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ORIGINAL ARTICLE

Sleep among gender minority adolescents

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Abstract

Study Objectives: Stigmatized youth experience poorer sleep than those who have not experienced stigma. However, no studies have examined the sleep of gender minority adolescents (GMAs). Examining sleep disparities between GMAs and non-GMAs is critical because poor sleep is associated with mental health outcomes experienced disproportionately by GMAs. We examined sleep duration, sleep problems, and sleep quality among our sample and compared these parameters between GMAs and non-GMAs.

Methods: Adolescents aged 14–18 years (n = 1,027 GMA, n = 329 heterosexual non-GMA, n = 415 sexual minority non-GMA; mean age = 16 years; 83% female sex at birth) completed a cross-sectional online survey, reporting sex assigned at birth and current gender identity, sleep duration, sleep problems (too much/too little sleep and inadequate sleep), sleep quality, and depressive symptoms.

Results: Accounting for demographic covariates, GMAs were more likely to report *inadequate sleep* and shorter *sleep duration* and had higher odds of reporting poor *sleep quality* and getting *too little/too much sleep* than heterosexual non-GMAs. After also adjusting for depressive symptoms, the finding that GMAs more often reported poor *sleep quality* remained significant.

Conclusions: This first large, nationwide survey of sleep among GMAs suggests that GMAs may be more likely to have poor sleep than non-GMAs. The significance of our results was reduced when adjusting for depressive symptoms, suggesting that poorer sleep may occur in the context of depression for GMAs. Future work should include objective measures of sleep, examine the emergence of sleep disparities among GMAs and non-GMAs, and explore pathways that increase risk for poor sleep among GMAs.

Statement of Significance

Emerging evidence suggests that stigmatized youth, such as those who identify as racial or sexual minorities, may experience poorer sleep than those who have not experienced stigma. However, no studies have examined disparities in sleep among transgender adolescents. Our findings indicate the presence of sleep disparities among gender minority adolescents compared to cisgender adolescents in unadjusted models, including sleeping fewer hours, being "poor sleepers," and being more likely to report sleep problems. Differences remained significant when controlling for demographic covariates but were attenuated when accounting for depressive symptoms. Future studies should examine the emergence and pathways contributing to sleep disparities among transgender adolescents and whether poor sleep contributes to the emergence of mental health disparities.

Key words: adolescence; sleep; mental health; disparity; depression; survey

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Introduction

Adolescence is a time of profound changes. With regard to sleep, adolescents experience a phase delay of the circadian timing system and slower accumulation of homeostatic sleep pressure [1], as well as developmental changes in psychosocial factors affecting sleep, such as increasing autonomy, academic pressures, extracurricular activities, and late-night socializing with peers [1]. These changes often result in delayed sleep timing and insufficient sleep duration during adolescence [1]. Despite recommendations that teenagers obtain 8–10 hours of sleep every night [2], data from the 2017 Youth Risk Behavior Survey (YRBS) show that only 25% of high school students in the United States get the minimum recommended amount of 8 hours [3], while subjective reports of indicators of sleep problems range from 7% to 45% among adolescents worldwide [4–6]. Though common, insufficient, and problematic sleep are associated with damaging consequences during adolescence, such as mood disturbances and depressive symptoms, poorer academic performance, overweight and obesity, risk-taking behaviors, and drowsy driving [7, 8].

Emerging evidence suggests that stigmatized youth, such as those who identify as racial and/or sexual minorities, may experience even poorer sleep than those who have not experienced stigma. A recent review of 23 studies of youth ages 6–19 years old found that racial/ethnic minority children and adolescents experience poorer sleep than nonminority youth [9], with Black and Hispanic youth experiencing shorter sleep duration and more sleep problems than White youth [9]. Sexual minority youth also experience disparities in sleep, including both sleep duration and quality [10]. Data from the 2017 YRBS show that only 18% of gay, lesbian, and bisexual students obtained eight or more hours of sleep as compared to 26% of heterosexual students [3]. Likewise, data from the 2015 YRBS showed that bisexual girls and girls unsure of their sexual identity, as well as boys who are gay or unsure, were more likely to report very short sleep duration (≤5 hours) compared to their heterosexual counterparts [11]. Data from 123,459 youth from China also indicate poor sleep quality is more common among sexual minority youth than their heterosexual peers [12].

While some investigations of sleep among racial and sexual minority adolescents have been published in the literature, no prior studies have examined sleep disparities among transgender or gender minority adolescents (GMAs), those whose true gender identity differs from their sex assigned at birth. One recent study reported that roughly 80% of a sample of transgender *adults* reported poor sleep quality [13], but no prior work has examined sleep quality or quantity among GMAs, who may be more vulnerable to poor sleep due to developmental changes occurring during this period. Investigating sleep disparities between GMAs and their cisgender, non-GMA peers (adolescents whose current gender identity is the same as their sex assigned at birth) is critical, given that low sleep duration and poor sleep quality are predictive of depressive symptoms and suicidality among adolescents, two mental health outcomes experienced disproportionately by GMAs [14, 15]. However, no prior studies have examined sleep quality or quantity among GMAs.

There are several pathways through which GMAs may have poorer sleep, including greater exposure to stress, adversity, and stigmatization [16], unsafe living environments or homelessness [17], or co-occurring mental health conditions such as depression. Minority Stress Theory is an overarching framework that addresses these elevated risks and proposes that sexual and gender minority individuals experience discrimination and internalize stigmatization of their minority status, increasing their vulnerability to mental and behavioral health problems [18, 19]. GMAs may experience unique stigma and stress, including discriminatory policies and attitudes within home or schools environments, such as requiring students to use bathrooms or locker rooms which do not align with their current gender identity, as well as bullying and victimization targeting their gender identity [20–27]. Further, efforts to pass as one's true gender identity in social contexts can be a source of stress for GMAs, including instances where individuals are "misgendered" by others who use pronouns or other terms that correspond to an individual's sex assigned at birth rather than their current gender identity [23]. A review of papers published from 2011 to 2016 suggests that depression is more common among GMAs than among their cisgender peers, with 12%–58% of transgender youth identified as having depression, dysthymia, or depressive symptoms [14]. These increased rates of depression have been linked to minority stress experiences among GMAs [28]. Moreover, the increased rate of depression among GMAs is especially relevant to our understanding of the pathways through which GMAs may experience poorer sleep because disturbed sleep is both a diagnostic criterion of depression [29] and a contributor to the development of the disease [30]. Identifying sleep disparities among GMAs may shed light on a modifiable health behavior linked to high rates of mental health problems among GMAs.

This study is the first nationwide survey of adolescents that was designed to examine disparities in sleep between GMAs and non-GMAs using robust self-report measures of sex assigned at birth, current gender identity, and sleep. We examined sleep duration, sleep problems, and sleep quality among our sample of adolescents and compared these parameters among three groups: GMAs, non-GMAs who identify as heterosexual, and non-GMAs who identify as a sexual minority (SM GMAs). Given that prior research has documented higher rates of sleep disturbance among sexual minority adolescents, we chose this coding strategy to compare GMAs directly to heterosexual non-GMAs. To further explore whether there is distinct risk of poor sleep among different groups of stigmatized youth, we also examined whether GMAs differ from SM non-GMAs on these sleep parameters in post hoc analyses. Because depressive symptoms are related to sleep quantity and quality, and are known to be higher among GMAs, we also evaluated these relations with and without covarying for depressive symptoms.

Method

Procedure

The Gender Minority Youth Study (GMY Study) is a cross-sectional online survey of GMAs and non-GMAs conducted from July to October 2018. Detailed information about the GMY Study has been previously reported [31]. Here, we use the term GMA to refer to any adolescent who identifies as a gender that differs from the sex they were assigned at birth, which may include the following terms: *transgender, female-to-male transgender/FTM, male-to-female transgender/MTF, trans male/trans masculine, trans female/trans feminine, genderqueer, gender expansive, intersex, androgynous, nonbinary, two-spirited, third gender, agender, genderfluid,*

or not sure. Participants were recruited via paid advertisements on Facebook and Instagram, social media platforms used by the vast majority of adolescents [32]. GMAs are a hidden population, and social media recruitment procedures reached a diverse sample of GMAs, including those who had not yet disclosed their gender identity to others. Two sets of advertisements targeted Facebook and Instagram users ages 14–18 years in the United States. One advertisement set had additional targets to reach GMAs using interest labels such as "Transgender," "Gender-specific and gender-neutral pronouns," "Genderqueer," and "Passing (gender)." All ads included pictures of racially/ethnically diverse adolescents. Clicking the ad opened the survey webpage, where participants provided assent (with a waiver of parental permission) and then completed anonymous questionnaires hosted on a secure server. Data were collected privately on participants' own electronic devices, and participants viewed a message regarding safety and security before starting the survey. Participants had the opportunity to enter a drawing for a $50 electronic gift card. The University's Human Research Protection Office approved this study.

Advertisements were served 377,469 times, and 8,747 clicks were recorded (2.48% click-through rate). A total of 5,642 participants assented, entered the survey, and began responding to questions. Adolescents were screened out of the survey if they were outside the targeted age range. Recruitment of GMAs assigned male at birth was slower than other groups; therefore, we adopted a screening procedure during the last 4 weeks of recruitment to recruit only these participants. In total, 1,997 participants who were either outside the targeted age range (n = 39) or who were not GMAs assigned male at birth (n = 1,958) were screened out.

Multiple steps were taken to ensure the quality of collected data. First, Internet Protocol (IP) addresses were used to identify potential duplicate cases, and cases with the same IP address were reviewed by hand. Duplicates with the same demographic characteristics and/or height/weight were removed (n = 320). Second, outlier analysis indicated that no cases had evidence of values outside expected range on variables reported as counts. Third, free-response text was reviewed, and seven cases that had inappropriate responses to survey questions were removed.

Participants

Participants were 14–18-year-old gender minority and cisgender adolescents living in the United States who participated in the GMY Study. The current sample included 1,779 adolescents (mean age = 16.0 years; SD = 1.2) who entered the survey and completed the sleep questions. Compared to the full sample of 3,318 participants, these 1,779 participants were older, were more likely to have female assigned sex at birth, and they were more likely to report a bisexual or pansexual sexual orientation.

Measures

Demographic variables

Participants self-reported the following: age, race/ethnicity (coded as White, Black, Latinx, Asian/Pacific Islander, Mixed, and Native American/other), sexual orientation (coded as heterosexual, gay/lesbian, bisexual/pansexual, and queer/questioning/other), and subjective social status (SSS) on a 10-point scale using the MacArthur Scale of Subjective Social Status [33]. SSS, which reports how adolescents perceive their social standing, has been validated for use with adolescents [33].

Sex and gender identity

Participants reported their sex assigned at birth as *male*, *female*, or *intersex*. Intersex participants were excluded because of low base rate (n = 11) and difficulty categorizing them as either male or female assigned at birth, a component of analyses for the current study. Participants selected all gender identities they currently identify with: *male, female, transgender, female-to-male transgender/FTM, male-to-female transgender/MTF, trans male/trans masculine, trans female/trans feminine, genderqueer, gender expansive, intersex, androgynous, nonbinary, two-spirited, third gender, agender, not sure,* and *other* (including free text). Gender identity was coded as non-gender minority (non-GMA; male, female), and gender minority (GMA; all other response choices).

Sleep disturbance

We assessed perceived sleep duration, sleep problems, and sleep quality with various items used in nationally representative surveys.

Sleep duration

Participants who indicated they were currently enrolled in school (high school or college) responded to the following question, adapted from the YRBS:[34] "On an average school night, how many hours of sleep do you get?" Participants responded with the following scale: 4 or less hours, 5, 6, 7, 8, 9, 10, or 11 or more hours. Given that the recommended amount of sleep for adolescents is 8–10 hours [6], we differentiated those who obtained 10 hours (within the recommended range) from those who obtained 11 or more hours (*more* than the recommended amount). In order to calculate mean hours of sleep, "4 or less hours" was scored as 4 hours and "11 or more hours" was scored as 11 hours. We added the following item to capture sleep duration on non-school nights: "On an average non-school night (for example, weekend or summer night), how many hours of sleep do you get?" Participants responded with the eight-category response scale provided above. A weighted *Sleep Duration* variable was calculated for participants in school by multiplying school night hours by 5/7 and non-school night hours by 2/7, and then summing these two numbers [35, 36]. Participants who indicated they were not currently enrolled in school responded to the following question from the National Longitudinal Study of Adolescent to Adult Health (Add Health):[37] "On a typical night, how many hours of sleep do you get?" Participants responded with the eight-category response scale provided above, and this number was used as their *Sleep Duration*.

Sleep problems

All participants responded to two items assessing sleep problems from the School Sleep Habit Survey [38, 39]. The first question (*too much/too little sleep*) asked, "In general, do you feel you usually get…" with answer choices including too much sleep, enough sleep, or too little sleep. Responses were dichotomized as 0: too much/too little and 1: enough. Second, participants responded to the question "How often do you think that you get enough sleep?" using answer choices on a 5-point Likert scale from "never" to "always" (termed *inadequate sleep*). These

variables reflect individual perceptions of whether and how often each participant obtains enough sleep.

Sleep quality

Participants reported on their *sleep quality* with one dichotomized item assessing whether they consider themselves to be a 0: poor or 1: good sleeper.

Depressive symptoms

Symptoms of depression were assessed with the Center for Epidemiologic Studies Depression Scale (CES-D) [40]. The CES-D includes twenty items, answered on a 4-point Likert scale, assessing depressive symptoms experienced in the past week, including depressed mood, anhedonia, and hopelessness. A composite mean score was calculated for each participant excluding one item assessing restless sleep. The 19-item scale had excellent reliability ($\alpha = 0.93$).

Data analytic plan

Descriptive data for each sleep outcome within GMAs and non-GMAs were examined. Participants were then categorized into the following three groups for analyses: GMAs, heterosexual non-GMAs, and sexual minority non-GMAs (SM non-GMAs). Unadjusted associations between group (GMAs, heterosexual non-GMAs [reference group], and sexual minority non-GMAs) and sleep outcomes were examined using OLS regression for continuous outcomes (*sleep duration* and *inadequate sleep*) and logistic regression for dichotomized outcomes (*too much/too little sleep* and *sleep quality*). Third, multivariate regression models were estimated to examine demographically adjusted associations between group and sleep while adjusting for sex assigned at birth, age, SSS, and race/ethnicity. Another set of adjusted regression models was estimated including the above demographic variables as well as depressive symptoms to determine the unique associations between group and sleep problems, over and above current depressive symptoms. For dichotomous outcomes, logistic regression can overestimate odds ratios, especially for outcomes with high prevalence [41]. To account for this limitation, we also re-estimated rate ratios for all dichotomous models using Poisson regression with robust standard errors [42], and we report these re-estimated rate ratios. We conducted post hoc analyses with sexual minority non-GMAs recoded as the reference group to examine differences between GMAs and sexual minority non-GMAs on sleep outcomes, following the same approach outlined above. Last, since the sleep item was removed from the CES-D ("my sleep was restless"), we examined associations of our participant groups with this item since it is a continuous measure of sleep quality.

Results

Descriptive demographic information for the full sample, for GMAs, and for non-GMAs (heterosexual and SM) is presented in Table 1. Non-GMAs were similar to nationally representative data with regard to race/ethnicity [43]. Compared to non-GMAs, GMAs were more likely to report White race/ethnicity, minority sexual orientations, older age, lower SSS, and female sex assigned at birth. According to zip codes, participants lived in all 50 states as well as Washington, DC and Puerto Rico. Means and standard deviations of each sleep outcome and depressive

Table 1. Demographic and clinical characteristics of the sample

	Full sample (n = 1,779)		Non-GMA (n = 752)		GMA (n = 1,027)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age	16.0	1.2	15.9	1.1	16.0	1.2
Subjective social status	5.7	1.6	6.0	1.6	5.4	1.5
Sex assigned at birth	*n*	%	*n*	%	*n*	%
Female	1,479	83	557	74	922	90
Male	300	17	195	26	105	10
Race/ethnicity	*n*	%	*n*	%	*n*	%
White	1,167	66	468	62	699	68
Black	156	9	77	10	79	8
Latinx/Hispanic	156	9	78	10	78	8
Asian/Pacific Islander	64	4	40	5	24	2
Native American/Other	25	1	9	1	16	2
Mixed	210	12	79	11	131	13
Sexual orientation						
Straight/Heterosexual	359	20	329	44	64	3
Gay/Lesbian	289	16	98	13	368	19
Bisexual/Pansexual	768	43	263	35	927	48
Queer/Other/Questioning	351	20	54	7	542	28
Sleep parameters (range)						
Sleep duration (4–11)	6.72	1.33	6.82	1.19	6.64	1.42
Poor sleeper (0–1)	0.58	0.49	0.49	0.50	0.65	0.48
Inadequate sleep[†] (0–4)	1.83	0.92	1.97	0.91	1.72	0.91
Too much/too little sleep (0–1)	0.29	0.46	0.35	0.48	0.25	0.44
CES-D Composite Mean Score (without sleep) (1–4)	2.53	0.68	2.30	0.70	2.69	0.62

[†]lower score = more likely to have inadequate sleep.

symptoms are reported for the full sample, GMAs, and non-GMAs. GMAs reported sleeping an average of 6.64 hours each night, and non-GMAs reported sleeping 6.82 hours.

Unadjusted models

In unadjusted models (see Table 2 for full unadjusted results), GMAs reported sleeping significantly fewer hours each night compared to heterosexual non-GMAs (*sleep duration*). GMAs also had higher odds of *too much/too little sleep* and reported *inadequate sleep* more often than heterosexual non-GMAs. Finally, GMAs also had higher odds of poor *sleep quality* than heterosexual non-GMAs in unadjusted models. Similarly, sexual minority non-GMAs reported poorer sleep on all outcomes compared to heterosexual non-GMAs.

Adjusted Models

After adjusting for demographic covariates (sex assigned at birth, age, social status, and race/ethnicity; see Table 3), GMAs had higher odds of reporting poor *sleep quality* and getting *too little/too much sleep* compared to heterosexual non-GMAs. GMAs continued to report *inadequate sleep* significantly more often than heterosexual non-GMAs. Finally, GMAs reported sleeping significantly *fewer hours* than heterosexual non-GMAs, even when accounting for demographic variables. Similarly, sexual minority GMAs evidenced poorer sleep than heterosexual non-GMAs in demographically adjusted models with the exception of *inadequate sleep*.

In models adjusted for both demographics and depressive symptoms (Table 4), GMAs continued to be significantly more likely to report *poor sleep* quality than heterosexual non-GMAs, with a trend for a significant difference between these groups on *inadequate sleep*. All other differences were attenuated, and sexual minority non-GMAs were no longer significantly different than heterosexual GMAs on any sleep outcomes.[1]

Post hoc analyses

In additional analyses comparing GMAs to sexual minority non-GMAs, GMAs reported worse sleep on all variables in unadjusted models, with the exception of *sleep duration*. Significant differences were maintained in models examining likelihood of poor sleep and inadequate sleep when demographic covariates were added to the models, but all differences were attenuated when depressive symptoms were further added (values available upon request).

Given that the sleep item ("my sleep was restless") was removed from CES-D scores during coding, we ran additional analyses examining associations of our participant groups with this continuous measure of sleep as the outcome. Results using this variable showed that both GMAs and sexual minority non-GMAs reported significantly more restless sleep than heterosexual non-GMAs. While these effects remained significant when accounting for demographic covariates, differences fell below traditional levels of statistical significance when also accounting for depressive symptoms (values available upon request).

[1] We examined differences in sleep among gender identity subgroups (cisgender male [reference group], cisgender female, transgender female, transgender male, nonbinary female at birth, nonbinary male at birth, questioning gender identity). Nearly all groups reported significantly worse sleep on each sleep parameter in unadjusted models compared to cisgender males. Models adjusted for demographic variables showed that transgender males and females, and nonbinary females were significantly more likely to report poor sleep; all subgroups except nonbinary males were significantly more likely to report too little/too much sleep and inadequate sleep; transgender males and females, and questioning youth reported significantly shorter sleep duration. In models that further adjusted for depressive symptoms, cisgender females and transgender males reported being significantly more likely to report too little/too much sleep.

Table 2. Unadjusted OR and 95% CI for each sleep parameter for covariates and gender identity

	Poor sleep§				Too little/too much sleep‖				Inadequate sleep¶		Sleep duration#	
	OR	95% CI	RR	95% CI	OR	95% CI	RR	95% CI	*B*	*SE*	*B*	*SE*
Age	1.02	0.39–1.11	1.01	0.97–1.04	**0.90**	**0.82–0.98**	**0.93**	**0.87–0.99**	−0.1	0.02	0.01	0.03
Subjective social status	**0.82**	**0.77–0.82**	**0.92**	**0.90–0.95**	**1.17**	**1.09–1.25**	**1.11**	**1.07–1.17**	**0.04**	**0.01**	**0.09**	**0.02**
Sex assigned at birth*	**0.67**	**0.53–0.87**	**0.84**	**0.74–0.94**	**1.88**	**1.45–2.43**	**1.52**	**1.29–1.78**	**0.15**	**0.06**	0.15	0.08
Race/ethnicity†												
Black	1.31	0.93–1.85	1.11	0.98–1.26	0.84	0.58–1.22	0.88	0.67–1.16	**−0.20**	**0.08**	**−0.63**	**0.11**
Latinx/Hispanic	1.04	0.74–1.47	1.02	0.88–1.17	0.73	0.50–1.08	0.80	0.60–1.07	−0.11	0.08	−0.15	0.11
Asian/Pacific Islander	0.73	0.44–1.21	0.87	0.68–1.11	1.03	0.60–1.77	1.02	0.70–1.48	−0.20	0.12	−0.15	0.17
Native American/Other	**5.38**	**1.60–18.08**	**1.53**	**1.31–1.78**	0.71	0.28–1.80	0.78	0.39–1.58	−0.06	0.07	−0.29	0.27
Mixed	0.88	0.66–1.18	0.95	0.83–1.08	0.84	0.61–1.17	0.89	0.70–1.12	−0.20	0.12	−0.03	0.10
CES-D Composite Mean Score (w/o sleep) (1 – 4)	**2.95**	**2.52–3.45**	**1.54**	**1.46–1.64**	**0.38**	**0.32–0.45**	**0.52**	**0.47–0.58**	**−0.47**	**0.03**	**−0.62**	**0.04**
Gender identity‡												
GMA	**2.34**	**1.81–3.01**	**1.47**	**1.29–1.67**	**0.51**	**0.39–0.66**	**0.40**	**0.35–0.46**	**−0.32**	**0.06**	**−0.31**	**0.08**
Sexual Minority non-GMA	**1.38**	**1.03–1.85**	**1.18**	**1.02–1.38**	**0.68**	**0.50–0.92**	**0.63**	**0.53–0.75**	**−0.14**	**0.07**	**−0.24**	**0.10**

B = beta; CI = confidence interval; OR = odds ratio; RR = rate ratio; SE = standard error.
*Female is reference group; †White is reference group; ‡Heterosexual non-GMA is reference group; §Measure of sleep quality (scored 0 (poor sleeper) or 1 (good sleeper)); ‖Measure of sleep disturbance related to usually getting too much or too little sleep (scored at 0) or enough sleep (scored as 1); ¶Measure of sleep disturbance related to how often one gets enough sleep (5-point Likert scale from "never" to "always"; #Hours slept per night, range of 4–11 hours.
Bold values in table indicate significant findings.

Table 3. Adjusted odds ratios and 95% CI for each sleep parameter for covariates and gender identity

	Poor sleep[§]				Too little/too much sleep[‖]				Inadequate sleep[¶]		Sleep duration[#]	
	OR	95% CI	RR	95% CI	OR	95% CI	RR	95% CI	*B*	*SE*	*B*	SE
Age	1.00	0.92–1.09	0.999	0.97–1.03	**0.90**	**0.82–0.98**	**0.93**	**0.87–0.99**	−0.003	0.02	0.02	0.03
Subjective social status	**0.85**	**0.80–0.91**	**0.94**	**0.91–0.96**	**1.14**	**1.06–1.22**	**1.09**	**1.04–1.14**	0.02	0.01	**0.07**	**0.02**
Sex assigned at birth*	0.80	0.61–1.04	0.91	0.80–1.02	**1.68**	**1.28–2.20**	**1.40**	**1.19–1.64**	0.08	0.06	0.08	0.09
Race/ethnicity[†]												
Black	1.28	0.90–1.84	1.10	0.97–1.26	0.88	0.60–1.29	0.92	0.70–1.20	**−0.21**	**0.08**	**−0.62**	**0.11**
Latinx/Hispanic	1.02	0.71–1.45	1.01	0.88–1.16	0.80	0.53–1.18	0.85	0.64–1.14	−0.13	0.08	−0.12	0.11
Asian/Pacific Islander	0.89	0.53–1.49	0.95	0.74–1.22	0.89	0.51–1.54	0.92	0.64–1.34	**−0.27**	**0.12**	−0.22	0.17
Native American/Other	**4.43**	**1.30–15.08**	**1.39**	**1.19–1.63**	0.86	0.34–2.21	0.90	0.44–1.84	**−0.43**	**0.18**	−0.19	0.27
Mixed	0.81	0.60–1.10	0.92	0.81–1.05	0.90	0.64–1.26	0.93	0.74–1.17	−0.05	0.07	−0.01	0.10
Gender identity[‡]												
GMA	**2.07**	**1.59–2.70**	**1.39**	**1.22–1.58**	**0.61**	**0.47–0.81**	**0.73**	**0.61–0.87**	**−0.30**	**0.06**	**−0.28**	**0.09**
Sexual Minority non-GMA	**1.38**	**1.02–1.85**	**1.18**	**1.01–1.37**	**0.70**	**0.52–0.96**	**0.80**	**0.66–0.97**	−0.13	0.07	**−0.23**	**0.10**

*Female is reference group; [†]White is reference group; [‡]Heterosexual non-GMA is reference group; [§]Measure of sleep quality (scored 0 [poor sleeper] or 1 [good sleeper]); [‖]Measure of sleep disturbance related to usually getting too much or too little sleep (scored at 0) or enough sleep (scored as 1); [¶]Measure of sleep disturbance related to how often one gets enough sleep (5-point Likert scale from "never" to "always"; [#]Hours slept per night, range of 4–11 hours.
B = beta; CI = confidence interval; OR = odds ratio; RR = rate ratio; SE = standard error.
Bold values in table indicate significant findings.

Table 4. Adjusted OR and 95% CI for each sleep parameter for gender identity and covariates, including depression

	Poor sleep[§]				Too little/too much sleep[‖]				Inadequate sleep[¶]		Sleep duration[#]	
	OR	95% CI	RR	95% CI	OR	95% CI	RR	95% CI	B	SE	B	SE
Age	1.01	0.92–1.10	1.01	0.97–1.04	**0.89**	**0.81–0.98**	**0.93**	**0.87–0.99**	−0.01	0.02	0.01	0.02
Subjective social status	**0.91**	**0.85–0.97**	**0.97**	**0.94–0.99**	1.07	0.99–1.15	1.04	0.995–1.09	−0.02	0.01	0.02	0.02
Sex assigned at birth*	0.97	0.73–1.29	0.97	0.87–1.09	**1.43**	**1.07–1.89**	**1.22**	**1.04–1.43**	−0.02	0.06	−0.05	0.08
Race/ethnicity**												
Black	1.26	0.87–1.82	1.10	0.97–1.24	0.91	0.61–1.35	0.94	0.72–1.23	**−0.20**	**0.07**	**−0.60**	**0.11**
Latinx/Hispanic	1.001	0.69–1.45	1.01	0.88–1.16	0.81	0.54–1.21	0.87	0.65–1.17	−0.12	0.08	−0.11	0.11
Asian/ Pacific Islander	0.96	0.56–1.64	0.97	0.76–1.24	0.81	0.46–1.45	0.88	0.61–1.28	**−0.30**	**0.11**	−0.27	0.16
Native American/Other	**3.85**	**1.08–13.67**	**1.26**	**1.07–1.50**	1.09	0.41–2.92	1.06	0.54–2.07	**−0.36**	**0.18**	−0.12	0.26
Mixed	0.81	0.59–1.11	0.92	0.81–1.04	0.86	0.61–1.22	0.90	0.72–1.12	−0.06	0.07	−0.02	0.10
CES-D Composite Mean Score (w/o sleep) (1 – 4)	**2.64**	**2.24–3.12**	**1.47**	**1.38–1.57**	**0.41**	**0.34–0.49**	**0.55**	**0.49–0.62**	**−0.46**	**0.03**	**−0.61**	**0.05**
Gender identity***												
GMA	**1.45**	**1.09–1.92**	**1.20**	**1.06–1.36**	0.89	0.66–1.19	0.95	0.79–1.14	−0.11	0.06	−0.03	0.09
Sexual Minority non-GMA	1.16	0.85–1.59	1.10	0.95–1.27	0.83	0.60–1.14	0.91	0.75–1.09	−0.04	0.06	−0.11	0.09

*Female is reference group; **White is reference group; ***Heterosexual non-GMA is reference group; [§]Measure of sleep quality (scored 0 [poor sleeper] or 1 [good sleeper]); [‖]Measure of sleep disturbance related to usually getting too much or too little sleep (scored at 0) or enough sleep (scored as 1); [¶]Measure of sleep disturbance related to how often one gets enough sleep (5-point Likert scale from "never" to "always"); [#]Hours slept per night, range of 4–11 hours.
B = beta; CI = confidence interval; OR = odds ratio; RR = rate ratio; SE = standard error.
Bold values in table indicate significant findings.

Sensitivity analyses

We conducted sensitivity analyses to examine whether limiting our sample to adolescents currently enrolled in high school produced similar results as described above. The rationale for this analysis is based on the likelihood that being in school may impact sleep patterns experienced by adolescents (e.g. they have a set time they need to awaken for school in the morning), which might not be felt by adolescents not enrolled in school. Eighty-eight percent of participants indicated they were currently enrolled in high school (n = 1,564). When including only participants enrolled in high school, the same general pattern of results was observed in all adjusted models. We also examined differences in sleep among youth who were enrolled in high school (n = 1,560) as compared to youth enrolled in college (n = 144) and those not enrolled in any school (n = 274) (n = 1 did not provide data on this question). While systematic differences among these groups were not observed, youth not enrolled in school were more likely to report being a poor sleeper than those enrolled in school (χ^2 = 10.44, df = 2, p=0.005). Moreover, youth not enrolled in school were more likely to report poor sleep quality on the CES-D item than those enrolled in high school (t = –2.96, df = 81.5, p = 0.04) or college (t = –0.30, df = 216, p = 0.04).

Discussion

This is the first study to examine disparities in sleep between GMAs and their cisgender peers. Youth in our sample represent all 50 states, as well as Washington, DC and Puerto Rico, though the sample is not nationally representative. Our findings indicate the presence of sleep disparities among GMAs

compared to heterosexual non-GMAs, including sleeping fewer hours, being "poor sleepers," and being more likely to report sleep problems (too much/too little sleep and inadequate sleep) in unadjusted models, all of which were subjectively self-reported. These differences were maintained after adjusting for demographic variables. Only differences in sleep quality (being a poor sleeper) remained after controlling for demographic covariates and depressive symptoms, which may indicate the importance of the *perception* of poor sleep in this population. Consistent with prior literature, sexual minority non-GMAs also showed poorer sleep as compared to heterosexual non-GMAs [3, 10], though all differences between these two groups were no longer significant when controlling for depressive symptoms. GMAs reported poorer sleep on all sleep variables as compared to sexual minority non-GMAs, though these differences were also attenuated when including depressive symptoms and demographics in the models. Nevertheless, these differences suggest that GMAs may have an even greater risk of poor sleep than sexual minority non-GMAs, a group with documented sleep disparities [3, 10].

There are several reasons that GMAs may be more likely to exhibit sleep problems. Consistent with Minority Stress Theory, GMAs are more likely to experience early and current acute and chronic life stress, including childhood maltreatment and adversity [44], social rejection, and violence, among others [26, 27]. Each of these adverse experiences is individually tied to higher rates of sleep problems among adolescents, which can persist into adulthood [45]. GMAs also are more likely to be homeless, often as a result of unsupportive home environments, which may result in unsafe living and sleeping environments [46]. In our sample, 11.5% of GMAs participants reported ever being homeless for at least a week (compared to 4.9% of heterosexual non-GMAs, and 4.6% of sexual minority non-GMAs), suggesting that some youth represented here may have experienced such unsupportive environments. Unsupportive peer and family environments also may lead to social isolation and loneliness, which have also been linked with poor sleep [47]. These acute and chronic stressors are linked with disruptions in the biological stress response, including heightened cortisol and physiological activation, which may promote a heightened state of threat and alertness that interferes with sleep [48]. Thus, higher rates of adversity and stress among GMAs may be one mechanism through which GMAs have poorer sleep.

Sleep disparities observed among GMAs in this study may also result from disparities in mental health conditions, such as depression [14]. The significance of our results was reduced when adjusting for depressive symptoms, which suggests that poorer sleep may occur in the context of depression among GMAs. Specifically, poor sleep may be one symptom in a broader depressive disorder. However, given the cross-sectional nature of this study, the directionality and temporality of sleep and depression cannot be differentiated. Thus, sleep disturbances may be present prior to the onset of depression and other mental health problems, consistent with a growing body of research indicating that sleep problems precede depression [49], and in some cases contribute to its onset [30]. Alternatively, individuals with depression are more likely to have cognitive biases [50], which also may explain greater perceptions of sleep problems and being a poor sleeper. Regardless, sleep problems predict a more severe and poorer course of depression, and heightened risk for suicidality among all adolescents. This may be even further pronounced among GMAs, who are at heightened risk for depression and suicide [14].

Importantly, the amount of sleep reported by youth in our study was slightly lower than that reported among adolescents in the 2017 YRBS, which showed 25% of US high school students obtain 8 hours of sleep or more. In our study, 16% of non-GMA high school students reported obtaining 8 hours or more (15% sexual minority non-GMAs and 17% heterosexual non-GMAs). This rate could be lower in our sample because almost half of non-GMA participants identified as sexual minorities, and sexual minority adolescents are more likely to get less than 8 hours of sleep [3]. Additionally, since our sample was comprised of social media users (all participants were recruited via social media), the low rate of sufficient sleep in our sample may be related to the association of decreased sleep duration with screen time among adolescents [51].

To further advance our understanding of sleep disparities among GMAs compared to non-GMAs, future nationally representative studies of adolescents in the United States must measure gender identity accurately to determine whether our findings generalize, perhaps using the robust measurement of gender identity utilized in this study, or another similar measurement method. Since being enrolled in school may contribute to sleep–wake times that may be different during the school week (when youth cannot entirely choose their sleep schedule) than the weekend (when they may have more choice), we asked youth enrolled in school to provide information on sleep timing separately for weekday and weekend. Youth not enrolled in school may be less likely to have external influences on their sleep timing, without the schedule of school, or have schedules that are not consistent with weekend/weekdays, so they were asked about their sleep timing across the week as a whole. Indeed, our findings showed that youth not enrolled in school reported poorer sleep quality than those enrolled in high school or college. Future work should work to understand the mechanisms explaining this difference in poor sleep quality; moreover, future studies should consider asking questions pertaining to sleep patterns on weekend/weekdays (sometimes called free/work days) similarly across all participants to limit any potential measurement error. Last, in this study, sleep quality was primarily assessed with one item taken from the SSHS. Because the GMY Study covered many areas of health and functioning, we chose to ask about sleep quality with just one item to limit burden on participants. Future studies should seek to replicate our findings with a different measure of sleep quality, such as the Pittsburgh Sleep Quality Index [52], which has more than one item and may limit measurement error that could result from the dichotomization of poor sleep.

Further, more comprehensive and objective measures of sleep should be included in future studies to clarify whether differences in sleep are also reflected in objective measures. In addition, future longitudinal studies should examine the emergence of sleep disparities among GMAs and non-GMAs, which may identify specific pathways contributing to heightened risk for poor sleep and whether poor sleep contributes to the emergence of other observed mental health disparities. Future studies should also examine stages of gender transition, whether GMAs are engaging in hormone therapy, and the impact of testosterone and estrogen levels as potential contributors of sleep problems among GMAs. Last, given that our findings indicate the importance of *perceived* sleep problems, future efforts to intervene on sleep problems in gender minority youth may find the most impact by focusing on perceived sleep problems and poor sleep quality, should our findings be replicated.

This study indicates that GMAs may be more likely than non-GMAs to have poor sleep, including perceptions of sleep problems and perceived sleep quality. Given that GMAs have higher rates of negative mental health outcomes, and that sleep robustly predicts a range of health outcomes, sleep disparities may be a promising target for prevention and intervention programs to improve other health outcomes in GMAs, including depression and suicidality.

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