ORIGINAL CONTRIBUTION

The dynamics of adolescents' pornography use and psychological well-being: a six-wave latent growth and latent class modeling approach

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Abstract

Despite increasing concerns that pornography decreases adolescents' well-being, existing empirical support for this position is largely limited to cross-sectional studies. To explore possible links between adolescent pornography use and psychological well-being more systematically, this study focused on parallel dynamics in pornography use, self-esteem and symptoms of depression and anxiety. A sample of 775 female and 514 male Croatian high school students ($M_{\text{age at baseline}}$ 15.9 years, SD 0.52) from 14 larger secondary schools, who were surveyed 6 times at approximately 5-month intervals, was used for the analyses. The longitudinal data were analyzed using latent growth curve and latent class growth modeling. We observed no significant correspondence between growth in pornography use and changes in the two indicators of psychological well-being over time in either female or male participants. However, a significant negative association was found between female adolescents' pornography use and psychological well-being at baseline. Controlling for group-specific trajectories of pornography use (i.e., latent classes) confirmed the robustness of findings in the both female and male samples. This study's findings do not corroborate the notion that pornography use in middle to late adolescence contributes to adverse psychological well-being, but do not rule out such a link during an earlier developmental phase—particularly in female adolescents. The findings have ramifications for educational and adolescent health specialists, but also for concerned parents.

Keywords Adolescents · Pornography use · Depression and anxiety · Self-esteem · Psychological

Introduction

There are clear reasons to believe that pornography use may negatively impact the physical, psychological, and sexual well-being of some adolescents. Research conducted among adolescents and young adults has demonstrated that pornography use is associated with less social interaction and bonding [1], insecure attachment orientations [2], lower life satisfaction [3], lower satisfaction with sexual experiences [4] and self-esteem [5, 6], as well as the experience of more negative affect [2] and symptoms of depression [7, 8]. Indeed, a recent review of the literature concerning sexual media and pornography use among adolescents, published in *Pediatrics*, called for increased resources to help parents manage "negative media influences on their children's sexual well-being and development" [9].

Pornography use risks damaging the psychological well-being of adolescents through processes of scripting, self-objectification, and social comparison. It is said that pornography depicts fleeting non-committal sexual encounters that are devoid of intimacy [2], and the internalization of such scripts [10], as suggested by the experimental evidence of the effects of prolonged exposure to pornography on sexually permissive attitudes [11], may disrupt the development of healthy relationship styles and impair social functioning. Sexual media generally, and pornography particularly, have also long been recognized as agents of sexual commodification that contribute to sexual self-objectification [12]. Its use may restrict adolescents' sources of self-worth to their

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sexual characteristics, ultimately contributing to negative self-image and, consequently, poorer general self-esteem. Media presentations also serve as a reference for social comparison [13] and the idealized bodies and over-the-top depictions of fantastical sexual prowess and pleasure may leave adolescents feeling that their own bodies and sexual experiences are deficient in comparison. Such linkages should have especial ramifications for the well-being of adolescents because they are assumed to be particularly vulnerable to the effects of sexual media due to their stage of cognitive development [9].

Despite the theoretical reasons to believe that pornography use contributes negatively to adolescents' well-being, existing empirical support for this position is largely limited to the findings of cross-sectional studies. Such findings cannot speak to issues of temporal precedence, an important criterion for evaluating assertions involving the potential causal harms of pornography use. When dealing with socially disapproved and potentially harmful behaviors among adolescents, researchers interested in examining causal claims tend to be limited to longitudinal designs. In this respect, only two studies have examined temporal links between pornography use and psychological well-being among adolescents. Studying the antecedents of pornography use, Peter and Valkenburg [3] reported that low life satisfaction was associated with increases in pornography use over time among both adolescents and emerging adults. More recently, Kohut and Štulhofer [14] found that pornography use was not consistently associated with decreases in psychological well-being and self-esteem or with increases in symptoms of depression and anxiety across two samples of adolescent men and women.

On the basis of the most recent longitudinal findings [14], it may appear that pornography use does not undermine the well-being of adolescents. Although the study controlled for some personality and family-related differences that, according to the differential susceptibility to media effects model [15], can diminish connections between pornography use and well-being, it did not directly assess possible associations between the dynamics of pornography use (i.e., the rate of change in pornography use) and the indicators of psychological well-being. In addition, it failed to fully take into account the heterogeneity of individual trajectories of pornography use during adolescence. Considering that the average dynamics of adolescent pornography use obscures substantial variability, both between- and within-gender, [16, 17] this is a serious limitation that we attempted to overcome in the current study.

The current study

To further the exploration of links between adolescent pornography use and psychological well-being, here we focused on the assessment of parallel dynamics in the frequency of pornography use and psychological well-being over a period of more than 2 years. Our analyses attempted to answer the following two research questions: (1) do changes in pornography use in the period from middle to late adolescence correspond to changes in psychological well-being; and (2) does controlling for differences in group-specific trajectories of pornography use affect the answer to the previous question? Answers to these questions have important ramifications for educational and adolescent health specialists, but also for concerned parents and the general public.

Methods

Participants and procedures

The data for this study were collected in a panel sample of adolescents recruited in the third largest urban setting in Croatia as a part of the PROBIOPS (Prospective Biopsychosocial Study of the Effects of Sexually Explicit Material on Young People's Sexual Socialization and Health) project and were previously analyzed by Kohut and Štulhofer [14]. At baseline (December 2015), the sample included high school sophomores recruited from 14 of the total of 22 secondary schools in the city. Due to financial limitations, seven small schools were omitted from the sample. In addition, one larger high school was dropped due to an arson-related pending investigation. The panel included 1287 participants ($M_{\text{at baseline}}$ 15.9 years, SD 0.52) or 78% of the city's high school sophomore population. Over two-thirds of participants (71%) attended vocational schools, while the rest attended more prestigious gymnasiums.[1] To maximize confidentiality in classroom-based data collection, screens were placed between students. Students received no compensation for participation.

The study included six waves spaced approximately 5 months apart, which covered the period from middle to late adolescence. The panel size varied from 1287 at wave 1

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[1] Only primary schooling (8 years) is compulsory in Croatia. A great majority of children who finish a primary school continue their education. Secondary schools are divided into vocational schools (3- or 4-year programs) and gymnasiums (only 4-year programs). In contrast to students from vocational schools, the majority of gymnasium students enter a college or university program. Expectedly, there is are substantial differences in family socioeconomic status and parents' education between students from vocational schools (lower) and gymnasiums (higher).

(T1) to 892 at wave 6 (T6); at T5, it dropped to 931 participants because students enrolled in 3-year vocational schools finished their secondary education prior to T5. Attrition seemed mostly due to school absenteeism and mistakes in re-creating a 5-digit alphanumeric identification code that was used to link responses over time.

To enable robust estimation of latent trajectories of change, adolescents who participated in at least three of the six data collection waves (the minimum for latent growth modeling) were included in this study (775 female and 514 male students). To address possible bias introduced by participant drop out, multivariate logistic regression analysis was carried out with the dependent variable differentiating between two groups of adolescents: those who were included in this study (coded 1) and those who were omitted (coded 0). In addition to baseline pornography use, depression/anxiety and self-esteem, several sociodemographic indicators (gender, father's and mother's education, academic achievement and religiosity) were also included as predictors of group membership. Female participants (AOR 1.91, $p < 0.05$) and students with a higher academic achievement (AOR 2.32, $p < 0.001$) were characterized by higher odds of being included in this study.

According to the Croatian national guidelines for ethical research in minors, which stipulate that adolescents aged ≥ 14 years can give informed consent, parents of students from the selected schools were sent a letter with information about the study prior to the initial survey. In addition to consent-related information, all questionnaires contained the contact of a national organization that offers support and counseling to children and young people. The ethical research board of the University of Zagreb approved all study procedures.

Measures

Pornography use

The frequency of pornography use was assessed with the following question: "How often have you used pornography during the last 6 months?" Preceding the question, pornography was defined in the questionnaire as any material which openly depicts sexual activity; material which shows naked bodies but not sexual intercourse or other sexual activity does not belong to pornography as here defined. Response options included: 1 = not once, 2 = several times a month, 3 = once a month, 4 = 2–3 times a month, 5 = once a week, 6 = several times a week, 7 = every day or almost every day, and 8 = several times a day. Stability coefficients for the indicator across all six measurement occasions ranged from 0.74 to 0.83. Age at first exposure to pornography was also assessed with a single retrospective item: "How old were you when you first saw, accidentally or deliberately, a pornographic video or movie?"

Negative and positive psychological well-being

To address participants' psychological well-being, we measured levels of depression and anxiety (the indicator of negative well-being), and self-esteem (the indicator of positive well-being). The first construct was assessed using the Patient Health Questionnaire for Depression and Anxiety (PHQ-4; [18], a brief 4-item screening scale that asks about the symptoms of depression (2 items) and anxiety (2 items) experienced in the 2 weeks preceding the survey. The frequency of symptoms was measured on a 4-point scale ranging from 1 = not at all to 4 = nearly every day. The measure had satisfactory reliability (Cronbach's α were in the 0.83–0.86 range) and reasonable stability ($r = 0.51$–0.64) across all measurement occasions. General self-esteem was assessed by a four-item scale (e.g., In general, I like myself the way I am and When I do something, I do it well) used in a longitudinal study of Canadian teenagers [19]. A Likert-like scale, ranging from 1 = it does not relate to me at all to 5 = it completely relates to me, was employed to anchor responses. This indicator had satisfactory reliability (Cronbach's $\alpha = 0.81$–0.84) and stability ($r = 0.59$–0.74) in this study.

Analytical strategy

To address possible underestimation of measurement errors due to cluster-based sampling, data nestedness in high school classes was explored first. Taking into account that hierarchical unconditional means model pointed to a small proportion of variability in the dynamics of participants' pornography use ($\leq 4\%$), self-esteem ($\leq 6\%$) and depression/anxiety symptoms ($\leq 4\%$) explained at the level of school class (the analysis was carried out by gender), the effects of intra-class correlation were ignored in all subsequent analyses. Full information maximum likelihood estimation was employed to handle missing observations [20], given that less than 2% of data was missing due to non-response in a more narrow sense (i.e., discounting attrition).

The relationship between pornography use and the two indicators of psychological well-being was explored by multi-domain latent growth curve modeling (LGCM). The approach, which enables simultaneous estimation of individual- and group-level changes over time [21]—i.e., individual variability (random effects) around group-level or mean change (fixed effects)—is based on associations among latent intercept and slope that describe the dynamics in each construct. Latent intercepts represent baseline levels of each construct and latent slopes their change over time (i.e., positive or negative growth). The potential for

simultaneous modeling of growth in different constructs is an advantage of LGCM over mixed effects hierarchical regression approach [22]. In this way, it improves on the recent analysis by Kohut and Štulhofer [14].

LGCM was carried out in several steps. First, two different growth curves were fit to each construct (pornography use, depression/anxiety, and self-esteem) by gender: a linear growth curve (specified in months) and an unspecified non-linear or cumulative curves [23]. As recommended, error variances of observed variables were constrained to equality in all analyses [24]. The results of the standard χ^2 difference test, which was used to compare the fit of two curves specifications, indicated that a linear specification was superior to a non-linear specification in the case of male adolescents' pornography use and self-esteem. Due to gender-specific growth trajectories in two of the three key constructs, an unconditional multi-domain model was explored separately for each gender. Following guidelines for longitudinal assessment [21], model fit was evaluated based on comparative fit index (CFI), and the root mean square error of approximation (RMSEA). Excellent fit to the data was indicated by CFI values ≥ 0.95 and RMSEA values ≤ 0.05, with the upper 90% confidence interval value ≤ 0.08.

Next, latent class growth modeling (LCGM) was carried out by gender to distinguish among groups of participants characterized by a distinct trajectory of pornography use. Originally introduced by Nagin [25], LCGM is an extension of latent growth curve modeling approach that enables the estimation of parameters across unobserved subpopulations in the dataset [26–28]. Instead of treating all participants as sharing a general latent growth trajectory, LCGM identifies groups of individuals who are characterized by distinct latent growth. Since the population heterogeneity is unobserved, the number of groups or subpopulations (i.e., latent classes) needs to be specified by the researcher. Usually, a number of models with different number of latent classes (ranging from 2 to 6 or more) are estimated and their fit to the data compared. Given that the magnitude and the direction of change can vary among groups, model parameters (i.e., intercept and slope) are estimated separately for each latent class (see [29]). Unlike the standard latent growth modeling technique in which individual differences in both the slope and intercept are estimated using random coefficients [30], LCGM fixes the slope and the intercept to equality across individuals in each latent class—the approach justified by individual differences being represented by multiple trajectories included in a number of competing models (with different number of latent classes) [26].

An expectation-maximization (EM) algorithm was used to simultaneously estimate the specified latent model and class membership probabilities. Since the latent class approach involves assigning probabilities of belonging to each latent class, it represents a fuzzy clustering technique.

In the absence of commonly accepted procedures for choosing the correct number of latent classes, we followed recommendations by Grimm et al. [28], Nagin and Odgers [31], and Nylund et al. [32] and used log-likelihood, AIC and BIC values and meaningful interpretation of group-specific growth as the criteria for identifying the best fitting model by gender. All analyses were carried out using the lcmm package [33] in R. Since LCGM can converge to local minima, each analysis was run multiple times with different randomly chosen starting values to increase the probability of reaching a global minimum.

To explore the robustness of the unconditional multi-domain model findings across groups with distinct growth trajectories of pornography use, in the final analytical step the multi-domain models were conditioned on the latent class membership (two dummy variables with the largest group serving as the reference category were included as controls).

Results

Table 1 provides description of the key indicators. Consistent and significant gender differences were found in mean levels of pornography use, as well as in depression/anxiety symptoms and self-esteem. Compared to their female peers, male participants reported significantly higher frequency of pornography use and self-esteem, but lower levels of depression and anxiety symptoms. Cross-correlations between the three constructs over time are presented in Table 2.

The unconditional female adolescent model is presented in Fig. 1 and the male model is displayed in Fig. 2. Both multi-domain models were characterized by adequate fit [female participants: $\chi^2_{(147)} = 413.18$, CFI = 0.960, RMSEA = 0.048 (0.043–0.054) and male participants: $\chi^2_{(155)} = 236.52$, CFI = 0.977, RMSEA = 0.032 (0.024–0.040)]. In the adolescent women's model, all latent constructs had mean values significantly different from zero and significant individual variation around mean estimates (Table 3). On average, we observed a decrease in depression and anxiety symptoms and increases in pornography use and self-esteem among female students in the observed period. In the male model, two latent means (growth in pornography use and self-esteem) did not reach significance, but individual variation around all latent mean estimates was highly significant. Similar to what was observed in the female sample, levels of depression and anxiety decreased over time in adolescent men.

In adolescent women, significant cross-domain associations were observed only at baseline. Higher initial frequency of pornography use was related to more anxiety and depression symptoms ($r = 0.18$, SE = 0.17, $p < 0.001$)

Table 1 Description of the key variables

	M^a	SD^a	Range^a	Gender difference, t (df)
Pornography use at T1	1.73/4.82	1.36/2.17	1–8/1–8	26.16 (636)**
Pornography use at T2	1.77/5.04	1.40/2.12	1–8/1–8	28.07 (706)**
Pornography use at T3	1.77/4.75	1.42/2.14	1–8/1–8	25.29 (654)**
Pornography use at T4	1.90/4.92	1.54/2.11	1–8/1–8	25.07 (680)**
Pornography use at T5	1.91/5.14	1.49/2.02	1–8/1–8	24.58 (490)**
Pornography use at T6	1.99/5.14	1.54/2.06	1–8/1–8	23.35 (509)**
Depression/anxiety at T1	9.57/7.75	3.35/2.80	4–16/4–16	− 9.66 (1019)**
Depression/anxiety at T2	8.78/7.340	3.08/2.62	4–16/4–16	− 8.26 (1047)**
Depression/anxiety at T3	8.34/7.28	2.91/2.60	4–16/4–16	− 6.17 (968)**
Depression/anxiety at T4	8.72/7.39	3.06/2.60	4–16/4–16	− 8.13 (982)**
Depression/anxiety at T5	8.37/6.94	2.97/2.56	4–16/4–16	− 7.13 (702)**
Depression/anxiety at T6	8.50/7.19	2.99/2.55	4–16/4–16	− 6.66 (717)**
Self-esteem at T1	15.23/16.49	2.90/2.49	4–20/6–20	7.53 (979)**
Self-esteem at T2	15.51/16.71	2.95/2.527	4-20/8–20	7.55 (1045)**
Self-esteem at T3	15.46/16.18	2.71/2.54	6–20/7–20	4.50 (1095)**
Self-esteem at T4	15.76/16.62	2.71/2.36	4–20/8–20	5.57 (1067)**
Self-esteem at T5	15.81/16.361	2.77/2.52	7–20/4–20	2.93 (714)*
Self-esteem at T6	15.70/16.34	2.76/2.33	4–20/10–20	3.56 (726)***

^{a}Values in the female sample are presented first, followed by values in the male sample

*$p < 0.01$, **$p < 0.001$

and lower self-esteem ($r = − 0.19$, SE$= 0.14$, $p < 0.001$) at baseline. The size of both relationships was small. The association between depression and anxiety symptoms and self-esteem was significant (both at baseline and over time), negative, and moderate in size.

No significant associations between pornography use and the psychological well-being indicators were found among male participants. The only significant cross-domain associations were observed between the indicators of well-being. As in the female model, the correlations were negative. Due to the limited scaling of the pornography use measure, a negative link between the initial pornography use and its subsequent dynamics ($r = − 0.44$, SE$= 0.01$, $p < 0.001$), which suggested that participants with higher pornography use at baseline reported lower growth over time, is likely a statistical artifact (see [21]: 260).

Multi-group assessment by latent growth trajectory classes

In the female sample, a model with five classes was characterized by the best fit (i.e., the lowest BIC and AIC values). However, other considerations, primarily model interpretability and classification accuracy, favored a model with three classes (Fig. 3). It should be noted that compared to the model with five classes, in which the lowest posterior classification was $\geq 89\%$, the respective value for the model with 3 classes was $\geq 94\%$. As shown in Fig. 3, the selected model distinguished

among participants who reported a relatively low use of pornography at baseline and subsequent growth ($n = 117$; $M_{intercept} = 2.60$, $p < 0.001$; $M_{slope} = 0.41$, $p < 0.001$), participants characterized by almost no use at baseline and no significant growth over time ($n = 595$; $M_{intercept} = 1.24$, $p < 0.001$; $M_{slope} = 0.03$, $p < 0.09$) and those who reported relatively high baseline usage and some subsequent growth ($n = 63$; $M_{intercept} = 4.89$, $p < 0.001$; $M_{slope} = 0.15$, $p < 0.05$).

In the male adolescents' sample, a model with three classes had the best fit and satisfactory posterior classification accuracy ($\geq 91\%$). The smallest of the three classes (the top graph in Fig. 4) represented participants who reported the lowest baseline use of pornography and significant growth over time ($n = 107$; $M_{intercept} = 2.10$, $p < 0.001$; $M_{slope} = 0.14$, $p < 0.01$), while the largest group (the bottom graph in Fig. 4) was high and stable pornography users ($n = 254$; $M_{intercept} = 6.33$, $p < 0.001$; $M_{slope} = 0.02$, $p < 0.47$). The remaining latent class included participants characterized by moderate baseline consumption and substantial growth ($n = 153$; $M_{intercept} = 4.35$, $p < 0.001$; $M_{slope} = 0.20$, $p < 0.001$) which was similar in size to the one observed in the first latent class.

Next, two conditional multi-domain models were carried controlling for latent class membership. In the female adolescents' model [$\chi^2_{(173)} = 983.12$, CFI$= 0.904$, RMSEA$= 0.078$ (0.073–0.083)], associations between baseline levels of pornography use and the two indicators of psychological well-being remained significant and with

Table 2 Associations between the key variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Pornography use T1		0.68**	0.58**	0.56**	0.57**	0.53**	0.12**	0.17**	0.20**	0.12**	0.19**	0.17**	−0.16**	−0.13**	−0.07	−0.11**	−0.09	−0.11*
2. Pornography use T2	0.70**		0.72**	0.67**	0.65**	0.61**	0.14**	0.14**	0.15**	0.10	0.17**	0.12**	−0.12**	−0.10**	−0.04	−0.07	−0.09	−0.09*
3. Pornography use T3	0.62**	0.77**		0.68**	0.66**	0.63**	0.14**	0.15**	0.15**	0.13**	0.25**	0.17**	−0.17**	−0.10*	−0.07	−0.09*	−0.10*	−0.15**
4. Pornography use T4	0.56**	0.69**	0.75**		0.77**	0.70**	0.13**	0.10*	0.17**	0.11*	0.17	0.11*	−0.06	−0.06	−0.07	−0.05	−0.03	−0.05
5. Pornography use T5	0.51**	0.59**	0.68**	0.71**		0.78**	0.11*	0.10*	0.14**	0.14**	0.12**	0.06	−0.13**	−0.07	−0.06	−0.09	−0.10*	−0.13*
6. Pornography use T6	0.51**	0.54**	0.60**	0.66**	0.69**		0.10*	0.11*	−18**	0.19**	0.16**	0.17**	−16**	−0.11**	−0.05	−0.13**	−0.12**	−0.18**
7. Depression/anx. T1	0.03	0.01	0.01	0.01	0.04	0.02		0.64**	0.53**	0.48**	0.46**	0.44**	−0.31**	−0.37**	−0.23**	−0.29**	−0.25**	−0.19**
8. Depression/anx. T2	0.04	0.09	0.05	0.11*	0.03	0.04	0.55**		0.58**	0.54**	0.54**	0.53**	−0.32**	−0.34**	−0.26**	−0.30**	−0.29**	−0.29**
9. Depression/anx. T3	0.05	0.10	0.09	0.11*	0.03	0.04	0.53**	0.57**		0.61**	0.60**	0.53**	−0.27**	−0.32**	−0.34**	−0.33**	−0.33**	−0.27**
10. Depression/anx. T4	0.06	0.09	0.11*	0.11*	0.08	0.08	0.48**	0.52**	0.59**		0.56**	0.57**	−0.25**	−0.28**	−0.25**	−0.36**	−0.32**	−0.33**

Table 2 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
11. Depression/anx. T5	0.06	0.02	0.03	0.10	0.09	0.15*	0.46**	0.45**	0.50**	0.52**		0.64**	−0.27**	−0.28**	−0.23**	−0.28**	−0.38***	−31**
12. Depression/anx. T6	0.04	0.08	0.07	0.12	0.08	0.08	0.52**	0.53**	0.52**	0.60**	0.56**		−0.25**	−0.33**	−0.24**	−0.36**	−0.35***	−0.35**
13. Self-esteem T1	−0.03	0.02	−0.04	−0.04	−0.03	0.01	−0.21**	−0.23**	−0.22**	−0.14*	−0.10	−0.19**		0.72**	0.63**	0.67**	0.62**	0.57**
14. Self-esteem T2	0.01	−0.06	−0.08	−0.05	−0.07	−0.03	−0.18**	−0.28**	−0.25**	−0.17**	0.13*	−0.25**	0.72**		0.71**	0.69**	0.66**	0.62**
15. Self-esteem T3	0.00	0.01	−0.01	−0.04	−0.04	−0.03	−0.22**	−0.18**	−0.24**	−0.25**	−0.18**	−0.18**	0.63**	0.66**		0.71**	0.70**	0.64**
16. Self-esteem T4	0.00	−0.02	−0.11*	−0.07	−0.03	−0.04	−0.17**	−0.24**	−0.29**	−0.28**	−0.16**	−0.22**	0.66**	0.65**	0.67**		0.75**	0.74**
17. Self-esteem T5	0.04	−0.03	−0.06	−0.08	−0.01	−0.01	−0.17**	−0.23**	−0.29**	−0.27**	−0.16**	−0.22**	0.52**	0.55**	0.59**	0.69**		0.78**
18. Self-esteem T6	−0.00	−0.05	−0.04	0.03	0.03	0.02	−0.15*	−0.15*	−0.23**	−0.23**	−0.28**	−0.28**	0.53**	0.58**	0.55**	0.64**	0.63**	

Zero-order coefficients in the female sample are presented above the main diagonal and those in the male sample are shown below it
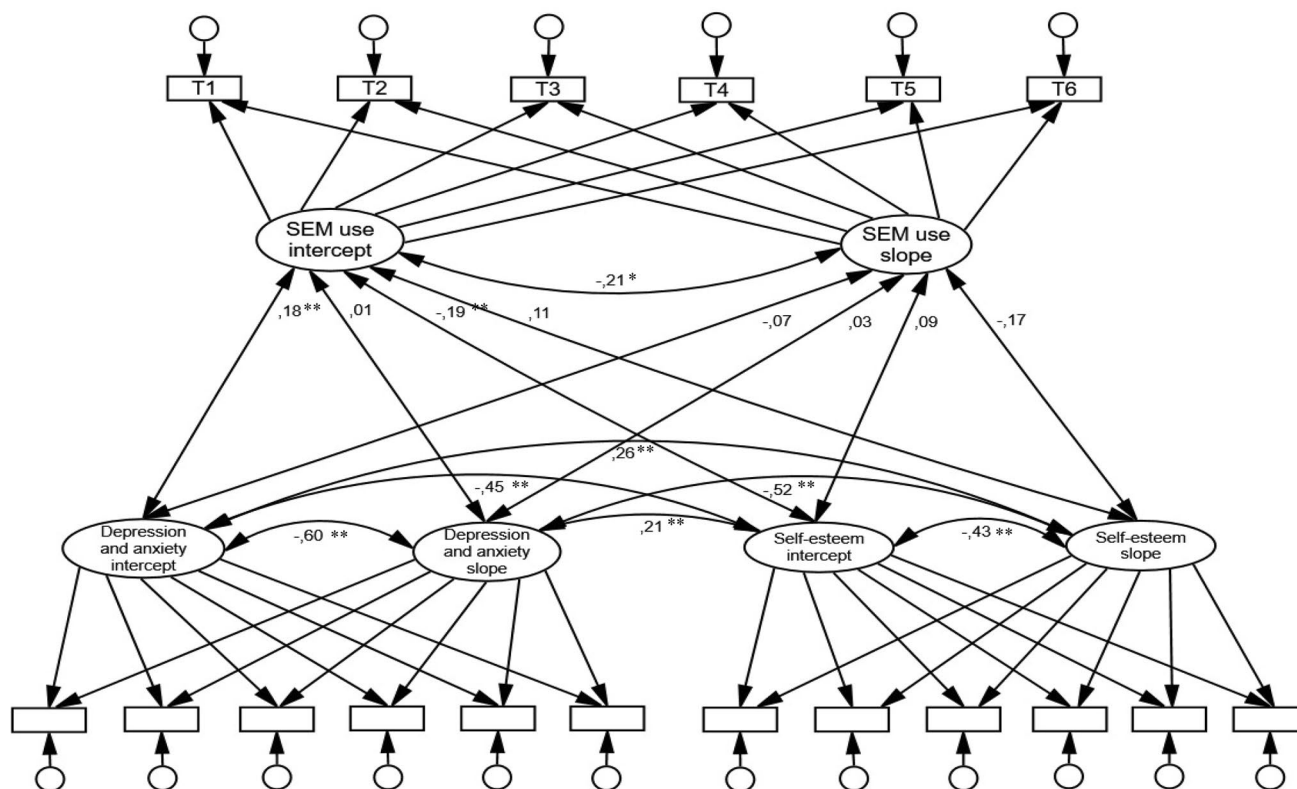
*$p < 0.05$, **$p < 0.01$

Fig. 1 Structural associations in the multi-domain latent growth model of adolescent women's pornography use, depression and anxiety and self-esteem (*n* = 775). Model fit: $\chi^2_{(151)} = 428.24$, TLI = 0.953, CFI = 0.959, RMSEA = 0.049 (0.043–0.054); *p* < 0.01, **p* < 0.001; standardized path coefficients are presented

the same sign as in the unconditional model. In a subsequent multi-group analysis of latent growth in the two indicators of psychological well-being, we found no significant difference baseline levels of depression and anxiety and self-esteem across the three latent classes. In the male conditional model [$\chi^2_{(181)} = 481.85$, CFI = 0.935, RMSEA = 0.057 (0.051–0.063)], no significant cross-domain associations were observed across any of the latent classes. The additional multi-group analysis pointed to significant differences in baseline levels of negative mood but not self-esteem among the latent classes. The low pornography use class was characterized by the lowest depression and anxiety (*M* 7.33, SE 0.25) and the moderate use class the highest depression and anxiety levels (*M* 8.20, SE 0.23).

Importantly, post hoc analyses revealed that latent classes characterized by the lowest and the highest use of pornography over time differed significantly in the average age at first exposure to pornography, both among female (*F* = 3.32, *p* < 0.05) and male students (*F* = 19.18, *p* < 0.001). Compared to high use participants ($M_{females}$ 11.61, SD 1.43 and M_{males} 11.12, SD 1.23), low use participants reported seeing a pornographic content for the

first time about a year later ($M_{females}$ 12.34, SD 2.02 and M_{males} 12.12, SD 1.70).

Discussion

In this study, we attempted to determine if there was longitudinal evidence that would justify increasing concerns about a negative contribution of pornography use to adolescent well-being. Considering conceptual reasons for linking pornography use and adolescents' well-being, which point to processes of sexual callousness scripting, self-objectification, and social comparison, our analysis explored whether changes in pornography use corresponded to changes in psychological well-being, operationalized by self-esteem and negative mood. Parallel growth modeling pointed to no significant associations between changes in pornography use and changes in self-esteem and depression/anxiety levels over a period of more than 2 years. However, as underscored by the differential susceptibility to media effects model [15], the use of sexually explicit material should not be expected to have a similar effect in all adolescents. Various personality, family and peer-related factors may be responsible for different trajectories of pornography use and, plausibly, a
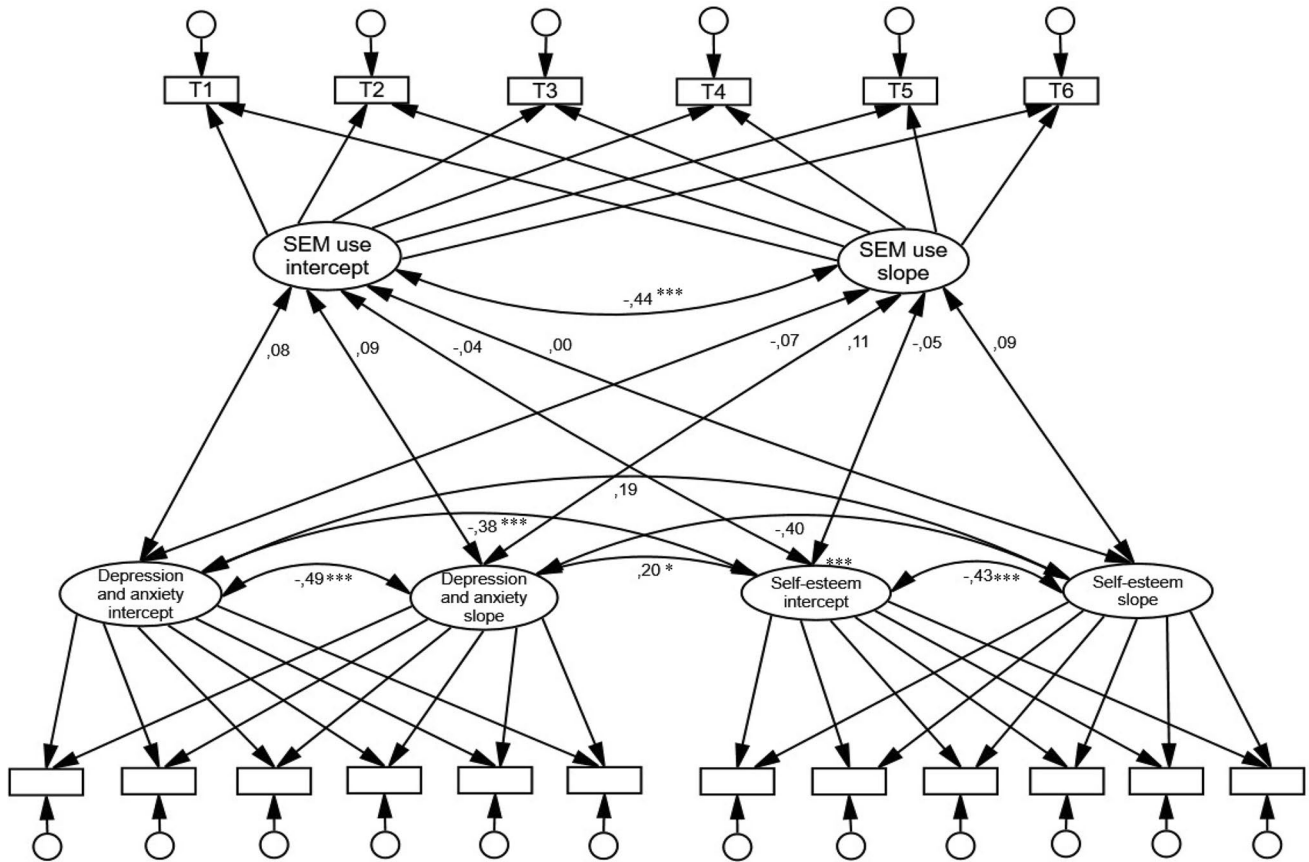
Fig. 2 Structural associations in the multi-domain latent growth model of adolescent men's pornography use, depression and anxiety and self-esteem ($n=514$). Model fit: $\chi^2_{(151)}=229.75$, TLI=0.975, CFI=0.978, RMSEA=0.032 (0.023–0.040); *$p<0.05$, **$p<0.01$, ***$p<0.001$; standardized path coefficients are presented

Table 3 Unconditional multi-domain latent growth model estimates and fit by gender

	Adolescent women ($n=775$)	Adolescent men ($n=514$)
Pornography use		
Mean intercept	1.72 (SE=0.05)**	4.87 (SE=0.09)**
Variance in individual intercepts	1.36 (SE=0.09)**	3.54 (SE=0.27)**
Mean slope	0.22 (SE=0.05)**	0.08 (SE=0.00)
Variance in individual slopes	0.93 (SE=0.13)**	0.01 (SE=0.00)**
Depression/anxiety		
Mean intercept	9.51 (SE=0.12)**	7.79 (SE=0.13)**
Variance in individual intercepts	8.09 (SE=0.60)**	4.94 (SE=0.49)**
Mean slope	−1.12 (SE=0.12)**	−0.63 (SE=0.13)**
Variance in individual slopes	4.27 (SE=0.62)**	1.59 (SE=0.49)*
Self-esteem		
Mean intercept	15.27 (SE=0.10)**	16.48 (SE=0.11)**
Variance in individual intercepts	6.52 (SE=0.43)**	4.62 (SE=0.37)**
Mean slope	0.60 (SE=0.10)**	0.01 (SE=0.01)
Variance in individual slopes	2.35 (SE=0.38)**	0.00 (SE=0.00)**
$\chi^2(df)$	413.18 (147)	236.52 (155)
TLI/CFI	0.954/0.960	0.975/0.977
RMSEA (90% CI)	0.048 (0.043–0.054)	0.032 (0.024–0.040)

SE standard errors

*$p<0.01$, **$p<0.001$

Fig. 3 Growth dynamics in three latent classes of female adolescent pornography use
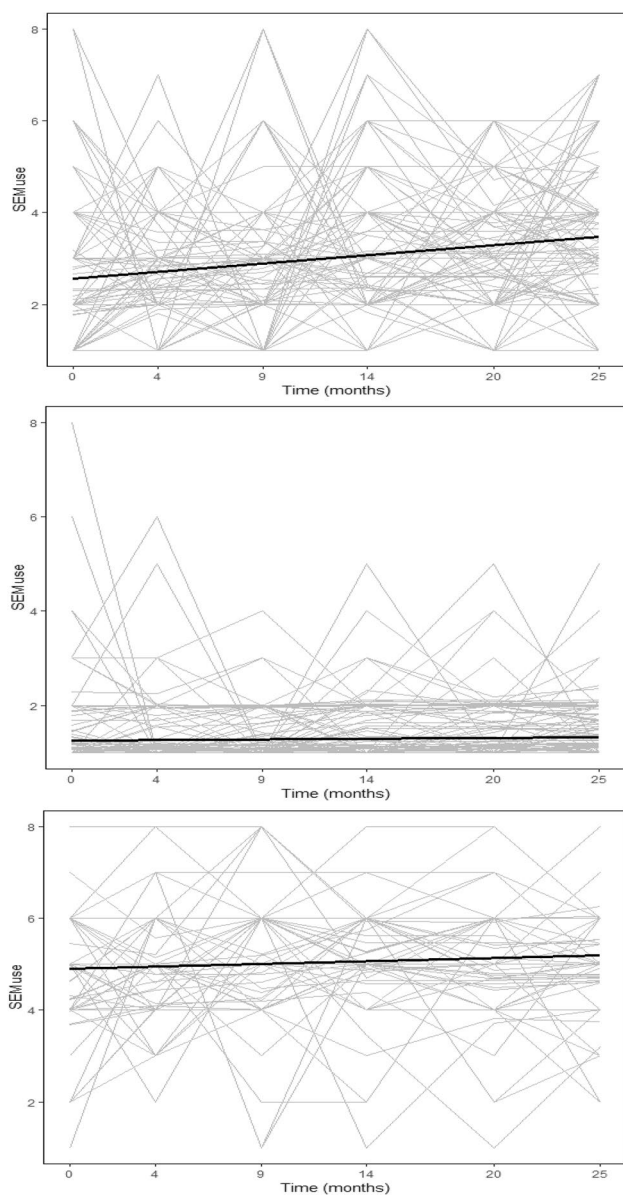

Fig. 4 Growth dynamics in three latent classes of male adolescent pornography use

differential impact of the consumption. To control for different dynamics of individual pornography use in the middle to late adolescence, we employed latent class growth modeling to compare if parallel growth between pornography use on the one hand and self-esteem and depression/anxiety on the other hand was distinct for participants with distinct patterns of use. Again, no evidence of a dynamic relationship was found, regardless of the pattern of use over time.

The significant associations between baseline levels (at the age of 16 years) of pornography use and self-esteem and depression/anxiety levels observed in female participants can be accounted for by either the third-variable perspective, which we discuss later, or by a dynamic relationship between
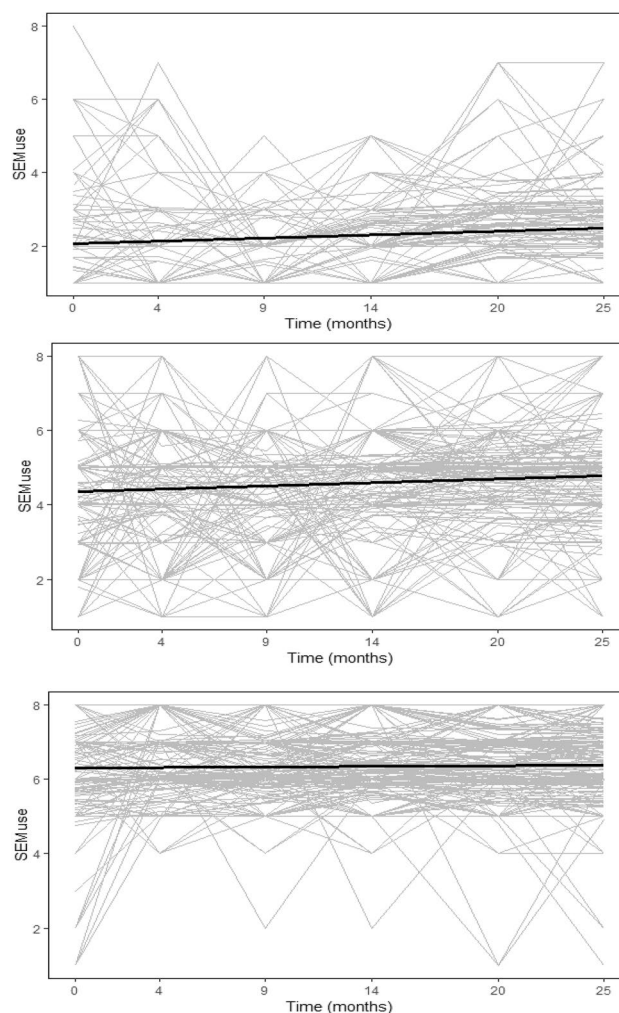
the constructs during an earlier developmental period. Although the levels of pornography use were, expectedly [14, 16, 34], substantially lower in female compared to male participants, the gender-specific finding may be related to both the non-normativeness of girls' use of pornography and to the stereotypical depiction of women in sexually explicit material. Both types of pressure may affect an adolescent woman's self-esteem and mood during early to middle adolescence [15]. The finding that female adolescents (as well as their male peers) who reported most frequent pornography use also reported being introduced to it at an earlier age than other participants speaks in favor of the media effects perspective, but only if this earlier exposure also marks a prolonged exposure to pornography contents—which can only be speculated about. However, the lack of the dose-response dependence in our study suggests that systematic associations between female adolescents' pornography use on the one hand and self-esteem and negative mood on the

other hand, if they exist at all, do not extend to middle and late adolescence. This is corroborated by the finding that levels of self-esteem and negative mood did not significantly vary by the pattern of pornography use.

The third-variable perspective emphasizes the possibility that the observed associations between key constructs are spurious or fully explained by the effect of one or more unobserved variables, such as impulsivity or poor family functioning. Such characteristics, and potentially others (e.g., early sexual initiation, sociosexuality, paraphilic interests, etc.), seem to play a role in both pornography use and psychological well-being [14, 35–37]. For example, there is evidence that early sexual activity—whether caused by earlier maturation and high interest in sexuality, peer pressure, or sexual grooming—is related to a range of psychological problems [38–40], as well as to pornography use [41]. Similarly, some scholars have explicitly warned that established associations between pornography use and sexual aggression [42], and between pornography and relationship functioning [43, 44], may in fact be the product of confounding variables. Future studies interested in examining the potentially causal influence of pornography use on adolescent well-being would do well to rule out alternative competing causes.

The finding that the lowest levels of depression and anxiety were found among male adolescents who reported the lowest frequency of pornography use at baseline should be considered together with the fact that the highest levels of negative mood were not observed among participants with the highest initial frequency of pornography use, but in their peers who reported moderate levels of pornography use at baseline (and, subsequently, the largest increase). This pattern is more consistent with the third-variable perspective than with the standard media grooming (or cultivation) explanation. However, the findings are also concordant with the recently proposed differential susceptibility to the media effects model [15], which posits that the media influence is dependent on personality-, developmental- and social environment-specific factors. Due to this multi-dimensional susceptibility, similar exposure to sexually explicit material could have a vastly different impact on adolescents with distinct psychosocial profiles.

Although comparisons with the two other studies that examined the trajectories of adolescent pornography use [16, 45] are difficult due to differences in participants' age (on average, both studies sampled younger adolescents) and analytical approach (the US study did not carry out a latent class analysis by gender), there are some notable similarities. Two of the three latent classes of female adolescents' trajectory in pornography use over 18 months (no/low use and stable occasional use) reported in the Dutch study closely correspond with our findings. A latent class characterized by a strong increase in pornography use—obtained among both

male and female Dutch participants, but unobserved in our study—is likely related to the age difference between the two panel samples, with younger Dutch participants being more likely to experience substantial changes in interest for sexually explicit material. Although the US study reported three distinct latent trajectories, which were somewhat similar to our findings, the fact they did not distinguish between female and male adolescents' dynamics of pornography use (which were found substantially different in both the Dutch and our study) renders any comparison problematic.

Finally, this study's findings add to a recent longitudinal exploration that controlled for some personality and family-related differences hypothesized to reduce connections between pornography use and well-being, but did not address possible correspondence between the trajectories in pornography use and psychological well-being [14]. Taken together, the two studies' offer no support for the notion of the causal role of pornography use in the dynamics of adolescents' self-esteem and negative mood.

Strengths and limitations

This study is characterized by several strengths. First, it appears to be the first systematic exploration of the relationship between adolescent growth in pornography use and changes in psychological well-being over time. Second, we used a reasonably large panel sample and six observation points, which translated into substantial statistical power to detect structural relationships [24]. Third, our statistical approach enabled insights beyond the usual between-person level, including the exploration of specific trajectories of change in constructs of interest, which is particularly important in explorations of potentially harmful outcomes. Apart from these advantages, some study limitations also need consideration. To assess pornography use, we used a single-item indicator that was validated in a number of studies [14, 46–48]. Despite the literature that encourages the use of single-item indicators when the measured construct and its attributes are easily and uniformly understood [49, 50], single-item indicators render the assessment of measurement error problematic. The fact that the pornography use question asked about frequency of use in the past 6 months may have contributed to some imprecision in our measurement of change in pornography use, because the spacing between data collection waves was on average a month shorter.

Another limitation pertains to the bias related to participant attrition. The fact that students characterized by lower academic achievement at baseline had lower odds of being included in the presented analyses compared to their peers, may have affected our assessment of depression/anxiety and self-esteem. Taking into account that higher academic achievement has been associated with higher levels of

adolescent psychological well-being [51], the attrition bias has likely affected baseline levels of the key indicators, but not necessarily their relationships (including the dynamic ones). Finally, structural estimates pertaining to the two smallest latent classes (i.e., low male adolescent pornography users and high female adolescent users) were likely underpowered, which calls for caution in interpreting our findings—primarily those observed in female adolescents.

Conclusions

According to this longitudinal study's findings, pornography use during the period from middle to late adolescence is unlikely to be causally related to female and male adolescents' self-esteem and negative mood. However, we found some evidence that for female adolescents the association may be relevant in an earlier developmental phase, underscoring the importance of media literacy programs and the inclusion of critical discussion of sexualized media, including pornography, in comprehensive school-based sexuality education.

Compliance with ethical standards

Conflict of interest The authors have no financial relationships relevant to this article.

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