A cross-sectional study on extensive gaming in adolescents

Frida André, Emma Claesdotter-Knutsson, Maria Fridh, Carl Delfin, Anders Håkansson, Martin Lindstrom

1Department of Clinical Sciences Lund, Faculty of Medicine, Lund University, Lund; 2Region Skåne, Malmö Addiction Centre, Gambling Disorder Unit, Malmö; 3Social Medicine and Health Policy, Department of Clinical Sciences in Malmo, Lund University, Sweden

Abstract

Background: Extensive gaming and the consequences thereof is frequently reported from child and adolescent psychiatry and school health care. The behavior is associated with compulsion, psychiatric and physical symptoms, impaired cognitive development, and poorer school performance. This phenomenon has been described as an emergent health issue for men and little is known about its potential gender-specific characteristics. The aim of this study was to explore extensive gaming among male and female adolescents and to investigate whether the frequency of often feeling low, often feeling anxious, self-reported ADHD, self-reported ASD, being satisfied with one’s own general health, poor sleep, loneliness, and having tried smoking, alcohol, and/or other substances differed among those with and without extensive gaming.

Design and Methods: This study was based on data collected through a public health survey distributed in 2016 to pupils in 9th grade of primary school and in second grade of secondary school, including a total of 13498 participants. The association between extensive gaming and different factors was estimated among male and female respondents separately.

Results: Roughly 30% of the male and 5% of the female respondents were categorized as extensive gamers. Extensive gaming was associated with a higher prevalence of poor sleep and a lower prevalence of being satisfied with one’s own health among boys and (to a higher degree) among girls.

Conclusions: Altogether, our results contribute to the impression that extensive gaming is more heavily related to subjective health complaints among female than male adolescents.

Introduction

Internet gaming disorder (IGD) receives increasing amount of attention and has relatively recently been formally acknowledged.1-3 The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) identifies IGD as a condition requiring additional research and clinical experience before inclusion as a formal disorder while the 11th revision of the International Classification of Diseases (ICD 11) includes gaming disorder, defined as a gaming behaviour in sufficient severity to cause significant impairment in areas of function.1,3

Despite an increasing recognition theoretically, scientifically as well as formally,1-5 disagreements remain in the IGD research field that still lacks consistency regarding terminology, diagnostic cut-off and accordingly both prevalence rates and comorbidity estimates.6-7 However, most research agree on a pathological potential in the behaviour and the reports on negative health consequences are numerous.7-10 Gaming disorder has been associated with depression, anxiety, low self-esteem, sleeping disorder, loneliness and low social competence but also to the neuropsychiatric conditions attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD).4-9,11-13 Some scholars argue that the gaming itself might not be the issue, but the time spent that occur at the expense of other beneficial activities.9 The number of hours spent on gaming have been shown to be associated with both the development of game addiction but also to independently increase the probability of adverse health consequences such as depressive symptoms.14-16

Most research report on a male predominance in IGD and the phenomenon has been described as an emergent health issue for men.4-5,17-19 Boys in general are known to spend more time on gaming than their female peers and they are overrepresented among the minority that exhibits gaming problems.4,5,17,20 Time spent on gaming has been reported as a risk factor for IGD,4,5,15,16 but whether the time spent constitute a greater increase in risk for boys than for girls remains uncertain. Previous research suggests that the motives for gaming differ between gender, as male gamers are more likely to engage in gaming for social motives whereas female gamers are more likely to do so as a coping mechanism.16 IGD apparently shows differences between boys and girls but female gaming, sex differences in gaming and potential gender-specific health correlates are poorly understood.

We explored the frequency of extensive gaming among Swedish male and female adolescent pupils and investigated...
whether the frequency of the suspected associated factors differed among those with and without extensive gaming.

Specifically, we used a large sample of Swedish pupils from primary and secondary school to investigate if those with and without extensive gaming differed in the frequency of often feeling low,1,2 often feeling anxious,3 self-reported ADHD,4 self-reported ASD,5 being satisfied with one’s own general health,6 poor sleep,7 loneliness, and having tried8 smoking,9 alcohol, and/or10 other substances. The frequency of suspected associated factors was explored, stratified by gender.

**Design and Methods**

This study uses data collected from a public health survey that was distributed in 2016 to pupils in 9th grade in primary school and in 2nd grade of secondary school. Distribution covered all 33 municipalities in Skåne, a region in the south of Sweden (although most primary schools in Lund municipality did not participate in the survey), with a response rate of 77% in 9th grade and 73% in 2nd grade. The survey’s primary purpose was to investigate the current health, way of life, and various social factors among Swedish adolescents, and was provided by Region Skåne in cooperation with the municipal association of Skåne. It was answered anonymously. All participation was voluntary, all measures were based on self-report, and all questions were described as optional. Claesdotter-Knutsson *et al.*, used the same study sample and health correlates to explore problematic gambling (2021, submitted manuscript) and extensive smartphone use (2021, submitted manuscript).

**Measures**

**Extensive gaming**

Respondents were asked to rate on a 4-point scale (“none”, “less than 1 hour”, “1-3 hours”, “more than 3 hours”) how much time they spent on gaming (using either a computer or a gaming console) every day. A new binary variable labelled “Extensive gaming” was created in which more than three hours of gaming was categorized as “yes” and all other responses as “no”.

**Associated factors**

Based on clinical experience combined with previous research outlined in the introduction we chose to investigate a wide range of suspected associated factors. These factors were related to general well-being, mental health, and various adverse or risk-taking behaviors. Using the available survey data, we created new, binary variables in order to examine the frequency of each factor.

Respondent’s psychological health was assessed using two questions from the Health Behaviour in School-Aged Children Symptom Checklist, both with separately verified satisfactory test-retest reliability.21 Respondents rated, on a five-point scale (“about every day”, “more than once a week”, “about every week”, “about every month”, “rarely or never”), how often they had “felt low” and “anxious/worried” during the past six months. We created two new binary variables, labelled “Often feeling low” and “Often feeling anxious”, where those who answered “about every day” or “more than once a week” were categorized as “yes” and all others as “no”.

Several questions on long-term somatic or psychiatric disorders were included in the survey. Respondents were asked whether they had “ADHD or ADD” and “Autism/Asperger’s syndrome”, and based on their answers two new binary variables, labelled “ADHD” and “ASD”, were created, where those who affirmed ADHD/ADD or ASD were categorized as “yes” and all others as “no”.

Respondents’ general health status was assessed, on a five-point scale (“very good”, “rather good”, “neither good nor poor”, “rather poor”, “poor”), with the Self-Rated Health instrument (Erikkson *et al.*, 2001). A new binary variable labelled “Satisfied with health” was created, with those answering “very good” or “rather good” classified as “yes” and all others as “no”.

Respondents rated, on a three-point scale, how many hours a night they usually slept on weekdays (“less than 7 hours”, “7-9 hours”, “more than 9 hours”). Based on their answers we created a new binary variable, labelled “Poor sleep”, with those answering “less than 7 hours” classified as “yes” and all others as “no”.

Respondents, rated on a four-point scale (“have no close friend”, “have one close friend”, “have two close friends”, “have several close friends”), whether they presently have a close friend with whom they can talk in confidence about almost any personal matter. We created a new binary variable, labelled “Loneliness”, with those answering “have no close friend” classified as “yes” and all others as “no”.

The survey included several questions about smoking, alcohol habits, and other substance use. We created three new binary variables, labelled “Tried smoking”, “Tried alcohol”, and “Tried other substances”, with affirming of any kind of frequency classified as “yes” and all other responses as “no”.

**Statistical analysis**

We used the R statistical programming language, version 4.0.4 for all statistical analysis,22 along with several functions from the R package tidyverse for intermediate data processing.23 A fully Bayesian approach to statistical analysis was used, which has a clear advantage over frequentist approaches in that it facilitates genuine probabilistic statements about estimated parameters.24 We used the R package brms,25 which provides an interface between R and the Stan probabilistic programming language to specify Bayesian models.26 Specifically, we used Bayesian binomial regression models with weakly informative priors centered around zero, providing moderate regularization while still having minimal impact on obtained estimates,27 in order to assess whether the frequency of a suspected associated factor was different among those with and without extensive gaming. Finally, we used the R package emmeans for post-processing results.28

Estimated group differences are presented as estimated median absolute percentage differences and associated odds ratios along with 95% highest density intervals (HDIs) presented within square brackets. The 95% HDI may be interpreted such that it has a 95% probability of actually containing the values inside it.29 Furthermore, we used the region of practical equivalence (ROPE) approach to determine whether an estimated difference was of practical and/or clinical importance.29 Specifically, we considered an estimated difference of at least 5% (in either direction) as the minimal difference for “practical equivalence”, and if the 95% HDI was not beyond this cutoff, we deemed the results as uncertain in terms of practical and/or clinical importance.

**Results**

**Sample characteristics**

Around thirty percent of boys in both 9th grade of primary school and 2nd grade of secondary school were classified as extensive gamers, whereas for girls the corresponding percentage was around five percent in both grades (see Table 1 for additional details). The frequency of having poor sleep emerged as the largest and most robust difference between those with and without
extensive gaming, followed by satisfaction with one’s own health. For several other variables the differences between the two groups were robustly above zero, although the estimated differences were not, with 95% probability, at least +/- 5% or larger.

Boys in 9th grade of primary school
Among boys in 9th grade of primary school, we found that 37% (N=532) of boys with extensive gaming were classified as having poor sleep, compared to 23.7% (N=698) of those without extensive gaming, with an estimated difference of 13.3% [10.9%, 15.8%] and a corresponding odds ratio of 1.89 [1.68, 2.11]. Although the estimated differences did not, with 95% probability, exceed the prespecified ROPE, boys with extensive gaming were also less satisfied with their own health and reported a higher frequency of loneliness than those without extensive gaming. Full details are presented in Table 2 and Figure 1A.

Girls in 9th grade of primary school
Among girls in 9th grade of primary school, we found that those with extensive gaming were robustly and substantially less satisfied with their own health compared to those without extensive gaming [66.5% [N=181 compared to 86.1% (N=3295)], with an estimated difference of -19.5% [-24.4%, -14.8%] and a corresponding odds ratio of 0.32 [0.25, 0.39]. Furthermore, the difference in frequency of poor sleep between those with [52.7% (N=154)] and without [35.4% (N=1430)] was also both substantial and robust, with an estimated difference of 17.4% [12.4%, 22.3%] and a corresponding odds ratio of 2.04 [1.65, 2.47]. Finally, girls with extensive gaming reported higher frequencies of ADHD, ASD, loneliness, and having tried smoking and other substances than those without extensive gaming, but these estimates did not, with 95% probability, exceed the ROPE. Full details are presented in Table 3 and Figure 1B.

Table 1. Frequency of extensive gaming, based on data collected in southern Sweden in 2016.

|                      | Number of respondents | Valid responses (%) | Extensive gaming (%) | No extensive gaming (%) |
|----------------------|-----------------------|--------------------|---------------------|------------------------|
| Boys in 9th grade of primary school | 4609 | 4401 (95.5) | 1442 (32.8) | 2959 (67.2) |
| Girls in 9th grade of primary school | 4497 | 4383 (97) | 293 (6.7) | 4070 (93.3) |
| Boys in 2nd grade of secondary school | 3945 | 3756 (95.2) | 1054 (28.1) | 2702 (71.9) |
| Girls in 2nd grade of secondary school | 3955 | 3847 (97.3) | 201 (5.2) | 3646 (94.8) |

Diff., estimated difference; OR, odds ratio; HDI, highest density interval. Estimated differences that, with 95% probability, are above the prespecified cutoff for practical equivalence are highlighted in bold.

Table 2. Extensive gaming and associated factors among boys in 9th grade of primary school, based on data collected in southern Sweden in 2016.

|                      | N. Extensive gaming % | No extensive gaming % | % Diff. [95% HDI] | OR [95% HDI] |
|----------------------|-----------------------|-----------------------|-------------------|--------------|
| Often feeling low    | 4227                  | 9.4 (N=131)           | 8.1 (N=230)       | 1.3 [-0.2%, 2.9%] | 1.18 [0.96, 1.41] |
| Often feeling anxious| 4215                  | 7.8 (N=108)           | 6.9 (N=195)       | 0.8 [-0.8%, 2.3%] | 1.13 [0.9, 1.37] |
| Satisfied with health| 3941                  | 89.6 (N=1169)         | 95.4 (N=2515)     | -5.7 [-7.3%, -4.2%] | 0.42 [0.33, 0.51] |
| ADHD                 | 4221                  | 3.4 (N=49)            | 2.5 (N=70)        | 0.9 [0%, 1.9%] | 1.39 [0.98, 1.85] |
| ASD                  | 4221                  | 2.6 (N=37)            | 2 (N=57)          | 0.6 [-0.2%, 1.4%] | 1.31 [0.87, 1.79] |
| Poor sleep           | 4378                  | 37 (N=532)            | 23.7 (N=698)      | 13.3 [10.9%, 15.8%] | 1.89 [1.68, 2.11] |
| Loneliness           | 4560                  | 10.4 (N=149)          | 7.7 (N=226)       | 2.7 [1.2%, 4.3%] | 1.39 [1.14, 1.65] |
| Tried smoking        | 4225                  | 32 (N=445)            | 30.9 (N=875)      | 1.1 [-1.3%, 3.6%] | 1.05 [0.94, 1.18] |
| Tried alcohol        | 4284                  | 57 (N=805)            | 56.1 (N=1612)     | 0.8 [-1.7%, 3.5%] | 1.03 [0.93, 1.15] |
| Tried other substances| 4167                  | 6.9 (N=96)            | 6.4 (N=177)       | 0.6 [0%, 0.4%] | 1.11 [0.87, 1.34] |

Diff., estimated difference; OR, odds ratio; HDI, highest density interval. Estimated differences that, with 95% probability, are above the prespecified cutoff for practical equivalence are highlighted in bold.

Table 3. Extensive gaming and associated factors among girls in 9th grade of primary school, based on data collected in southern Sweden in 2016.

|                      | N. Extensive gaming % | No extensive gaming % | % Diff. [95% HDI] | OR [95% HDI] |
|----------------------|-----------------------|-----------------------|-------------------|--------------|
| Often feeling low    | 4270                  | 22 (N=61)             | 23.8 (N=947)      | -1.9 [-5.9%, 2.4%] | 0.9 [0.69, 1.12] |
| Often feeling anxious| 4262                  | 19.2 (N=55)           | 19.4 (N=770)      | -0.2 [-4%, 3.9%] | 0.99 [0.75, 1.26] |
| Satisfied with health| 4098                  | 66.5 (N=181)          | 88.1 (N=3295)     | -19.5% [-24.4%, -14.8%] | 0.32 [0.25, 0.39] |
| ADHD                 | 4229                  | 6.4 (N=18)            | 2.8 (N=110)       | 3.5 [1.2%, 5.9%] | 2.34 [1.38, 3.38] |
| ASD                  | 4216                  | 5 (N=14)              | 0.8 (N=31)        | 4.1 [2.1%, 6.3%] | 6.54 [3.3, 10.38] |
| Poor sleep           | 4336                  | 52.7 (N=154)          | 35.4 (N=1430)     | 17.4 [12.4%, 22.3%] | 2.04 [1.65, 2.47] |
| Loneliness           | 4336                  | 12.4 (N=36)           | 5.6 (N=226)       | 6.7 [3.5%, 9.9%] | 2.37 [1.67, 3.15] |
| Tried smoking        | 4277                  | 42 (N=121)            | 32.3 (N=1287)     | 9.7 [4.8%, 14.6%] | 1.52 [1.22, 1.84] |
| Tried alcohol        | 4315                  | 54.8 (N=159)          | 55.5 (N=2233)     | -0.6 [-5.0%, 4.4%] | 0.97 [0.78, 1.17] |
| Tried other substances| 4250                  | 7.3 (N=21)            | 4.4 (N=173)       | 2.9 [0.4%, 5.5%] | 1.71 [1.08, 2.42] |

Diff., estimated difference; OR, odds ratio; HDI, highest density interval. Estimated differences that, with 95% probability, are above the prespecified cutoff for practical equivalence are highlighted in bold.
**Boys in 2nd grade of secondary school**

Our findings among boys in 2nd grade of secondary school largely mirrored those of boys in 9th grade of primary school. Of those with extensive gaming, 48.4% (N=506) were classified as having poor sleep and 84.3% (N=805) reported being satisfied with their own health, compared to 39.3% (N=1058) and 92.9% (N=2244) among those without extensive gaming, respectively, with estimated differences of 9.1% [6.2%, 12.1%] (corresponding odds ratio of 1.45 [1.28, 1.63]) for poor sleep and -8.6% [-10.8%, -6.5%] (corresponding odds ratio of 0.41 [0.33, 0.49]) for being satisfied with their own health. Those with extensive gaming also reported a higher frequency of often feeling low, ADHD, and ASD, but these estimates did not, with 95% probability, exceed the ROPE. Full details are presented in Table 4 and Figure 1C.

**Girls in 2nd grade of secondary school**

Again, findings among girls in 2nd grade of secondary school were similar to those observed among girls in 9th grade of primary school. 62% (N=124) of those with extensive gaming were classified as having poor sleep, compared to 43.9% (N=1594) of those without extensive gaming, with a robust and substantial estimated difference of 18.1% [12.4%, 24.1%] and a corresponding odds ratio of 2.09 [1.58, 2.62]. Furthermore, 71.1% (N=128) of those with extensive gaming were satisfied with their own health, compared to 82.9% (N=2802) of those without extensive gaming, again with a robust and substantial estimated difference of -11.7% [-17.3%, -6.1%] and a corresponding odds ratio of 0.51 [0.37, 0.66]. In addition, girls in 2nd grade of secondary school classified as extensive gamers also reported higher frequencies of ADHD, ASD, and loneliness, as well as lower frequencies of having tried smoking and alcohol. Still, these estimates did not, with 95% probability, exceed the ROPE. Full details are presented in Table 5 and Figure 1D.

**Discussion**

This study used a large, representative sample of Swedish adolescent pupils and found that extensive gaming, defined as spending more than three hours on computer and/or console gaming daily, was relatively prevalent among boys (~30% of respondents), especially when compared to girls (~5% of respondents). Furthermore, extensive gaming was robustly associated with a substantially higher prevalence of poor sleep and a substantially lower prevalence of being satisfied with one’s own health. Our findings showed that the prevalence of poor sleep was between ~9% to ~18% higher among those with extensive gaming, whereas the number of respondents reporting that they were satisfied with their own general health was between ~6% to ~20% lower among those with extensive gaming. Overall, differences were greater among girls than among boys. In addition, several suspected associated factors differed reliably from zero between those with and without extensive gaming. Although these estimates were, overall, relative-

| N. | Extensive gaming % | No extensive gaming % | % Diff. [95% HDI] | OR [95% HDI] |
|----|-------------------|----------------------|------------------|-------------|
| Often feeling low | 3644 | 13.4 (N=138) | 10.9 (N=285) | 2.4 [0.4%, 4.5%] | 1.26 [1.03, 1.5] |
| Often feeling anxious | 3645 | 10.3 (N=106) | 9.3 (N=243) | 1 [-0.8%, 2.9%] | 1.12 [0.89, 1.35] |
| Satisfied with health | 3637 | 4.2 (N=43) | 2.2 (N=58) | 2% [0.9%, 3.1%] | 1.93 [1.31, 2.61] |
| ASD | 3636 | 5.3 (N=54) | 1.4 (N=36) | 3.8 [2.7%, 5.1%] | 3.97 [2.64, 5.5] |
| Poor sleep | 3537 | 4.4 (N=506) | 39.3 (N=1068) | 9.1 [6.2%, 12.1%] | 1.45 [1.28, 1.63] |
| Loneliness | 3732 | 8.4 (N=68) | 7.2 (N=194) | 1.1 [-0.5%, 2.8%] | 1.17 [0.92, 1.43] |
| Tried smoking | 3598 | 55.4 (N=560) | 57.1 (N=1478) | -1.7 [-4.7%, 1.4%] | 0.93 [0.82, 1.05] |
| Tried alcohol | 3505 | 81.8 (N=843) | 83.5 (N=2188) | -1.7 [-3.9%, 0.6%] | 0.89 [0.75, 1.04] |
| Tried other substances | 3337 | 17.8 (N=177) | 16.6 (N=421) | 1.2 [-1.1%, 3.6%] | 1.09 [0.92, 1.27] |

Diff., estimated difference; OR, odds ratio; HDI, highest density interval. Estimated differences that, with 95% probability, are above the prespecified cutoff for practical equivalence are highlighted in bold.

**Table 4. Extensive gaming and associated factors among boys in 2nd grade of secondary school, based on data collected in southern Sweden in 2016.**

| N. | Extensive gaming % | No extensive gaming % | % Diff. [95% HDI] | OR [95% HDI] |
|----|-------------------|----------------------|------------------|-------------|
| Often feeling low | 3788 | 28.1 (N=56) | 27.9 (N=1003) | 0.1 [-5.3%, 5.5%] | 1.01 [0.75, 1.28] |
| Often feeling anxious | 3795 | 25.8 (N=51) | 22.3 (N=801) | 3.4 [-1.7%, 8.7%] | 1.21 [0.89, 1.55] |
| Satisfied with health | 3560 | 71.1 (N=128) | 82.9 (N=2802) | -11.7 [-17.3%, -6.1%] | 0.51 [0.37, 0.66] |
| ADHD | 3767 | 8.2 (N=16) | 3.1 (N=111) | 5 [1.8%, 8.2%] | 2.75 [1.58, 4.69] |
| ASD | 3767 | 5.1 (N=10) | 0.6 (N=23) | 4.3 [1.9%, 6.9%] | 8.15 [3.27, 13.7] |
| Poor sleep | 3829 | 62 (N=124) | 43.9 (N=1594) | 18.1 [12.4%, 24.1%] | 2.09 [1.58, 2.62] |
| Loneliness | 3839 | 12.1 (N=24) | 4.8 (N=175) | 7.1 [3.3%, 11%] | 2.69 [1.7, 3.75] |
| Tried smoking | 3756 | 44.6 (N=86) | 52.8 (N=1883) | -8.3 [-14.2%, -2.2%] | 0.72 [0.55, 0.9] |
| Tried alcohol | 3700 | 74.7 (N=145) | 82.2 (N=2949) | -7.4 [-12.7%, 2.2%] | 0.64 [0.47, 0.83] |
| Tried other substances | 3715 | 13.4 (N=25) | 11.3 (N=399) | 2 [-2.2%, 6.2%] | 1.21 [0.79, 1.76] |

Diff., estimated difference; OR, odds ratio; HDI, highest density interval. Estimated differences that, with 95% probability, are above the prespecified cutoff for practical equivalence are highlighted in bold.

**Table 5. Extensive gaming and associated factors among girls in 2nd grade of secondary school, based on data collected in southern Sweden in 2016.**

---

PagePress Journals Limited. All rights reserved.
ly modest, with median estimated differences below 5%, they represent factors that may be worthy of further research.

Poor sleep was the only variable shown to be consistently associated with extensive gaming. Both male and female extensive gamers in both 9th grade of primary school and in 2nd grade of secondary school showed a robust overrepresentation of poor sleep. Previous research seems to agree on the association between poor sleep and screen time in general but also to extensive gaming specifically.30,31 The fact that insufficient sleep is associated with both mental health problems and poor academic performance makes this relationship particularly clinically relevant.31,32 The overrepresentation was consistently greater among the extensively gaming girls (the estimated difference in the prevalence of poor sleep among extensive vs. non-extensive gamers were 13% and 9% for boys and 17% and 18% for girls). Whether female gender strengthens the adverse effect of gaming on sleep quality is to our knowledge not previously investigated and the relationship deserves further exploration.

Lee et al. showed that the prevalence of depressive symptoms, suicidal behaviour and being bullied increased steadily with increasing time spent on video games increased among female adolescents while the male adolescents showed the same tendency but not to the same extent.20 Concordant with the results presented by Lee et al. our study showed that female extensive gamers were consistently less likely to be satisfied with their general health status. The male extensive gamers in 2nd grade of secondary school showed the same pattern to a lesser degree.

Marmet et al. reported on an association between game addiction and addiction to tobacco, alcohol and illicit drugs among adult men.33 The extensive gaming girls in 9th grade of primary school showed a significantly greater prevalence of individuals who reported that they had ever tried both cigarettes and other substances, though not robustly so. This association was not seen among their male peers or in 2nd grade of secondary school. The female gamers in 2nd grade of secondary school showed an almost opposite pattern with a significantly reduced prevalence of individuals with the experience of both cigarettes and alcohol, still not robustly. Reasonably, an experience of cigarettes and other substances represent a more severe risk-taking behaviour the younger you are, as there is evi-

Figure 1. General health status in A) boys in 9th grade of primary school; B) girls in 9th grade of primary school; C) boys in 2nd grade of secondary school; D) girls in 2nd grade of secondary school.
dence that these kinds of behaviour are more common later in adolescence.\textsuperscript{34,35} One could further argue that you would expect that a majority of the respondents in 2nd of secondary school should report a lifetime experience of either alcohol or cigarettes,\textsuperscript{34,35} possibly as part of a social and exploratory behaviour. If that was true, the lack of such experience seen among the extensive gaming girls in 2nd of secondary school could be considered deviating and possibly as a part of the increased degree of loneliness also seen in this group. The estimated differences were modest but noteworthy and deserves additional exploration.

ADHD is a heterogeneous childhood neurodevelopmental disorder with persistent symptoms of hyperactivity, inattention and impulsiveness that impair functioning in multiple settings.\textsuperscript{1} The condition is recognized as relatively common in childhood with an estimated worldwide prevalence of 5 per cent (36, 37). DSM-5 lists ADHD as a comorbidity of IGD,\textsuperscript{1} and the condition has repeatedly been reported as associated with both addictive and problematic gaming.\textsuperscript{7,8,38} In our material, both the female and the male extensive gamers showed a disproportionate high prevalence of ADHD in 2nd of secondary school while the association was seen only among the girls in 9th grade. Yen et al. reported on ADHD as more heavily related to internet addiction among females than males and perhaps this applies for extensive gaming as well.\textsuperscript{39}

Autism spectrum disorder (ASD) is a persistent and impairing neurodevelopmental disorder with an early onset.\textsuperscript{40} ASD is one of the most common developmental disabilities, characterized by deficits in social interaction, communication and stereotypic behaviour.\textsuperscript{41} Previous research describes an association between ASD and gaming, suggesting a greater risk for pathological game use among ASD individuals.\textsuperscript{31} Furthermore, it has been hypothesized that the behavioural phenotype of ASD make ASD individuals more vulnerable for problematic gaming but also that an extensive gaming might aggravate ASD related difficulties, such as social capacity or educational success, perhaps as a consequence of the displacement of time that could be spent on social or educational activities.\textsuperscript{12} The research on potential gender discrepancies is scarce at best and a great proportion appears to focus on boys with autism only.\textsuperscript{4,31} Interestingly, in our material, the female extensive gamers in both grades showed an overrepresentation of self-reported ASD. ASD was also more common among male gamers in 2nd of secondary school but not in the 9th grade of primary school. The relationship and potential consequences thereof need to be further examined to be fully understood and whether girls with autism could be more vulnerable for pathological gaming than boys, is a relevant question for future research to answer.

Problem gaming is usually described as an introvert behaviour and addictive gaming has been coupled to both loneliness, social phobia and low social competence.\textsuperscript{7,8} Both the male and the female extensive gamers in 9th grade of primary school were concordantly more likely to report that they had no close friend at all. In 2nd grade of secondary school, only the extensively gaming girls were more likely to report on the absence of a close friend. Our results suggest that the female extensive gamers are more likely to be lonely than the male extensive gamers. Such gender bound discrepancy could not easily be found in the literature and warrants additional investigation.

These results should be considered within the limitations of the present study. The measures we used for this study were all based on self-reported data and the accuracy could be limited by recall bias. The generalizability could be limited by diverse motivation to engage in answering questionnaires among different groups.\textsuperscript{42} Also, the current study presents cross-sectional data, which precludes conclusions of causality; this would require longitudinal investigation.

With these limitations in mind, the present study explores a large, representative and population-based material with a relatively high response rate limiting the risk of selection bias. Also, the Bayesian approach facilitates genuine probabilistic findings and the application of the ROPE procedure as a guide to determine which effects may be of clinical and/or practical importance offer further robustness to our findings.

Conclusions

The current study provides an exploration of extensive gaming in a large representative sample of adolescents. Extensive gaming was found robustly associated with a substantially higher prevalence of poor sleep and a substantially lower prevalence of being satisfied with one’s own health. Other associated factors varied by gender and age as well as regarding robustness and size of the estimated difference. Altogether, our results contribute to an impression that extensive gaming is more heavily related to subjective health complaints among female than male adolescents.

Correspondence: Emma Claesdotter-Knutsson, Department of Clinical Sciences Lund, Faculty of Medicine, Psychiatry, Lund, Sweden. Region Skåne, Child and Adolescent Psychiatry, Regional Out-patient Care, Lund University Hospital, Sofiavägen 2D, SE-22241 Lund, Sweden. Tel. +46.768871765. E-mail: emma.claesdotter-knutsson@med.lu.se

Key words: Extensive gaming; Internet gaming disorder; Adolescents; Screen time.

Funding: Region Skåne; Swedish government research grant (Grant name: Yngre Alf); Craaford Foundation grant; Fanny Ekdahls stiftelse and Svenska spels forskningsråd.

Conflict of interest: The authors contributed equally.

Conflict of interest: Anders Håkansson has a position as a researcher in addiction medicine at Lund University which is sponsored by the Swedish state-owned gambling operator AB Svenska Spel, as part of AB Svenska Spel’s responsible gambling policies. He also has research funding from the research council of AB Svenska Spel, and from the research council of the Swedish alcohol monopoly (Systembolaget AB) and from the Swedish Sports Federation (Riksidrottsförbundet). Frida André and Emma Claesdotter-Knutsson also have fundings from the research council of AB Svenska Spel. None of these organization have been involved in or had any influence on any part of the present work.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Patient consent for publication: Consent for publication has been given by all participants in the study.

Received for publication: 24 June 2021. Accepted for publication: 1 July 2021.

©Copyright: the Author(s), 2021 Licensee PAGEPress, Italy Journal of Public Health Research 2022;11:2498 doi:10.4081/jphr.2021.2498 This work is licensed under a Creative Commons Attribution NonCommercial 4.0 License (CC BY-NC 4.0).
References

1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®). Washington, DC: American Psychiatric Association; 2013.
2. Yau YH, Potenza MN. Gambling disorder and other behavioral addictions: recognition and treatment. Harv Rev Psychiatry 2015;23:134-46.
3. World Health Organization. International classification of diseases for mortality and morbidity statistics (11th Revision). 2018. Available from: https://icd.who.int/browse11/l-m/en
4. Paulus FW, Ohmann S, von Gontard A, Popow C. Internet gaming disorder in children and adolescents: a systematic review. Dev Med Child Neurol 2018;60:645-59.
5. Desai RA, Krishnan-Sarin S, Cavallo D, Potenza MN. Videogaming among high school students: health correlates, gender differences, and problematic gaming. Pediatrics 2010;126:e1414-24.
6. Aarseth E, Bean AM, Boonen H, et al. Scholars’ open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal. J Behav Addict 2017;6:267-70.
7. Ferguson CJ, Coulson M, Barnett J. A meta-analysis of pathological gaming prevalence and comorbidity with mental health, academic and social problems. J Psychiatr Res 2011;45:1573-8.
8. González-Bueso V, Santamaria JJ, Fernández D, et al. Association between internet gaming disorder or pathological video-game use and comorbid psychopathology: A comprehensive review. Int J Environ Res Public Health 2018;15:668.
9. Lemmens JS, Valkenburg PM, Peter J. Psychosocial causes and consequences of pathological gaming. Comput Hum Behav 2011;27:144-52.
10. Lam LT. Internet gaming addiction, problematic use of the internet, and sleep problems: a systematic review. Curr Psychiatry Rep 2014;16:444.
11. Engelhardt CR, Mazurek MO, Hilgard J. Pathological game use in adults with and without Autism Spectrum Disorder. PeerJ 2017;5:e3393.
12. Mazurek MO, Engelhardt CR. Video game use in boys with autism spectrum disorder. ADHD, or typical development. Pediatrics 2013;132:260-6.
13. Weinstein A, Weizman A. Emerging association between addictive gaming and attention-deficit/hyperactivity disorder. Curr Psychiatry Rep 2012;14:590-7.
14. Hellström C, Nilsson KW, Leppert J, Åslund C. Effects of adolescent online gaming time and motives on depressive, musculoskeletal, and psychosomatic symptoms. Ups J Med Sci 2015;120:263-75.
15. Rho MJ, Lee H, Lee TH, et al. Risk factors for internet gaming disorder: Psychological factors and internet gaming characteristics. Int J Environ Res Public Health 2017;15:40.
16. Salam Z, Sadiq Z, Tajamul U, et al. Internet gaming disorder in students of Peshawar: A cross sectional survey. J Ayub Med Coll Abbottabad 2019;31:548-52.
17. Chen KH, Oliffe JL, Kelly MT. Internet gaming disorder: An emergent health issue for men. Am J Mens Health 2018;12:1151-9.
18. Stevens MW, Dorstyn D, Delfabbro PH, King DL. Global prevalence of gaming disorder: A systematic review and meta-analysis. Aust N Z J Psychiatry 2021;55:553-68.
19. van den Eijnden R, Koning I, Doornwaard S, et al. The impact of heavy and disordered use of games and social media on adolescents’ psychological, social, and school functioning. J Behav Addict 2018;7:697-706.
20. Lee HH, Sung JH, Lee JY, Lee JE. Differences by sex in association of mental health with video gaming or other nonacademic computer use among US adolescents. Prev Chronic Dis 2017;14:E117.
21. Haugland S, Wold B. Subjective health complaints in adolescence—Reliability and validity of survey methods. J Adolesc 2001;24:611-24.
22. R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2021.
23. Wickham H, Averick M, Bryan J, et al. Welcome to the Tidyverse. J Open Source Softw 2019;4:1686.
24. Wagenmakers E-J, Marsman M, Jamil T, et al. Bayesian inference for psychology. Part I: Theoretical advantages and practical ramifications. Psychon Bull Rev 2018;25:35-57.
25. Bürkner P-C. brms: An R Package for Bayesian Multilevel Models Using Stan. 2017;2017:80:28.
26. Carpenter B, Gelman A, Hoffman MD, et al. Stan: A probabilistic programming language. J Stat Soft 2017;76:32.
27. Gelman A, Simpson D, Betancourt M. The prior can often only be understood in the context of the likelihood. Entropy 2017;19:555.
28. Lenth RV. Emmeans: Estimated marginal means, aka least-squares mean. 2021. Available from: https://cran.r-project.org/web/packages/emmeans/emmeans.pdf
29. Kruschke J. Rejecting or accepting parameter values in Bayesian estimation. Adv Meth Pract Psychol Sci 2018;1:270-80.
30. Brunborg GS, Mentzoni RA, Melkevik OR, et al. Gaming addiction, gaming engagement, and psychological health complaints among Norwegian adolescents. Media Psychology 2013;16:115-28.
31. Hale L, Guan S. Screen time and sleep among school-aged children and adolescents: a systematic literature review. Sleep Med Rev 2015;21:50-8.
32. Stormark KM, Fosse HE, Pallesen S, Hysing M. The association between sleep problems and academic performance in primary school-aged children: Findings from a Norwegian longitudinal population-based study. PLoS One 2019;14:e0224139.
33. Marmet S, Studer J, Wicki M, et al. Unique versus shared associations between self-reported behavioral addictions and substance use disorders and mental health problems: A commonality analysis in a large sample of young Swiss men. J Behav Addict 2019;8:664-77.
34. Fridh M, Grahn M, Lindström M, Modén B. [Folkhålsrapport Barn och Unga i Skåne 2016 – en undersökning om barn och ungdomars livsvillkor, levnadsvanor och hälsa]. (Public health report children and young in Scania 2016 - a survey of living conditions, living habits and health among the young).[in Norwegian]. Samhällsanslygs, Region Skåne, 2016. Updated: 2016-02-26. Accessed: 2021 June 8. Available from: https://utveckling.skane.se/utvecklingsomraden/folkhals-och-social-hallbarhet/folkhalsrapporter/folkhalsrapport-barn-och-unga-i-skane/
35. Skogen JC, Boe T, Sivertsen B, Hysing M. Use of alcohol, tobacco and illicit drugs among ethnic Norwegian and ethnic minority adolescents in Hordaland county, Norway: the youth@hordaland-survey. Ethn Health 2018;23:43-56.
36. Reebye P. Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment, third Edition. J Can Acad Child Adolesc Psychiatry 2008;17:31-3.
37. Nuyens F, Deleuze J, Maurage P, et al. Impulsivity in multiplayer online battle arena gamers: Preliminary results on experimental and self-report measures. J Behav Addict 2016;5:351-6.
38. Walther B, Morgenstern M, Hanewinkel R. Co-occurrence of addictive behaviours: personality factors related to substance use, gambling and computer gaming. Eur Addict Res 2012;18:167-74.
39. Yen JY, Liu TL, Wang PW, et al. Association between Internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: Impulsivity and hostility. Addict Behav 2017;64:308-13.
40. Tachibana Y, Miyazaki C, Ota E, et al. A systematic review and meta-analysis of comprehensive interventions for pre-school children with autism spectrum disorder (ASD). PLoS One 2017;12:e0186502-e.
41. Newschaffer CJ, Croen LA, Daniels J, et al. The epidemiology of autism spectrum disorders. Annu Rev Public Health 2007;28:235-58.
42. Rattray J, Jones MC. Essential elements of questionnaire design and development. J Clin Nurs 2007;16:234-43.