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Adult Body Mass Index Trajectories and Sexual Orientation:

The Nurses' Health Study II

Hee-Jin Jun, ScD, Heather L. Corliss, PhD, MPH, Lauren P. Nichols, BA, Mathew J. Pazaris, MS, Donna Spiegelman, ScD, and S. Bryn Austin, ScD

Channing Laboratory (Jun, Spiegelman, Austin), Brigham and Women's Hospital, Harvard Medical School, the Department of Society, Human Development, and Health (Jun, Austin), the Department of Epidemiology (Pazaris, Spiegelman), Harvard School of Public Health, the Division of Adolescent and Young Adult Medicine (Corliss, Nichols, Austin) Children's Hospital, Boston, Massachusetts

Abstract

Background—Cross-sectional research has documented elevated prevalence of obesity in lesbian and bisexual women relative to heterosexual women, but little is known about disparities in longitudinal patterns in BMI change during adulthood.

Purpose—To examine sexual orientation–related disparities in individual BMI trajectories throughout adulthood.

Methods—Data on BMI, sexual orientation, and sociodemographics were gathered prospectively from 1989 through 2005 from 90,713 U.S. women in the Nurses' Health Study II and examined in 2011 using general growth mixture modeling to identify BMI trajectories from ages 25 to 59 years. Multinomial logistic regression was used to determine whether sexual orientation was associated with BMI trajectory group membership.

Results—Four BMI trajectory groups were identified and labeled based on mean BMI within each group at baseline and final follow-up: Group 1: slow-weight-gain trajectory; Group 2: moderate-weight-gain trajectory; Group 3: rapid-weight-gain trajectory; and Group 4: obese-to-overweight trajectory. Lesbian and bisexual women showed consistently higher odds of membership in Groups 2–4 (adverse-weight-gain trajectories) versus Group 1 (the slow-weight-gain trajectory) relative to heterosexual women.

Conclusions—Both lesbian and bisexual women were more likely than heterosexual women to experience adverse-weight-gain trajectories in adulthood. New research efforts are needed to understand and eliminate these pronounced disparities.

Introduction

In the past 3 decades, the obesity prevalence, or percentage of adults with a BMI ≥ 30 has substantially increased in the U.S. population from 15% to 34%, resulting in a vast increase of related health consequences.^{1, 2} In 2007–2008, almost two thirds of women in the U.S.

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Address correspondence to: S. Bryn Austin, ScD, Division of Adolescent and Young Adult Medicine, Children's Hospital, 300 Longwood Ave., Boston MA 02115. bryn.austin@childrens.harvard.edu.

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aged ≥ 20 years were overweight ($25.0 \leq \text{BMI} < 30$) or obese ($\text{BMI} \geq 30$) and were therefore exposed to a seven-fold increased risk for diabetes, sixfold increased risk for high blood pressure, and fourfold increased risk for fair or poor health compared with adults of a healthy weight.^{2, 3}

The prevalence of overweight and obesity is higher among certain social groups, including those defined by race/ethnicity, region of residence, and age.⁴ Several studies have also found an increased likelihood of overweight and obesity among lesbian and bisexual girls and women compared to their heterosexual counterparts.^{5–10} Boehmer et al. found in a representative sample of U.S. women aged 15–44 years, that even when controlling for sociodemographic factors such as age, race/ethnicity, education, and health insurance, women with female partners had almost three and one half times the odds of being obese compared to women with male partners only.⁷ Similarly, studies have found a higher prevalence of overweight and obesity among bisexual girls and women compared to heterosexual peers.^{6, 9} In cross-sectional analyses based on data from 90,823 women aged 32–51 years participating in 1995 in the Nurses' Health Study II (NHSII), a prospective cohort of U.S. women, 19.8% of heterosexual women were obese compared to 28.2% of bisexual women and 28.1% of lesbians.⁹

The extant literature provides clear evidence from cross-sectional analyses that lesbian and bisexual women have disproportionately higher prevalence of overweight and obesity relative to heterosexual women. No studies to date, however, have prospectively examined sexual orientation differences in individual BMI change trajectories through adulthood. The current study will address this gap in the literature by examining weight change trajectories from early adulthood through midlife in a large sample of women ranging in age from 25 to 59 years.

Methods

Study Population

The NHSII began in 1989, when baseline questionnaires were sent to approximately 520,000 registered nurses from 14 populous U.S. states, and 116,430 women aged 24–44 years were enrolled in the study. Returning a completed questionnaire was considered an indication of consent to participate in the study. The cohort has been followed with biennial questionnaires assessing risk factors and disease incidence.¹¹ This study was approved by the IRBs at Brigham and Women's Hospital and the Human Subjects Committee at the Harvard School of Public Health.

A total of 25,717 were excluded from the original NHSII sample. Among them, 22,749 did not respond to the survey wave when sexual orientation was assessed, 2831 did not describe their sexual orientation as heterosexual, lesbian/gay, or bisexual, 100 did not report height at baseline, six had no BMI information, and 31 did not have BMI information during at least two different age groups were excluded. The final analytic sample included 90,713 women.

Measures

Outcome variables—NHSII participants reported their height and weight at baseline and each follow-up questionnaire, which was used to calculate their age-specific BMI from 1989 to 2005. Age-specific BMIs were averaged in 5-year groupings—ages 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, and 55–59 years—and then categorized as underweight ($\text{BMI} < 18.5$), healthy weight ($18.5 \leq \text{BMI} < 25$), overweight ($25 \leq \text{BMI} < 30$), and obese ($\text{BMI} \geq 30$). BMI values were excluded at waves when the participants were pregnant.

Predictor variables—To assess sexual orientation identity, an item was added to the questionnaire in 1995. The item read: “Whether or not you are currently sexually active, what is your sexual orientation or identity? (Please choose one answer),” with response options: “(1) Heterosexual, (2) Homosexual (Lesbian or gay), (3) Bisexual, (4) None of these, (5) Prefer not to answer.” In this study, the participants who reported their identity as heterosexual; lesbian, gay or homosexual; or bisexual were included.

Other Sociodemographics

Potential confounders were identified based on the theoretic and empirical literature and on prior research in NHSII^{9, 12} indicating that sexual orientation and BMI in the cohort differ by age, race/ethnicity, and region of residence at age 30 years. Thus, these variables were considered as potential confounders.

Statistical Analyses

This study was conducted in 2011. In the study, a longitudinal cohort sequential design was used, which allows assessment of the adulthood trajectory of BMI from ages 25 to 59 years using 1989–2005 data. Cohort sequential design¹ provides a valid way to link adjacent segments of limited longitudinal data (in this case, at most 16 years of data) from different age cohorts to determine the existence of a common developmental trend. Based on each age cohort from age 24 to 44 years at baseline, which contributes a different section of the overall curve, the complete curve using information from all cohorts simultaneously was built.²

Data analyses involved two steps. First, using prospectively collected, repeated measures data, general growth mixture modeling (GMM) was conducted for a categorical/ordinal outcome with Mplus version 5.1¹³ to identify distinct trajectories of change in 5-year averaged BMI (categorized as underweight, healthy weight, overweight or obese) from ages 25–29 to 55–59 years. GMM is a latent growth modeling technique that empirically classifies heterogeneity in developmental trajectories into groups that share similar growth patterns.¹⁴ GMM assumes that populations can be classified into two or more distinct subpopulations with different developmental trajectories.¹⁴ Second, once trajectories were identified, multinomial logistic regression was conducted, using the slow-weight-gain trajectory group as the reference, to determine whether sexual orientation was associated with trajectory group membership.

To estimate the GMM latent classes, maximum likelihood estimation using the expectation-maximization algorithm was used. Missing data were handled applying the assumption of missing at random.¹⁵ If models with two or more latent classes fit the data better, it is evidence of the existence of two or more trajectory classes. A series of models was fitted, beginning with a one-group trajectory model and moving to a five-group trajectory model, all with random starting values. The best-fitting model was established using the Bayesian Information Criteria (BIC), which is a commonly used fit index that compares non-nested models with different numbers of latent classes^{16, 17}. A lower BIC value indicates a better-fitting model. Also other considerations were used when selecting the optimal number of trajectory groups including adequate sample sizes within classes.^{14, 18}

Classification of respondents into a trajectory group is based on the model estimated posterior probabilities of belonging to each trajectory group. Participants were assigned to the trajectory group for which they had the highest posterior probability of membership.¹⁹ Final participant latent class trajectory membership was regressed on sexual orientation using multinomial logistic regression in SAS 9.1,²⁰ adjusting for baseline age, race/ethnicity, and region of residence at age 30 years.

Results

One through five trajectory models were compared to determine the optimal number of trajectory groups explaining change in BMI through adulthood. To assess the model fit, BIC values were inspected, starting at 475,457 for the one-trajectory model and decreasing with each increase in the number of trajectory groups, which indicated improvement in fit. The BIC value decreased to 474,338 for the two-trajectories model, to 474,019 for the three-trajectories model, to 473,480 for the four-trajectories model, and finally to 473,248 for the five-trajectories model.

For the one- through four-trajectories models, the number of participants in each trajectory group was greater than 1% of the analytic sample, but with the five-trajectories model, the number of participants in one group was unacceptably low ($n=328$, which is 0.3% of the analytic sample). Therefore, the four-trajectory model was chosen as the final model. This model provided four distinct trajectories of BMI change over time within the longitudinal sample, spanning from the youngest age period (25–29 years) to the oldest age period (55–59 years). In the final model, the four trajectory groups were labeled as follows based on mean BMI within each group at baseline in 1989 and at follow-up in 2005: Group 1: slow-weight-gain trajectory; Group 2: moderate-weight-gain trajectory; Group 3: rapid-weight-gain trajectory; and Group 4: obese-to-overweight trajectory.

Most participants were in the healthy BMI range for the study period (slow-weight-gain group, 61.8% of participants). The moderate-weight-gain trajectory included 22.4% who started off in the healthy weight ranges but over two thirds of the women became overweight or obese when they were in their late 50s. The rapid-weight-gain group included 14.0% of participants who were healthy or overweight at the beginning, but around late forties to early fifties, all members became obese.

The fourth trajectory, obese-to-overweight (1.8%), included those who started off obese and stayed obese until they were in their late 30s. The proportion of obese members in this group began to drop when participants were in their late 40s and 50s, but at the end of the trajectory participants were either obese or overweight. Figure 1 displays the mean BMI within each trajectory group at each age period from baseline to final follow-up.

Table 1 summarizes the distributions of sexual orientation and other sociodemographics within each of the four BMI trajectory groups. Women who were sexual minorities, in the younger age cohort, who were of African-American race/ethnicity, or who lived in the Midwest were over-represented in the other types of BMI trajectories relative to distributions of these sociodemographics within the Slow-weight-gain group.

Multinomial logistic regression models were fitted to determine whether being lesbian or bisexual was associated with BMI trajectory group membership after controlling for potential confounding (Table 2). Sexual minorities showed consistently higher odds of membership in moderate-weight-gain, rapid-weight-gain, and obese-to-overweight trajectory compared to the slow-weight-gain trajectory (Group 1) relative to heterosexual women. Lesbian women were more likely to be in the moderate-weight-gain group (OR=1.3, 95% CI=1.1, 1.6), rapid-weight-gain (OR=1.8, 95% CI=1.4, 2.2) and the obese-to-overweight group (OR=1.8, 95% CI=1.1, 3.0); bisexual women were also more likely to be in the moderate-weight-gain (OR=1.6, 95% CI=1.2, 2.0) and rapid-weight-gain group (OR=1.7, 95% CI=1.3, 2.3) and 2.4 times (95% CI=1.3, 4.7) more likely to be in obese-to-overweight group relative to heterosexual women.

Discussion

Longitudinal patterns in BMI change in women were examined. Both lesbian and bisexual women are more likely than heterosexual women to experience steep weight-gain trajectories throughout adulthood. After identifying four distinct BMI trajectories in a prospective cohort of almost 100,000 women, lesbian and bisexual women had between one and one third and two and one half times the risk of being in the three most adverse weight trajectories compared to heterosexual women.

There have now been a number of cross-sectional studies examining overweight and obesity in adult lesbians, and these studies have consistently found elevated prevalence in lesbian relative to heterosexual women.²¹ The magnitude of observed sexual orientation-related BMI disparities is as large as that observed by race/ethnicity in U.S. women.^{8, 22} This current work using growth mixture modeling techniques with prospective data from NHSII indicates that lesbians are more likely than heterosexual women to experience adverse, continual-weight-gain trajectories from their mid-20s through age 59 years, the age range observed in the study.

In addition, bisexual women in the cohort were similar to lesbians in experiencing elevated risk of continual-weight-gain trajectories compared to heterosexual women. Elevated BMI in bisexual women and girls relative to heterosexual peers was also found in the Growing Up Today Study, a longitudinal cohort of over 16,000 adolescent children of women participating in NHSII.⁶ This finding for bisexuals differs from two previous cross-sectional studies, both of which used representative samples and did not find elevated BMI in bisexual relative to heterosexual women.^{9–11}

It is noteworthy that NHSII, and therefore also the cohort of their adolescent children, is relatively homogenous, and, as a result, confounding by race/ethnicity and SES is reduced by design and findings from both cohorts may be most generalizable to white women and girls. Differing findings for bisexual women/girls in representative samples suggests either that those analyses are affected by residual confounding after controlling for race/ethnicity and SES, as these studies did, or that race/ethnicity, SES, or other factors may modify associations between sexual orientation and BMI. Of note, race/ethnicity and SES are differentially distributed across sexual orientation subgroups in representative samples.^{8, 10} New research is critically needed to investigate ways that the health experiences of lesbian and bisexual women may differ by race/ethnicity, SES, and other important social factors.

Causal mechanisms that underlie the pronounced sexual orientation related disparities in BMI trajectories adult women are not known, although it has been proposed that the combined effects of stress associated with being a member of a socially stigmatized group and sexual orientation-related gender nonconformity may contribute to elevated BMI in lesbian and bisexual women.⁶ Sexual Minority Stress Theory posits that sexual minority populations (e.g., lesbian, gay, or bisexual people or people with same-sex sexual partners or attractions) experience unique stressors in environments that stigmatize minority sexual orientations²³ and that these stressors cause adverse health consequences for sexual minorities in a range of health domains, including depressive symptoms, PTSD, eating disorder symptoms, and substance use.^{23–28}

In addition to the possible effects of minority stress on BMI, another plausible pathway involves gender socialization and norms. Weight-related behaviors/concerns are well-recognized as culturally gendered (e.g., dieting and excessive concern with weight are culturally defined as feminine)^{44, 45}; the combined influences of normative gender socialization and gender nonconforming expression, which is more common in lesbian and bisexual than in heterosexual women and girls,^{40, 41} may pattern weight-related behaviors

and concerns in a way that increases obesogenic behaviors in lesbian and bisexual women and girls. Further research is needed to examine these and other plausible psychological, physiologic, and behavioral pathways to explain sexual orientation–related obesity disparities in women and girls.

There are several limitations to the study. NHSII is a cohort of registered nurses and is not a representative sample. Because the cohort is made up primarily of white women and includes a narrower socioeconomic range than can be found in the U.S., generalizability is reduced, although the risk of confounding by uncontrolled factors associated with race/ethnicity and SES is also reduced. The cohort was not assembled on the basis of sexual orientation, which eliminates enrollment bias related to the primary predictor in the analyses.

Among the 25,717 participants who were excluded from the analyses, the vast majority were nonrespondents to the 1995 questionnaire, while 1.9% responded to this questionnaire but skipped the item on sexual orientation and 0.5% checked a response indicating that they preferred not to answer or did not describe themselves as heterosexual, lesbian, or bisexual. While some of these participants may have been lesbian or bisexual but were reluctant to identify themselves that way on the survey, the participants were likely heterogeneous and therefore were excluded from analyses because it was not possible to determine their sexual orientation. Height and weight data were self-reported rather than measured, which can introduce some misclassification, although expecting this misclassification to be modest⁴² and to be nondifferential relative to sexual orientation, as one recent study found no evidence of sexual orientation–related bias in self-reported BMI in women.⁴³

Large disparities in overweight and obesity adversely affecting lesbian and bisexual women are well-documented, clear, and compelling. The reasons underlying these disparities, however, are poorly understood. Eliminating these profound disparities will require serious scientific attention from both the obesity and disparities research communities to uncover both the causes of high prevalence of overweight and obesity in lesbian and bisexual women and also effective leverage points to reduce and ultimately eliminate these disparities.

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Figure 1.
BMI trajectories for ages 25–59 years (The Nurses' Health Study II, N=90,713)

Sample distributions across four groups of BMI trajectory in women aged 25–59 years participating in the Nurses' Health Study II (N=90,713), *n* (%)

Table 1

	Slow-weight-gain	Moderate-weight-gain	Rapid-weight-gain	Obese-to-overweight
	56085 (61.8)	20292 (22.4)	12,738 (14.0)	1598 (1.8)
Sexual orientation				
Heterosexual	55,558 (99.1)	20,033 (98.7)	12,539 (98.4)	1,572 (98.4)
Lesbian	367 (0.7)	170 (0.8)	140 (1.1)	16 (1.0)
Bisexual	160 (0.3)	89 (0.4)	59 (0.4)	10 (0.6)
Age group at baseline (years)				
24–34	27,148 (48.4)	9,647 (47.5)	6,502 (51.0)	1,221 (76.4)
35–44	28,937 (51.6)	10,645 (52.4)	6,236 (49.0)	377 (23.6)
Race/ethnicity				
White	51,804 (92.4)	18,787 (92.6)	11,788 (92.5)	1,466 (91.7)
Black	569 (1.0)	342 (1.7)	341 (2.7)	33 (2.1)
Latina	735 (1.3)	301 (1.4)	179 (1.4)	22 (1.4)
Asian and others	2,977 (5.3)	862 (4.3)	430 (3.4)	77 (4.8)
Region of residence at age 30 years				
Northeast	17,464 (31.2)	6,178 (30.4)	3,720 (29.2)	405 (25.4)
Midwest	15,970 (28.4)	6,148 (30.3)	4,198 (33.0)	524 (32.8)
South	8015 (14.3)	2954 (14.6)	1911 (15.0)	220 (13.8)
West	8,235 (14.7)	2,593 (12.8)	1,298 (10.2)	114 (7.1)
Non-U.S. or missing	6,401 (11.4)	2,419 (11.9)	1,611 (12.7)	335 (21.0)

ORs (95% CI) for sexual orientation predicting slow-weight-gain versus other types of BMI trajectory groups in women aged 24–59 years participating in the Nurses' Health Study II

Table 2

	Moderate-weight-gain			Rapid-weight-gain			Obese-to-overweight		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Sexual orientation									
Heterosexual	1.0			1.0			1.0		
Lesbian	1.3	(1.1, 1.6)	0.004	1.8	(1.4, 2.2)	<.0001	1.8	(1.1, 3.0)	0.026
Bisexual	1.6	(1.2, 2.0)	0.001	1.7	(1.3, 2.3)	0.001	2.4	(1.3, 4.7)	0.006
Age at baseline (years)									
35–44	1.0			1.0			1.0		
24–34	1.0	(0.9, 1.0)	0.018	1.1	(1.1, 1.2)	<.0001	3.3	(2.9, 3.7)	<.0001
Race/ethnicity									
White	1.0			1.0			1.0		
Black	1.7	(1.4, 1.9)	<.0001	2.7	(2.3, 3.1)	<.0001	2.3	(1.6, 3.3)	<.0001
Latina	1.2	(1.0, 1.4)	0.018	1.2	(1.0, 1.4)	0.054	1.2	(0.8, 1.8)	0.503
Asian and others	0.8	(0.8, 0.9)	<.0001	0.7	(0.6, 0.7)	<.0001	0.9	(0.7, 1.1)	0.288
Region of residence at age 30 years									
Northeast	1.0			1.0			1.0		
Midwest	1.1	(1.1, 1.1)	<.0001	1.2	(1.2, 1.3)	<.0001	1.4	(1.2, 1.6)	<.0001
South	1.0	(1.0, 1.1)	0.202	1.1	(1.0, 1.2)	0.003	1.1	(1.0, 1.4)	0.118
West	0.9	(0.8, 0.9)	<.0001	0.7	(0.7, 0.8)	<.0001	0.6	(0.5, 0.8)	<.0001
Non-U.S. or missing	1.1	(1.0, 1.1)	0.011	1.2	(1.1, 1.2)	<.0001	1.9	(1.7, 2.2)	<.0001