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SPECIAL SECTION ON COVID-19: QUANTITATIVE RESEARCH

Pathways of association between disordered eating in adolescence and mental health outcomes in young adulthood during the COVID-19 pandemic

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Abstract

Objectives The COVID-19 pandemic has been associated with increased mental health problems. We investigated (1) associations between disordered eating in adolescence and mental health problems after one year of the pandemic and (2) the mechanisms explaining associations.

Method We analyzed data from a population-based birth cohort in Quebec, Canada (557 males and 759 females). High and low levels of disordered eating symptom trajectories were previously estimated (age 12, 15, 17, and 20 years). Anxiety, depression, non-suicidal self-injury, and suicidal ideation were assessed at 23 years (March–June 2021). Putative mediators included loneliness and social media use (age 22 years, July–August 2020). Analyses controlled for mental health and socio-economic status at age 10–12 years and were conducted for males and females separately.

Results Females in the high-level disordered eating symptom trajectory were at increased risk for non-suicidal self-injury (OR 1.60; 95% CI 1.02–2.52) and suicidal ideation (2.16; 1.31–3.57), whereas males were at increased risk for severe anxiety (2.49; CI 1.11–5.58). Males and females in the high-level trajectory were more likely to report severe depression (2.26; 1.14–5.92 and 2.15, 1.36–3.38 respectively). Among females, associations were partially explained (17–35%) by loneliness during the first 4 months of the pandemic.

Conclusion Young adults who experienced disordered eating as adolescents were at increased risk of mental health problems during the pandemic. Loneliness partially mediated the effect, suggesting that pandemic mitigation resulting in increased social isolation may have exacerbated mental health problems among women with a history of disordered eating.

Résumé

Objectifs La pandémie de COVID-19 a été associée à une augmentation des problèmes de santé mentale. Nous avons investigué 1) les associations entre les problèmes de comportement alimentaire à l'adolescence et les problèmes de santé mentale après un an de pandémie et 2) les mécanismes expliquant les associations.

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Méthode Nous avons analysé les données d'une cohorte de naissance basée sur la population au Québec, Canada (557 hommes et 759 femmes). Nous avons utilisé des trajectoires précédemment estimées indicatives d'un haut et bas niveau de problèmes alimentaires (à l'âge de 12, 15, 17 et 20 ans). L'anxiété, la dépression, l'automutilation et les idées suicidaires ont été évaluées à 23 ans (mars à juin 2021). Les médiateurs putatifs incluaient la solitude et l'utilisation des réseaux sociaux (à l'âge de 22 ans, juillet à août 2020). Les analyses contrôlaient la santé mentale et le statut socio-économique à l'âge de 10 à 12 ans et ont été menées séparément pour les hommes et les femmes.

Résultats Les femmes dans la trajectoire des problèmes alimentaires élevés présentaient un risque accru d'automutilation non-suicidaire (OR 1,60; IC à 95 % 1,02-2,52) et d'idées suicidaires (2,16; 1,31-3,57), tandis que les hommes présentaient un risque accru d'anxiété sévère (2,49; IC 1,11-5,58). Les hommes et les femmes de la trajectoire élevée étaient plus susceptibles de déclarer une dépression grave (2,26; 1,14-5,92 et 2,15; 1,36-3,38, respectivement). Chez les femmes, les associations s'expliquaient en partie (17-35 %) par la solitude durant les 4 premiers mois de la pandémie.

Conclusion Les jeunes adultes ayant connu des problèmes de comportement alimentaire à l'adolescence couraient un risque accru de problèmes de santé mentale pendant la pandémie. La solitude a partiellement atténué l'effet, suggérant que l'isolation accrue entrainée par la pandémie peut avoir exacerbé les problèmes de santé mentale chez les femmes ayant des antécédents de problèmes de comportement alimentaire.

Keywords COVID-19 · Longitudinal cohort · Disordered eating · Mental health · Suicide · Loneliness

Mots-clés COVID-19 · cohorte longitudinale · troubles alimentaires · santé mentale · suicide · solitude

Introduction

The COVID-19 pandemic has been associated with millions of deaths, drastic mitigation measures, and major concerns for its impact on mental health (Campion et al., 2020). According to the conclusions of the World Health Organization (WHO) 2022 scientific brief on the plethora of research conducted on the impact of COVID-19 on mental health, symptoms of anxiety and depression increased from before to during the pandemic in the general population (Prati & Mancini, 2021). Pooled effects of mostly cross-sectional studies suggested that suicidal ideation and behaviours among youth increased during the pandemic (Dubé et al., 2021). Moreover, evidence shows that females and young people are at greater risk for mental health problems during the pandemic (Patel et al., 2022). Yet, high-quality longitudinal research investigating mental health outcomes of potentially vulnerable populations is still lacking (WHO, 2022).

The COVID-19 context exacerbated risk factors for disordered eating, such as isolation and dysfunctional disordered eating thoughts (Vitagliano et al., 2021). Although both males and females would be affected, there are substantial differences between sexes in the disordered eating literature that should be noted suggesting that it would be beneficial to study disordered eating and its correlates among males and females separately. Further, males are under-represented in the disordered eating literature and empirical findings related to men specifically are flagrantly needed (Weltzin et al., 2005). It is well known that the prevalence of eating disorders is higher among females than among males with, for example, 56% of 14-year-old girls and 28% of 14-year-old boys reporting at least one disordered eating behaviour (Croll et al., 2002). Body image concerns are as prevalent among males as among females, but the preferred body type often differs (i.e., muscular versus thin). The prevalence of specific eating disorder symptoms also differs, e.g., males are more likely than females to instate rigid excessive exercise routines but are less likely to present purging behaviours such as vomiting or excessive laxative use (Womble et al., 2001). The psychological correlates of eating disorders such as eating expectancies also differ across sex (Hayaki & Free, 2016). Researchers found that associations between disordered eating and COVID-19-related stress and anxiety were stronger among women than among men (Swami et al., 2021). Also, research shows that the mechanisms underlying disordered eating behaviours would differ across sex (Weltzin et al., 2005; Womble et al., 2001). Taken together, empirical studies with gender-specific results would be beneficial.

Cross-sectional research found that disordered eating problems during the COVID-19 pandemic were associated with increased mental health problems, including symptoms of anxiety (Bayram Deger, 2021; Czepczor-Bernat et al., 2021) and depression (Chan & Chiu, 2021; Giel et al., 2021), but the direction of the association is difficult to establish using cross-sectional data. There are a few longitudinal studies on disordered eating prior to the pandemic and mental health outcomes during COVID-19. For instance, researchers in the United Kingdom showed that young adults (N = 2657) with disordered eating problems prior to the pandemic (age 25 years) were at increased risk of anxiety, depression, and lower levels of well-being during the pandemic (age 28 years) independently of pre-pandemic mental health and well-being (age 22–24 years) (Warne et al., 2021). Kwong et al. (2021) found significant

associations between disordered eating traits prior to the pandemic and anxiety and depression during the pandemic among young adults but not among older adults. Weight stigma prior to the pandemic was related to negative outcomes such as increased depression, COVID-19-related stress, and binge eating (Puhl et al., 2020). In comparison to healthy controls, patients with eating disorders prior to the pandemic experienced increased post-traumatic responses, compensatory exercise habits, and binge eating during COVID-19 (Castellini et al., 2020). Yet, the mechanisms behind these associations remain unclear. Understanding these mechanisms could allow for the identification of targets for prevention of mental health problems among adolescents and young adults.

Many studies suggest that mitigation measures during the COVID-19 pandemic (e.g., distancing, lockdowns) increased youths' feelings of loneliness, which were more pronounced among young adults (Killgore et al., 2020) and have been associated with a wide range of physical and mental health problems (Park et al., 2020), including depression and suicidal ideation (Killgore et al., 2020). Those with disordered eating vulnerabilities would tend to be more secretive and alienate themselves from others which would increase their feelings of loneliness (Levine, 2012). Loneliness would then in turn contribute to increases in mental health problems such as depression, anxiety, and suicidal behaviours (Killgore et al., 2020; Park et al., 2020). Further, there is mounting evidence that social media use increased during the lockdown (Drouin et al., 2020). Prior studies have shown that heavy social media use can be associated with adverse mental health outcomes (e.g., anxiety, depression) because it often provokes comparisons, jealousy, and low self-esteem (Drouin et al., 2020; Verduyn et al., 2017). Content frequently includes body-centric messaging (e.g., thin/fit body ideals, sexualizing content, glorification of diets and exercise), which is particularly detrimental for people with disordered eating vulnerabilities (Cooper et al., 2020). Many studies have shown that exposure to these types of messages can provoke body image concerns, negative affect, and disordered eating behaviours among men and women (Agliata & Tantleff-Dunn, 2004; Hawkins et al., 2004; Sabik et al., 2020). Taken together, this evidence supports the hypothesis that increased loneliness and social media use during lockdowns may partially explain increases in mental health challenges during the pandemic among those with prior disordered eating symptoms.

Using a large population-based cohort from the Canadian province of Québec, our first aim was to investigate the association between disordered eating problems from age 12 to 20 years (2010–2018) and mental health problems (namely, anxiety, depression, non-suicidal self-injuries, and suicidal ideation) at age 23 years, one year after the onset of the COVID-19 pandemic (winter and spring 2021). Our second aim was to estimate to what extent perceived loneliness and social media use during the first 4 months of the pandemic mediated these associations. Given the importance of sex-based differences related to disordered eating, associations were investigated in males and females separately.

Methods

Sample

Participants were drawn from the Québec Longitudinal Study of Child Development (QLSCD), which is conducted by the Institut de la Statistique du Québec: a population-based birth cohort of children born in the province of Québec in Canada in 1997 and 1998, and followed up annually or biannually until now (Orri et al., 2021). Of the 2120 participants (N female = 1040; 49.1%) initially included in the cohort, we retained participants with information on disordered eating symptoms with data from at least one time point (12–20 years) and mental health assessment at age 23 years. Analyzed data included 759 females and 557 males. As in other studies conducted with this cohort, participants who were more likely to be excluded from our study sample were males, came from families with lower socio-economic status, and had mothers who experienced higher rates of depression at childbirth and who were younger at the time of birth of their first child (see Table S1, available online). The QLSCD protocol was approved by the Institut de la statistique du Québec ethics committee. The 2021 Special Round data collection (23 years) was also approved by the Douglas Research Centre Ethics Committee and by the CHU Ste-Justine research ethics committee. Informed consent was obtained from participants and/or their parents at each data collection.

Measures

Exposure: disordered eating trajectories from 12 (2010) to 20 (2018) years

Disordered eating problems were measured at age 12, 15, 17, and 20 years using the 5-item self-report questionnaire Sick, Control, One stone, Fat, Food (SCOFF) (Morgan et al., 2000), which has been psychometrically validated in French (Garcia et al., 2011). The SCOFF assesses the presence of disordered eating behaviours (yes vs no) during the past year, including purging, loss of control, weight loss, feeling overweight, and attributing importance to food. Behaviours were summed up to create a total score ranging from 0 to 5. We used group-based trajectories previously calculated (Breton et al., 2022). Some females (N = 188) and males (N = 284) had missing data

on all time points and were therefore excluded. Two trajectories best fit the data indicative of high- and low-level trajectories. Twelve percent of males ($N = 67$) and 37% of females ($N = 278$) were assigned to the high-level trajectory. The mean a posteriori probability of being assigned to high- and low-risk groups was above the recommended .7 threshold (females: high risk M = .86, low risk M = .85; males: high risk M = .80, low risk M = .91), suggesting that hard classification into high and low groups can be confidently used as an exposure variable (Nagin, 2005). Note that the average number of disordered eating symptoms was higher among females than among males (Breton et al., 2022).

Mental health outcomes at 23 years old

Mental health outcomes were measured between March and June 2021 when participants were 23 years old and in a province-wide lockdown, which included closures of all non-essential services (e.g., restaurants, gyms, theatres) and schools, with learning moved to virtual platforms.

Anxiety symptoms Participants reported their symptoms over the past 2 weeks using the *Generalized Anxiety Disorder 7 (GAD-7) scale*. The GAD-7 is a widely used efficient screening questionnaire with excellent psychometric properties, including internal consistency ($\alpha = .91$) and criterion, construct, and factorial and procedural validity. Scores > 14 indicate severe symptoms (Micoulaud-Franchi et al., 2016; Spitzer et al., 2006).

Depressive symptoms Participants reported their symptoms over the past week using the short form of the *Center for Epidemiological Studies-Depression Scale (CES-D)*, a widely used screening tool for depression symptoms. The CES-D has good internal consistency ($\alpha = .87$) and test-retest reliability as well as construct and factorial validity. Scores > 20 indicate severe symptoms (Radloff, 1977).

Non-suicidal self-injury Non-suicidal self-injury was measured with the item: "*In the past 12 months, did you ever deliberately harm yourself but not mean to take your life?*" (1 = yes, 0 = no), which has been successfully used in previous cohort studies (Georgiades et al., 2019).

Suicidal ideation Suicidal ideation was measured with the item: *In the past 12 months, did you ever seriously consider taking your own life or killing yourself?* (1 = yes, 0 = no), which has been successfully used in previous cohort studies (Georgiades et al., 2019).

Mediators during the COVID-19 pandemic (22 years old)

Mediators were measured from July to August 2020 during the first wave of the COVID-19 pandemic at age 22 years.

Loneliness Loneliness was measured with the *UCLA Loneliness Scale,* which is a valid and reliable ($\alpha = .84$) self-report measure with three items (feeling left out; feeling isolated from others; lack of companionship). Participants are prompted to rate the frequency of their feelings over the last 2 weeks (1 = almost never; 3 = often). Total scores were converted into a standardized scale ranging from 0 to 10 (de Grâce et al., 1993).

Social media use Participants reported how much time per day between mid-March and mid-June 2020 they estimated using social media (e.g., Facebook, Instagram, TikTok) (1 = no use; 5 = over 6 h per day).

COVID-19 news on social media Participants reported the average time per day they estimated consulting COVID-19-related news on social media between mid-March and mid-June 2020 (e.g., Facebook, Twitter, Reddit) (1 = never; 7 = more than 4 h).

Confounders

Confounders were measured at 10 and 12 years of age and averaged. Family socio-economic status (SES) was measured with an aggregate of five items regarding parental education, parental occupation, and annual gross income (range: 3 [low] to 3 [high], 0 centered) (Willms & Shields, 1996). Externalizing (3 items) and internalizing (2 items) symptoms were self-reported using the Social Behavior Questionnaire, which is a valid and reliable measure of symptoms among children (Murray et al., 2019).

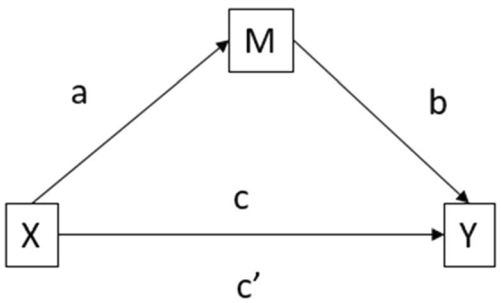

Fig. 1 Conceptual model of mediation analyses. Note: X = exposure (high- or low-level disordered eating trajectories). M = mediator (loneliness). Y = internalizing symptoms (anxiety, depression, non-suicidal self-injury, or suicidal thoughts). ab = indirect effect of X on Y. c = total effect of X on Y. c' = direct effect of X on Y

Data analyses

All statistical analyses were conducted using SPSS, version 26. As recommended by guidelines such as those of the Canadian Institutes of Health Research (Coen & Banister, 2012; Rich-Edwards et al., 2018), we investigated sex differences by stratifying analyses by sex. First, we present descriptive statistics for all key variables. Second, prospective associations (i.e., total association) between disordered eating trajectories and mental health outcomes were estimated using logistic regressions. To conduct mediation analyses, we used the macro PROCESS v4 (model 4) (Hayes, 2017). This model allowed us to partition the total association into an indirect association (i.e., the part of the total association explained by the hypothesized mediator) and a direct association (i.e., the remaining part of the total association not explained by the hypothesized mediator). Effect size of the indirect association was calculated using the ratio between indirect and total associations (indicating the % of association mediated). We tested mediation models if disordered eating trajectories were associated with the mediator, and if the mediator was associated with the outcome (Fig. 1) (MacKinnon, 2008). The amount of missing data in mediators and confounders is detailed in Supplementary Table S2. We used the expectation maximization (EM) algorithm to handle missing data in the mediators and confounding variables. EM is a maximum likelihood–based approach that consists in iterating the expected log-likelihood function and a maximization estimate based on available data (Dong & Peng, 2013). To minimize bias due to the fact that more vulnerable participants were excluded from analyses, we applied inverse probability weighting. First, a variable "missing at follow-up" was created, with values of 1 if participants are missing and 0 if otherwise. Second, we used a binary logistic regression model to predict missing at follow-up from a large number of potential variables (socio-demographic, parental, and behavioural characteristics). The predicted probabilities (p) estimated from this model represent the likelihood of being missing at follow-up based on participants' characteristics. Third, the inverse of these probabilities ($1 - p$) was used as a weight to account for the fact that certain participants may be under-represented because they are more likely to leave the cohort. All regression analyses are presented with and without adjusting for confounding factors. Statistical tests were two-tailed and considered significant for $p < 0.05$. As recommended (Hayes, 2017), 95% confidence intervals for the direct and indirect associations were calculated with 10,000 bootstrapped samples.

Table 1 Descriptive statistics for key variables in high- and low-level disordered eating trajectories for males and females separately

	All	Low risk	High risk	*p*	*Effect size*[a]
Males (N = 557)		*N* = 490	*N* = 67		
Mediators					
Loneliness *(M, SD)*	2.48 (2.52)	**2.39 (2.41)**	**3.12 (3.20)**	**0.025**	**.26**
Social media *(M, SD)*	3.05 (.81)	3.05 (.81)	2.99 (.75)	0.567	.08
COVID news *(M, SD)*	2.62 (1.16)	2.58 (1.15)	2.87 (1.24)	0.053	.24
Outcomes					
Severe anxiety *(N, %)*	36 (6.5%)	**26 (5.3%)**	**10 (14.9%)**	**0.003**	**.13**
Severe depression *(N, %)*	38 (6.8%)	**28 (5.7%)**	**10 (14.9%)**	**0.005**	**.12**
Self-harm *(N, %)*	45 (8.1%)	36 (7.3%)	9 (13.4%)	0.086	.07
Suicidal ideation *(N, %)*	40 (7.2%)	32 (6.5%)	8 (12.1%)	0.099	.07
Females (*N* = 759)		*N* = 481	*N* = 278		
Mediators					
Loneliness *(M, SD)*	3.33 (3.12)	**3.00 (2.95)**	**3.91 (3.32)**	**< 0.001**	**.29**
Social media *(M, SD)*	3.46 (.81)	3.42 (.80)	3.53 (.83)	0.074	.13
COVID news *(M, SD)*	2.66 (1.35)	2.61 (1.33)	2.74 (1.39)	0.215	.10
Outcomes					
Severe anxiety *(N, %)*	84 (11.1%)	**45 (9.4%)**	**39 (14.1%)**	**< 0.001**	**.08**
Severe depression *(N, %)*	87 (11.5%)	**40 (8.3%)**	**47 (17.0%)**	**< 0.001**	**.14**
Self-harm *(N, %)*	89 (11.7%)	**47 (9.8%)**	**42 (15.1%)**	**< 0.001**	**.10**
Suicidal ideation *(N, %)*	70 (9.2%)	**32 (6.6%)**	**38 (13.7%)**	**< 0.001**	**.12**

Data were compiled from the final master file of the Québec Longitudinal Study of Child Development (1998–2022). Significant results in bold. ©Gouvernement du Québec, Institut de la statistique du Québec. $p < 0.05$ in bold

[a] Cohen's d is calculated for continuous variables; Phi coefficient is calculated for categorical variables

Table 2 Prospective associations between high- and low-level disordered eating trajectories and mental health problems at age 23

High-risk trajectory (reference = 0)	Severe anxiety OR (95% CI)	Severe depression OR (95% CI)	Non-suicidal self-injury OR (95% CI)	Suicidal ideation OR (95% CI)
Males				
Unadjusted	**3.06 (1.40–6.67)**	**2.80 (1.29–6.09)**	1.96 (0.90–4.28)	1.98 (0.88–4.47)
Adjusted[a]	**2.49 (1.11–5.58)**	**2.26 (1.14–5.92)**	1.69 (0.761–3.77)	1.62 (0.70–3.76)
Females				
Unadjusted	**1.59 (1.01–2.51)**	**2.24 (1.43–3.52)**	**1.64 (1.05–2.56)**	**2.26 (1.37–3.71)**
Adjusted[a]	1.52 (0.96–2.41)	**2.15 (1.36–3.38)**	**1.60 (1.02–2.52)**	**2.16 (1.31–3.57)**

Data were compiled from the final master file of the Québec Longitudinal Study of Child Development (1998–2022), ©Gouvernement du Québec, Institut de la statistique du Québec. Significant results in bold (95% CI)

OR odds ratio, *CI* confidence interval

[a] Adjusted for socio-economic status and prior mental health at 10–12 years old. Weighted results reported

Results

Descriptive statistics are presented in Table 1. For males, 6.5% reported severe anxiety problems, 6.8% severe depression, 8.1% non-suicidal self-injury, and 7.2% suicidal ideation. For females, 11.1% reported severe anxiety problems, 11.5% severe depression, 11.7% non-suicidal self-injury, and 9.2% suicidal ideation.

Prospective associations between disordered eating trajectories and mental health problems (total association)

Males or females in the high-level disordered eating trajectory reported higher levels of non-suicidal self-injury, anxiety, and depression than males or females in the low-level trajectory. Females in the high-level trajectory reported higher levels of suicidal ideation than females in the low-level trajectory, whereas these differences did not reach statistical significance among males.

In adjusted models, females in the high-level disordered eating trajectory were more likely to engage in non-suicidal self-injury (OR 1.60; 95% CI 1.02–2.52) and to think about suicide during the COVID-19 pandemic (OR 2.16; 95% CI 1.31–3.57), whereas males in the high-level trajectory were more likely to report severe anxiety (OR 2.49; 95% CI 1.11–5.58). Both males and females in the high-level-trajectory groups were more likely to report severe depression (OR 2.26; 95% CI 1.14–5.92 and OR 2.15; 95% CI 1.36–3.38 respectively) (Table 2).

Association of disordered eating trajectories with loneliness and social media use

We used Student's *t* test to compare mean levels of loneliness and social media use among males and females in the high- versus low-level trajectories. Males in the high-level trajectory scored significantly higher than males in the low-level trajectory on loneliness. The same significant differences were observed among females. There were no significant differences in social media use in the high and low trajectories (Table 1).

Loneliness as a mediator between trajectories and mental health problems

Mediation models were tested based on previously stated requirements (MacKinnon, 2008). Among females, we found significant indirect effects of loneliness in the association between disordered eating trajectory and all our outcomes (Table 3). The proportion of the association explained by loneliness was 35.2% for severe anxiety, 23.1% for severe depression, 16.8% for non-suicidal self-injury, and 18.1% for suicidal ideation. After accounting for the mediators, significant direct effects for all outcomes except anxiety were still observed. However, no significant indirect effect of loneliness was found for males on any of the mental health problems (Table 3).

Discussion

Drawing on a large population-based cohort born in the Canadian province of Québec, we found that males and females with high levels of disordered eating symptoms from age 12 to 20 years were more likely to experience severe levels of anxiety and depression symptoms during the COVID-19 pandemic. This converges with longitudinal findings (Warne et al., 2021) and cross-sectional research on associations between disordered eating and symptoms of depression (Chan & Chiu, 2021; Giel et al., 2021) and anxiety (Chan & Chiu, 2021; Czepczor-Bernat et al., 2021). We also found that females with prior disordered eating problems were at increased risk of suicidal ideation and non-suicidal self-injury during the pandemic. The same pattern in prevalence

Table 3 Direct and indirect effects of trajectories on mental health problems via loneliness among males and females

	Direct effect OR (95% CI)	Indirect effect OR (95% CI)	% mediation
Females			
Severe anxiety	1.32 (0.83–2.10)	**1.16 (1.06–1.31)**	35.2%
Severe depression	**1.93 (1.21–3.09)**	**1.22 (1.09–1.41)**	23.1%
Non-suicidal self-injury	**1.56 (1.02–2.55)**	**1.10 (1.02–1.20)**	16.8%
Suicidal ideation	**1.82 (1.09–3.03)**	**1.14 (1.05–1.28)**	18.1%
Males			
Severe anxiety	2.10 (0.90–4.91)	1.19 (0.98–1.52)	
Severe depression	1.53 (0.63–3.73)	1.20 (0.98–1.58)	
Non-suicidal self-injury	1.39 (0.61–3.18)	1.15 (0.93–1.41)	
Suicidal ideation	1.23 (0.50–3.02)	1.19 (0.98–1.53)	

Data were compiled from the final master file of the Québec Longitudinal Study of Child Development (1998–2021), ©Gouvernement du Québec, Institut de la statistique du Québec. Significant results in bold (95% CI). Results adjusted for prior mental health and socio-economic status at 10–12 years old

OR odds ratio, *CI* confidence interval

was observed among males, but differences were not statistically significant. One possible explanation is that the number of males with suicidal behaviours was low, which could lead to a lack of statistical power to detect a true effect. Another possibility is that males in the high-level disordered symptom trajectory group had a lower intensity of symptoms than females in the high-risk group. This lower level of intensity could explain in part why there were no significant associations with suicidal ideation and self-harming behaviours among men. Collectively, these associations show that youth with prior disordered eating are at greater risk for experiencing mental health problems during stressful contexts such as the COVID-19 pandemic.

Loneliness during lockdown explained a part of the association between prior disordered eating and mental health problems among women, but not among men. Feelings of loneliness are a well-established risk factor for physical and mental health problems (Park et al., 2020). Experts highlight that research on individuals with disordered eating vulnerabilities, whether within or apart from the pandemic context, should focus on loneliness and related concepts such as social support that contribute to the development and maintenance of disordered eating symptoms (Cooper et al., 2020). Those with disordered eating patterns tend to alienate themselves from others, which would be associated with the often secretive nature of problem eating behaviours (e.g., food restriction, binging, purging), low self-esteem, and negative perceptions of others (Levine, 2012). In the context of COVID-19, increased feelings of loneliness have been well documented in general populations and associated with mental health problems especially among young women (Killgore et al., 2020; Park et al., 2020). Though young women with prior disordered eating may have been at greater risk for experiencing loneliness and mental health problems in young adulthood regardless of the pandemic, our study highlighted that COVID-19 mitigation measures may have impacted a highly relevant risk factor among those with a disordered eating history which would exacerbate the problem.

Loneliness did not appear to play a mediating role in the association between prior disordered eating and mental health problems among males. We can advance several possible explanations for our findings. First, associations between feelings of loneliness or lack of social support and anxiety, depression, suicidal ideation, and self-harming behaviours tend to be stronger among young females than among males (Beutel et al., 2017; Elbogen et al., 2021). The weaker associations observed among males could explain in part why our study did not evidence loneliness as a mediator. Second, a few studies evidenced that factors implicated in disordered eating behaviours would be similar across both sexes, but that the underlying mechanisms would differ (Weltzin et al., 2005). For instance, males would be more likely than females to binge eat because of body image concerns and less likely to restrict eating to cope with negative affect (Womble et al., 2001). Our results might suggest that loneliness is an important mechanism underlying associations between disordered eating symptoms and other mental health problems that would be pertinent to females specifically. Alternatively, the finding could be a false-negative result due to the lower statistical power in our male sample.

Contrary to our hypotheses, we did not find that social media use during lockdown explained the associations between disordered eating symptoms and mental health problems. This hypothesis was mostly grounded in research conducted outside of the pandemic context and theoretical arguments supporting its relevance during COVID-19 (Cooper et al., 2020). Though empirical research is scarce, one

longitudinal study conducted during the pandemic evidenced that time spent on Facebook was associated with increased body image and weight concerns, which was explained by passive but not active use (Mannino et al., 2021). Outside of the pandemic context, multiple studies revealed both positive and negative effects of social media use on well-being. For instance, passive use could increase envy and negative affect whereas active use (e.g., private chats with friends) could enhance social ties and decrease loneliness (Verduyn et al., 2017). Our measure of social media use relied on a single item which did not allow us to distinguish between different types of use nor indicate the specific platforms used (e.g., Instagram versus Reddit), which may contribute to why we did not observe an association. Longitudinal event–level studies could be an interesting design to better ascertain the phenomenon. For instance, using a smartphone application, researchers could additionally take daily measures of multiple facets of social media use daily and monitor participants' subsequent feelings.

Our study should be interpreted in light of several limitations. First, as in all longitudinal studies, participants with certain characteristics were more likely to drop out, which could lead to an under-representation of these individuals. In order to minimize this bias, we applied inverse probability weighting on key variables. Second, despite the use of a longitudinal design, definitive conclusions about causality between disordered eating and mental health problems and the underlying processes cannot be ascertained as non-included confounding factors could influence results. However, as we adjusted analyses for important confounding factors, namely socio-economic status and prior mental health problems, that source of bias is thought to be minimal. We did not statistically adjust for the uncertainty of individuals being assigned to their respective trajectories, but the posterior probabilities were high and we believe bias is minimal. Similar studies with larger sample sizes may consider adjusting for this potential source of bias in the future. Though the SCOFF is a well-known screening assessment, the self-report format can cause bias and it did not allow us to account for specific types of eating disorders nor the intensity of each symptom. Our measures of social media use relied on single items created for the purpose of this study rather than validated psychometric scales. Our study did not have enough statistical power to test for sex interactions, but our stratified analyses suggested important sex differences and lay the grounds for larger-scale studies investigating moderation. As the majority of our cohort was of Caucasian decent (Orri et al., 2021), generalization of our results to gender (vs sex), minority groups such as the LGBTQ+ community, or diverse socio-cultural environments is unclear and it would be important to conduct research on the topic.

Main strengths of our study include reliance on representative longitudinal cohort data with several assessment time points spanning from infancy to young adulthood. We were able to adjust for confounding variables in childhood including socio-economic status and mental health problems, which allows us to better establish causal inferences. By making use of disordered eating trajectories that were calculated in another study, we were able to capture the phenomenon over the course of adolescence rather than relying on a sole time point, which reduces measurement error. We used validated tools to measure mental health problems with excellent psychometric properties and evaluated clinically relevant outcomes. Further, we measured mental health outcomes in 2021, a year after the outbreak of the COVID-19 pandemic. Males are often neglected and under-represented in the eating disorder literature, but we were able to include over 500 men in analyses and highlight sex-based differences. We were among the few to conduct a longitudinal study on prior disordered eating as a vulnerability factor leading to anxiety and depression during the pandemic and the first to include measures of self-harm and suicidal ideation as outcomes. We were also the first to pinpoint loneliness as an explanatory factor which can allow us to implement evidence-based strategies to mitigate mental health problems during the pandemic among women with prior disordered eating.

Conclusion

Males and females with a history of disordered eating during their adolescence were at higher risk for experiencing mental health problems during the stressful period of the COVID-19 pandemic. Researchers and policy makers should be attentive to this group and implement evidence-based strategies to help support at-risk individuals. According to the WHO (2022), effective interventions in the COVID-19 context include programs focused on self-help, cognitive behavioural training, psycho-education, and relaxation which can be delivered in person or via online platforms. Our findings evidenced that loneliness could be a potential target for the prevention of anxiety, depression, non-suicidal self-injury, and suicidal ideation among females with prior disordered eating symptoms. Effective cognitive behavioural techniques to decrease loneliness include addressing maladaptive cognitive beliefs (e.g., negative evaluations of others, lack of interpersonal trust), training in social skills, encouraging socialization and community involvement (e.g., volunteering), and increasing opportunities for socialization (Mann et al., 2017). Though we found that loneliness explained 17–35% of the associations among females, more research would be needed in order to identify explanatory mechanisms among males and better understand sex-related differences. Further research would also be needed to better ascertain the longer-lasting effects of the pandemic on the individuals in our cohort and how the effects may carry over to their offspring.

Contributions to knowledge

What does this study add to existing knowledge?

- Young adults in Québec with a history of problematic eating behaviours in adolescence were at greater risk for severe anxiety and depression and suicidal behaviours during the COVID-19 pandemic.
- Our study was the first to pinpoint that loneliness during lockdown could explain associations between prior disordered eating symptoms and mental health problems among women.
- We included a large sample of males, who are most often neglected in the disordered eating literature, and highlighted differences across sex.

What are the key implications for public health interventions, practice, or policy?

- Public policies should focus on those with prior disordered eating antecedents as they would be at greater risk for developing mental health problems later in life and under stressful conditions such as the current pandemic context.
- As loneliness partially explained these associations with mental health problems among women, intervention and prevention efforts could focus on promoting social ties.

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Author contributions TL, NC, MC, SC, and MO conceptualized the study and analyses. RT, MB, MC, and SC collected the data. EB provided the calculations for the trajectories. TL drafted the paper and performed the analyses. SC provided supervision. All of the authors revised the paper and approved the final version of the manuscript.

Availability of data and material Not applicable

Code availability Not applicable

Declarations

Ethics approval The QLSCD protocol was approved by the Institut de la statistique du Québec ethics committee. The 2021 Special Round data collection (23 years) was also approved by the Douglas Research Centre Ethics Committee and by the CHU Ste-Justine research ethics committee. Informed consent was obtained from participants and/or their parents at each data collection.

Consent to participate Informed consent was obtained from participants and/or their parents at each data collection.

Consent for publication Not applicable

Conflict of interest The authors declare no competing interests.

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