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Sexual orientation and adolescent suicide attempt and self-harm: a co-twin control study

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Background: Research has demonstrated that individuals who identify as a sexual minority (e.g., gay/lesbian, bisexual) are at increased risk for suicidality-related outcomes. However, previous research is primarily limited by the lack of adjustment for unmeasured (i.e., genetic and environmental) confounding factors and previous psychopathology. **Methods:** Using the Child and Adolescent Twin Study in Sweden, we employed a co-twin control design to examine the extent to which the association between sexual orientation and adolescent suicide attempt and self-harm (SA/SH) was independent of genetic and environmental factors shared by twins, as well as measured symptoms of childhood psychopathology. **Results:** Adolescents who identified as a sexual minority (i.e., gay/lesbian, bisexual, or other sexual orientation) were at two-fold increased odds for SA/SH (OR, 2.01 [95% confidence interval, 1.63–2.49) compared to heterosexual adolescents. When adjusting for all genetic and shared environmental factors that make twins similar and for measured childhood psychopathology, the association remained positive but attenuated to OR, 1.55 (1.11–2.16). **Conclusions:** Identifying as a sexual minority was associated with approximately 50% increased odds of SA/SH in adolescence after adjusting for unmeasured genetic and environmental factors shared by twins and for childhood psychopathology. The results support that environmental factors specifically associated with identifying as a sexual minority likely increase risk for SA/SH. Our findings highlight the need to monitor suicidality risk among this group. **Keywords:** Sexual behavior; suicidal behavior; twins.

Introduction

Suicidal ideation and behavior dramatically increase during puberty; approximately 12% of adolescents experience suicidal ideation, 4% make a suicide plan, and 4% have attempted suicide (Nock et al., 2013). In order to improve targeted treatment efforts, researchers have identified groups of adolescents who may be at elevated risk for suicidality, such as lesbian, gay, bisexual, transgender, and queer (LGBTQ) youth. Adolescence is a critical developmental period for understanding the relation between sexual identity and suicidality, as this stage of life encompasses the average age of communicating one's sexual preferences, identity, or orientation (referred to as 'coming out'); significant changes in social ties and pressures; and exploration/consolidation of one's overall self-identity (Russell & Toomey, 2012).

Data from recent community studies suggest that individuals who identify as a sexual minority (e.g., gay, bisexual) are at a 2- to 7-fold increased risk for suicidality compared to heterosexual adolescents (Garofalo, Wolf, Wissow, Woods, & Goodman, 1999; Herrell et al., 1999; Remafedi, French, Story, Resnick, & Blum, 1998; Russell & Joyner, 2001; Russell & Toomey, 2012). However, the association appears to differ depending on the measurements of suicidality (Silenzio, Pena, Duberstein, Cerel, & Knox, 2007) and the degree of adjustment for potential confounding factors. Previous research has adjusted for measured covariates such as biological sex (i.e., sex assigned at birth), socioeconomic/poverty status, parental education, alcohol and substance use, and depression (Herrell et al., 1999; Remafedi et al., 1998; Russell & Joyner, 2001; Russell & Toomey, 2012). The associations between identifying as a sexual minority and suicidal behavior attenuate slightly but largely remain. This may be consistent with the minority stress hypothesis, which stipulates that the experiences of stigma, victimization, prejudice, and discrimination affecting individuals who occupy minority sociocultural positions increase their likelihood of psychopathology and suicidality (Marshal et al., 2011).

However, previous studies have been limited by small sample sizes (Plöderl et al., 2013), cross-sectional designs, lack of comparison group, and an inability to rule out potential confounding factors, whether unmeasured (e.g., genetic and shared environmental) or measured factors (e.g., psychopathology) (King et al., 2008). This is important, as

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numerous studies of varying methodologies, including univariate twin studies (Långström, Rahman, Carlström, & Lichtenstein, 2010) and single nucleotide polymorphism studies (Wang et al., 2012), indicate that genetic factors influence sexual orientation. Additionally, a recent large-scale genome-wide association study (GWAS) found that the aggregate of genetic variants associated with same-sex sexual behavior (i.e., polygenic score) was correlated with psychopathology, including major depressive disorder (Ganna et al., 2019). The analyses in this GWAS study, however, were unable to distinguish whether the same genetic factors influence multiple traits (e.g., sexuality and suicidality) or influence one trait (e.g., sexuality) that is causally associated with another trait (e.g., suicidality) (Solovieff, Cotsapas, Lee, Purcell, & Smoller, 2013).

In contrast, the use of the co-twin control design (the comparison of discordant identical and fraternal twins) allows researchers to test alternative hypotheses by helping to rule out all factors shared within twin pairs (McGue, Osler, & Christensen, 2010). Specifically, the co-twin control design compares risk of suicidality between a twin who identifies as a sexual minority and their co-twin who does not identify as a sexual minority. The design, thereby, accounts for all familial factors that make twins similar, both genetic and environmental, which may explain the association between sexual orientation and suicidality. It is possible that children who identify as a sexual minority are also from families with increased risk for suicidality, and the association between sexual minority and suicidality is not due to the conferred risk of sexual minority identity, but rather to shared familial factors. Therefore, through adjustment for shared factors, the co-twin control designs allows researchers to more rigorously examine the hypothesis that a given phenotype is causally associated with an outcome.

We are aware of only one study that examined the association between being gay/lesbian and suicidality symptoms using a twin design, which concluded that the association was independent of potential unmeasured (i.e., genetic and environmental) and measured factors (e.g., depression) (Herrell et al., 1999). However, this study was restricted to adult male veterans in the United States, potentially limiting the generalizability of the findings. As previously mentioned, many cross-sectional studies have adjusted for psychopathology, thereby assuming that psychopathology is a confounding factor. However, many studies theorize that psychopathology functions as a mediating factor (Garofalo et al., 1999; Herrell et al., 1999; Russell & Joyner, 2001). Careful consideration of confounding within the context of sexual orientation and suicidality is needed (Wichstrøm & Hegna, 2003). In this study, we additionally examined the possible confounding role of pre-existing psychopathology.

Our study objectives were to use a population-based, longitudinal, adolescent twin study from Sweden to examine the magnitude of the association between self-reported sexual orientation and suicide attempt and self-harm, while adjusting for shared genetic and environmental factors and potential confounding due to childhood psychopathology using a co-twin control design.

Method

Sample

The Child and Adolescent Twin Study in Sweden (CATSS) is an ongoing, population-based, longitudinal study targeting nearly all adolescent twins born in Sweden. CATSS uses both parent and youth report to measure a variety of psychological constructs and medical conditions. Additional information about CATSS can be found elsewhere (Anckarsäter et al., 2011). Data collection occurred at three waves when the youth were 9 or 12, 15, and 18 years old. We examined all three waves and included those who were eligible to participate in the last completed wave of data collection (i.e., those born between 1994 and 1999 and followed through 2017, n = 13,850). For twins with an available DNA sample, zygosity was determined via analysis of 48 single nucleotide polymorphisms. For twins without a DNA sample, zygosity was determined from five questions indexing twin similarity (Anckarsäter et al., 2011). We included all zygosity types: monozygotic (MZ; n = 3,689 individuals), same-sex dizygotic (DZ; n = 4,844), opposite-sex DZ (n = 4,772), and unknown (n = 547). The Research Ethical Committee at the Karolinska Institute approved the original CATSS study. The Internal Review Board at Indiana University and the Regional Ethical Review Board in Stockholm, Sweden, approved the analyses.

Measures

Sexual orientation. At age 15, youth completed a sexuality questionnaire, which included the question: 'What alternative about your sexual orientation is correct today?' Adolescents had the option of choosing 'homosexual,' 'bisexual,' 'heterosexual,' 'other,' or 'do not know/want to answer.' Examples of free-text responses provided by participants describing an orientation of 'other' included pansexual, asexual, and queer. While the term 'homosexual' was used in the questionnaire, we use 'gay/lesbian' throughout the current paper as it is more culturally appropriate.

Suicide attempt/self-harm. At age 18, youth completed the Lifetime History of Aggression (LHA) questionnaire, which contained an assessment of suicide attempt (SA) and self-harm (SH). The LHA included the following two questions: 'Have you ever deliberately attempted to kill yourself when you were angry or despondent' and 'Have you ever deliberately attempted to injure yourself physically when you were angry or despondent?' Note that because the former LHA item does reference intent to die, we used the term suicide attempt. In the latter item, we cannot differentiate suicide attempt from nonsuicidal self-injury as intent to die is unclear; therefore, we used the term self-harm. The response scale indicated six options ranging from 'Never' to 'More times than I can count.' We dichotomized each item into absent (0) or ever present (1). Refer to Table 1.

Covariates. At age 9/12, parents completed the Autism–Tics, AD/HD and other Comorbidities (A-TAC) Inventory about

Table 1 Demographics of sexual orientation and SA/SH

	Multiple imputation sample *N* (%)[a]	Complete case sample *N* (%)[b]
Sexual orientation		
Heterosexual	7,012 (50.62)	5,117 (87.89)
Gay/Lesbian	159 (1.15)	113 (1.94)
Bisexual	255 (1.84)	195 (3.35)
Other	82 (0.59)	51 (0.88)
Do not know/want to answer	529 (3.82)	346 (5.94)
Missing	5,815 (41.98)	0
Suicide Attempt/Self-Harm		
Self-Harm		
Never	5,661 (40.87)	4,259 (73.15)
Once	731 (5.28)	536 (9.21)
2–3 times	630 (4.55)	473 (8.12)
4–9 times	312 (2.25)	235 (4.04)
10+ times	194 (1.40)	139 (2.39)
More times than I can count	253 (1.83)	180 (3.09)
Missing	6,071 (43.83)	0
Suicide attempt		
Never	7,306 (52.74)	5,515 (94.73)
Once	276 (1.99)	179 (3.07)
2–3 times	116 (0.84)	75 (1.29)
4–9 times	37 (0.27)	27 (0.46)
10+ times	19 (0.14)	12 (0.21)
More times than I can count	22 (0.16)	14 (0.24)
Missing	6,076 (43.86)	0

Female and male refer to biological sex, rather than gender.
[a]Based on 13,852 unique individuals.
[b]Based on 5,822 unique individuals.

each child. The A-TAC questionnaire is a valid and reliable measure of mental health symptoms that largely corresponds to DSM-IV diagnoses but groups items by constructs (e.g., attention and impulsivity compared to ADHD) (Anckarsäter et al., 2011). In order to improve administration efficiency, the questionnaire included a gate-item structure. Parents could respond to each item as 'Yes' (1), 'Yes, to a certain extent' (0.5), or 'No' (0). We summed the items above the gate for concentration/attention (range 0–9), impulsivity/activity (0–10), opposition (0–5), conduct (0–5), eating (0–2), and reality/psychosis (0–1).

Analyses

We completed all data analysis in SAS 9.4. To examine whether our sample was biased due to missing responses, we predicted the SA/SH outcomes from a missing indicator at age 9/12 or 15. Missing at age 9/12 did not predict SA/SH but missing at age 15 was associated with an increased odds of SA/SH at age 18 (Table S1). Therefore, we conducted multiple imputation to address potential bias due to the arbitrary missing data pattern. Given the inclusion of categorical variables in the imputation, we used a fully conditional specification method to impute sexual orientation from a discriminant function and the SA/SH items from logistic regression. After 30 imputations, we dummy-coded two levels (sexual minority and do not know/want to answer) in reference to heterosexuality and combined both LHA items into an 'any SA/SH' item category, which was equal to 1 if an individual endorsed either suicide attempt or self-harm.

We then conducted a series of regression models. First, we conducted logistic regression to compare all individuals and adjusted standard errors to account for the clustered nature of the data (i.e., twin pairs). Second, we used a co-twin control method, in which twins who identified as one sexual orientation were compared to their co-twin who identified as a different sexual orientation to adjust for genetic and environmental confounding factors on the association between sexual orientation and SA/SH in adolescence. The co-twin control method adjusts for all environmental factors that make twins similar (Herrell et al., 1999). Given that DZ and MZ twins share (on average) 50% or 100% of their segregating alleles, respectively, the co-twin control method can also adjust for genetic confounding factors (McGue et al., 2010). If there was no evidence for confounding by genetic and shared environmental factors, we would expect to see that the association between sexual orientation and SA/SH among discordant twin pairs is equivalent to that among unrelated individuals. If there was evidence for confounding, we would expect to see that the association attenuated among discordant twin pairs compared to the association between unrelated individuals. Finally, we included the A-TAC summed measures as covariates in the model to rule out potential measured confounding due to childhood psychopathology. We included biological sex as a covariate in all models given its association with sexual orientation and SA/SH (Table S2).

Sensitivity analyses

In order to address the various assumptions and decisions made about our dataset and definitions, we conducted a set of sensitivity analyses. First, we performed a complete case analysis including those who contributed to age 15 and 18 data collection and were not missing on the predictor or outcomes (n = 5,822, 42.03% of the total sample). A complete case analysis is an alternative approach to examine the assumptions made under multiple imputation (e.g., joint distribution). Second, previous research suggests that bisexual adolescents may be at an increased risk for suicidality compared to nonbisexual adolescents (Marshal et al., 2011). In order to expand upon our main analyses and previous research, we examined different categorizations within the sexual minority group. Because associations with the bisexual and other orientation groups did not statistically significantly differ (Table S3), we combined them into one group to improve precision. Third, we conducted a co-twin control analysis within a subsample of MZ twins to remove nearly all genetic confounding (Turkheimer & Harden, 2014).

Results

Table 1 presents the distribution of adolescents' responses among the multiply imputed and complete case sample. Approximately 42% of the adolescents did not provide information about sexual orientation; of these individuals, 76.1% did not participate in age 15 data collection despite their eligibility and 23.9% participated but did not complete the question regarding their sexual orientation. Approximately 43% did not provide information about SA/SH; of those, 78.9% did not complete age 18 data collection despite eligibility and 21.1% did not complete the self-harm question, for example. Among those who contributed to the complete case analysis, the majority of adolescents identified as heterosexual (87.9%), whereas 1.9% identified as gay/lesbian, 3.4% as bisexual, 0.9% as other, and

5.9% as not knowing or wanting to answer. For self-reported SA/SH, 26.9% reported at least one instance of self-harm and 5.3% reported a suicide attempt by age 18. Given that the co-twin control method utilizes discordant twin pairs, Table S4 presents the frequency of twin pairs who were discordant on both sexual orientation and SA/SH items (i.e., doubly discordant) and contributed to the co-twin control analyses.

The odds ratios (ORs) and 95% confidence intervals (CIs) between sexual orientation and SA/SH are shown in Table 2. Among unrelated youth, adolescents who identified as a sexual minority were at a two-fold increased odds for any SA/SH (OR, 2.01 [1.63–2.49]), self-harm (OR, 2.02 [1.63–2.50]), and suicide attempt (OR, 1.89 [1.29–2.78]) compared to heterosexual youth. Individuals who did not know/want to answer were not at statistically significantly increased odds for the SA/SH outcomes, except for suicide attempt (OR, 1.48 [1.03–2.14]). When accounting for all factors that make twins similar via the co-twin control design, the associations attenuated but remained elevated. Within twin pairs, identifying as a sexual minority predicted any SA/SH (OR, 1.61 [1.17–2.23]) and self-harm (OR, 1.61 [1.17–2.21]). Reduced statistical power when examining doubly discordant twin pairs widened confidence intervals when examining suicide attempt, although the magnitude of the point estimate remained elevated (OR, 1.63 [0.93–2.86]). Finally, the inclusion of childhood psychopathology did not further attenuate the association (e.g., any SA/SH, OR, 1.55 [1.11–2.16]).

Table 2 Association between sexual orientation and SA/SH items across the three aims

Sexual orientation	Either self-harm or suicide attempt	self-harm	Suicide attempt
Among unrelated individuals; OR (95% CI)			
Heterosexual	REF	REF	REF
Sexual minority status[a]	2.01 (1.63–2.49)	2.02 (1.63–2.50)	1.89 (1.29–2.78)
Do not know/want to answer	1.16 (0.92–1.47)	1.15 (0.90–1.48)	1.48 (1.03–2.14)
Co-twin control; OR (95% CI)			
Heterosexual	REF	REF	REF
Sexual minority status[a]	1.61 (1.17–2.23)	1.61 (1.17–2.21)	1.63 (0.93–2.86)
Do not know/want to answer	1.01 (0.72–1.41)	1.02 (0.72–1.45)	1.29 (0.73–2.27)
Co-twin control with adjustment for psychopathology; OR (95% CI)[b]			
Heterosexual	REF	REF	REF
Sexual minority status[a]	1.55 (1.11–2.16)	1.55 (1.11–2.15)	1.56 (0.88–2.75)
Do not know/want to answer	0.94 (0.65–1.35)	0.95 (0.65–1.39)	1.10 (0.60–2.00)

Includes adjustment for biological sex. Based 13,852 unique individuals (415,560 observations after 30 imputations).
[a]Includes gay/lesbian, bisexual, and other sexual orientation.
[b]Adjusted for A-TAC summed scores for ADHD, opposition, conduct, psychosis, and eating symptomology.

Sensitivity analyses

When comparing differing methodological approaches to handle missing data, the unadjusted associations between identifying as a sexual minority and SA/SH were larger in the complete case analyses compared to the multiply imputed analyses. However, both approaches demonstrated a similar pattern of results. The complete case analysis found that adolescents who identified as a sexual minority were at elevated odds for all outcomes (e.g., any SA/SH, OR, 2.45 [1.96–3.06]). This associated attenuated when adjusting for shared twin factors (e.g., any SA/SH, OR, 1.72 [1.12–2.65]) and additionally adjusting for childhood psychopathology (e.g., any SA/SH, OR 1.76 [1.08–2.86]). Those who did not know/want to answer were not at elevated odds, although precision decreased in the co-twin analyses (Table S5).

Sensitivity analyses that examined various sexual minority subgroups suggested that among unrelated individuals, individuals who identified as bisexual or other were at the highest odds (ORs ranged from 1.95 to 3.43) for all outcomes. Youth who did not know/want to answer were not at elevated odds, except for suicide attempt (OR, 1.48 [1.03–2.13]). When conducting the co-twin control method and additionally adjusting for childhood psychopathology, there was a similar pattern of results as when examining sexual minority adolescents as one category. However, confidence intervals widened for identifying as gay/lesbian, suggesting that we lacked statistical power for these comparisons (Table S6).

Finally, when more completely adjusting for genetic influences among the subset of MZ twins, those who identified as a sexual minority were at increased odds for any SA/SH (OR, 2.16 [1.49–3.13]), self-harm (OR, 2.19 [1.52–3.17]), and suicide attempt, although the point estimate was not statistically significant (OR, 1.86 [0.96–3.62]). When comparing within discordant MZ twin pairs, the associations remained elevated for any SA/SH (OR, 1.97 [0.95–4.10]), self-harm (OR, 1.96 [0.94–4.08]), and suicide attempt (OR, 1.94 [0.60–6.27]), although confidence intervals included the null.

Discussion

The primary aim of the current study was to investigate the magnitude of the association between sexual orientation and SA/SH after adjusting for unmeasured and measured factors that may confound the association. When first comparing

unrelated individuals, the results suggest that identifying as a sexual minority (i.e., gay/lesbian, bisexual, or other sexual orientation) was associated with two-fold elevated odds of SA/SH in adolescence, consistent with prior research (Marshal et al., 2011).

When we conducted the co-twin control design, thereby adjusting for potential unmeasured confounding factors, we found that the associations were slightly attenuated. This supports the conclusion that unmeasured genetic and environmental factors that make twins similar partially account for the association between identifying as a sexual minority and SA/SH. However, the association did not fully attenuate, suggesting that the experience of being a sexual minority may uniquely increase risk for SA/SH in adolescence. This pattern of results was also supported when examining MZ twins, though we were unable to precisely estimate the risk in this subset. Given that the MZ results were not statistically significant, we cannot entirely rule out the role of genetic influences. However, the results are consistent with the main finding that shared factors within twin pairs partially, but not entirely, explain the association between sexual orientation and SA/SH.

In order to account for potential confounding due to differences that vary within twin pairs, we included psychopathology at age 9/12. Differences between twins in prior psychopathology did not entirely account for the association between sexual orientation and adolescent SA/SH. By including psychopathology to adjust for potential confounding (i.e., common causes of orientation and SA/SH), we do not presume that psychopathology at a young age causes sexual orientation, but rather we sought to adjust for covarying developmental pathways associated with both.

After adjusting for factors shared within twin pairs and childhood psychopathology, there was an elevated association between sexual minority status and SA/SH, indicating that sexual orientation may uniquely predict SA/SH in adolescence. One potential explanation is the minority stress hypothesis, which proposes that experiences of prejudice, discrimination, concealment of identity, internalizing homophobia, and perception of stigma increase risk for mental health problems (Baams, Grossman, & Russell, 2015). For example, studies have found that victimization regarding sexual orientation mediates the relationship between sexual minority status and suicidal ideation and suicide attempt (Burton, Marshal, Chisolm, Sucato, & Friedman, 2013). In our adjustment for unmeasured and measured confounding, our findings add further support for the unique risk of sexual minority status. We want to be explicit that we do not suggest that sexual orientation is a modifiable risk factor. Rather, we suggest that future research will need to further explore social environmental mediators while adjusting for unmeasured factors.

When examining sexual minorities separately, bisexual and other sexual orientation were at the greatest odds for all SA/SH outcomes. In unadjusted estimates (i.e., among unrelated individuals), those who identified as gay/lesbian and bisexual/other sexual orientation differed in their self-harm behaviors. Prior research examining specific minority groups of sexual orientation has found support that those identifying as bisexual and 'unsure' are at increased risk for suicidality compared to gay/lesbian identification (Salway et al., 2019). Research suggests that bisexual young adults may be at increased risk for numerous outcomes, such as depression, anxiety, and substance use, compared with both heterosexual and gay/lesbian young adults (Bostwick & Dodge, 2019; Feinstein & Dyar, 2017). These findings apply to various definitions of bisexuality, including attraction, behavior, and identity (Feinstein & Dyar, 2017). Researchers have proposed that bisexual individuals may not only experience minority stress, but may also experience unique challenges of not conforming to a culture typified by one-gender sexual attraction (Bostwick & Hequembourg, 2014).

Our results suggesting the association between sexual orientation and SA/SH is partially independent of at least some unmeasured and measured factors is consistent with past research (Herrell et al., 1999). Previous research has reported associations that are likely consistent with a causal interpretation of the experience of identifying as a sexual minority increasing SA/SH risk, as well as somewhat explained by unmeasured and measured factors. Importantly, the findings highlight the need to improve screening in and develop targeted interventions for sexual minority youth. Although there may be associated costs with increased suicidality screening, we reiterate calls made by suicide initiatives that screening is vital in health care settings, especially those in contact with sexual minority youth. However, preventive efforts are needed in other settings (e.g., school) because individuals who identify as sexual minority face systematic barriers in accessing health care services (Alencar Albuquerque et al., 2016).

Strengths and limitations

This study is strengthened by the use of a large-scale, population-based dataset from Sweden. This longitudinal study was prospectively collected, limiting potential recall bias. In a sensitivity analysis, we also examined multiple groups of sexual orientation. While the experience of being a sexual minority is likely heterogeneous within groups, we were able to capture group-level differences, which may be particularly advantageous in prevention efforts. Additionally, previous research has conceptualized psychopathology as a mediating factor but included it as a covariate (Garofalo et al., 1999; Herrell et al.,

1999; Russell & Joyner, 2001). In our study, psychopathology was measured at age 9/12, providing stronger justification to include various psychopathology measures as covariates. Finally, our use of an adolescent co-twin control design is a significant contribution to the field. Twins who identify as differing sexual orientations, as compared to unrelated controls, serve as a superior counterfactual condition because examining discordant twin pairs adjusts for unmeasured factors that makes twins similar (Turkheimer & Harden, 2014).

A few limitations of the current study need to be considered when interpreting the results. First, we were limited by a large amount of missing data. However, we found comparable results using multiple imputation and a complete case analysis.

Second, the co-twin control design relies on assumptions that may bias our estimates. For example, the design assumes that the exposure of one twin does not influence the exposure or outcome of their co-twin (McGue et al., 2010). If the sexual orientation of one twin leads to environmental risk factors (e.g., bullying) that influence both twins in the family, our within-twin association would underestimate the true influence on SA/SH.

Third, our results may be affected by disclosure bias. Adolescents who identify as a sexual minority have come out, even if only to themselves. These individuals may differ in their risk for SA/SH compared to those who have not come out but are attracted to same-sex individuals or have had same-sex relationships (Russell & Joyner, 2001). Individuals who share their sexual orientation to unsupportive family or peers may be at greater risk of victimization. It is also possible that coming out increases social support, as individuals may seek out support from LGBTQ communities (Russell & Joyner, 2001). On the other hand, those who have not shared their sexual orientation may experience greater negative emotionality. Not only may environmental processes differ after coming out, but those who share versus not may differ in their 'willingness to self-identify' (McDaniel, Purcell, & D'Augelli, 2001). Given stigmatizing beliefs about sexual orientation, the prevalence of sexual minority status is likely underreported in the current study.

Fourth, while we were able to examine various groups of sexual orientation, our categorization remains crude (Wichstrøm & Hegna, 2003). Past research has utilized a Likert scale of identification or attraction, which may be more appropriate to capture variation within groups (Remafedi et al., 1998). While the sexuality questionnaire did include an open-ended response, the diversity in responses from adolescents limited our ability to distinguish groups. We also measured sexual orientation at one time point, and sexual orientation is likely a fluid experience.

Fifth, our measure of psychopathology at age 9/12 and sexual orientation at age 15 does not necessarily demonstrate strong temporal precedence. The underlying construct of sexual orientation likely has roots prior to age 15, as sexual fantasy and activity often begins before identification. For example, research suggests that boys experience same-sex sexual attraction before puberty (Friedman, 1999). Also, our measure of sexual orientation may also fail to capture the sexual orientation(s) with which one may identify after age 15.

Sixth, we did not have access to measures of suicidal ideation, which may vary in its relation to sexual orientation compared to SA/SH. Our measures of self-harm did not include a measure of intent to die, thus limiting our ability to distinguish non-suicidal self-injury from suicide attempt. Our measures of SA/SH are also lifetime self-report, which may be subject to recall bias (Nock et al., 2012), concealing past or present SA/SH (Nock et al., 2008), or uncertainty about what constitutes SA/SH (Meehan, Lamb, Saltzman, & O'Carroll, 1992).

Finally, we derived all results from a Swedish sample of adolescent twins, which may limit the generalizability to adolescents in other counties, such as the United States. For example, according to a European Union report in 2015, 90% of sampled Swedish individuals agreed that same-sex couples should be allowed to marry (European Commission, 2015); comparatively, a 2018 Gallup Poll showed that 67% of Americans believed that same-sex marriage should be recognized with all the same rights as nonsame-sex marriage (Gallup, 2018). Sweden has passed anti-discrimination laws against LGBTQ citizens, whereas the United States provides no federal protection against anti-discrimination toward LGBTQ individuals. Given prominent structural and societal differences, it is possible that the association between sexual orientation and SA/SH may vary between Sweden and other countries. Informed by the minority stress hypothesis, we may expect a stronger association between sexual minority status and SA/SH in countries with less cultural and legislative support for LGBTQ individuals.

Conclusion

To our knowledge, this was the first adolescent twin study examining the association between sexual orientation and SA/SH. After adjustment for unmeasured factors that make twins similar and for childhood psychopathology, the association between sexual orientation and adolescent SA/SH was slightly attenuated but remained elevated, suggesting that environmental factors specifically associated with identifying as a sexual minority uniquely contribute risk for SA/SH in adolescence. The results indicate that sexual minority youth may benefit from improved screening and intervention efforts targeting suicidality and self-harm. Future research should consider the role of potential mediators of this association, such as gender nonconformity, victimization experiences, internalized homophobia, and

poor social support, within a genetically informative framework (McDaniel et al., 2001), utilizing varying definitions of sexual diversity and suicidality, and the generalizability of these findings in other countries.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Association between missing at age 9/12 or 15 and SA/SH.
Table S2. Association biological sex with sexual orientation and SA/SH.
Table S3. Wald's Chi-Square test between sexual minority groups predicting any LHA item.
Table S4. Frequency of outcome discordant and exposure-outcome discordant twin pairs.
Table S5. A complete case analysis of the association between sexual orientation and SA/SH items across the three aims.
Table S6. Association between sexual orientation by separate groups and SA/SH items across the three aims.

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Key points

- Sexual minority status (e.g., identifying as gay/lesbian, bisexual or other sexual orientation) is associated with increased odds of suicide attempt and self-harm in adolescence.
- Previous research is limited by the inability to rule out unmeasured (i.e., genetic and environmental) factors and measured confounding factors.
- Using a co-twin control design and including measured covariates, we concluded that sexual minority status is associated with a 50% relative increase in odds of both suicide attempt and self-harm.
- Our results may lend support to the minority stress hypothesis, such that the experience of identifying as a sexual minority likely increases risk for later suicide attempt and self-harm in adolescence.
- Continual screening is vital for the detection, prevention, and intervention of suicidality among sexual minority youth.

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