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ORIGINAL ARTICLE

Perceived problems with computer gaming and Internet use are associated with poorer social relations in adolescence

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Abstract
Objectives Young people's engagement in electronic gaming and Internet communication have caused concerns about potential harmful effects on their social relations, but the literature is inconclusive. The aim of this paper was to examine whether perceived problems with computer gaming and Internet communication are associated with young people's social relations.
Methods Cross-sectional questionnaire survey in 13 schools in the city of Aarhus, Denmark, in 2009. Response rate 89 %, $n = 2{,}100$ students in grades 5, 7, and 9. Independent variables were perceived problems related to computer gaming and Internet use, respectively. Outcomes were measures of structural (number of days/week with friends, number of friends) and functional (confidence in others, being bullied, bullying others) dimensions of student's social relations.
Results Perception of problems related to computer gaming were associated with almost all aspects of poor social relations among boys. Among girls, an association was only seen for bullying. For both boys and girls, perceived problems related to Internet use were associated with bullying only.
Conclusions Although the study is cross-sectional, the findings suggest that computer gaming and Internet use may be harmful to young people's social relations.

Keywords Adolescents · Social relations · Computer gaming · Internet use

Introduction

Strong and supportive social relations are important prerequisites for positive youth development (Due et al. 2011), and it is important to identify circumstances which influence the amount and quality of social relations in adolescence. Engagement in computer gaming and Internet communication is an increasing activity among young people. There are concerns about negative side effects such as negative influences on social relations in adolescence (Blais et al. 2008). It is still unclear whether Internet communication and computer gaming have a positive or negative impact on young people's social relations (Valkenburg and Peter, 2009; Blais et al. 2008). This paper addresses two separate issues, the association between computer gaming and social relations, and the association between Internet communication and social relations.

A range of studies report that computer gaming is associated with poorer social relations. A study of Korean

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children aged 10–12 years reports that playing games online is associated with decreased time spent with family and decreased communication with family members (Lee and Chae 2007). Similarly, among adolescents aged 14–15 years from New Zealand, Richards et al. (2010) found that increased time spent playing on the computer is associated with low attachment to parents.

Separate literature on young people's use of the Internet for communication documents associations with poor social relations. A study among Italian adolescents aged 14–19 years showed that those with problematic Internet use have worse interpersonal relations than peers without problematic Internet use (Milani et al. 2009). Bonetti et al. (2010) found that Australian students aged 10–16 years reporting to be lonely have a significantly higher amount of online communication than non-lonely students, and in a sample of US adolescents Sanders et al. (2000) found that low Internet users, compared to high users, have significantly better relationships with their mothers and friends. Also, Shao-Kang et al. (2005) showed that high levels of online gaming was associated with poorer quality of interpersonal relations.

Yet another body of literature shows that young people's engagement in computer gaming and Internet communication is not detrimental to their social relations and may even facilitate strong and positive relations. Durkin and Barber (2002), who studied 16 year old Australian adolescents, found that computer and console gamers report closer family relationships than non-gamers. Valkenburg and Peter (2009) studied Dutch adolescents aged 10–17 years and found that Internet use for communication has a positive longitudinal effect on the quality of adolescents' existing friendships. In a study of US college students, Hu et al. (2004) found that Internet communication is positively associated with social intimacy and that frequent Internet conversation encourages the desire to meet face-to-face. Also, Kuntsche et al. (2009) found in a cross-national study that electronic media communication among adolescents facilitates rather than supersedes face-to-face contacts.

The association between Internet communication and social relations may be more differentiated. Weiser (2001) suggests that the effects of Internet use may depend on its function in young people's lives. His study among university students shows that Internet use for entertainment is negatively associated with social integration while Internet use for information acquisition is positively associated with social integration. Blais et al. (2008) suggest that different Internet-based activities may be differentially associated with social relations. They showed that Internet use for communication with known others increased romantic relationships and best friendship quality, while Internet communication with strangers reduced romantic relationships and best friendship quality. Blais et al. (2008) summarise that there seems to be some support for two very different hypotheses: the reduction hypothesis, which states that online communication impedes further development of pre-existing friendships, and the stimulation hypothesis stating that Internet communication may strengthen communication with strangers.

The above-mentioned studies are somewhat contradictory. They are also difficult to compare because of differences in study population and in conceptualisation and measurement of both computer gaming, Internet communication, and social relations. We suggest that use of an explicit conceptualisation of social relations may provide a clearer insight into these associations. Also, the previous studies generally focus on time use (screen time). The present study examines computer gaming and Internet use in the perspective of everyday life sociology, i.e. how the individual or group typically acts, thinks, and feels about everyday practice. In this perspective, time use is not sufficient to describe young people's computer gaming and Internet use. It is important also to understand how they think about these behaviours and we use a newly developed non-clinical and non-pathological measure which reflects young people's own perceptions about problems related to computer gaming and Internet communication, regardless of screen time (Holstein et al. 2014).

Therefore, the aim of this study is to examine (1) whether perceived problems with computer gaming are associated with characteristics of young people's social relations, and (2) whether perceived problems with Internet communication are associated with characteristics of young people's social relations.

The present study applies a conceptualisation of social relations based on the framework by Due et al. (1999). This framework separates two main dimensions of social relations: structure and function. The structural aspect of social relations is defined by the individuals with whom one has an interpersonal relationship and the linkages between these individuals cover both formal and informal relations. Measurements involve, e.g., number and type of relations, frequency of contacts, diversity, and reciprocity. The functional aspect of social relations is defined as the interpersonal interactions within the structure of the social relations and the function covers qualitative and behavioural aspects of the social relations. These include social support involving, e.g., emotional, instrumental and informational support, relational strain involving conflicts and excessive demands, and social anchorage covering social integration.

This study focuses on associations rather than influences as the applied design is cross-sectional. In line with most of the literature in this area of interest, we believe that social relations is the dependent variable, but we stick to the association terminology rather than terminology which

implies causal relations. Furthermore, we avoid pathological terminology such as problematic Internet use, pathological gaming, and addiction. Our measures tap into everyday life and experiences of teenagers rather than potential pathological aspects of their computer use.

Methods

Design

The Aarhus School Survey is a school-based, cross-sectional questionnaire survey conducted in the city of Aarhus, the second largest city in Denmark (314,000 inhabitants). The survey was conducted in 2009 and was an interim data collection of a nationally representative survey conducted every fourth year constituting the Danish contribution to the cross-national Health Behaviour in School-aged Children (HBSC) survey (Roberts et al. 2009; Currie et al. 2009).

Sampling and study population

The Aarhus School Survey applied a strategic sampling procedure to ensure sufficient variability in socioeconomic position and ethnic background. Thirteen schools were included. All students at grades 5, 7, and 9 corresponding to the age groups of 11, 13, and 15 years were invited. A total of 2,100 students were included in the final data file corresponding to 99 % of the students present on the day of data collection and 89 % of the students enrolled in the sampled classes.

Parts of the internationally standardised HBSC instrument were included in the applied questionnaire for measuring socio-demographic factors, health, health behaviours, well-being, and social relations (Roberts et al. 2009). Additional items were developed for the survey on perceived problems related to computer gaming and use of Internet for communication and surfing.

The study complies with the Helsinki II declaration. In Denmark there is no formal agency for approval of population-based surveys. The schools decide autonomously whether to participate in such surveys. In each participating school, the school board, headmaster, and schoolchildren's council had approved the study and the school nurse was informed. The survey was conducted under full confidentiality, informed consent, and voluntary participation. Students returned their questionnaire in sealed envelopes in order to protect their anonymity.

Measurements

Since we study young people's use of computers and the Internet in a sociological everyday-life context, we avoided pre-existing scales which often focus on pathological aspects of computer gaming and Internet use. We developed new measures which included the respondents' own perceptions of computer gaming and Internet use: (1) whether the respondent perceives him/herself to be dependent of computer gaming/Internet use for communication and surfing; (2) whether the respondent feels bad if not able to use computer/Internet; (3) whether the family shows concerns about the adolescent's use of computer/Internet (see items and response categories in Table 1).

We tested a first version of these items among 44 students in two age groups (11- to 14-year-olds) and learned about students' perceptions, understanding, and experiences in focus group discussions. These documented a high face validity of the items and that it was meaningful to separate two kinds of computer/Internet use: computer gaming and use of the Internet for communication and surfing (not homework). Responses were dichotomized into

Table 1 Measurement of perceived problems related to computer gaming and Internet use; The Aarhus School Survey, Denmark, 2009

Item wording	Statements	Response keys
How much do you agree or disagree in the following statements on computer gaming?	1. I think I spend way too much time playing computer games	1. Strongly agree
	2. I get in bad mood when I cannot spend time on computer games	2. Partly agree
		3. Neither/nor
	3. My parents tell me I spend way too much time on computer gaming	4. Partly disagree
		5. Strongly disagree
How much do you agree or disagree in the following statements on use of the Internet for surfing and chatting (not for homework)?	1. I think I spend way too much time on Internet communication and surfing	1. Strongly agree
	2. I get in bad mood when I cannot spend time on Internet communication and surfing	2. Partly agree
		3. Neither/nor
	3. My parents tell me that I spend way too much time on Internet communication and surfing	4. Partly disagree
		5. Strongly disagree

Strongly agree + Partly agree (coded 1) versus the remaining categories (coded 0). For computer gaming and Internet communication and surfing, respectively, a summary index for perceived problems was constructed ranging from 0 to 3. For the three items forming the summary index on perceived problems related to computer gaming, Cronbach's coefficient alpha was 0.72. For perceived problems related to Internet communication and surf Cronbach's alpha was 0.76. There was some differential item functioning (DIF) in relation to sex and age group in the index for perceived problems related to computer gaming and some DIF in relation to sex in the index on perceived problems related to Internet communication and surfing (Holstein et al. 2014). Therefore, we conducted all analyses separately for boys and girls and tested associations for interaction with age group. Missing values were few (Table 3) and were left out of analyses.

In the present study, the included measures of social relations covered the structure of informal relations by measures of frequency and number of contacts. The functional aspect of social relations were covered by questions on emotional support and relational strain and involved measures of confidence with significant others and experiences with bullying. Table 2 presents the item wordings, response categories, and dichotomizations applied in analyses. For afternoons with friends, number of same sex/opposite sex friends, and frequency of being bullied/bullied others, there is no clear theoretical justification for choice of cut-point. Decisions on cut-points were, therefore, based on pragmatic choices also considering the distribution of responses. Here we supplemented with sensibility analyses. Alternative dichotomizations showed fairly similar estimates. The direction of the associations remained unchanged.

We included grade, family social class, and migration status as confounders. Parents' occupational social class was coded based on students' reports of parents' job situation. The responses were coded in accordance with the HBSC coding recommendations which have many similarities with the Registrar-General's Social Class measure (Macintyre et al., 2003). Each student was classified by the highest-ranking parent into high (I–II), medium (III–IV), and low (V + economically inactive) family social class. Sixteen percent of the students gave insufficient information for a proper coding. We included 'unclassifiable social class' as a fourth and separate category in order to avoid losing too many observations in the analyses. Validation studies show that children of the age of 11 and above can provide reliable and valid information about their parents' occupation (Lien et al. 2001; Vereecken and Vandegehuchte 2003) although often with a high proportion of unclassifiable.

Migration status was based on students' reports on own and parents' place of birth. The analyses separated children

Table 2 Measurement of social relations; The Aarhus School Survey, Denmark, 2009

Item wording	Response keys	Dichotomization applied for analyses
Structure: frequency of informal contacts		
How many days a week do you usually spend with friends right after school	0, 1, 2, 3, 4, 5 days	None or one vs. two or more days
Structure: number of informal relations		
At present, how many close male and female friends do you have? (response given separately for male and female friends)	None, one, two, three, or more	Two or less vs. three or more close friends of same sex None vs. one or more close friends of opposite sex
Function: emotional support		
How easy is it for you to talk to the following persons about things that really bother you? (responses given for father, mother, best friend, same-sex friend, and friend of opposite sex)	Very easy, easy, difficult, very difficult, do not have or see this person	Very easy or easy vs. difficult or very difficult ('do not have or see this person' is coded missing)
Function: relational strain		
In the past couple of months: how often have you been bullied at school?	I have not been bullied, it has happened once or twice, 2 or 3 times a month, about once a week, several times a week	Haven't been bullied vs. once or more
In the past couple of months: how often have you taken part in bullying another student(s) at school?	I have not bullied another student(s), it has happened once or twice, 2 or 3 times a month, about once a week, several times a week	Haven't bullied others vs. once or more

with Danish background, immigrants, and descendants of immigrants.

Statistical analyses

We used a Chi square test to test for significant differences in pair-wise comparisons of distributions.

Associations between social relations (dependent variables) and perceived problems related to computer gaming and Internet use (independent variables) were estimated by multivariate logistic regression analyses in SAS/version 9.1. Perceived problems related to computer gaming and Internet use were defined by index scores of 2 or 3. A logistic model was chosen as most of the applied social relations variables are categorical and generally had few categories, whereby a linear model could not be conducted.

Initial bivariate analyses tested grade, family social class, family structure, and migration status as potential confounders. Chi square test of associations between each potential confounder and social relations and perceived problems related to computer gaming/Internet use were performed. This resulted in a final analytical model for perceived problems related to Internet use adjusted for age, family occupational social class, and migration status. The final model for perceived problems related to computer gaming was adjusted for age.

Regression analyses were run as multilevel models (PROC GLIMMIX) to account for the design effect caused by the cluster sampling. Each aspect of social relations was analyzed separately. This approach is chosen through a recognition that the concepts underlying the varying aspects of social relations may be overlapping. Potential multicollinearity is, therefore, not an issue. Analyses were conducted stratified by gender. Statistical interactions with grade were tested by including an interaction term in the model for girls and boys separately.

For three variables of social relations the proportion of missing data was approximately 10 % or more. For these variables, analyses of non-response was conducted by Chi square tests for significant differences in pair-wise comparisons of distributions between respondents and non-respondents in relation to perceived problems related to computer gaming and Internet use, respectively.

Results

Table 3 shows the distributions of the two summary indexes for perceived problems related to computer gaming and Internet use. A score of 2 or 3 on the index on computer gaming was more prevalent among boys (22 %) than girls (7.7 %) ($p < 0.001$). Perceived problems related to computer gaming was most prevalent among girls in grade 5 ($p > 0.001$). No significant age difference was seen among boys. A score of 2 or 3 on the index on Internet use was observed among more girls (13.4 %) than boys (9.9 %) ($p = 0.003$). Perceived problems related to Internet use was most prevalent among boys and girls in grade 9 (girls: $p < 0.001$, boys: $p = 0.005$).

Table 3 also shows the prevalence of poor social relations and distributions according to family social class and migration status. Spending few afternoons with friends was most prevalent among older students ($p < 0.001$). Few friends of opposite sex was most prevalent among the youngest students (girls: $p = 0.005$, boys: $p < 0.001$) while few same-sex friends was most prevalent among older students (girls: $p = 0.003$, boys: $p < 0.014$). Relatively more girls than boys have low confidence in father ($p < 0.001$), and generally, low confidence with parents increased by increasing age (p-range: <0.001–0.029). Low confidence in best friend ($p < 0.001$) and friends of same-sex ($p < 0.001$) were most prevalent among boys, while low confidence in friends of opposite sex was more prevalent among girls ($p < 0.001$). For all measures of low confidence in friends we observed a decrease by increasing age (p-range: <0.001–0.010). Involvement in bullying others was most prevalent among boys ($p < 0.001$) and decreased by increasing age (girls: $p = 0.008$, boys: $p = 0.042$). A similar pattern by age was seen for being bullied (girls: $p = 0.001$, boys: $p = 0.001$).

Table 4 presents associations between perceived computer gaming problems, perceived problems related to Internet use, and poor social relations. Girls perceiving problems with computer gaming showed higher prevalence of both being bullied and having bullied others. They spend few afternoons with friends (non-significant), and they more often reported low confidence in father, mother (non-significant and non-graded), and best friend (non-significant). Boys perceiving problems related to computer gaming were characterised by being bullied, having bullied others, spending few afternoons with friends, having no or only few close friends, and reporting low confidence in father, mother, best friend, same-sex friend, and opposite-sex friends (non-significant). No significant interactions with grade were identified.

Girls reporting problems related to Internet use were characterised by being bullied and by having bullied others (non-significant). They had increased OR for having no or few close friends of same-sex (non-significant) and reported low confidence in mother. Finally, they had decreased OR for low confidence in friends of opposite sex. Boys with perceived problems related to Internet use were characterised by being bullied and by having bullied others, and they also showed increased

Table 3 Characteristics of the study population by the applied variables; The Aarhus School Study, Denmark, 2009

	Girls				Boys			
	All girls ($n = 1069$), %	Grade 5 ($n = 389$), %	Grade 7 ($n = 397$), %	Grade 9 ($n = 283$), %	All boys ($n = 1031$), %	Grade 5 ($n = 366$), %	Grade 7 ($n = 378$), %	Grade 9 ($n = 287$), %
Perceived problems regarding computer gaming/index score								
0	77.8	70.4	78.3	87.3	54.4	57.7	53.7	51.2
1	12.9	18.3	12.1	6.7	20.9	20.2	22.5	19.5
2	6.0	7.2	6.3	3.9	18.1	15.3	17.2	23.0
3	1.7	2.6	1.5	0.7	3.9	3.3	4.2	4.2
Missing	1.6	1.5	1.7	1.4	2.7	3.6	2.4	2.1
Perceived problems related to Internet use/index score								
0	70.1	81.8	63.0	59.4	74.4	79.2	74.1	68.6
1	16.6	9.0	19.4	21.6	13.0	9.6	14.3	15.7
2	9.4	6.2	10.3	12.6	7.7	5.5	6.4	12.2
3	4.0	1.8	5.3	5.3	2.2	2.2	2.4	2.1
Missing	1.6	1.3	2.0	1.4	2.7	3.6	2.9	1.4
Indicators of poor social relations								
Structure: frequency of informal contacts								
Spend 0–1 afternoons/week with friends, %missing = 1.0	38.5	31.7	34.9	53.0	37.6	32.1	33.1	50.5
Structure: number of informal relations								
0 friends of opposite sex, % missing = 1.4	17.7	23.8	13.8	15.0	21.1	31.8	15.2	15.2
0–2 same-sex friends, % missing = 1.4	9.0	6.7	7.7	13.9	11.4	11.5	8.1	15.4
Function: emotional support								
Low confidence in father, % missing = 5.4	40.5	31.0	45.6	46.2	25.8	19.3	23.9	36.0
Low confidence in mother, % missing = 5.9	16.0	11.8	18.3	18.4	16.9	8.9	17.6	25.9
Low confidence in best friend, % missing = 9.9	6.6	9.9	5.7	3.9	21.4	26.7	20.2	17.2
Low confidence in same-sex friend, %missing = 9.5	15.3	19.4	11.2	14.9	27.1	30.3	26.0	24.9
Low confidence in other-sex friend, %missing = 11.4	54.6	70.6	53.0	38.5	44.6	58.2	39.8	37.2
Function: relational strain								
Been bullied more than once, % missing = 0.9	18.1	22.3	19.3	10.6	18.9	25.6	16.1	14.0
Bullied others more than once, % missing = 0.9	11.8	7.8	14.7	13.2	25.4	22.9	23.7	30.9
Family social class								
High	42.4	40.9	43.6	42.8	43.6	40.7	45.0	45.3
Middle	27.6	23.7	29.2	30.7	25.6	24.6	24.6	28.2
Low	16.2	16.2	15.4	17.3	12.7	11.2	13.8	13.2
Non-classifiable	12.3	18.0	10.1	7.4	16.1	21.9	13.8	11.9
Missing	1.6	1.3	1.8	1.8	2.0	1.6	2.9	1.4
Migration status								
Natives	82.0	84.1	82.1	78.8	83.2	83.6	83.3	82.6
Migrants	5.1	4.1	6.1	5.0	5.3	4.6	4.8	7.0
Descendants	12.4	11.6	10.8	15.6	10.1	9.8	10.9	9.4
Missing	0.7	0.3	1.0	0.7	1.4	1.9	1.1	1.1

Table 4 Adjusted OR (95 % CI) for poor social relations by perceived problems related to computer gaming and Internet use; The Aarhus School Study, Denmark, 2009

	Structure			Function						
	Frequency of informal contacts	Number of informal relations		Emotional support from parents and friends					Relational strain	
	Spend 0–1 afternoons/ week with friends	0 close friends of opposite sex	0–2 close same-sex friends	Low confidence in father	Low confidence in mother	Low confidence in best friend	Low confidence in same-sex friend	Low confidence in friend of opposite sex	Have been bullied more than once	Have bullied others more than once
Perceived problems related to computer gaming[a]										
Girls	$N = 1043$	$N = 1038$	$N = 1043$	$N = 935$	$N = 969$	$N = 924$	$N = 957$	$N = 896$	$N = 1048$	$N = 1048$
Index score 0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Index score 1	1.20 (0.82–1.77)	0.91 (0.56–1.48)	1.12 (0.58–2.14)	1.20 (0.80–1.80)	**1.74 (1.07–2.81)**	1.65 (0.83–3.30)	1.29 (0.78–2.14)	0.96 (0.63–1.47)	**2.46 (1.62–3.71)**	**1.71 (1.00–2.93)**
Index score 2 + 3	1.54 (0.96–2.46)	1.24 (0.71–2.18)	1.05 (0.46–2.37)	**1.83 (1.10–303)**	1.60 (0.87–2.94)	1.74 (0.74–4.04)	1.10 (0.54–2.24)	1.15 (0.65–2.03)	**1.93 (1.14–3.28)**	**2.35 (1.29–4.28)**
Boys	$N = 992$	$N = 984$	$N = 992$	$N = 929$	$N = 945$	$N = 857$	$N = 877$	$N = 815$	$N = 1000$	$N = 1000$
Index score 0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Index score 1	1.23 (0.88–1.72)	0.95 (0.62–1.44)	0.87 (0.50–1.50)	0.86 (0.58–1.29)	0.91 (0.60–1.47)	1.16 (0.76–1.77)	1.19 (0.81–1.74)	1.26 (0.88–1.80)	**1.56 (1.03–2.34)**	1.39 (0.97–2.00)
Index score 2 + 3	**1.69 (1.22–2.33)**	**1.85 (1.27–2.68)**	**1.61 (1.02–2.54)**	**1.65 (1.16–2.36)**	**1.69 (1.13–2.53)**	**1.68 (1.14–2.48)**	**1.45 (1.01–2.08)**	1.30 (0.92–1.85)	**1.90 (1.27–2.82)**	**1.45 (1.02–2.07)**
Perceived problems related to Internet use[a]										
Girls	$N = 1027$	$N = 1023$	$N = 1027$	$N = 925$	$N = 955$	$N = 910$	$N = 944$	$N = 885$	$N = 1028$	$N = 1027$
Index score 0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Index score 1	0.95 (0.66–1.35)	0.98 (0.62–1.55)	1.46 (0.83–2.57)	1.30 (0.90–1.89)	1.38 (0.87–2.20)	1.32 (0.65–2.70)	1.19 (0.73–1.95)	0.88 (0.61–1.29)	1.40 (0.90–2.19)	1.22 (0.73–2.04)
Index score 2 + 3	0.95 (0.65–1.40)	0.60 (0.34–1.05)	1.68 (0.94–3.02)	1.28 (0.86–1.91)	**1.82 (1.13–2.92)**	0.81 (0.33–2.00)	0.81 (0.45–1.47)	**0.64 (0.42–0.93)**	**1.68 (1.06–2.67)**	1.55 (0.92–2.59)
Boys	$N = 968$	$N = 962$	$N = 970$	$N = 903$	$N = 916$	$N = 834$	$N = 853$	$N = 798$	$N = 968$	$N = 968$
Index score 0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Index score 1	0.94 (0.63–1.40)	0.71 (0.42–1.21)	1.06 (0.57–1.96)	1.21 (0.78–1.87)	1.28 (0.78–2.10)	1.00 (0.61–1.66)	1.14 (0.73–1.78)	0.84 (0.55–1.27)	1.07 (0.64–1.78)	**1.79 (1.18–2.70)**
Index score 2 + 3	1.02 (0.65–1.61)	0.75 (0.42–1.33)	1.61 (0.88–2.96)	1.10 (0.66–1.83)	1.37 (0.80–2.37)	0.95 (0.52–1.74)	1.11 (0.65–1.86)	0.98 (0.60–1.60)	**2.18 (1.31–3.61)**	**2.29 (1.45–3.60)**

Significant associations are in bold

Adjusted by grade, family social class, and migration status

Multilevel logistic regression analyses are conducted to adjust for the design factor introduced by cluster sampling

[a] Perceived problems related to computer gaming and Internet use increases by increasing index score

OR for having no or few close friends of same-sex (non-significant). No significant interactions with grade were identified.

Analyses of non-response revealed that for confidence in best friend, a significantly larger proportion of non-respondents had an index-score of 2 or 3 for perceived problems related to computer use compared to respondents ($p = 0.021$).

Discussion

This study shows that most young people perceived their computer gaming and Internet use as unproblematic and that a large minority of adolescents perceive problems in their use of computer games and the Internet. Perceived problems related to computer gaming were more common among boys than girls, while perceived problems related to Internet use were more common among girls than boys. Unlike most other studies in this area of interest, we apply a conceptualisation of social relations which is appropriate because it provides a more complete picture of both structural and functional aspects of social relations. Unlike most other studies, we do not focus on time use, but how young people perceive their habits of computer gaming and Internet communication.

The study supports parts of the existing literature which document that young people's engagement in computer gaming (Lee and Chae 2007; Richards et al. 2010; Shao-Kang et al. 2005) and Internet communication (Milani et al. 2009; Bonetti et al. 2010; Sanders et al. 2000; Lee and Chae 2007) is associated with poor social relations. Especially for computer gaming, poor informal relations in terms of number and frequencies of contacts, poor emotional support, and experienced relational strain were observed, and this pattern was most marked among boys. Perceived problems related to Internet use was primarily associated with functional aspects of social relations, whereas problems related to computer gaming was associated with both functional and structural aspects of social relations. These findings do not support the idea that friendships obtained via computer gaming and Internet use replace other kinds of social relations.

The study does not reveal the mechanisms behind these associations. Computer gaming may replace time spend with friends and parents (Cummings and Vandewater, 2007), and thereby reduce the possibilities for establishing and maintaining close and sound relations with friends and parents. Another potential interpretation is that students with poor social relations with friends and parents engage in computer gaming to an extent that they themselves perceive as causing problems. Additional studies are needed to explore such a hypothesis.

The present findings are inconsistent with the study by Durkin and Barber (2002) who studied 16-year-old Australian adolescents and found that computer and console gamers report closer family relationships than non-gamers. Durkin and Barber (2002) measured computer gaming by time use, whereas we applied a measure of perceived problems related to computer gaming. Still, other issues may contribute to the inconsistency in findings in this area of research. Cole and Griffiths (2007) showed that online role-playing games among college students (e.g. World of Warcraft) can be social games with high percentages of gamers making life-long relations. This highlights the relevance of specifying the type of games that young people engage in. Kuntsche et al. (2009) also addressed this issue and suggested that "electronic media can be used to arrange appointments and to coordinate and manage face-to-face contacts among peer group members" (Kuntsche et al. 2009), an issue also highlighted by Blais et al. (2008) and by Weiser (2001).

The Internet may provide an opportunity for developing and maintaining social relations and friendships among lonely and isolated adolescents that do not pose the necessary communication skills for establishing face-to-face friendships (Valkenburg and Peter 2009; Blais et al. 2008). Bonetti et al. (2010) conclude that lonely children value the Internet as a communicative protected environment in which they can better express their inner selves and find conversation more satisfying than they do offline (Bonetti et al. 2010). In the present study, students who perceived problems related to Internet use have higher odds for being exposed to bullying and for engaging in bullying. Otherwise, they do not have worse social relations and they can, therefore, not be characterised as socially isolated. Still, a potential mechanism underlying these associations may be that students exposed to or involved in bullying may find Internet communication more appealing than face-to-face contact. This hypothesis does not appear to be documented in the existing literature, and additional studies are needed to explore such a mechanism.

The participation rate was high and we do not anticipate substantial selection bias. Potentially, the 11 % non-participants include a substantial proportion of students perceiving problems related to computer gaming and Internet use and also students characterised by poor social relations. In this case, the reported OR-values do probably underestimate the studied associations. Analyses of non-response at the item level suggested that this is not due to significant bias.

Unmeasured confounding may exist. Factors such as parental guidance and parental monitoring may be potential confounders in these analyses. Unfortunately, such data were not available. We decided not to include mental health status and school satisfaction in the

statistical models despite their association with problematic gaming and Internet communication (Desai et al. 2010; Morrison and Gore 2010; Liu et al. 2011; Lorains et al. 2011). These variables do not comply with the definition of a confounder. Rather, they may reflect pathways between perception of problems related to computer gaming and Internet communication and poor social relations, or they may be outcomes of poor social relations (Due et al. 2005; Fekkes et al. 2006; Analitis et al. 2009; Lund et al. 2009). In that case, inclusion in the statistical model would result in over-control or misleading estimates. The strengths of the study are the large community-based sample, the social diversity of the study population, and the use of conceptually anchored measures of social relations.

It would have been interesting to study cyber bullying. By the increasing use of the Internet among adolescents the need for managing cyber bullying are similarly increasing (Wolak et al. 2007). The literature shows that Internet activities, especially participating in social networking sites, represent a risk for being bullied online (Mesch 2009). Unfortunately, data on cyber bullying were not available for analyses in the present study. The study also misses information about the use of smart phones which is an important medium for computer gaming, Internet use, and cyber bullying.

In future studies it is important to identify the causality, i.e. use a prospective study design to understand whether gaming and Internet communication influences social relations or vice versa. In line with a recent study by Augner and Hacker (2012), we propose that future studies include other technical devises, e.g. mobile phones. Future studies would also benefit from addressing health related outcomes of computer and electronic game use. Examples of this focus are the study by Haug et al. (2009), which surprisingly report weak associations between these behaviours and being overweight, the study by Nuutinen et al. (2014), which suggests that health consequences of excessive computer use may be mediated by sleep restriction, and the study by Olafsdottir et al. (2014), which shows an association between high screen time and high sweetened beverage consumption. Further, we propose use of qualitative studies to get more insight into the observed associations. The practical implication of the study is first of all to raise awareness. Parents, professionals, and young people themselves need to be aware of the associations between perceived problems related to computer gaming and Internet use and poor social relations. This awareness could serve as a sound platform for discussions and guidance about appropriate involvement in computer gaming and Internet communication.

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