Video gaming disorder and sport and exercise in emerging adulthood: a longitudinal study

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ABSTRACT

Among the negative consequences of video gaming disorder, decreased participation in sport and exercise has received little attention. This study aimed to assess the longitudinal association between video gaming disorder and the level of sport and exercise in emerging adult men. A questionnaire was completed at baseline and 15-month follow-up by a representative national sample of 4,933 respondents. The seven items of the game addiction scale were used to construct a latent variable representing video gaming disorder. Level of sport and exercise was also self-reported. Cross-lagged path modeling indicated a reciprocal causality between video gaming disorder and the level of sport and exercise, even after adjusting for a large set of confounders. These findings support the need for better promotion of sport and exercise among emerging adults in order to contribute to the prevention of video gaming disorder, and raise the low level of sport and exercise in addicted gamers.

Keywords: Emerging adulthood; Longitudinal survey; Sport and exercise; Video gaming disorder.

INTRODUCTION

Interest in the excessive use of internet or video games continues to grow. Section III of the recent fifth edition of the Diagnostic and Statistical Manual of Mental Disorders included Internet Gaming Disorder as a condition warranting further study.[1] Although a broad range of terms is used to refer to this concept, including game addiction, video gaming disorder, video game dependence, problematic game playing, and pathological gaming, there is a growing agreement that it has the potential to become an addictive behavior.[2, 3]

The prevalence of addictions appears to be particularly high in the period of life between adolescence and adulthood, also referred to as emerging adulthood.[4] Usually defined as between 18 and 25 years of age, emerging adulthood is characterized by a high degree of freedom and a decrease in parental control. The majority of video game users are in fact over the age of 18.[5] Although research has mainly focused on children and adolescents, there has been a recent development of interest in emerging adults.[6, 7] Video game use has been linked to greater drug use, drinking behaviors, and lower quality relationships with friends and parents.[6] A negative association has been reported in relation to academic performance.[5] A systematic review covering various age groups identified numerous psychosocial and psychosomatic consequences of video gaming disorder (e.g. obsession with gaming, aggressive behavior, stress, maladaptive coping, suicidal ideation, sleeping disorders).[8] In a national representative study in Norway, video gaming disorder was associated with poorer self-reported physical and mental health.[9] Similarly, an Australian study reported that video game usage was inversely associated with health related quality of life.[10]

Like other sedentary behaviors, video game play appears a good candidate as a correlate of physical activity. The displacement hypothesis states that spending time on one activity leaves less time for others.[11] Engaging in sedentary behaviors may impede physical activity by reducing the time available for being physically active. This issue was addressed in emerging adults by Ballard et al.[12] Based on a sample of 116 male students, the authors concluded that video game use was inversely related to exercise, particularly among those who played online games. More studies have been undertaken in younger people. In a recent meta-analysis in children and adolescents, Pearson et al. reported a significant, but small, negative association between sedentary behaviors – including video game play – and physical activity.[13] In a nationally representative study of U.S. adolescents, excessive use (> 3 hours per day) of computer or video games was negatively associated with participation in team sports, but not with participation in exercise classes.[14] Other studies did not find any significant association between video game use and the level of sport and exercise among adolescents,[15] adolescents and emerging adults,[16] and young adults.[9] Some authors have even suggested that levels of vigorous exercise may be higher among users of massively multiplayer online games than the general population.[17]

Charlton et al. emphasized the importance of distinguishing between high engagement and addiction to video games.[18] There is growing evidence that video game addiction is markedly associated with negative health outcomes, whereas this is not necessarily the case for a strong engagement with video games.[19-23] The literature on the relationship between video gaming disorder and sport and exercise is inconclusive, and has addressed the frequency of video game play but never video game addiction. Longitudinal associations have yet to be investigated, particularly among emerging adults whose propensity to instability may favor behavioral changes over time. Video gaming disorder may be a risk factor for decreased participation in

sport and exercise, but it may also be a consequence of insufficient participation in sport and exercise. Therefore, the present study's aim was to assess the cross-sectional and longitudinal associations between video gaming disorder and the level of sport and exercise in emerging adult men.

METHODS

Study design

Participants were enrolled at three of Switzerland's six national army recruitment centers, covering 21 of 26 Swiss cantons (including all French-speaking ones). Attending military recruitment is obligatory for men in Switzerland; there is no pre-selection and this provided a representative sample of young Swiss men. Recruitment centers were used to enroll participants, but assessments at baseline and follow-up were done outside of any military environment. Baseline data were collected between September 2010 and March 2012, and follow-up data between January 2012 and April 2013.

Participants

A total of 5990 participants gave written informed consent to their participation in the study and subsequently completed the questionnaire at baseline. Of these, 5223 (87.2%) completed the follow-up questionnaire. Missing values were listwise deleted, and a final sample of 4933 participants (94.4% of follow-up responders) was analyzed. Mean (standard deviation) age was 19.95 (1.20) years old at baseline and 21.25 (1.22) years old at follow-up. The delay between

baseline and follow-up measurements was 15.52 (2.74) months. Approval for the study was granted by the local Ethics Committee (Protocol No. 15/07).

Measurements

Game addiction scale. The seven-item game addiction scale (GAS), developed by Lemmens et al.[24] and based on the criteria for pathological gambling found in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), was used to assess video gaming disorder. This scale includes one item for each component of video gaming disorder: Salience (GAS 1): 'Did you think about playing a game all day long?'; Tolerance (GAS 2): 'Did you spend increasing amounts of time on games?'; Mood modification (GAS 3): 'Did you play games to forget about real life?'; Relapse (GAS 4): 'Have others unsuccessfully tried to reduce your game use?'; Withdrawal (GAS 5): 'Have you felt bad when you were unable to play?'; Conflict (GAS 6): 'Did you have fights with others (e.g., family, friends) over your time spent on games?'; Problems (GAS 7): 'Have you neglected other important activities (e.g., school, work, sports) to play games?' These questions were preceded by the following prompt: 'How often during the last six months…' Response choices were: 'never' (coded 1); 'rarely' (coded 2); 'sometimes' (coded 3); 'often' (coded 4); or 'very often' (coded 5). Calculation of Cronbach's alpha indicated good internal consistency at baseline (α=.78) and follow-up (α=.78). Consistent with the methodology described by Lemmens et al.[24], problematic video game use was indicated by a score of 3 or more on at least any four of seven criteria, following a polythetic approach. In contrast, video game addiction was indicated by a score of 3 or more on all seven criteria, following a monothetic approach.

Sport and exercise. The level of sport and exercise was assessed by asking: 'Over the past 12 months, how often did you participate in sports or exercising?' Response choices were: 'never' (coded 1); 'a few times a year' (coded 2); '1 to 3 times per month' (coded 3); 'at least once per week' (coded 4); or 'almost every day' (coded 5).

Covariates. All covariates were assessed at baseline. Socio-demographic variables were measured and recorded as follows: *age*, *language* ('German'; 'French'), *family financial situation* ('below average'; 'average or above'), *educational level* ('lower secondary school'; 'vocational upper secondary school'; 'general upper secondary school' [high school or equivalent]; 'tertiary' [university or other graduate school]), *parents' educational level* ('lower secondary school'; 'vocational upper secondary school'; 'general upper secondary school' [high school or equivalent]; 'tertiary' [university or other graduate school]), *employment status* ('employed'; 'student'; 'inactive' [unemployed, social or disability pension]), *type of community* ('rural' [below 10000 inhabitants]; 'urban' [10000 inhabitants or above]).

Substance abuse disorders were also assessed as covariates. An alcohol dependence status was defined as a positive response to at least any three of seven dependence criteria from the DSM-IV.[25] A nicotine dependence status was defined as a score of 4 or above on the Fagerström Test for Nicotine Dependence.[26] Cannabis use disorder was defined as a score of 8 or above on the Cannabis Use Disorder Identification Test (CUDIT).[27]

Statistical analysis

Descriptive statistics were used to present video gaming disorder in relation to the level of sport and exercise at baseline. Differences between levels of sport and exercise were tested using one-way ANOVA (continuous variables) or Chi-squared tests (categorical variables). Two multiple

logistic regression models were constructed by incorporating problematic video game use (model 1) and video game addiction (model 2) as the dependant variables, and sport and exercise as the independent variable. To explore the degree of confounding, models were run unadjusted and adjusted for covariates.

The longitudinal association between video gaming disorder and the level of sport and exercise was assessed using cross-lagged path analysis. As illustrated in Figure 1, this type of structural equation model (SEM) involves computing three kinds of correlations between variables measured at two time points (baseline and follow-up). Synchronous correlations (A and B) refer to the cross-sectional associations between variables at each time point; autocorrelations (C and D) refer to the association of a variable at follow-up with its earlier level at baseline; and cross-lagged correlations (E and F) refer to the associations of a variable at follow-up with other variables at baseline.[28] The cross-lagged correlations therefore give the impact of a variable at a given point in time on the values of another variable later in time, controlling for synchronous correlations and autocorrelations. To capture the maximum possible information from video gaming disorder, a latent variable was constructed using the seven items of the GAS. The model was controlled for all covariates at baseline. To appraise the extent to which longitudinal associations were affected by substance abuse disorders, the model was rerun using only socio-demographic variables as covariates. Model fit was assessed using the root mean square error of approximation (RMSEA), which should not give a result over .06, and the comparative fit index (CFI), which should not give a result under .95.[29]

All analyses were conducted using SPSS 21 software (IBM, Armonk, NY), except for the cross-lagged path analysis which was computed using Mplus 6 software.[30]

RESULTS

Table 1 displays the GAS scores for its seven criteria according to sport and exercise levels at baseline. ANOVAs indicated a significant difference in each criteria between the levels of sport and exercise (all *ps*<.001 except for GAS 6 for which *p*=.001), with high scores observed at low frequencies of sport and exercise, and low scores observed at high frequencies of sport and exercise. Following a polythetic approach, the prevalence of problematic video game use was significantly different between the levels of sport and exercise (*p*<.001) and ranged from 9.7% ('almost every day') to 18.8% ('never'). Following a monothetic approach, the prevalence of video game addiction was also significantly different between the levels of sport and exercise (*p*=.001) and ranged from 1.6% ('almost every day') to 5.5% ('never'). Overall prevalence of problematic video game use and video game addiction at baseline (11.9% and 2.2%, respectively) were close to those at follow-up (9.6% and 2.3%, respectively, not indicated in Table 1).

Multiple logistic regression models analyzing cross-sectional associations between problematic video game use, video game addiction and the level of sport and exercise are indicated in Table 2. In the unadjusted models, there was a significant odds ratio (OR) of problematic video game use for sport and exercise 'never' (OR=2.16; *p*<.001) and 'a few times a year' (OR=2.10; *p*<.001) when compared to 'almost every day'. There was also a significant OR of video game addiction for sport and exercise 'never' (OR=3.47; *p*<.001) and 'a few times a year' (OR=2.18; *p*=.018) when compared to 'almost every day'. Adjusting for socio-demographic variables only slightly attenuated these associations. Moreover, when further adjusting for substance abuse disorders, there was still a significant OR of problematic video game use for sport and exercise

'never' (OR=1.86; p=.001) and 'a few times a year' (OR=1.96; p<.001) compared to 'almost every day', and a significant OR of video game addiction for sport and exercise 'never' (OR=2.60; p=.008) compared to 'almost every day'.

Figure 2 illustrates the cross-lagged path analysis examining the longitudinal associations between video gaming disorder and the level of sport and exercise. The covariates were included in the model but for clarity are not presented on the figure. The model exhibited a good fit to the data (RMSEA=.035, CFI=.96). Synchronous correlations between video gaming disorder and the level of sport and exercise were significant at baseline (β=-.113, p<.001) and follow-up (β=-.082, p=.002). Autocorrelations were significant for both video gaming disorder (β=.635, p<.001) and the level of sport and exercise (β=.587, p<.001). Cross-lagged correlations were significant but small. The level of sport and exercise at baseline significantly predicted video gaming disorder at follow-up (β=-.039, p=.024). The level of sport and exercise at follow-up, in turn, was significantly predicted by video gaming disorder at baseline (β=-.052, p=.001). When the model was run without adjusting for substance abuse disorders, then synchronous correlations, autocorrelations, and cross-lagged correlations remained almost unchanged.

DISCUSSION

The present study aimed to assess the associations between video gaming disorder and the level of sport and exercise in emerging adult men. The results showed that participants with a low level of sport and exercise had more symptoms of video gaming disorder than those with a higher level. When dichotomizing video gaming disorder, there was a higher prevalence of problematic video game use and video game addiction among participants with low levels of sport and exercise, compared to those who exercised more regularly. The cross-lagged path analysis indicated a reciprocal causality between video gaming disorder and the level of sport and exercise. These cross-sectional and longitudinal associations persisted after controlling for a set of socio-demographic confounders and substance abuse disorders.

Dichotomizing the GAS using both polythetic and monothetic approaches provided prevalence estimates of problematic video game use and video game addiction of respectively 11.9% and 2.2% in this representative sample of emerging adult Swiss men. These values are similar to those reported by Lemmens et al.[24] in adolescent girls and boys. Other authors using the same scale have reported a higher prevalence in adolescents,[9, 20] and a lower prevalence in young adults.[31, 32] This is consistent with a recent study where the frequency and the problematic use of video games had curvilinear relationships with age, rising through childhood and adolescence to a peak in late adolescence, and then decreasing in emerging adulthood due to interference with life obligations.[33] Confounding factors such as gender and geographical location may also hamper any interpretation of the heterogeneity in prevalence across studies.

The multiple logistic regression models indicated that participants who never or rarely participated in sport and exercise were significantly more likely to exhibit problematic video game use and video game addiction than those who exercised regularly, even after adjusting for a large set of confounders. A recent study reported that alcohol dependence, nicotine dependence and cannabis use disorder were inversely associated with sport and exercise.[34] In the present study, adjusting for substance abuse disorders did not dramatically change the cross-sectional associations observed between problematic video game use, video game addiction and the level of sport and exercise. It seems, therefore, that different mechanisms are behind the associations between addiction to video games and the level of sport and exercise on the one hand, and substance use and the level of sport and exercise on the other hand.

Synchronous correlations of the cross-lagged model confirmed significant cross-sectional associations observed using multiple logistic regression models. Cross-lagged correlations analyzing the direction of effects over time indicated reciprocal causality between video gaming disorder and the level of sport and exercise, but the magnitude of these longitudinal associations was small. Stronger longitudinal associations may be observed with longer follow-up. Furthermore, caution has been expressed when interpreting small effect sizes as trivial, particularly in variables with multiple determinants.[35, 36] In this context, the complexity of human behaviors such as playing video games and doing sport or exercise supports the public health significance of the present findings. At least, there is no doubt that future studies on the determinants of video gaming disorder should take into account the level of sport and exercise.

Since the frequency of video game use was not measured, the present study cannot directly determine whether participating to sport and exercise reduced the time available for playing video games, and hence if the displacement hypothesis acts as a mediator of the association

between the level of sport and exercise at baseline and video gaming disorder at follow-up. However, the modification of a behavioral addiction over time is more likely to be explained by other psychological, social, and genetic factors. For instance, it has been suggested that team sports might be used to promote interaction with peers in real life, rather than merely interacting with them in a virtual environment. It would also satisfy the need to engage in competitive and pleasurable activities.[37] Similarly, a Chinese study reported that prescribing sport during a cognitive behavioral group therapy may enhance the effect of the intervention on internet addiction disorder.[38]

Video gaming disorder at baseline was negatively associated with the level of sport and exercise at follow-up. A decrease in participation in sport and exercise can therefore be added to the list of the negative consequences of video gaming disorder already identified in the literature.[5, 6, 8-10] The displacement hypothesis is likely to explain this relationship. In parallel, video gaming disorder may be associated with factors that impede subsequent participation in sport and exercise. In a review and meta-analysis of personality correlates of physical activity, high scores in extraversion and conscientiousness, and low scores in neuroticism, were significantly associated with physical activity.[39] A recent study concluded that video game addiction is associated with higher level of depression,[19] which in turn may be associated with decreased motivation for sport and exercise.

The main strengths of the present study include its longitudinal design, a large, nationally representative sample, and adjustment for a comprehensive set of confounders. However, some limitations must also be acknowledged. First, women could unfortunately not be included because army recruitment in Switzerland is only mandatory for men. Previous studies showed that video gaming disorder is more prevalent in males than females.[9, 16] The conclusions cannot

be generalized to women. Second, although video gaming disorder was assessed using a validated and widely used tool, the frequency of video game play was not measured. The associations observed in this study between video gaming disorder and the level of sport and exercise should not be considered as informative on occasional video game play that falls outside the realm of video gaming disorder.

CONCLUSION

To the best of our knowledge, this is the first study to specifically address the association between video gaming disorder and the level of sport and exercise in emerging adult men. The reciprocal causality observed supports the need for a better promotion of sport and exercise, both as a preventive strategy for video gaming disorder, and as a means of limiting or reversing the low level of participation in sport and exercise by addicted gamers. Finally, rigorous interventional studies are needed to test the therapeutic effectiveness of sport and exercise on video gaming disorder.

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Table 1. Video gaming disorder according to sport and exercise levels at baseline

	Total (N=4933)	Never (N=255)	A few times a year (N=425)	1 to 3 times per month (N=675)	At least once per week (N=2060)	Almost every day (N=1518)		
							ANOVA	
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	$F_{4, 4932}$	P
GAS 1	1.95 (1.92-1.98)	2.19 (2.01-2.37) [ab]	2.25 (2.13-2.38) [b]	2.01 (1.92-2.10) [ac]	1.93 (1.88-1.98) [cd]	1.83 (1.78-1.89) [d]	15.05	<.001
GAS 2	2.31 (2.28-2.34)	2.36 (2.18-2.54) [ab]	2.52 (2.39-2.64) [b]	2.25 (2.16-2.34) [a]	2.34 (2.29-2.39) [a]	2.23 (2.17-2.29) [a]	5.49	<.001
GAS 3	1.69 (1.66-1.72)	1.93 (1.77-2.09) [a]	1.92 (1.80-2.03) [a]	1.70 (1.63-1.78) [bc]	1.69 (1.65-1.73) [b]	1.58 (1.53-1.63) [c]	13.38	<.001
GAS 4	1.50 (1.48-1.53)	1.69 (1.55-1.83) [a]	1.64 (1.54-1.74) [a]	1.45 (1.39-1.51) [b]	1.50 (1.47-1.54) [b]	1.45 (1.41-1.50) [b]	7.10	<.001
GAS 5	1.32 (1.30-1.34)	1.51 (1.39-1.63) [a]	1.42 (1.35-1.50) [ab]	1.35 (1.29-1.40) [bc]	1.31 (1.28-1.34) [c]	1.28 (1.25-1.31) [c]	8.54	<.001
GAS 6	1.38 (1.36-1.40)	1.53 (1.41-1.65) [a]	1.47 (1.39-1.55) [ab]	1.36 (1.30-1.41) [bc]	1.36 (1.33-1.40) [bc]	1.35 (1.32-1.39) [c]	4.78	.001
GAS 7	1.49 (1.46-1.51)	1.64 (1.51-1.78) [ab]	1.68 (1.58-1.78) [b]	1.52 (1.46-1.59) [ac]	1.47 (1.44-1.51) [c]	1.42 (1.38-1.46) [c]	10.54	<.001
							Chi-squared	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	χ^2	P
Problematic video game use	589 (11.9%)	48 (18.8%) [+]	78 (18.4%) [+]	80 (11.9%)	236 (11.5%)	147 (9.7%)	35.93	<.001
Video game addiction	109 (2.2%)	14 (5.5%) [+]	15 (3.5%)	17 (2.5%)	38 (1.8%)	25 (1.6%)	19.92	.001

GAS 1-7 = items of the game addiction scale, scored on a five-point Likert scale coded from 1 (never) to 5 (very often)

[a, b, c, d] Means with different superscript letters differ significantly (post-hoc Tukey HSD tests at $p<.05$).

[+] Significantly higher prevalence than expected (standardized residuals >2.81 to adjust for multiple testing)

Table 2. Cross-sectional associations between sport and exercise levels and problematic and addictive video game use.

	Problematic video game use			Video game addiction		
	Unadjusted OR (95% CI)	**Adjusted 1 † OR (95% CI)**	**Adjusted 2 ‡ OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted 1 † OR (95% CI)**	**Adjusted 2 ‡ OR (95% CI)**
Sport and exercise						
Never	2.16 (1.51-3.09) ***	1.99 (1.38-2.87) ***	1.86 (1.28-2.70) **	3.47 (1.78-6.77) ***	2.95 (1.49-5.85) **	2.60 (1.28-5.25) **
A few times a year	2.10 (1.56-2.83) ***	1.99 (1.46-2.70) ***	1.96 (1.44-2.67) ***	2.18 (1.14-4.18) *	1.91 (0.99-3.7)	1.82 (0.93-3.55)
1 to 3 times per month	1.25 (0.94-1.67)	1.25 (0.93-1.67)	1.24 (0.93-1.67)	1.54 (0.83-2.88)	1.47 (0.78-2.75)	1.44 (0.76-2.71)
At least once per week	1.21 (0.97-1.50)	1.21 (0.97-1.50)	1.20 (0.96-1.50)	1.12 (0.67-1.87)	1.14 (0.68-1.89)	1.11 (0.67-1.86)
Almost every day	1.00	1.00	1.00	1.00	1.00	1.00

Notes: OR = odds ratios; CI = confidence intervals; * = p<.05; ** = p<.01; *** = p<.001; † adjusted for socio-demographic variables; ‡ adjusted for socio-demographic variables and substance abuse disorders.

FIGURE LEGEND

Figure 1 Cross-lagged model assessing three types of correlation. GAS = game addiction scale. Letters refer to synchronous correlations (A and B), autocorrelations (C and D), and cross-lagged correlations (E and F).

Figure 2 Cross-lagged model analyzing the longitudinal association between video gaming disorder and sport and exercise. Ovals represent latent variables and boxes represent measured variables. The model was controlled for all covariates at baseline.

* $p<.05$; ** $p<.01$; *** $p<.001$

Standardized β are given.

Figure 1

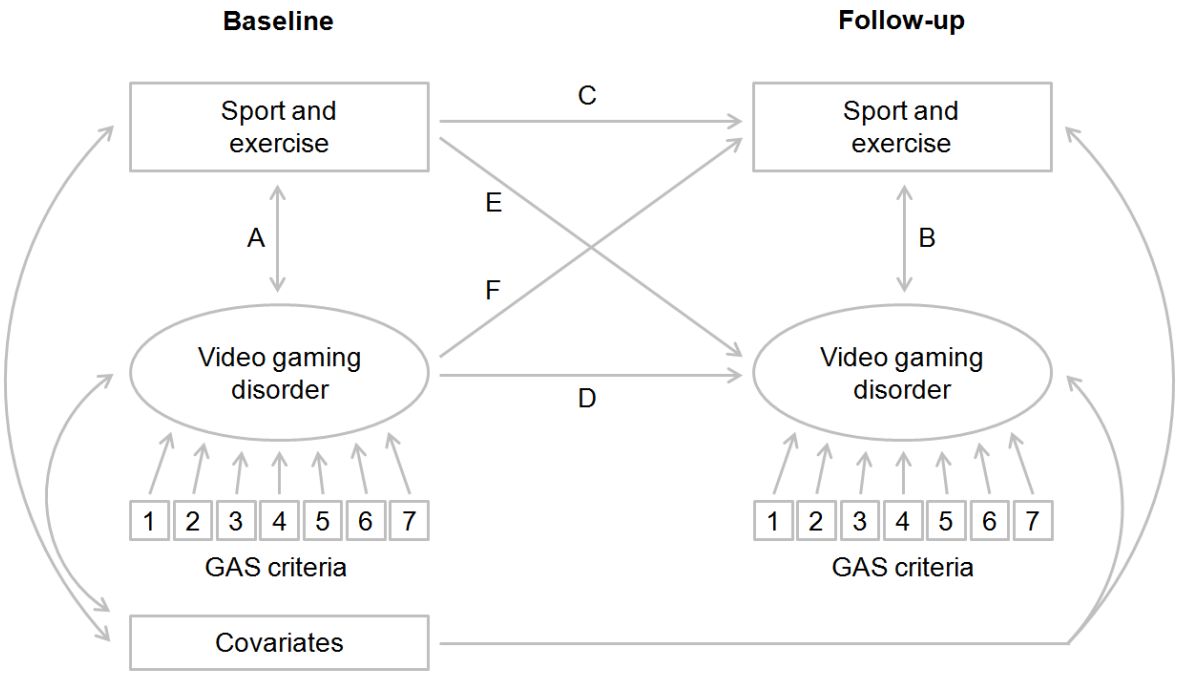
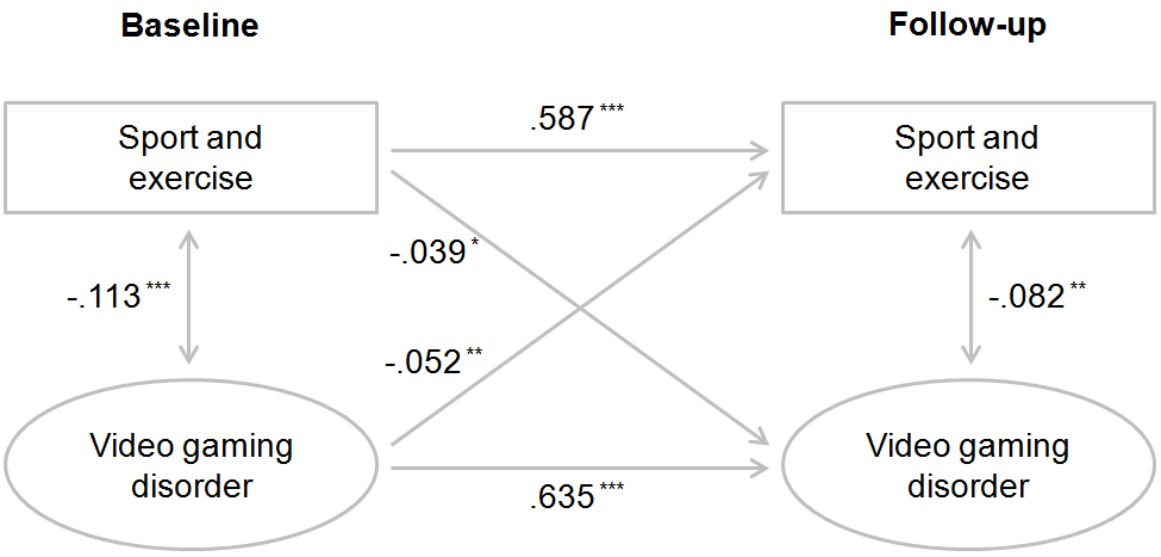

Baseline
Follow-up
Sport and exercise
Sport and exercise
C
E
F
A
B
Video gaming disorder
Video gaming disorder
D
1 2 3 4 5 6 7
1 2 3 4 5 6 7
GAS criteria
GAS criteria
Covariates

Figure 2


Baseline
Follow-up
Sport and exercise
Sport and exercise
.587***
-.039*
-.113***
-.082**
-.052**
Video gaming disorder
Video gaming disorder
.635***