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Exploring patterns of online sexual experiences and associated factors in 7,901 high school students in Hong Kong: A latent class analysis

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ABSTRACT

Online sexual experiences in adolescents are increasing but the patterns of use and associated factors remain unclear. This study investigated the latent heterogeneity of online sexual experiences in a large sample of 7901 adolescents (4362 males and 3539 females; mean age = 14.6 years, SD = 1.5). Participants were recruited from 25 high schools in Hong Kong via the Youth Sexuality Study in 2021. The participants completed an anonymous self-report questionnaire on online sexual experiences, family characteristics, psychological distress, and risk behaviors. Latent class analysis was conducted on 11 items of online sexual experiences in male and female adolescents separately. The latent classes were substantively checked with family, psychological, and behavioral factors via the BCH method and multinomial logistic regression. Both males and females supported three latent classes of online sexual experiences: abstinent class (male: 37.3%, female: 41.8%), normative class (male: 48.4%, female: 47.4%), and active class (male: 14.3%, female: 10.8%) with minimal, occasional, and frequent online sexual experiences, respectively. Males showed significantly higher prevalence of online sexual experiences and substance use; while females showed significantly higher levels of psychological distress and suicidal attempt. The active class was significantly associated with poorer family relationship, more digital screen time, higher psychological distress, and higher rates of sexual harassment by others, substance use, and suicide attempt than the other two classes. This study provides the first results on latent heterogeneity of online sexual experiences in Hong Kong adolescents and elucidated the associated factors across family, psychological, and behavioral domains.

1. Introduction

Digital technology has revolutionized human lifestyles and their ways of communication through the digital world over the past decades. Generation Z is the first cohort of digital natives that have grown up with access to the Internet during childhood. Internet and social media uses characterize the social life of adolescents and are crucial in their development of interpersonal relationships (Twenge, Martin, & Spitzberg, 2019). Given the accessibility and anonymity, the mobile technology and social media have played an increasing role in shaping the behaviors and sexual experiences of adolescents in their search for sex-related information and socialization with peers (O'Sullivan, 2014).

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Sexuality is a main component of pubertal development in the form of sexual desire, experiences, and behaviors during adolescence and adolescent sexual behaviors have substantial implications on their physical and psychosocial health (Vasilenko, Lefkowitz, & Welsh, 2014). The COVID-19 pandemic and associated lockdown have brought various psychological responses and situational impact (Fong et al., 2024), which further accentuated the reliance on the social media for sexual interactions (Tse et al., 2023).

Online sexual experiences refer to the use of Internet or social media for a range of behaviors that involve sexual contents, topics, and stimuli (Shaughnessy, Byers, & Walsh, 2011). Examples of online sexual experiences include accessing web-based sexual information, sexting, online dating, watching sexually explicit online media, and naked chat (Mori, Choi, Temple, & Madigan, 2021). Adolescents are now exposed to pornographic contents via the Internet and social media. Previous studies have linked pornography use with risky sexual behaviors in Australian adolescents (Lim, Agius, Carrotte, Vella, & Hellard, 2017) and Chinese adolescents (Y. D. Zhang, Wang, & Liang, 2022), and online sexual activities were significantly associated with compulsive sexual behaviors among Israeli adolescents (Efrati & Amichai-Hamburger, 2021). In Hong Kong, a large-scale survey conducted among adolescents in 2016 found that sexting and naked chats were positively associated with family factors such as not living with both parents and lower family life satisfaction (Wong et al., 2020). A recent local study (Fong, Cheung, et al., 2024) found elevated levels of online sexual experiences to be associated with higher levels of psychological distress, sexual risk behaviors, and behavioral health outcomes such as drug use and suicidal ideation in young adults.

Cooper, Putnam, Planchon, and Boies (1999) proposed three types of users of online sexual activities: recreational users, sexual compulsives, and at-risk users. A previous study (Del Rey, Ojeda, Casas, Mora-Merchán, & Elipe, 2019) not only found a growing prevalence of sexting among Spanish high school students, but also revealed the emotional impact of such behaviors in terms of the psychological need for popularity among peers. However, sexting is just a particular facet within a diverse spectrum of online sexual experiences. There remains a lack of comprehensive understanding on the patterns of these experiences and their potential associated factors across the demographic, family, psychosocial, and behavioral domains. In particular, Lefkowitz and Vasilenko (2014) highlighted the importance of accounting for interindividual differences in sexual health outcomes and advocated the use of innovative methodological approaches to explore the potential heterogeneity of online sexual experiences. Latent class analysis (LCA) is a person-centered statistical method (Collins & Lanza, 2009) that classifies respondents from a heterogeneous population into latent classes based on categorical observed indicators. LCA allows an in-depth analysis of the sample heterogeneity and has recently been applied in the context of latent heterogeneity of deviant behaviors in adolescents (Cui, Fong, & Yip, 2024).

We searched Web of Science using specific keywords of ((online sexual experiences OR online sexual behavior OR online sexual activities [title]) AND latent class [title]) up to August 10, 2024 and only identified two articles in the database on the topic. Though LCA has recently been applied to examine profiles of substance use behaviors and online sexual behaviors in young adults (Boislard et al., 2023; Fong, Cheung, et al., 2024), there remains scarce research on sexual experiences of adolescents in the online context. Besides, existing LCA studies on sexual experiences among adolescents (Maas, Bray, & Noll, 2018, 2019; Pravosud, Ballard, Holloway, & Young, 2024) have been limited by small sample sizes (N = 181–322) or limited to females. This highlights the need for larger-scale research to uncover the heterogeneity of online sexual experiences among adolescents in the digital era.

In response to these research gaps, the present study aimed to evaluate the underlying patterns of a variety of online sexual experiences via LCA in a large sample of adolescents in Hong Kong. It is of practical relevance to explore the potential heterogeneous profiles of online sexual experiences among adolescents in the current digital landscape. The derived latent classes would be validated through examination of their associations with external variables across the demographic, family, psychosocial, and behavioral domains. Findings of this study would provide empirical insights on the complexities of online sexual experiences among adolescents, which help inform practical implications for policy-making and health interventions for the adolescents.

2. Methods

2.1. Participants and procedures

Data of the present study were from the Youth Sexuality Study (YSS) of the Family Planning Association of Hong Kong conducted from April 2021 to July 2021. The YSS was conducted every 5 years to examine the sexual knowledge, attitude, and behaviors in Chinese adolescents in Hong Kong. Details of the sampling methods could be found in the survey report (Family Planning Association of Hong Kong, 2023). Briefly, 25 local high schools were randomly selected via stratified random sampling based on five district clusters in Hong Kong: Hong Kong Island, Kowloon East, Kowloon West, New Territories East, and New Territories West. Two classes of each study year from Form 1 to Form 5 (equivalent to US Grade 7 to Grade 11) of each selected school were randomly chosen to participate in the survey. Invitation letters were sent to the principals of the selected schools. Schools that declined to join were replaced by another school randomly re-sampled in the same cluster. Overall, 25 out of the 83 invited schools agreed to participate in this survey, with a school response rate of 30.1%.

The study objectives and procedures were explained to the students by the research team's staff or school teacher in each classroom. Anonymity, confidentiality and voluntary participation were emphasized. No personal identifiable information was collected and the participants reserved the right not to answer any questions. To avoid potential interference, teachers were instructed not to disturb the students, and students were reminded to avoid discussion during the survey and encouraged to complete the questionnaire seriously. Written informed consent was obtained from the student and his/her parent/guardian. Contact details of emotional support hotline were provided at the end of the survey and the students were encouraged to seek help in case of psychological distress. The anonymous data were only accessible to the research staff but not the teachers or schools. Ethical approval of the study has been obtained from the Ethics Panel of the Family Planning Association of Hong Kong and the Human Research Ethics Committee of the authors' university (Reference number: EA200333) and the investigation was carried out in accordance with the Declaration of Helsinki.

The paper-and-pencil questionnaires were administered and completed in classrooms of around 32 students each with the attendance of teachers or research team's staff. The students were given adequate time to answer the questionnaire, which took on average 20–30 min to complete. Due to school suspension amid the COVID-19 pandemic, a fifth of the participants completed the questionnaires in a secured online interface. The two (paper-and-pencil and web-based) questionnaire versions were identical in terms of the question items, wordings, and order of presentation in the survey. There was no substantial difference in the response rate of the students between the two formats. We checked the time the students completed the web-based survey and no students were identified to rush through the survey (completion time $<$3 min) or take an unusually long time to complete it (completion time $>$5 h). The quality of the collected data was scrutinized by checking for inconsistent and duplicate responses, and outliers to ensure their comparability across formats.

2.2. Measurements

The anonymous self-report questionnaire included demographic information, online sexual experiences, school and family characteristics,

impacts of COVID-19, psychosocial factors, and risk behaviors and the questionnaire items are shown in the supplementary file. It was designed by the YSS 2021 Task Force with reference to questionnaires in recent similar surveys (Fong, Cheung, et al., 2024; Wong et al., 2020). Demographic characteristics included sex, age, marital status of their parents, and whether they were born in Hong Kong.

2.2.1. Online sexual experiences

The previous YSS 2016 included five questions on sex-related actions online: discussed sex through the Internet, dated people acquainted through the Internet, viewed pornography online, received pornographic messages online, and sent pornographic messages online. In the present YSS 2021, five new questions were added based on updated literature on online sexual behaviors and social media use (Del Rey et al., 2019; Peter & Valkenburg, 2016): online access to contents related to sex knowledge, exposed to pornographic contents in video games, uploaded/shared indecent photos on social media, had naked chat online, and had sexual relationship with people acquainted with online. The original item on use of pornography online was split into two items: exposed to pornographic contents online and actively looked for pornographic contents online.

The 11 items covered three subtypes of online sexual activities as suggested by Shaughnessy, Fudge, and Byers (2017): non-arousal (accessing sex knowledge), solitary-arousal (viewing pornography, exposed to pornographic contents in video games, and uploading indecent photos), and partnered-arousal (sending and receiving pornographic messages, naked chat, and sexual relationship with people acquainted with online). As shown in Table 1, online sexual experiences of the respondents were assessed by the 11 questions (answer options yes/no) on sex-related actions online or through social media. The 11 items showed good reliability (Cronbach α = 0.84) in the present sample.

2.2.2. School and family characteristics

Respondents' well-being at school was measured by three questions on satisfaction with school life, relationship with classmates, and academic performance on a 5-point Likert format from 1 = "very dissatisfied/very bad" to 5 = "very satisfied/very happy". Perceived family relationship was assessed by four questions on relationship between father and mother, satisfaction with family life, relationship with father, and relationship with mother on a 5-point Likert format from 1 = "very poor" to 5 = "very good" (Wong et al., 2020). Well-being at school and perceived family relationships showed marginal (α = 0.65) and good (α = 0.86) reliability in the present sample. The participants were also asked the number of days they had family meals (breakfast and dinner) per week, which was regarded as a proxy for the amount of family time and family interaction (Utter et al., 2013). For the school and family characteristics, higher scores indicated better functioning at school and in family.

2.2.3. Impacts of COVID-19

The present study measured the perceived impact of the COVID-19 pandemic of the adolescents on the following three domains (Tse et al., 2023): 1) family relationship, 2) online learning on their studies, and 3) time spent on digital devices. The first two questions were rated on a 5-point Likert format from 1 = "much better"; 2 = "better"; 3 = "unchanged"; 4 = "poorer"; and 5 = "much poorer". The third question was rated on a 5-point Likert format from 1 = "much less"; 2 = "less"; 3 = "unchanged"; 4 = "more"; and 5 = "much more". For these three items, higher scores indicated greater negative impacts due to COVID-19.

2.2.4. Psychological distress

The 4-item Patient Health Questionnaire (PHQ4) (Kroenke, Spitzer, Williams, & Lowe, 2009) was used to assess psychological distress. The PHQ4 combines the two items from the PHQ2 with two other items on anxiety disorder as a measure of anxiety and depressive symptoms over the past two weeks. Example items include "feeling down, depressed or hopeless" and "feeling nervous, anxious or on edge". The items were rated on a 4-point Likert scale from 0 = "not at all" to 3 = "nearly every day" and the composite score ranges from 0 to 12. The PHQ4 has been validated in Hong Kong young adults under the COVID-19 pandemic (Fong, Ho, & Yip, 2023) and showed excellent reliability (α = 0.91) in the present sample.

2.2.5. Risk behaviors

The participants were asked whether they experienced sexual harassment by others, sexually transmitted infections (STI), and had attempted suicide in the past year (Fong, Cheung, et al., 2024). Substance use on whether they tried psychotropic substances, namely, ketamine, ecstasy, ice, halcion, cannabis, organic solvents, cough medicine, cocaine, and heroin were asked, and rated as no or yes (use of any of the above).

2.3. Data analysis

Sex differences in the probabilities of online sexual experiences and demographic characteristics, psychosocial factors, and risk behaviors of the sample were examined by chi-square test and independent *t*-test using SPSS 26. The effect sizes were indicated by Cohen *d* (Cohen, 1988) with cut-off scores of 0.2, 0.5, and 0.8 denoting small, moderate, and large sizes, respectively. Latent class analysis (LCA) was used to analyze the 11 binary items on online sexual experiences using robust maximum likelihood estimator in Mplus 8.7 (Muthén & Muthén, 2017). LCA was selected for its ability to identify distinct profiles within the sample, allowing for a nuanced understanding of the heterogeneity in online sexual experiences. This method could uncover hidden patterns that are not apparent through traditional statistical approaches and could account for misclassification errors in the analysis. There were minimal amount of missing data (<1.4%) for the study variables in the present sample, which were handled by full information maximum likelihood under the missing-at-random assumption (Collins, Schafer, & Kam, 2001).

Given the likely sex differences in online sexual experiences, LCA was conducted separately in males and females. Model fit was evaluated using the Bayesian information criterion (BIC) (Raftery, 1995) with a lower value denoting a better fit. The Lo-Mendell-Rubin (LMR) likelihood ratio test (Nylund, Asparoutiov, & Muthen, 2007) compared the

Table 1
Prevalence of online sexual experiences in male and female participants.

Online sexual experiences (yes %):	Male	Female	χ^2	*p*
1. Accessed contents related to sex knowledge online	61.0%	59.5%	2.01	0.16
2. Exposed to pornographic contents online	63.3%	57.9%	23.9	<0.01*
3. Discussed sex with others through social media	46.7%	41.2%	24.2	<0.01*
4. Actively looked for pornographic contents online	39.4%	22.0%	275.0	<0.01*
5. Exposed to pornographic contents in video games	38.0%	22.4%	223.1	<0.01*
6. Dated people acquainted with through social media	22.0%	18.3%	16.4	<0.01*
7. Received pornographic messages through social media	23.6%	17.5%	44.6	<0.01*
8. Uploaded/shared indecent photos on social media	16.8%	8.4%	123.6	<0.01*
9. Sent pornographic messages through social media	10.9%	5.1%	24.2	<0.01*
10. Had naked chat online	6.4%	2.7%	57.4	<0.01*
11. Sexual relationship with people acquainted with online	9.2%	3.8%	91.4	<0.01*

*p < 0.01; N = 4362/3539 in males/females.

model fit of the k-class LCA model to the alternative k-1 class LCA model with a small p-value <0.01 favoring the more complex model. Model classification quality was depicted by the entropy and average latent class probabilities with high values (>0.85) signaling adequate classification. The optimal LCA model was determined via the BIC plot, LMR likelihood ratio test, entropy, average latent class probabilities, and substantive interpretability. Heterogeneity of the LCA model was described by the latent class prevalence and associated conditional item probabilities, with probabilities greater than 0.40 regarded as substantial (Sinha, Calfee, & Delucchi, 2021).

Substantive checking of the latent classes was performed in three steps. First, demographic characteristics, school characteristics, family characteristics, and impact of COVID-19 were used as latent class predictors in the multinomial logistic regression using the R3STEP function (Asparouhov & Muthén, 2014). Second, psychological distress and proportions of sexual harassment, STI, substance use, and suicide attempt were evaluated as distal outcomes of the latent classes under the Bolck, Croon, and Hagenaars (BCH) approach (Bakk, Tekle, & Vermunt, 2013), with post-hoc comparisons conducted between the latent classes in a pairwise manner. The overall class differences were quantified by the eta-square (η^2) with cut-off scores of 0.01, 0.06, and 0.14 denoting small, moderate, and large sizes, respectively. Third, follow-up continuous and logistic regression analyses were conducted to examine the effects of latent class memberships on psychological distress and risk behaviors controlling for demographic, school, and family characteristics, and impact of COVID-19. Effects were evaluated via standardized regression coefficients for continuous variables and odds ratios (OR) for categorical variables. For OR, cutoff values of 1.68, 3.47, and 6.71 correspond to small, moderate, and large effect sizes, respectively (Chen, Cohen, & Chen, 2010). Given the large sample size, the present study set statistical significance at the 0.01 level and reported the 99% CI for the OR.

3. Results

3.1. Comparison of participant profiles by sex

The present sample comprised 7901 adolescents (4362 males and 3539 females) aged 12–17 years. The average age was 14.6 years (SD = 1.48), 81% were born in Hong Kong, and 15.2% of their parents were divorced or separated. Table 1 shows about half of the participants (44.2%–60.9%) had accessed contents related to sex knowledge online, exposure to pornographic contents online, or discussed sex with others through social media. Nearly one-third (31.0%–31.6%) had actively looked for pornographic contents online or been exposed to pornographic contents in video games. One-fifth (20.3%–20.9%) had dated people acquainted with or received pornographic messages through social media. Less than one-tenth (4.7%–8.3%) had sent pornographic messages, had naked chat online, or had sexual relationship with people acquainted with online. Males consistently showed significantly higher prevalence ($p < 0.01$) of all online sexual experiences except for access to contents related to sex knowledge. The 11 items on online sexual experiences showed acceptable item-total correlations ranging from 0.38 to 0.64 and the mean inter-item correlation was 0.33 (range = 0.13 to 0.81).

Table 2 shows no significant sex differences ($p > 0.01$) in terms of age, born in Hong Kong, divorced/separated parents, STI, and perceived family relationship. There were significant and small differences (d = 0.06–0.13, $p < 0.01$) in well-being at school, days of family meals per week, COVID-19 impact on family relationship, and COVID-19 impact on time spent on digital devices. Significantly more females had suicide attempts and had been sexually harassed while significantly more males had substance use ($p < 0.01$). Females showed significantly higher psychological distress and had experienced greater impact of COVID-19 on their studies due to online learning (d = 0.22–0.34, $p < 0.01$) than males. There were no significant differences in these characteristics between the adolescents who completed the questionnaire in school and those who completed the questionnaire online.

Table 2
Demographic characteristics, school, family and psychological factors, COVID-19 impacts, and risk behaviors of the participants by sex.

Categorical items		Male	Female	χ^2	p
		%	%		
Born in Hong Kong		81.9%	79.8%	5.35	0.02
Separated/divorced parents		14.3%	16.2%	5.09	0.02
Experience of sexual harassment by others		4.3%	15.9%	306.1	<0.01*
Sexually transmitted infections		1.3%	0.7%	6.43	0.011
Substance use		2.3%	1.0%	20.2	<0.01*
Suicide attempt		4.4%	9.0%	66.0	<0.01*
Continuous items	**Range**	**Mean (SD)**	**Mean (SD)**	**d**	**p**
Age, years	12–17	14.6 (1.48)	14.5 (1.48)	0.04	0.11
Well-being at school	1–5	3.46 (0.64)	3.42 (0.59)	0.06	<0.01*
Perceived family relationship	1–5	3.92 (0.78)	3.90 (0.80)	0.03	0.21
Days having family meals per week	1–7	4.81 (1.98)	4.55 (2.03)	0.13	<0.01*
COVID-19 impact on:					
family relationship	1–5	2.84 (0.88)	2.91 (0.86)	0.08	<0.01*
studies	1–5	3.63 (1.07)	3.86 (0.98)	0.22	<0.01*
time spent on digital devices	1–5	4.18 (0.90)	4.23 (0.84)	0.06	<0.01*
Psychological distress (PHQ-4)	0–12	2.79 (3.14)	3.89 (3.35)	0.34	<0.01*

*p < 0.01; PHQ = Patient Health Questionnaire; N = 4362/3539 in males/females; Higher scores indicate better functioning for the school and family characteristics, and greater negative interferences for the COVID-19 impact variables.

3.2. Latent class models

Table 3 shows decreasing trends in BIC from 1-class to 5-class LCA models in both males and females and all the LMR-LRT tests were significant ($p < 0.01$). In large datasets with many indicators, additional

Table 3
Fit indices and classification quality of latent class models on online sexual experiences by sex.

Model	#	BIC	LMR-LRT	Entropy	Average latent class probabilities
Males (N = 4362)					
1-class	11	50235	/	/	/
2-class	23	39448	<0.01	0.885	0.971–0.971
3-class	35	36503	<0.01	0.904	0.943–0.979
4-class	47	35656	<0.01	0.870	0.881–0.977
5-class	59	35265	<0.01	0.838	0.820–0.974
Females (N = 3539)					
1-class	11	34012	/	/	/
2-class	23	28080	<0.01	0.877	0.960–0.981
3-class	35	26507	<0.01	0.884	0.878–0.971
4-class	47	26184	<0.01	0.875	0.894–0.980
5-class	59	26097	<0.01	0.824	0.778–0.967

= number of free parameters; BIC = Bayesian information criterion; LMR-LRT = Lo-Mendell-Rubin Likelihood Ratio Test. Lower values of BIC and LMR-LRT ($p < 0.01$) indicate better model fit and higher values of entropy and average latent class probabilities indicate better model classification.

classes can often lead to a consistent decrease in the BIC, favoring the more complex model (Sinha et al., 2021). Fig. 1 shows the elbow plot of BIC of the 1-class to 5-class LCA models by sex. The plot suggested a point of inflection at three classes, where further increases in model complexity (i.e. more classes) yielded diminished decreases in BIC. The 3-class LCA model showed the highest entropy out of the five LCA models in both males and females. In males, the 3-class LCA model showed higher average latent class probabilities than both the 4-class and 5-class LCA models. Both the 4-class and 5-class LCA models consisted of a tiny class with prevalence of only 2.1%. The 3-class LCA model was chosen as the optimal model in both males and females.

Table 4 shows that 37.3% of males and 41.8% of females were classified as the abstinent class. Adolescents in this class had minimal or very low conditional item probabilities (< 10.0%) of engaging in any of the online sexual experiences. The second latent class referred to the normative class with the largest prevalence (48.4% in males and 47.4% in females) in the sample. Most adolescents (92.4%–96.9%) in this class had access to contents related to sex knowledge online or were exposed to pornographic contents online, and more than half of them (56.6%–60.6%) had discussed sex with others through social media. About half of the males (47.1%–51.3%) in this class had actively looked for pornographic contents online and were exposed to pornographic contents in video games. Females in the normative class showed lower but non-negligible conditional item probabilities (18.6%–25.7%) in terms of actively looking for pornographic contents online, being exposed to pornographic contents in video games, dating people acquainted with through social media, and receiving pornographic messages through social media. In contrast, this class had low conditional item probabilities (0.3%–9.8%) in experiences including uploading/sharing indecent photos on social media, sending pornographic messages through social media, having naked chat online and sexual relationship with people acquainted with online.

Class 3 was the smallest class (14.3% in males, 10.8% in females) in both sexes and was labeled as the active class. Adolescents in this class had high conditional item probabilities (53.9%–99.4%) of engaging in online sexual experiences including accessing contents related to sex knowledge online, passive/active exposure to pornographic contents online, online discussion about sex, exposure to pornographic contents in video games, dating people online, receiving pornographic messages through social media, and uploading/sharing indecent photos on social media. They also had higher conditional item probabilities (22.7%–52.3%) of the remaining online sexual experiences including sending pornographic messages through social media, having naked chat online, and having sexual relationship with people acquainted with online.

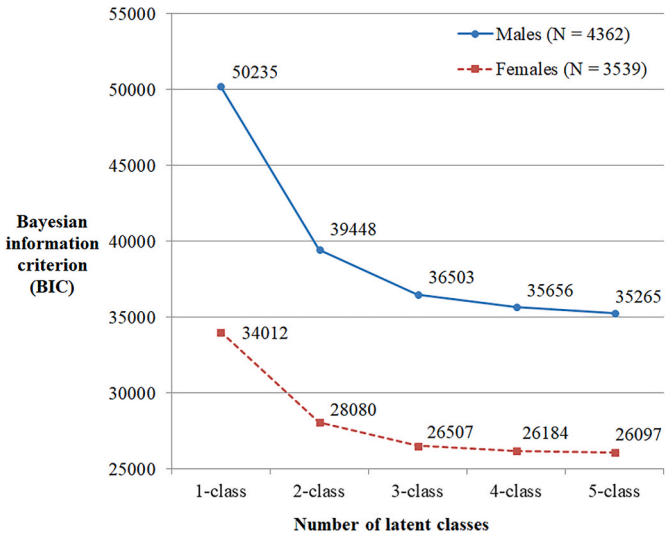

Fig. 1. Elbow plot of Bayesian information criteria (BIC) for the 1-class to 5-class latent class analysis models by sex.

3.3. Multinomial logistic regression of the three latent classes

Table 5 shows that divorced/separated parents, well-being at school, and COVID-19 impact on family relationship were not significantly ($p > 0.05$) associated with latent class membership. Poorer family relationship was significantly and positively associated with the active class compared to the abstinent class, and greater perceived COVID-19 impact of online learning on studies was significantly and positively associated with the normative class compared to the abstinent class. Older age, more time spent on digital devices due to COVID-19, and fewer days of family meals per week were significantly and positively associated with the normative and active classes compared to the abstinent class. Comparison between the normative and active classes did not show any significant differences ($p > 0.05$) in the female adolescents. In male adolescents, age and perceived impact of online learning on studies showed significant and positive associations with membership in the active class compared to the normative class.

3.4. Psychological distress and risk behaviors of the three latent classes

Table 6 shows that adolescents in the active and normative classes were significantly older and had worse family relationship and fewer days of family meals than abstainers according to the BCH approach. There were significant and small to moderate overall differences ($\eta^2 = 0.004–0.119$, $p < 0.01$) in most of the study variables across the three classes except for STI in females. Controlling for the model covariates, the normative class showed significantly higher levels of psychological distress ($\beta = 0.11–0.14$, $p < 0.01$) and prevalence of sexual harassment by others (OR = 2.24–2.28, $p < 0.01$) than the abstinent class in both males and females. These two classes showed no significant differences in the prevalence of STI ($p = 0.03–0.13$), substance use ($p = 0.02–0.78$), and suicide attempt (OR $p = 0.02–0.12$).

The active class showed significantly higher psychological distress than the abstinent class ($\beta = 0.18–0.19$, $p < 0.01$) and normative class ($\beta = 0.08–0.09$, $p < 0.01$) in both males and females. Compared to the abstinent class, the active class were significantly associated with higher odds of sexual harassment by others (OR = 4.09–6.51, $p < 0.01$), substance use (OR = 5.29–13.6, $p < 0.01$), and suicide attempt (OR = 2.26–2.44, $p < 0.01$) in both males and females. Compared to the normative class, the active class were significantly associated with higher odds of sexual harassment by others (OR = 1.89–3.70, $p < 0.01$), substance use (OR = 4.30–4.32, $p < 0.01$), and suicide attempt (OR = 1.70–1.97, $p < 0.01$) in both males and females. Males in the active class were significantly associated with higher odds of STI compared to those in the abstinent class (OR = 3.02, 99% CI = 1.15–7.97) and the normative class (OR = 8.39, 99% CI = 3.26–21.6).

4. Discussion

The present study provided the first results on the latent patterns of online sexual experiences in a large community sample of 7901 high school students in Hong Kong. A study strength was the use of LCA to handle sample heterogeneity and empirically compare different latent class models and classify the adolescents into the latent classes while taking into account the potential misclassification errors (Lanza & Cooper, 2016). Despite the appropriateness of this technique in modeling the sample heterogeneity of sexual behaviors (Lefkowitz & Vasilenko, 2014), it remains under-utilized in the cyber-sexual context. Our results not only elucidated the latent heterogeneity of online sexual experiences in terms of the abstinent, normative, and active classes, but also contributed to a better understanding of the associations between the latent class memberships and demographic, family and psychological factors and risk behaviors. The consistent patterns of associations between the latent classes and the external variables by sex support the

Table 4
Latent class prevalence of 3-class model and conditional item probabilities of online sexual experiences by class and by sex.

Online sexual experiences (yes %):	Males (N = 4362)			Females (N = 3539)		
	Class 1: Abstinent (37.3%)	Class 2: Normative (48.4%)	Class 3: Active (14.3%)	Class 1: Abstinent (41.8%)	Class 2: Normative (47.4%)	Class 3: Active (10.8%)
1. Accessed contents related to sex knowledge online	5.8%	**92.4%**	**99.4%**	9.2%	**95.2%**	**97.2%**
2. Exposed to pornographic contents online	6.1%	**96.9%**	**99.2%**	6.0%	**94.6%**	**98.4%**
3. Discussed sex with others through social media	8.9%	**60.6%**	**98.7%**	9.8%	**56.6%**	**95.2%**
4. Actively looked for pornographic contents online	1.6%	**51.3%**	**97.7%**	1.2%	24.4%	**92.0%**
5. Exposed to pornographic contents in video games	4.0%	**47.2%**	**95.7%**	2.6%	25.7%	**84.5%**
6. Dated people acquainted with through social media	3.2%	21.5%	**73.0%**	5.9%	20.3%	**57.8%**
7. Received pornographic messages through social media	8.2%	24.2%	**61.9%**	6.8%	18.6%	**53.9%**
8. Uploaded/shared indecent photos on social media	0.1%	9.8%	**84.5%**	0.4%	2.8%	**63.7%**
9. Sent pornographic messages through social media	1.3%	8.4%	**44.5%**	0.6%	3.0%	32.3%
10. Had naked chat online	0.1%	0.9%	**41.1%**	0.3%	0.3%	22.7%
11. Sexual relationship with people acquainted with online	0.3%	3.4%	**52.3%**	0.0%	1.6%	27.8%

Substantial conditional item probabilities greater than 0.40 are bolded for each latent class.

Table 5
Multinomial logistic regressions for associations of latent class memberships of online sexual experiences with demographic, family and psychological factors by sex.

Reference class = Abstinent class		Normative class	Active class
Sex	Factors	*OR (99% CI)*	*OR (99% CI)*
Male	Age	1.61* (1.49–1.74)	1.90* (1.71–2.12)
	Divorced/separated parents	1.01 (0.74–1.38)	1.25 (0.83–1.88)
	Well-being at school	1.08 (0.90–1.30)	1.01 (0.77–1.34)
	Family relationship	0.92 (0.78–1.08)	0.79* (0.63–0.99)
	Days of family meals per week	0.91* (0.86–0.96)	0.88* (0.81–0.95)
	COVID-19 impact on:		
	family relationship	0.95 (0.83–1.09)	1.09 (0.89–1.33)
	studies	1.15* (1.04–1.28)	0.97 (0.83–1.14)
	time spent on digital devices	1.58* (1.40–1.78)	1.24* (1.05–1.47)
Female	Age	1.32* (1.22–1.42)	1.39* (1.23–1.57)
	Divorced/separated parents	0.91 (0.67–1.25)	1.05 (0.67–1.65)
	Well-being at school	0.91 (0.74–1.11)	0.91 (0.63–1.31)
	Family relationship	0.88 (0.75–1.04)	0.77† (0.58–1.02)
	Days of family meals per week	0.93* (0.88–0.99)	0.86* (0.79–0.95)
	COVID-19 impact on:		
	family relationship	0.96 (0.83–1.10)	1.05 (0.83–1.35)
	studies	1.23* (1.10–1.39)	1.14 (0.92–1.41)
	time spent on digital devices	1.38* (1.20–1.58)	1.35* (1.02–1.79)

† $p < 0.05$; *$p < 0.01$; OR = odds ratios; CI = confidence interval; All variables except for divorced/separated parents are continuous variables, with ranges are shown in Table 2.

robustness of the 3-class model.

In the 3-class LCA model, adolescents in the abstinent class showed minimal online sexual experiences and this class resembled the non-users of online sexual materials. The normative class showed active search for, passive exposure, and discussion of sex knowledge and pornographic contents online but low probabilities for uploading/sharing indecent photos on social media, sending pornographic messages through social media, having naked chat online and sexual relationship with people acquainted with online. This class resembles the recreational users as suggested by Cooper et al. (1999) who are curious and inquisitive in exploring sexuality. Adolescents in this class showed higher psychological distress but not elevated risks of STI, substance use, and suicide attempt. A recent study (Mori et al., 2021) conducted LCA based on seven indicators of sexting and sexual behaviors and found four latent classes in 894 American youths. Both sexting and risky sexual behaviors combined were associated with greater depressive symptoms.

The active class showed the lowest prevalence in the sample. However, adolescents in this class consistently showed substantial probabilities of engaging in most online sexual experiences such as accessing contents related to sex knowledge online, passive/active exposure to pornographic contents online, online discussion about sex, exposure to pornographic contents in video games, dating people online, receiving and sending pornographic messages through social media, and uploading/sharing indecent photos on social media. Adolescents in this class showed elevated likelihoods to engage in naked chat online and have sexual relationship with people acquainted with online. Adolescents in this class resembled the at-risk users as suggested by Cooper et al. (1999) who are prone to greater risks of sexual health problems as in previous studies (Efrati & Amichai-Hamburger, 2021; Lim et al., 2017; Y. D. Zhang et al., 2022). In our study, the active class demonstrated elevated levels of psychological distress as well as more frequent risk behaviors.

In line with previous research findings (Liu & Zheng, 2020; Petersen & Hyde, 2010), the present study found increased vulnerability of male adolescents to online sexual addiction, as evidenced by the higher prevalence of the active class in males (14.3%) than in females (10.8%). On the one hand, males in the active class showed comparatively higher prevalence of STI and substance use than females in the active class. A narrative review pointed out linkages between substance use and STI and their potential associations with high-risk sexual behaviors (Strathdee, Bristow, Gaines, & Shoptaw, 2021). On the other hand, females across all three latent classes reported higher levels of psychological distress and were at greater risks of suicide attempts than their male counterparts. Our results align with the work by Twenge, Haidt, Joiner, and Campbell (2020), who found greater harms of digital media use on mental health in females than males. Besides, females are more prone to sexual vulnerabilities such as sexual harassment and sexual

Table 6
Demographic, school, family, and psychological factors, COVID-19 impacts and risk behaviors of the three latent classes of online sexual experiences by sex.

Variables	Abstinent class	Normative	Active class	3-class differences	
Males (N = 4362)	*Mean/% (SE)*	*Mean/% (SE)*	*Mean/% (SE)*	χ^2	η^2
Age, years	13.9 (0.04)^a	14.9 (0.03)^b	15.3 (0.06)^c	589.7*	0.119
Family relationship	4.00 (0.02)^c	3.92 (0.02)^b	3.73 (0.04)^a	48.5*	0.012
Days having family meals	5.19 (0.05)^c	4.64 (0.05)^b	4.41 (0.09)^a	98.1*	0.024
Psychological distress	2.02 (0.08)^a	3.04 (0.07)^b	3.94 (0.16)^c	171.3*	0.042
Sexual harassment by others	1.6% (0.3)^a	3.5% (0.4)^b	13.9% (1.5)^c	74.4*	0.022
Sexually transmitted disease	0.3% (0.2)^a	1.3% (0.3)^a	4.6% (0.9)^b	25.5*	0.013
Substance use	1.4% (0.3)^a	1.3% (0.3)^a	7.8% (1.2)^b	28.0*	0.018
Suicide attempt	3.1% (0.4)^a	4.2% (0.5)^a	8.7% (1.2)^b	19.5*	0.007
Females (N = 3539)	*Mean/% (SE)*	*Mean/% (SE)*	*Mean/% (SE)*	χ^2	η^2
Age, years	14.1 (0.04)^a	14.8 (0.04)^b	15.0 (0.08)^b	180.1*	0.047
Family relationship	4.01 (0.02)^c	3.85 (0.02)^b	3.69 (0.05)^a	52.0*	0.015
Days having family meals	4.90 (0.05)^c	4.37 (0.05)^b	3.98 (0.12)^a	79.1*	0.022
Psychological distress	3.01 (0.09)^a	4.36 (0.09)^b	5.27 (0.21)^c	184.3*	0.050
Sexual harassment by others	7.6% (0.7)^a	19.1% (1.0)^b	34.2% (2.7)^c	159.5*	0.004
Sexually transmitted disease	0.9% (0.3)^a	0.4% (0.2)^a	1.4% (0.7)^a	4.12	0.001
Substance use	0.3% (0.2)^a	0.8% (0.2)^a	4.1% (1.1)^b	14.7*	0.010
Suicide attempt	6.7% (0.7)^a	8.9% (0.8)^a	18.0% (2.2)^b	26.4*	0.011

*$p < 0.01$; η^2 = eta-square; SE = standard error; ^{abc} significant post-hoc differences among the 3 latent classes are denoted by their superscripts (a < b < c); Equality tests of means and proportions across classes were done by Bolck, Croon, and Hagenaars (BCH) procedure.

violence (Wang, Yogeeswaran, Andrews, Hawi, & Sibley, 2019). The observed sex differences in psychological distress and risk behaviors suggest different risk profiles and manifestations for the adolescents across sex. Further longitudinal studies should conduct in-depth investigations of the potential psychosocial and behavioral mechanisms that contribute to these sex disparities in mental distress. This would have practical significance in facilitating researchers and clinicians to design targeted interventions for male and female adolescents with distinctive needs.

The present study assessed online sexual experiences of the adolescents via 11 items with reference to the literature (Mori et al., 2021; O'Sullivan, 2014; Shaughnessy et al., 2011). The moderate item-total correlations and inter-item correlations support adequate discriminant validity and non-redundancy of the items. Apart from the 11 items, other potential items include sexual cyberbullying, online sexual intimacy, and compulsive online sexual behaviors. Further studies could evaluate the potential use of these 11 items and other items as an assessment tool of online sexual experiences (Lejars, Belanger, & Razmak, 2020) and the associated psychometric properties such as factor structure and measurement invariance by sex.

4.1. Practical implications

Adolescents in the active class were at a more advanced pubertal stage and had longer screen time in digital devices. A meta-analysis (Eckert-Lind et al., 2020) found a declining age of pubertal onset over the last three decades. The social isolation induced by the COVID-19 pandemic has led to increased screen time in the social media (Pandya & Lodha, 2021). Our findings are consistent with the linkage between early social media use and problematic digital behaviors (Charmaraman, Lynch, Richer, & Grossman, 2022). Digital screen time has been positively associated with depressive symptoms and suicidality in adolescents (Twenge et al., 2020). Given their heightened emotional sensitivity and vulnerabilities to social media influences (Crone & Konijn, 2018), this suggests the need to mitigate the effects of excessive digital media use and access to online pornographic materials among adolescents. Future research could explore the mediating role of the active class between digital screen time and mental distress.

In the family setting, the active class showed worse family relationships and less family meal time as an indicator of less family interaction. Previous local studies (Wong et al., 2020; H. P. Zhang, Zhang, Wong, Fan, & Yip, 2019) found that students with poor communication about sex with one's mother and lower family life satisfaction were more likely to engage in risky sexual behaviors. Frequent family meals have been associated with fewer depressive symptoms and risk behaviors in adolescents (Harrison et al., 2015). Promoting regular family meals may foster family connectedness and facilitate open communication about sex, thereby reducing adolescents' reliance on social media and exposure to sexually explicit content online. Parental interventions, such as restriction and active mediation, have been associated with reduced youth sexting (Corcoran, Doty, Wisniewski, & Gabrielli, 2022). Further studies should explore the effectiveness of family-based interventions to enhance parenting practices and improve interactions within the adolescent-parent dyads.

In school settings, comprehensive sex education programs should address contemporary sexuality issues, including internet pornography, sexting, cybersex, and risks of unsafe social media use (Andres et al., 2021). Teachers should engage the students in discussions about the phenomenon and potential risks of online sexual behaviors, and information workshops could equip students with more knowledge and awareness of sexual health, which enable them to make informed decisions about their sexual behaviors. These programs could be delivered in schools and also through online social media platforms to reach a wider audience (Jennings, Chen, Way, Borgogna, & Kraus, 2023; Leung & Lin, 2019). It is of practical importance to examine and compare the effectiveness of sex education programs on adolescents' self-efficacy in online sexual behaviors and their ability to mitigate sexual risks in the school settings and via online platforms. Furthermore, a systematic review (Biddle, Ciaccioni, Thomas, & Vergeer, 2019) highlighted the positive effects for physical activity interventions in schools on the physical, mental, and cognitive functioning of students. Promoting physical activity in schools could help them develop a more active lifestyle. The increased levels of physical activity could potentially address the adverse consequences of sedentary behaviors and reduce their digital screen time, thereby leading to lower risks of risky sexual behaviors online.

4.2. Limitations

There were several limitations in the present study. First, there could be under-reporting of the online sexual experiences among the adolescents. The cross-sectional study design did not permit us to examine the predictive validity of the latent classes, and the causal direction of the relationships remains to be verified. Longitudinal studies are needed to track the adolescents' developmental changes in online sexual experiences and distinguish between problematic and non-problematic uses in the longer term. Second, we did not ask the adolescents their motives for

engaging in online sexual activities. Future studies are needed to elucidate the underlying motives such as sensation seeking, mood regulation, stress and boredom regulation of adolescents in the normative and active classes (Karasavva, Brunet, Smodis, Swanek, & Forth, 2023). Third, as the study was conducted amid the COVID-19 pandemic and there had been periods of school closures as quarantine measures, we experienced more difficulties than the previous YSS waves in recruiting schools for the survey. The low response rate (30.1%) among the schools might imply sampling response bias and limit sample representativeness. Cautions are warranted in generalizing the present findings to the adolescent population in Hong Kong and elsewhere. Future studies could examine the latent heterogeneity of online sexual experiences in other age cohorts (Ballester-Arnal, Castro-Calvo, Garcia-Barba, Ruiz-Palomino, & Gil-Llario, 2021).

Fourth, a systematic review on 31 studies found that approximately one in five and one in nine youth experienced unwanted online sexual exposure and solicitation, respectively, to sexually explicit materials (Madigan et al., 2018). We did not focus on the voluntary or unwanted nature of the online sexual experiences (Gorissen, van den Berg, Ruiter, & Bijleveld, 2023). Further research should elucidate the potential effects of adolescents being lured or coerced into such experiences as a form of victimization. Fifth, a systematic review (Hermand et al., 2020) has linked problematic use of online sexual activities with internet addiction and online gaming symptoms. However, we did not measure the internet usage and gaming behaviors of the respondents. Further studies should elucidate the comorbidities between problematic patterns of online sexual experiences and internet gaming disorder symptoms and social withdrawal (Fong, Junus, Wen, & Yip, 2024). Finally, the measure on well-being at school only showed marginal value of Cronbach α in the present study. The lower levels of reliability could explain the lack of significant relationships with the latent class membership and validated measures are recommended in future studies.

5. Conclusions

The present findings contribute to a more nuanced understanding of the latent heterogeneity of online sexual experiences in a large sample of Hong Kong adolescents in 2021. The three latent classes showed significant associations with various family and psychological factors and risk behaviors. Our findings can be useful for formulating and testing targeted measures to mitigate the adverse effects on adolescents. Comprehensive sex education programs should include contemporary online sexuality issues and be delivered both in schools and on social media platforms to mitigate the effects of excessive digital sexual media use, with vigorous evaluation.

CRediT authorship contribution statement

Ted C.T. Fong: Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Edmond P.H. Choi:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Daniel Y.T. Fong:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Man Chun Kung:** Writing – review & editing, Project administration, Investigation. **Mona W.C. Lam:** Writing – review & editing, Supervision, Project administration, Investigation, Funding acquisition, Conceptualization. **Antoinette M. Lee:** Writing – review & editing, Methodology, Investigation, Conceptualization. **William C.W. Wong:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Tai Hing Lam:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Paul S.F. Yip:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Ethics approval

Ethical approval was obtained from the Human Research Ethics Committee of the University of Hong Kong (HREC Number = EA200333). The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant institutional committees on human experimentation and with the Declaration of Helsinki in 1975, as revised in 2008.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chbr.2024.100574.

Data availability

Data will be made available on request.

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