05; **: p < .01

**Watching television excessively.** In the single-screen time analyses excessively watching television was the only screen time behavior that was associated with being overweight (OR 1.77, 95% CI 1.31-2.40). Furthermore, excessively watching television was also associated with peer problems (OR 1.31, 95% CI 1.02-1.68), a problematic total SDQ score (OR 1.30, 95% CI 1.00-1.68), and for girls also with conduct problems (OR 1.95, 95% CI 1.27-3.00) (Table 4). In the comprehensive multi-screen time analysis being overweight was still significantly associated with excessively watching television (OR 1.71, 95% CI 1.17-2.51) and a
statistical trend with regard to its association to conduct problems was found, but the remaining associations from the single-screen time analyses were insignificant in this analysis (Table 5).

**Using the Internet/PC excessively.** Excessive Internet use was significantly associated with emotional problems (OR 1.65, 95% CI 1.15-2.37, only significant in girls), conduct problems (in boys OR 1.81, 95% CI 1.30-2.53 and in girls OR 1.55, 95% CI 1.01-2.38), hyperactivity (OR 1.97, 95% CI 1.59-2.43), pro-social behavioral problems (OR 1.48, 95% CI 1.15-1.90), a problematic total SDQ-score (OR 1.77, 95% CI 1.39-2.26) and a low GSE in girls (OR 1.86, 95% CI 1.26-2.73) (Table 4). In the multi-screen time analysis the association to hyperactivity (OR 1.88, 95% CI 1.41-2.52) and (in girls) to low GSE (1.94, 95% CI 1.05-3.58) were still the only associations that were significant. However, the associations to emotional problems, conduct problems, pro-social behavior and a problematic SDQ score were not (Table 5).

**Playing video games excessively.** Excessive video game playing was only significantly associated with conduct problems (OR 2.33, 95% CI 1.28-4.25) in the single-screen time analyses (Table 4). This association to conduct problems remained virtually similar (OR 2.46, 95% CI 1.71-6.33), but the weak association to peer problems and pro-social behavior were now not statistically significant. However, in this more comprehensive analysis, its association to less hyperactivity (OR 0.40, 95% CI 0.18-0.90) now emerged as being significant (Table 5).

**Compulsive Internet use.** In the single-screen time analyses CIU was significantly associated with emotional problems (OR 3.94, 95% CI 2.40-6.48), conduct problems (OR 3.47, 95% CI 2.15-5.60), hyperactivity (OR 2.64, 95% CI 1.68-4.14), peer problems (in boys OR 3.83, 95% CI 2.00-7.32 and in girls OR 2.30, 95% CI 1.13-4.70), pro-social

<table>
<thead>
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<th>Table 5</th>
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<tr>
<td></td>
<td>Excessive watching TV (&gt;14h/week)</td>
</tr>
<tr>
<td>Emotional problems</td>
<td>N.S.</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>Boys: N.S.</td>
</tr>
<tr>
<td>Girls: 1.87* (0.99-3.54)</td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>N.S.</td>
</tr>
<tr>
<td>Peer problems</td>
<td>N.S.</td>
</tr>
<tr>
<td>Pro-social problems</td>
<td>N.S.</td>
</tr>
<tr>
<td>Problematic SDQ d-score</td>
<td>N.S.</td>
</tr>
<tr>
<td>Overweight</td>
<td>1.71** (1.17-2.51)</td>
</tr>
<tr>
<td>Low GSE e</td>
<td>N.S.</td>
</tr>
<tr>
<td>Girls: 1.94* (1.05-3.58)</td>
<td></td>
</tr>
<tr>
<td>Girls: 4.39** (1.70-11.34)</td>
<td></td>
</tr>
</tbody>
</table>

Note.
All results were adjusted for sex, age, school, year of school, education level, ethnicity, socioeconomic status and the remaining screen time variables.

a CIU = Compulsive Internet Use Scale Score> 3.0, (range 0-4)
b CVP = Videogame Addiction Test Score> 3.0, (range 0-4)
c N.S. = Not Significant, p > .10
d SDQ = Strengths and Difficulties Questionnaire
e GSE = General Self-Efficacy

+ .10 > p > .05 *: p < .05; **: p < .01
Association of Screen Time Behaviors with Other Unhealthy Behaviors

The first study aim was to identify the associations of the different screen time behaviors with other unhealthy behaviors. Students that reported watching television excessively were not significantly more likely to report more other unhealthy behaviors than their peers that did not watch television excessively. Our findings differed from those in other studies that did report on significant associations with bullying, poorer eating habits and less physical exercise. However, those studies used less comprehensive multi-screen time behavioral correction for confounding. In our single-screen time behavior analyses that are more comparable to those performed in these studies, similar significant associations were in fact also found between watching television excessively and peer bullying, poorer nutritional habits, and less physical exercise. Therefore, the current findings demonstrated the possible overestimation of associations due to multi-screen time behavior confounding.

Secondly, excessive Internet users were more likely to be active alcohol users that non-excessive Internet users (Table 3), a finding comparable to several previous studies. In contrast to the study by Kim, we found no associations between excessive Internet use and smoking or marijuana use, when correcting for confounding by other screen time behaviors. However, in the single-screen time behavior analyses, excessive Internet use was associated with smoking. This again illustrates the importance of multi-behavioral analyses. Shi and Mao reported a significant association between excessive Internet use and poorer nutritional behaviors, similar to our findings, although the association in our study was only significant for girls. It was found that girls that used Internet excessively were more likely to report unhealthy eating patterns than non-excessive Internet users. Because no past studies reported this sex difference, this finding could not be interpreted using existing literature. Furthermore, the findings that excessive Internet users were less physically active than those who were not excessive Internet users was confirmed by earlier research.

Thirdly, excessive video game players were more likely to report skipping school (only significant for boys) than students not reporting to play video games excessively. This effect was impossible to determine for girls, because too few reported to play video games excessively. In contrast to the study of Ko et al, it was not significantly related to alcohol use. However, once more, in the single-screen time analyses students that were compulsive Internet users were more likely to be recent alcohol users than students that were not compulsive Internet users. However, no
literature was found to compare these findings because measuring CIU is not yet a standard practice in many adolescent health studies. This makes the persistent findings in our study with regard to such a wide range of health behaviors and outcomes being related to CIU even more provocative.

Compulsive video game users were significantly more likely to be bullies and to report poorer nutritional habits, findings not previously reported in the literature. Like CIU, CVP may need to be included as part of the standard set of adolescent health behaviors measured, given our new digital age.

Association of Screen Time Behaviors with Health Outcomes

Part of the first study aim was to examine whether students that presented ‘problematic’ screen time behaviors were more likely to report negative health outcomes, ie, having psychosocial problems, being overweight, and having low GSE.

As in previous studies⁴, students that reported watching television excessively were more likely to be overweight. No other associations were found, which is comparable to previous research.⁴³ These results, however, are in contrast to the findings of McClure et al.,⁴⁰ who reported that students that watched television excessively had lower self-esteem. However, direct comparability is limited by the fact that questions were not identical.

Students reporting excessive Internet use were more likely to report being hyperactive (part of the SDQ survey). Similar to findings by Mathers et al.,⁴⁹ we found no other significant association between excessive Internet use and total SDQ score. The specific association of excessive Internet use with psychosocial problems was only significant with regard to the hyperactivity sub-part of the SDQ. For girls an association with lower GSE was found for excessive Internet use, similar to what Nihill et al.⁴⁴ found.

Students who reported playing video games excessively were more likely to report conduct problems but less likely to report hyperactivity. Mathers et al.⁴⁹ found no association between video game playing and psychosocial problems.

Compulsive Internet use showed the strongest association among screen time behaviors with psychosocial problems, ie, emotional problems, conduct problems, hyperactivity, a problematic total SDQ score, and, for girls, a low GSE score. These findings were similar to those of previous research.⁶

Lastly, students who were compulsive video game players were more likely to report psychosocial problems. These findings were similar to those from other studies.⁷,⁴²,⁴³

Single-screen versus Multi-screen Time Behavior Analyses

The second aim of this study was to quantify the change in ORs that appeared after correcting for other screen time behavior variables in the multi-screen time analysis in comparison to the single-screen time analyses. Such a change would be indicative of a close interrelationship between the screen time behaviors and their relation to a particular outcome. Especially with regard to CIU, and to a lesser extent, with excessive Internet use, the significant associations of the single-screen time behavior analyses remained in the multi-screen time behavior analyses. However, the confounding effects that different screen time behaviors pose on each other’s associations to the outcomes in question in this study (other unhealthy behaviors and health outcomes) often were statistically significant. This indicates that the single-screen time behavior analyses might overestimate the associations with other unhealthy behaviors or health outcomes. It also implies that the “associated” unhealthy behaviors and health outcomes of adolescents that watch television excessively and/or play video games excessively or compulsively can be explained to a great extent by excessive or CIU of those adolescents. This is an important finding, particularly given previous studies that only investigate one screen time behavior and do not take a broader spectrum of screen time behaviors into account. These differences in analyses seem to explain the majority of the discrepancies between the findings of this study and previous literature. Although some of the confidence intervals were skewed (indicating a small cell size and that the results need to be interpreted with caution) this main conclusion still seems to hold true.

Strengths and Limitations

One strength of the study is that the study population is its representativeness of Dutch adolescents. A second strength is the specific set of multivariate analyses, and the comprehensive measures of adolescent health. Many previous studies only used what we have referred to in this paper as single-screen time behavior analyses instead of more comprehensive multi-behavioral analyses. Therefore, the current study is more likely to be properly conservative in its presented associations and conclusions.

However, our data were based on self-report and could have represent some reporting bias. However, this effect was minimized by only using validated questionnaires, mostly based on the large (international) HBSC survey. Secondly, the reported associations cannot be interpreted as causal relations, due to the cross-sectional nature of this study. Also, it has to be taken into account that the cut-off scores for excessive and compulsive screen time use are standard measures in the surveys used in the current study, but they may deviate from other investigations. The cut-off score for excessive screen time as problem behavior is sample dependent and study findings should not be generalized to other populations. Furthermore, many statistical tests have been performed, thereby rais-
ing the danger of an inflated Type-I error. However, despite these precautions, major conclusions from this study offer provocative implications for future research.

Recommendations for Future Research
As shown, different screen time behavior variables are often closely associated. A screen time variable that was not included in our study is the use of smart phones or tablets. As van Rooij et al previously stated "even during the time span of writing this thesis, various technological innovations have been introduced." Technology rapidly increases and smart phones seem to intensify people’s Internet use and with this increase, excessive and compulsive Internet use may evolve further. This study showed the potential for (psychosocial) problems associated with excessive or compulsive screen time behavior, and therefore, the authors recommend that future studies take this development into account. A second important aspect that currently is understudied is the content of the screen time behaviors ie, what adolescents watch, do, and play behind screens. As Mathers et al show, this might provide interesting insights that shed light on these new screen time behaviors.

Conclusions
These results show several significant associations between screen time behaviors and unhealthy behaviors as well as with health outcomes related to psychosocial problems, being overweight, and having low GSE. However, when correcting for the confounding effects by the other screen time behaviors in the multi-screen time analysis, declines and changes in these associations were noted. In this multi-screen time behavior analysis, excessive and compulsive Internet use was uniquely associated with unhealthy behaviors and undesirable health outcomes. Thus, these findings suggest that special attention should be paid in future studies to adolescents’ screen time and associated unhealthy behaviors in a clustered, comprehensive fashion.

Human Subjects Statement
This study was approved by the Institutional Review Board of the University Medical Center Utrecht, the Netherlands. METC-protocol number 11-397 / C.

Conflict of Interest Statement
All authors declare to have no conflict of interest.

Acknowledgment
Mr Busch and Ms Manders contributed equally to the research as primary authors.

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