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Are changes in binge drinking among European adolescents driven by changes in computer gaming?

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Abstract

Introduction. *There is currently no good explanation for the decline in adolescent drinking reported for many Western countries in recent years. As modern computer gaming is highly exciting and socially rewarding, it may function as a substitute for adolescent binge drinking. We hypothesized a negative correlation between country-level changes in computer gaming and binge drinking.* ***Methods.*** *We analysed within-country changes based on data from 15–16 year-old pupils (*n *= 517 794) participating in the European School Survey Project on Alcohol and Drugs from 1995 to 2015. Binge drinking in the last 30 days (5+ units on one occasion) was regressed on frequency of computer gaming and three control variables measuring the frequency of engagement in other hobbies, reading books and going out (to a disco, cafe, etc.).* ***Results.*** *Descriptive data showed no general decline in binge drinking across European countries. In contrast to our prediction, the association between binge drinking and computer gaming was not negative [*b *= 0.26, one-sided 95% confidence interval (−∞, 0.47),* P *= 0.98, Bayes Factor = 0.21]. We found the same pattern of result in a secondary analysis on six Nordic countries that have experienced declines in adolescent drinking recent years. In analyses with covariates reflecting engagement in other activities, we only observed statistical evidence for an effect of going out.* ***Discussion and Conclusions.*** *A substantial decline in adolescent binge drinking during the years 1995–2015 is only evident in some European countries, and it is likely not caused by increased computer gaming.* [Halkjelsvik T, Brunborg GS, Bye EK. Are changes in binge drinking among European adolescents driven by changes in computer gaming? *Drug Alcohol Rev* 2020]

Key words: adolescent drinking, computer gaming, Europe, European School Survey Project on Alcohol and Other Drug, youth culture.

Introduction

A decline in adolescent drinking and binge drinking has been observed in several countries in the last two decades. For example, results from the latest round of the European School Survey Project on Alcohol and Other Drugs (ESPAD) showed decline in drinking in 24 of 30 countries, and decreasing rates of binge drinking in the majority of countries [1,2]. Data from the Health Behaviour in School-Aged Children study in Europe, Canada and the US found that between 2002 and 2010, past week alcohol consumption declined in 20 out of 28 countries [3]. Similar decline in adolescent drinking has also been reported for Australia [4].

Many authors have attempted to explain this decline [cf. 5]. For example, Kraus and colleagues [6] proposed that alcohol has been devalued among recent cohorts of adolescents. Such a devaluation perspective was supported by a study investigating the coverage of alcohol in the Australian news media [7]. The disapproval of alcohol use in the media has coincided with a change in young people's attitudes, where drinking is considered more risky today than it was a decade or two ago [8]. The decline in adolescent drinking has also partly been attributed to changing parental control [3,5,8–10] and less parental supply of alcohol [11,12]; changes in secondary supply laws making it illegal to supply alcohol to people under 18 [9]; stricter access to alcohol and different family dynamics, where parents play a greater role in their children's lives [8]; health promotion interventions in schools and communities [9]; and campaigns to change social norms [12]. The new generation of adolescents may also be more concerned about health-related issues than previous generations, though research is inconsistent as to whether this is indeed the case, and the link to alcohol

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consumption is very uncertain [6]. Furthermore, while alcohol drinking has traditionally been a symbol of the transition into adulthood, it appears to have lost this function [13]. A final explanation of the decline in adolescent drinking is that they spend increasing amounts of time online on social media [5,9], and that spending time online may have changed how adolescents socialise [6,14].

Is the decline in adolescent drinking related to computer gaming?

For adolescents, drinking alcohol has traditionally functioned as rebellion against parents and other adults [15]; however, computer gaming and other online activities may currently be the main source of intergenerational conflict that tests the limits of an adolescent's autonomy [16]. There are several reasons to suspect that increase in computer gaming might be related to decrease in adolescent drinking. Alcohol may traditionally have been an outlet for thrill-seeking, and a means to alleviate boredom [17–19]. Boredom has also been found to be a predictor of motivation for gaming [20]. It could be the case that modern computer games have become a more easily accessible and efficient boredom-buster than drinking.

From the mid-1990s, revenues of the gaming industry have increased steadily [21], suggesting an increase in adaptation and use. The technology has also changed markedly, particularly in terms of the social aspect. Modern computer games allow for social interaction via the internet through chat functions and headphones, and in many online games, most of the communication is not instrumental to the game but of a more socio-emotional character [22]. Players can develop strong relationships and even long-lasting friendships based on in-game communication [23]. Social motives are typically relevant for the engagement in drinking and binge drinking [24,25] and have also become important for playing computer games [26]. Other motives typically considered important for drinking, such as coping, escapism and enjoyment [25,27], are also found for gaming [28–30].

The above overlap between drinking and gaming in their underlying motivations suggests that gaming is an activity that can substitute drinking. Such a substitution could happen at the level of youth culture, which does not require a positive association between drinking and gaming at the individual level. That is, if the need for thrills and socialising can be satisfied in front of a computer screen at home, this could recruit new subgroups of youth to gaming—subgroups that in another culture or period would have consumed alcohol to satisfy the same needs. Alternatively, the greater availability of captivating computer games and the increasing approval of gaming could have increased the attractiveness equally across subgroups and produced an overall shift in the level of gaming, which in turn may have changed the level of binge drinking. Such mechanisms would not depend on a particular within-culture association between gaming and drinking.

In terms of individual-level associations, it has been suggested that gamers are less likely to engage in problematic alcohol use because they have less available time to drink, and because intoxication interferes with gaming performance [31]. However, research into the association between gaming and alcohol use among adolescents has shown mixed results. Studies have found a positive association where adolescents who spend a great amount of time on games are more likely to drink alcohol [32,33]. Other studies have found no such association [34], or a negative association [31,35]. Finally, a recent study suggests a U-shaped relation where substance use is low among adolescents who play video games 1–5 h per week, but higher for adolescents who either do not play video games at all or who play for 30 h or more per week [36].

All these studies have focused on associations at the individual level and, therefore, do not directly address if change in adolescent alcohol use at the population level is associated with change in computer gaming at the population level. To our knowledge, no past studies have directly addressed this question.

The current study

Investigating explanations for the decline in adolescent drinking can be a methodological challenge. For instance, one should be cautious when drawing conclusions about the population level from individual level data, as this is an ecological fallacy in reverse [37]. To illustrate, a recent Swedish study utilised cross-sectional surveys from 2008, 2010 and 2012 and found that individuals who reported computer gaming more than 2 h at the weekends had a lower likelihood of drinking alcohol (in 2012, but not in 2008 and 2010) [35]. As the authors noted, it cannot be concluded from this study that that there is any relation between population level drinking and population level gaming. The main reason for this is that a correlation at the individual level can remain the same even if the whole distribution of scores in one of the variables is shifted upwards and the whole distribution of scores in the other variable is shifted downwards.

Most previous studies have investigated changes in drinking and not binge drinking. In the current study, we assess changes in binge drinking (≥ 5 drinks at the same occasion) rather than drinking any amount of alcohol because it is more closely related to negative outcomes, such as hangover, blackout, risky sex, fighting and injury [38]. Drinking and binge drinking do, however, tend to change correspondingly [1].

If the substitution of binge drinking with computer gaming is a process at the level of adolescent culture, as suggested in the introduction, a comparison between countries could be informative. The problem is that there are so many other things that differ between countries, for instance the affordability of technology and alcohol. For this reason, in the current study we focus on within-country changes. Rather than focusing on one or a few countries, we used data for all the countries that have taken part in the ESPAD.

The main hypothesis is that within-country changes in the prevalence of daily computer gaming are negatively associated with the prevalence of binge drinking. In addition, we wanted to make the methodological point that associations between binge drinking and computer gaming can differ according to the level of analysis.

Methods

Sample and setting

The cross-sectional school surveys in ESPAD have been repeated every 4 years since 1995 and include 15- and 16-year-old students (for a detailed description see [1]). An increasing number of countries have participated, from 23 countries in 1995 to 35 countries in 2015. In total, 48 European countries have participated at least once with a varying number of respondents. Data were collected by self-administered pen-and-paper questionnaire in all countries and years, with exception for a web-based questionnaire in Latvia and the Netherlands in 2015, and though generally high, there have been differences in response rates between countries and survey years [2].

Measures

Binge drinking. The outcome variable was binge drinking, measured with the question: 'Think back again over the last 30 days. How many times (if any) have you had five or more drinks on one occasion?' The response categories were 'None', '1', '2', '3–5', '6–9' and '10 or more times'. Responses were recoded to *binge drinking at least once* (coded 1) and *no binge drinking* (coded 0) in the main analysis. The full scale was used as a continuous variable in the secondary analyses (responses coded 1 to 6).

Computer gaming and other leisure activities. Respondents were asked the question 'How often (if at all) do you do each of the following?' and were presented a list of various activities. The item 'Play computer games' (Computer gaming) was the main predictor in our models. The response options were 'Never', 'A few times a year', 'Once or twice a month', 'At least once a week' and 'Almost every day'. The following activities were used as covariates in the secondary analyses: 'Actively participate in sports, athletics or exercising' (Sports), 'Go out in the evening (to a disco, cafe, party, etc.)' (Going out) and 'Other hobbies (play an instrument, sing, draw, write)' (Other hobbies). For interpretability in terms of country-level percentage point changes, the variable Computer gaming was recoded to 'almost daily' and 'not daily' in the main analysis, and the full scales (coded 1 to 5) were used in secondary analyses. The distribution of responses for Binge drinking and Computer gaming are provided in Figures S1 and S2 (Supporting Information).

Analysis

The analysis plan was preregistered at https://osf.io/u2ex6 in advance of data access. We are not entitled to share the data, but in our STATA syntax (see Appendix S2, Supporting Information), we provide a link to a synthetic dataset based on the characteristics of the original data [see 39].

In the main analysis, a country identification variable was treated as random intercept, and the predictors were survey year (five dummy indicators) and three terms representing daily computer gaming. The first term represents the between-country effect (each countries' average prevalence across years), the second term, concerning our main hypothesis, represents the within-country effect (the yearly average for each country minus the respective country's total average) and the third term is the individual level effect (the student's responses minus the within-country variable described above). This gives so-called within-between estimators [40], in our case extended to three levels (see equation in the Appendix S1, Supporting Information). As the data were heavily unbalanced (some countries only participated a few years), we added the between-country means of the year dummies as well [41]. These terms were not preregistered and for that reason we also report the original preregistered model (Table S1, Supporting Information).

We focus on results from linear probability models (linear models with dichotomous outcomes). Such models have limitations (such as the potential for predictions of probabilities outside the range of 0 and 1), but they provide reasonable estimates in many contexts, and they are readily interpretable because the coefficients reflect the average marginal effect in terms of proportion change [42]. For the main hypothesis, we also report the average partial effect calculated from a fractional probit model. Note that the observed proportions in the data are in the middle of the scale (typically between 0.2 and 0.6), an area that is approximately linear also in common non-linear models, such as probit and logit.

As there is lower-level clustering within countries (sampling of schools and classes) for which data are not available, and because the linear probability model is inherently heteroskedastic, we report cluster-robust standard errors adjusted at the level of countries. Clustering at the level of countries accommodates lower-order dependencies, such as differences between schools and serial correlation within countries [cf. 42].

Countries with observations for only a single country-year are included in the analyses because they contribute to the estimation of the individual level effect and between-country effects. We considered it more informative to use all available data than to select a few countries with full sets of observations. We did not impute missing values because we focus on within-country changes (it is difficult to see how an imputation model based on the available variables would account for bias that change over time). If the missing country-year data are due to administrational issues and unrelated to the level of gaming and drinking, missingness should not be a problem.

The Bayes-Ratio for the main hypothesis was calculated using an online calculator based on the likelihood of the null hypothesis and the likelihood of an alternative hypothesis corresponding to a half-normal distribution of effect sizes with $M = 0$ and SD = 0.2 [see 43], which we deemed reasonable given our belief that computer gaming would largely drive the change in binge drinking (0.2 corresponds to a 0.2 percentage point decrease in the prevalence of monthly binge drinking for an increase of one percentage point in the prevalence of daily gaming).

As the potential impact of gaming on binge drinking could be obscured by some of the countries' trends in other leisure activities, we ran secondary analyses that controlled for covariates representing other activities. These analyses used the original full response scales for all measures. To explore potential sex differences, the analyses were run separately for boys and girls. To simplify the interpretation, the data were aggregated to country by year means. These two analyses (boys and girls) were run with the user-written STATA command 'reghdfe' [44,45], which allows for two-way clustering. We corrected for clustering by country (to adjust for potential serial correlation within countries) and by survey year (in case of unmodelled co-movements for groups of countries) [46]. Thus, these models have less restrictive assumptions than the original analysis. Due to a small number of year clusters (survey years = 6), we obtained confidence intervals by Wild Cluster Bootstrapping with 9999 replications from the user-written command 'boottest' [47]. As we considered this analysis exploratory, we report two-sided confidence intervals.

Results

Approximately 3.2% of the individual level data on computer gaming were missing (not answered, answered more than one option, not resolved), and 4.9% of the data on binge drinking were missing. As can be observed in Figure 1, which shows the development in proportion of past 30-day binge drinkers and daily computer gamers, many of the countries have data for only some of the survey years. Based on visual inspection, we also note that only a few countries experienced a strong decline in adolescent binge drinking, and there appears to be no systematic decline or increase in computer gaming across all countries.

As to the preregistered hypothesis, the association between country-level changes in computer gaming and binge drinking was estimated as positive (see Table 1). That is, the result was in the opposite direction of what we predicted. The Bayes Factor, in terms of our original prediction of a negative effect versus the null, was 0.21, meaning that the null hypothesis is almost five times more likely than the alternative effect size specification. The average partial effect of the same effect (within-country changes) in the fractional probit model (see Appendix S2) was close to the coefficient of the main model, $b = 0.20$, one-sided 95% confidence interval ($-\infty$, 0.50).

The between-country effect of computer gaming was slightly negative. A negative association would mean that countries with a higher prevalence of daily gaming have a lower prevalence of binge drinking, but the upper bound of the confidence interval was positive by a large margin (i.e. there was no statistical evidence for a negative association). The between individual-effect was positive, suggesting a four percentage point (±2 percentage points) higher binge drinking prevalence among students who report playing computer games daily.

To test the hypothesis in a sample of countries known to have experienced a decline in drinking, we

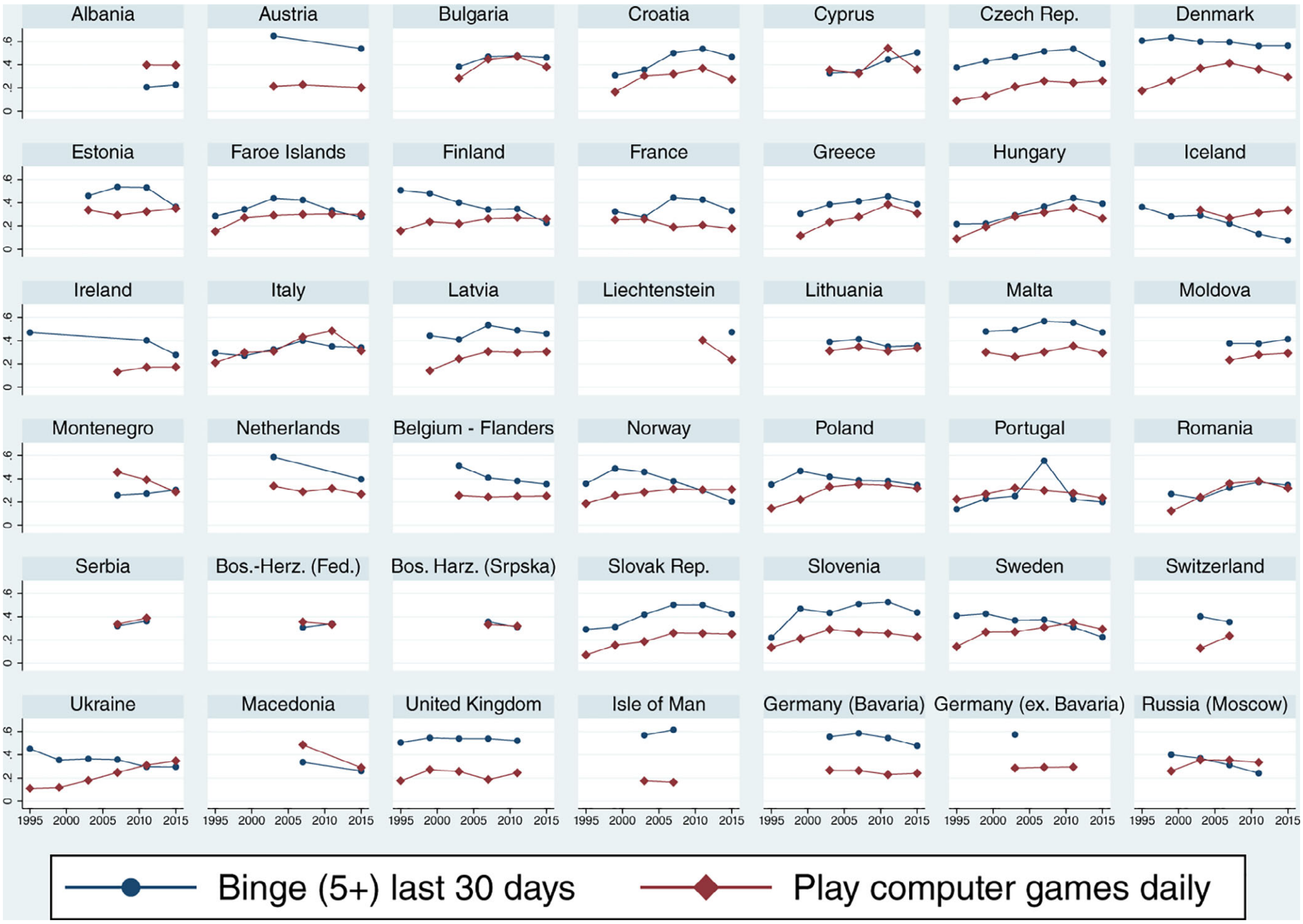

Figure 1. *The proportions of the samples reporting any binge drinking (5 units or more on same occasion; blue lines) and proportions reporting playing computer games daily (red lines). Bos-Herz, Bosnia and Herzegovina; Fed, Federation; Rep, Republic.*

ran the same analysis on six Nordic countries. The hypothesis was not supported in this limited sample, but we observed that gaming was negatively correlated with binge drinking at the individual level (see Table S2, Supporting Information).

Similar to the results above, the covariate-adjusted secondary analyses on the country-year averages of the full response scales did not show the hypothesized relation between binge drinking and country-level changes in computer gaming. The coefficients were in the opposite direction of our predictions (see Table 2). In descriptive terms, the magnitudes of the coefficients were somewhat different for boys and girls, but the confidence intervals were wide (in an unreported analysis the *P*-values for differences in coefficients were above 0.08). The variable Going out was associated with binge drinking. As this variable may be considered as a mediator or as a consequence of less drinking, we also ran the models without this term, which gave similar results.

Discussion

We hypothesized a negative association between country-level changes in the prevalence of past 30-day binge drinking (5 units or more on same occasion) and daily computer gaming. This was based on the idea that modern computer gaming, which offers both excitement and social interaction, can replace binge drinking as a reward seeking activity. Our results did not support this hypothesis. Nor was the hypothesis supported in the analysis of the Nordic countries, where there was a clear decline in adolescent binge drinking. In contrast to the main analysis, which showed a positive individual-level association between gaming and binge drinking, the analyses on the Nordic countries showed that individuals who were daily computer gamers were less likely to engage in binge drinking. In exploratory analyses, we observed that changes in the frequencies of going out (to a disco, cafe, party, etc.) were associated with changes in binge drinking,

Table 1. *Linear mixed model of binge drinking regressed on daily computer gaming*

		b	95% CI
	Intercept	0.45	0.18, 0.72
Gaming	Between countries	−0.14	−0.63, 0.36
	Within-country changes	0.26	-∞, 0.47[a]
	Between individuals	0.04	0.02, 0.06
Survey year	1999	0.01	−0.04, 0.06
	2003	0.00	−0.05, 0.06
	2007	0.03	−0.05, 0.11
	2011	0.01	−0.07, 0.09
	2015	−0.03	−0.11, 0.05
	1999 (between countries)	0.04	−0.42, 0.49
	2003 (between countries)	0.04	−0.32, 0.39
	2007 (between countries)	−0.03	−0.35, 0.29
	2011 (between countries)	−0.22	−0.54, 0.10
	2015 (between countries)	0.04	−0.27, 0.34
		SD	
Random effects	Country	0.10	
	Residual	0.48	

Confidence intervals (CI) are based on cluster-robust standard errors at the level of countries. Number of countries = 48, Country-Years = 179, Pupils = 517 794. The countries are identified in Figure 1, and the following had observations for one survey year: Russia (ex. Moscow), Turkey, Kosovo, Belgium (Wallonia), Greenland and Georgia. [a]One-sided 95% CI due to directional hypothesis (two-sided 95% CI [0.00, 0.52]).

Table 2. *Within-country changes in binge drinking regressed on computer gaming and other activities for girls and boys, respectively*

	Girls		Boys	
	b	95% CI	*b*	95% CI
Computer gaming	0.09	−0.02, 0.24	0.26	0.01, 0.55
Sports	−0.02	−0.35, 0.29	−0.11	−0.59, 0.38
Going out	0.22	−0.05, 0.47	0.37	0.08, 0.70
Other hobbies	−0.04	−0.26, 0.17	−0.03	−0.32, 0.26
Fixed effects	Included		Included	
Countries	Yes		Yes	
Survey year	Yes		Yes	

Standard errors clustered on survey year (six clusters) and country (40 clusters). Number of observations = 171 in each analysis. CI, confidence interval.

but this result is difficult to interpret as going to parties is closely tied to the outcome (e.g. a tendency not to drink would cause less going out to parties). In descriptive terms, we note that only a few of the countries experienced a substantial decline in binge drinking [see also 2].

A decline in the population level alcohol consumption in several countries appears to be driven by lower levels of alcohol consumption in younger birth cohorts [48–51], suggesting that ESPAD's cross-sectional design where new cohorts of 15/16-year-old students are sampled every fourth year should be well suited for investigations of the current type.

The fact that we did not observe the hypothesized relation between computer gaming and binge drinking does not rule out computer gaming as part of the explanation of changes in adolescent drinking. As we only used a single measure for computer gaming, we were not able to explore changes in qualitative aspects, such as the move towards online multiplayer gaming, and from personal computers to cell phones and tablets. Furthermore, we have no information about when and where the playing occurred, whether they played alone at home or with peers, and the amount of gaming (e.g. the changes in binge gaming). Furthermore, the prevalence of daily gaming can remain stable while the quality of gaming changes in terms of its social and stimulating appeal. Yet, if gaming becomes more appealing and thereby substitutes binge drinking, we should expect an increase in gaming (due to its higher appeal) that would coincide with a decrease in binge drinking. Based on the current results, we can therefore conclude that computer gaming is likely not an important driver of changes in binge drinking.

There could, however, be other aspects of digital culture that drive changes in binge drinking, such as the use of social media [5]. Note that there appears to be a positive correlation at the individual level between social media use and binge drinking [52], and social media has been characterised as a new arena for advertising alcohol [53], but this does not imply that the widespread adoption of social media use among adolescents will increase drinking at the country level (cf. our point about individual-level associations versus country-level changes). A study of electronic media communication, which in addition to social media also includes talking on the phone and sending SMS, showed that the use of electronic media communication was positively related to weekly drinking at the level of individuals, but not in terms of country-level changes [12].

If the research question concerns causal factors that explain country-level changes in an outcome, the most relevant level of analysis might be country-level changes. This is not to say that individual-level analyses are wrong. If there is theoretical ground to assume a causal effect of some variable on the risk of binge drinking among adolescents, one could attempt to explain within-country changes in terms of the composition of the samples [e.g. see 54]. However, the prevalence of an activity may reflect changes in adolescent culture that are not possible to detect in individual-level analyses. Although the discussion of explanations above implies causality, it is important to note that the present study and the studies cited above are observational and have not applied any causal designs.

Limitations and strengths

It has been suggested that reward-seeking tendencies among adolescents are expressed differently in different cultures [55], and we know from past studies that a decline in drinking is not strong in all the countries we studied [2]. Thus, one objection to the present work could be that the premise of the study is shaky: the decline in some countries may not be explained by factors that vary in all the included countries. We acknowledge that this is a valid point in terms of the original motivation for the study; still, we observed no strong association in the exploratory analysis of the Nordic countries, where we did observe a decline in adolescent binge drinking. Furthermore, in the search for more general cultural factors that determine adolescent binge drinking, we believe the best approach is to utilise all the country-level variation in the data available.

The alternative, to select the period from the highest peak to the lowest bottom and attempt to explain this change in one or a few countries, may not be the best option as the results will be difficult to generalise. Furthermore, this approach is more vulnerable to spurious correlations of trends (c.f. the amusing collection at http://tylervigen.com/spurious-correlations). In the present analysis, we controlled for the overall changes between the survey years, relied on within-country changes for a number of countries and did not select the countries and time periods with a decline (which means that we did not condition on observed values of the outcome). This may have reduced some of this potential confounding.

The ESPAD dataset contains survey weights for some of the countries, but for large parts of the data these are not available (e.g. in 2015, weights were available for only 11 countries). We chose not to use any weights, and the results are consequently generalisable only to populations with characteristics as the respondents.

When changes in countries are the units of analysis, power is typically an important issue as the availability of data on within-country changes is limited. Low power in combination with a lack of predefined analyses is a major problem for reproducible science [56]. A strength of the present article is that the analyses were theoretically grounded and specified in advance. This means that we did not mine the data and report the analyses that were 'statistically significant'. The drawback with the hypothesis testing approach is that we have not statistically tested and explored unexpected patterns, such as a positive association between gaming and binge drinking. Theoretically, it would not make sense to consider less computer gaming as cause of less drinking, and the positive coefficient observed in the main analysis was not observed in the analysis of the Nordic countries.

Conclusion

We hypothesized that within-country changes in computer gaming were related to within-country changes in adolescent binge drinking in Europe. Our results did not support this hypothesis. As also documented in past research, we note that the majority of the European countries did not show a strong decline in adolescent binge drinking. As a methodological point, we stress the fact that individual-level and country-level associations do not necessarily go in the same direction, which is an important point for future studies on developments in adolescent binge drinking.

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Conflict of Interest

The authors have no conflicts of interest.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Table S1. Original preregistered linear mixed model of binge drinking regressed on daily computer gaming.
Table S2. Linear mixed model of binge drinking regressed on daily computer gaming for the Nordic countries.
Figure S1. Distribution of responses for the entire sample, frequency of playing computer games.
Figure S2. Distribution of responses for the entire sample, five drinks or more on one occasion.
Appendix S1. Regression equation for main model.
Appendix S2. STATA analysis syntax.