



Article

Education and health: The joint role of gender and sexual identity

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ABSTRACT

Background: Prior research has found that education's association with health can differ by social positions such as gender. Yet, none of the existing work has tested whether the relationship between education and self-rated health is equivalent across sexual orientation groups, and additionally, if these associations differ for men and women. Deploying the intersectionality perspective, we expand current debates of education as a resource substitution or multiplication to include sexual orientation.

Methods: We answer these questions using data from the Behavioral Risk Factor Surveillance System (BRFSS), a probability-based sample of adults living in 44 US states and territories for selected years between 2011 and 2017 (n = 1,219,382).

Results: Supporting resource multiplication, we find that compared to their same-gender heterosexual counterparts, education is less health-protective for bisexual adults, especially bisexual women. Gay men and lesbian women, on the other hand, seem to have similar associations of education with health as their same-gender heterosexual counterparts. Turning to gender comparisons across sexual identity groups, we find that resource substitution may operate only among heterosexual women when compared with heterosexual men.

Conclusions: In sum, this study suggests that the relationship between education and health may depend on the intersection of gender and sexual orientation among U.S. adults.

Introduction

Education, a key component of socioeconomic status, is a fundamental cause of health (Link & Phelan, 1995; Ross & Mirowsky, 2010). Higher education is linked to an array of physical and mental health conditions, including health-promoting behaviors and psychological and physical wellbeing (Lawrence, 2017; Zhang et al., 2011). Yet, studies also suggest that education may not impart the same health benefits to all groups of people. For instance, Ross and Mirowsky (2010) found that education improved women's physical health more than men's health. They argued that this is due to *resource substitution*, wherein a disadvantaged group benefits more from additional resources compared to an already advantaged group. They also discussed an alternative perspective, *resource multiplication*, which argues that people in more advantaged social positions are better able to reap additional health benefits from further education.

However, to date, studies testing resource substitution have not considered sexual orientation. Sexual minorities—including lesbian,

gay, and bisexual (LGB) individuals—are an economically and socially disadvantaged group relative to heterosexuals with disparities particularly pronounced for bisexual men and women (Conron et al., 2010; Dilley et al., 2010; Gorman et al., 2015; Jackson et al., 2016). Yet, it remains unclear whether sexual minorities, and bisexual adults in particular, encounter more difficulties reaping health benefits from higher education. Additionally, research indicates that gay and lesbian adults have higher educational attainment than the US adult population, while bisexual adults have less (Herek et al., 2010; Pew Research Center, 2013), leaving open the question of whether their differential education levels translate to better health or counterbalance other health disadvantages. Moreover, prior research using samples of mostly heterosexual adults found that increased education was associated with more health improvement for women than men (Mirowsky & Ross, 2003). Yet, whether and how gender modifies the relationship between education and health among sexual minority adults remains unknown.

Given the importance of education for health and well-being across the life course (Mirowsky & Ross, 2003), our paper contributes to

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existing scholarship by investigating two related questions. First, does the association between educational attainment and self-rated health vary by sexual orientation? Inspired by the work of [Ross and Mirowsky \(2010\)](#), we test the resource substitution and resource multiplication perspectives in relationships between education and health based on sexual orientation. Second, does gender – another fundamental cause of poor health – moderate these relationships? Here we build upon prior studies that establish gender differences in how education relates to health status and further consider sexual orientation. As such, we apply an intersectional framework and examine whether selected intersectional groups (e.g., bisexual women) experience particularly poor health outcomes. To explore these questions, we use data from the 2011–2017 Behavioral Risk Factor Surveillance System (BRFSS) and examine how the association between education and self-rated health status (contrasting those who report poor-to-fair health with those who report better health) varies across intersections of sexual orientation and gender.

Literature review

Education and health: resource substitution or multiplication?

The annual number of deaths attributed to not having a high school diploma is larger than the number of deaths attributed to cigarette smoking ([Krueger et al., 2015](#)). Education's far reaching effects on health operate through various pathways, including increased economic resources (e.g., good employment, higher income), better access to medical care, larger social networks, a work environment that promotes healthier life styles, and increased self-efficacy that helps individuals devise better strategies to avoid poor health and cope with health-damaging conditions ([Mirowsky & Ross, 2003](#); [Turner & Lloyd, 1999](#); [Zimmerman et al., 2004](#)).

In this study, we draw on work from [Ross and Mirowsky \(2010\)](#) to examine how sexual orientation relates to education and health. Their *resource substitution* perspective posits stronger health-protective effects of education among disadvantaged populations because they have fewer alternative health-promoting resources. Guided by this perspective, current scholarship has examined how various social positions such as gender and childhood socioeconomic status moderate the relationship between education and health ([Bauldry, 2015](#); [Ross & Mirowsky, 2010](#); [Schann, 2014](#)). This research shows that U.S. women reap more mental and physical health benefits from higher education than men ([Ross et al., 2012](#); [Ross & Mirowsky, 2010](#); [Thurston et al., 2005](#); [Zajacova, 2006](#)), and that higher education improves mental wellbeing and reduces symptoms of depression more for individuals from poor families than those from better-off families ([Bauldry, 2015](#); [Schann, 2014](#)).

Alternatively, a *resource multiplication or reinforcement of advantage* perspective argues that people with more resources or in a more advantaged social position tend to realize more health benefits from higher education ([Ross & Mirowsky, 2010](#)). In line with this perspective, [Bauldry \(2014\)](#) found that a college degree improved the self-rated health of young adults from advantaged backgrounds more than disadvantaged youth. Other evidence also points to higher returns in life satisfaction and self-rated health from a college degree among men from privileged family backgrounds ([Andersson, 2016, 2018](#)). Taken together, the perspectives of *resource substitution* and *resource multiplication* may reflect the complex relationship between education and wellbeing rather than questioning the validity of either perspective, inviting a more nuanced analysis by considering varying social contexts and different health outcomes. Guided by this research, we aim to shed light on social groups that encounter more difficulties and structural barriers in translating educational gains into health benefits.

Education and health at the intersections of sexual identity and gender

Current work that simultaneously assess the role of sexual

orientation and gender in shaping the relationship between education and health is lacking. Yet, an intersectional approach argues that social positions including sexual orientation and gender, entail varying advantages and disadvantages and are interconnected in multiplicative ways, leading to substantial implications for health disparities ([Bowleg, 2012](#)). In other words, a health outcome does not result from a simple summation of advantaged and disadvantaged social positions. Rather, individuals with different combinations of social positions likely have unique health benefits or face additional challenges in improving health. One manifestation is that the health benefits associated with higher levels of education may be suppressed or magnified substantially by the presence of another social position (e.g., gender, sexual orientation), which is similar to the debate of resource substitution and multiplication perspectives in the association between education and health.

Moreover, recent studies have found evidence that gender and sexuality intersect in shaping physical health ([Conron et al., 2010](#); [Gorman et al., 2015](#); [Jackson et al., 2016](#)). Importantly, many of these studies not only unravel important intersecting effects of gender and sexuality for self-assessed health, they also emphasize the role of socioeconomic resources, including educational attainment, in these relationships ([Denney et al., 2013](#); [Liu et al., 2017](#); [Thomeer, 2013](#)). Yet, none of this research addresses whether and how sexual orientation and gender jointly modify the relationship between education and health. Further, most of this research relies on household rosters to identify same-sex couples, resulting in analyses of only cohabiting adults and preventing further analysis on sexual identity since all persons in same-sex relationships (e.g., gay, lesbian, bisexual) are combined together.

Sexual identity offers a new lens to examine the association between education and health ([Fine, 2015](#); [Herek et al., 2010](#); [Pew Research Center, 2013](#); [Solazzo et al., 2017](#)). Gay and lesbian adults, especially gay men, tend to have an educational advantage over their same-gender heterosexual counterparts ([Herek et al., 2010](#); [Fine, 2015](#)), while emerging evidence suggests that bisexual adults may have less education than heterosexual and gay and lesbian adults ([Mollborn & Everett, 2015](#); [Solazzo et al., 2017](#)). Health presents a similarly complex picture. Lesbian women, bisexual women, and gay men have higher odds of poor self-rated health than their same-gender heterosexual counterparts, with disparities greatest among bisexual women ([Dilley et al., 2010](#); [Fredriksen-Goldsen et al., 2010](#)). However, other work shows that gay and bisexual men have similar odds of poor self-rated health to heterosexual men, as do lesbian women compared to heterosexual women ([Conron et al., 2010](#); [Gorman et al., 2015](#)). Altogether, considering the lack of research on bisexual adults and that gay and lesbian adults report higher levels of education but not better self-rated health than their same-gender heterosexual peers, we should test whether education has different associations with health by sexual orientation.

Sexual identity is critical for analyzing the relationship between education and health because it is also a fundamental cause of poor health ([Hatzenbuehler et al., 2013](#)). Multiple pathways connect sexual minority status to health outcomes, including economic resources, health behaviors, access to medical care, and social networks ([Bränström et al., 2016](#); [Link & Phelan, 1995](#)), which are also important pathways connecting education and health ([Mirowsky & Ross, 2003](#)). An intersectionality perspective posits that the potential pathways from education to health status differ based on a person's positionality including those characterized by their gender and sexual identity.

The current study

Taken together, given the complex relationship between education, health, sexual orientation, and gender, we test the following hypotheses:

Hypothesis 1a. (resource substitution): Compared to their same-gender heterosexual peers, education will be *more* strongly related to self-rated health for gay, lesbian, and bisexual adults.

Hypothesis 1b. (resource multiplication): Compared to their same-gender heterosexual peers, education will be *less* strongly related to self-rated health for gay, lesbian, and bisexual adults.

After testing these two hypotheses among *men* and *women* separately, we next advance prior work by testing the gender differences in education's associations with health for each sexual-orientation group (i.e., heterosexual, gay and lesbian, and bisexual):

Hypothesis 2a. (resource substitution): Compared to men with the same sexual orientation, education will be *more* strongly related to self-rated health for women.

Hypothesis 2b. (resource multiplication): Compared to men with the same sexual orientation, education will be *less* strongly related to self-rated health for women.

Data and methods

Data and sample

Data for this study comes from the Behavioral Risk Factor Surveillance System (BRFSS). The Center for Disease Control (CDC) conducts the BRFSS annually, with individual state's (or territory's) health departments fielding the survey. Each year, households are selected through a disproportionate stratified sample design, with one individual adult member randomly selected to be surveyed for each household (CDC 2016). The BRFSS queries about demographics and socioeconomic characteristics, health behaviors, health status, and use of health care. In addition to questions required by the CDC, states can include extra questions they either write themselves or pull from optional modules on a variety of health-related topics, provided by the CDC. Between 2011 and 2017, 43 states and one territory asked about sexual orientation either through a question added by an individual health department, or through choosing to ask the questions included in the CDC's optional module on sexual orientation and gender identity (available for the 2014–2017 waves).

Our analytic sample includes all states and territories that asked about sexual orientation during this seven-year period (see Appendix A), resulting in 169 state-years and an initial sample of 1,537,332 adults. We included only men and women who identified as heterosexual, gay/lesbian, or bisexual and omitted those who identified their sexual orientation as "other" or had missing sexual orientation ($N = 1,314,868$). Next, we included only people who had no missing values on self-rated health and education ($N = 1,308,320$). We also limited the sample to those age 25 or above ($N = 1,219,382$), because most people should have adequate time to attain a college degree by age 25. Prior research has also shown that the effects of education on health are already detectable in young adulthood (Andersson, 2018; Bauldry, 2014). Altogether, this results in a final analytic sample of 9,598 gay men, 7,732 lesbian women, 5,050 bisexual men, 8,596 bisexual women, and 1,188,406 heterosexual men and women.

Measures

Our dependent variable is self-rated health, with respondents rating their general health status on a five-point scale. We dichotomized this into 1 = poor or fair health, and 0 = good, very good, or excellent health, since poor self-rated health (SRH) is correlated with numerous chronic conditions (Singh-Manoux et al., 2006). The independent variables of interest are education, sexual orientation, and gender. *Education* is measured as whether a person has less than a high school degree, a high school degree or GED, some college, or a college degree or more. We stratified our analysis based on *sexual orientation* and a dichotomous measure of *gender*. *Sexual orientation* measures whether someone identifies as heterosexual, gay or lesbian, or bisexual. Although the exact wording varies slightly on state-written sexual orientation questions, it was most often asked as "Do you consider yourself to be: 1)

heterosexual/straight, 2) lesbian or gay, 3) bisexual?"

We include a variety of control variables to adjust for potential confounders of the relationship between education, sexual orientation, gender, and health. Demographic controls include *age* (25–80) (an age-squared term is also included), *race/ethnicity* (non-Hispanic white, non-Hispanic black, Hispanic, other), *number of children under age 18 in household* (0–3+), and *marital status* (married, unmarried couple, formerly married, never married).

We include additional variables that are related to the pathways linking education and physical health (Mirowsky & Ross, 2003; Turner & Lloyd, 1999; Zimmerman et al., 2004). These pathways, including economic resources, healthier behaviors, access to medical care, and self-efficacy to cope with stress, are important to consider because they also vary significantly by gender and sexuality (Gorman et al., 2015; Institute of Medicine, 2011; Klawitter, 2014; Lunn et al., 2017; Przedworski et al., 2014). Specifically, measures of socioeconomic resources include total household income (less than \$25,000, \$25,000–49,999, \$50,000–74,999, and \$75,000 and more), employment status (paid employment, homemaker or student, retired, and out of work or unable to work), and dichotomous measures of *health insurance* and having *missed medical care in the past year due to cost*. For indicators of access to medical care and other health behaviors, we consider dichotomous measures of having had a *routine check-up in the past year* and having a *personal doctor*, *weight status* (underweight, normal weight, overweight, obese) and dichotomous measures of *exercised in the past month*, *any heavy drinking* (defined as more than 1 drink per drinking occasion for women, and more than 2 drinks per drinking occasion for men), and *current smoking*. Finally, a measure of the number of *poor mental health days in the past month* was included to capture variations in mental health across groups.

Analytic plan

Item non-response was small in our sample (2.5%), except for body weight status and income where 5.7% and 13.0% of cases were missing, respectively. We used multiple imputations with chained equation to manage item non-response and avoid biasing the data (Allison, 2012). Respondents who did not respond to the dependent variable and those with missing sexual orientation were included in the imputation but excluded in the analysis, in keeping with best practices (Von Hippel, 2007). Multiple imputation was done in Stata 15.0 using the "mi impute chain" command and five imputations.

We first present weighted descriptive statistics, stratified by gender and sexual orientation. We tested for group-level differences in descriptive statistics for gay, lesbian, and bisexual men and women compared to their same-gender heterosexuals. We also tested for group-level differences within sexual orientation and across gender (i.e. comparing gay men to lesbian women). Following, we ran logistic regression models to predict poor-to-fair self-rated health based on education. All models included state and year of interview to control for differences in LGB climate over the study period. Models were all weighted and adjusted for complex survey design using Stata's "svy" commands. In order to better understand results of logistic regressions in a linear scale (Mize, 2019), we graphed predictive probabilities of poor-to-fair self-rated health by education for specific gender*sexual orientation groups using the "mimgrns" command in Stata 15 for multiply imputed data (Klein, 2014).

Results

Descriptive statistics

Descriptive statistics are presented in Table 1, stratified by gender and sexual orientation. Looking first at self-rated health, a significantly higher proportion of gay men, bisexual men, and bisexual women reported poor-to-fair self-rated health than their heterosexual

Table 1
Descriptive statistics by sexual orientation and gender.

	Men			Women		
	Heterosexual (N = 495,723)	Gay (N = 9598)	Bisexual (N = 5050)	Heterosexual (N = 692,683)	Lesbian (N = 7732)	Bisexual (N = 8596)
Poor-to-fair self-rated health	18.02	15.89	23.05	19.16	20.33	27.34
Sociodemographics						
Race						
White (ref)	67.65	68.31	60.97	68.09	69.45	65.10
Black	9.49	8.61	10.92	<i>10.48</i>	10.55	12.50
Hispanic	15.04	15.13	16.43	<i>14.12</i>	11.21	13.57
Other	7.82	7.96	11.68	7.31	8.79	8.82
Age	50.83	47.07	47.14	<i>52.50</i>	47.55	39.95
Children in household	0.65	0.12	0.48	<i>0.71</i>	0.48	0.86
Marital status						
Married (ref)	61.78	19.24	34.76	56.50	28.90	33.62
Part of an unmarried couple	4.20	17.93	7.61	3.65	20.64	10.99
Formerly married	17.59	9.69	19.83	<i>27.49</i>	16.77	24.36
Never married	16.44	53.13	37.81	<i>12.35</i>	33.69	31.03
Socioeconomic status						
Education						
Less than high school (ref)	14.07	6.81	16.37	12.66	9.20	13.06
High school or GED	27.99	18.98	24.69	25.86	18.13	21.77
Some college	28.85	31.39	30.96	<i>32.08</i>	32.31	36.24
College or more	29.09	42.82	27.98	<i>29.40</i>	40.36	28.93
Employment status						
Employed (ref)	65.55	66.23	59.72	50.36	61.49	57.49
Homemaker or student	1.52	3.13	4.19	<i>14.84</i>	5.55	14.94
Retired	20.42	13.48	17.01	<i>21.83</i>	13.62	6.14
Out of work or unable to work	12.51	17.16	19.08	<i>12.96</i>	19.35	21.43
Income						
Less than \$25,000 (ref)	23.20	26.48	36.56	29.76	28.98	41.28
\$25,000–49,999	24.05	22.92	26.33	<i>24.72</i>	22.37	24.74
\$50,000–74,999	16.16	15.74	12.99	<i>15.29</i>	13.91	12.89
\$75,000 or more	36.59	34.86	24.12	<i>30.23</i>	34.73	21.09
Health insurance	87.07	88.27	82.21	<i>90.21</i>	88.86	85.13
Missed medical care due to cost	11.80	13.46	21.06	<i>13.98</i>	17.62	26.76
Health indicators						
Routine check-up in past year	66.48	71.28	65.36	<i>75.31</i>	71.68	64.93
Has personal doctor	76.48	82.33	72.03	<i>87.03</i>	84.57	76.90
Exercised in past month	76.32	78.53	74.39	<i>73.55</i>	75.72	75.66
Weight status						
Underweight (ref)	0.79	0.94	1.45	1.98	1.87	2.70
Normal	24.17	34.48	28.81	36.65	30.62	31.14
Over	43.29	39.47	37.95	<i>31.10</i>	29.82	25.66
Obese	31.75	25.11	31.79	<i>30.27</i>	37.69	40.51
Heavy drinker	21.71	24.53	25.21	<i>22.28</i>	34.46	37.09
Current smoker	18.79	25.42	25.36	<i>14.71</i>	25.90	30.79
Mental health						
Poor mental health days in past month	2.99	4.98	6.05	<i>4.06</i>	6.05	8.72

Note: **Bolded values** represent significant ($p < .05$) differences from same-gender heterosexuals; *Italicized values* represent significant ($p < .05$) comparisons to same-sexual orientation men.

counterparts. Of all groups, bisexual women had the highest rate of poor-to-fair self-rated health, at 27.3%.

Overall, **Table 1** also shows that, compared to their same-gender heterosexual peers, gay, lesbian and bisexual men and women were more disadvantaged in overall socioeconomic status (i.e., less income, higher likelihood of missing medical care due to cost), health indicators (i.e., higher proportions of heavy drinkers and current smokers), and mental health. Notably, however, we see that gay men and lesbian women reported significantly higher levels of education than their heterosexual and bisexual peers. Across all sexual orientation groups, **Table 1** generally shows that bisexual men and women had fewest socioeconomic and healthcare resources (e.g., lowest income, lowest insurance rate, and smallest likelihood of having a personal doctor).

Table 1 also includes comparisons across gender but within sexual orientation groups. Heterosexual, lesbian, and bisexual women all reported worse self-rated health than men of their same sexual orientation. Broad differences in other covariates were evident between heterosexual men and women, but differences between gay and lesbian adults as well as bisexual men and women were more muted. Gay men and lesbian

women were similar on a range of demographics (age), socioeconomic status (health insurance), and health indicators (routine checkup, personal doctor, and current smoker). Bisexual men and women showed less similarity across characteristics than gay and lesbian adults, with bisexual men being older, living with fewer children, and having a higher socioeconomic status than bisexual women. And while a lower proportion of bisexual men reported having a personal doctor than bisexual women, they reported lower rates of heavy drinking and smoking, and fewer days when their mental health was poor during the past month.

Logistic regression models

Tables 2 and 3 include results of analyses that test two-way interactions of education*sexual orientation as well as education*gender in models stratified by gender and sexual orientation, respectively. Models in **Table 2** control for state, survey year, and demographic variables. We draw on results from **Table 2** to test the basic relationship between education and health by gender and sexual identity. Models in

Table 2
Odds ratios for education predicting poor-to-fair self-rated health.

	Model 1 Men	Model 2 Women	Model 3 Heterosexual	Model 4 Gay/Lesbian	Model 5 Bisexual
Education (ref: Less than high school)					
High school or GED	0.46***	0.42***	0.47***	0.45**	0.74
Some college	0.34***	0.30***	0.35***	0.35***	0.49**
College or more	0.16***	0.13***	0.17***	0.20***	0.22***
Sexual orientation (ref: Heterosexual)					
Gay/Lesbian	0.92	0.93	/	/	/
Bisexual	0.96	1.32	/	/	/
Education*Sexual orientation					
Gay/Lesbian*High school or GED	0.97	1.43	/	/	/
Gay/Lesbian*Some college	1.03	1.46	/	/	/
Gay/Lesbian*College or more	1.16	1.35	/	/	/
Bisexual*High school or GED	1.65*	1.81**	/	/	/
Bisexual*Some college	1.56	1.71**	/	/	/
Bisexual*College or more	1.34	1.75**	/	/	/
Gender (ref: Men)					
Women	/	/	1.20***	1.30	1.47
Education*Gender					
Women*High school or GED	/	/	0.86***	1.23	0.97
Women*Some college	/	/	0.84***	1.20	0.97
Women*College or more	/	/	0.78***	0.86	1.05

***p < .001, **p < .01, *p < .05; All models include state and year of survey along with the demographic covariates.

Table 3
Odds ratios for education predicting poor-to-fair self-rated health.

	Model 1 Men	Model 2 Women	Model 3 Heterosexual	Model 4 Gay/Lesbian	Model 5 Bisexual
Education (ref: Less than high school)					
High school or GED	0.61***	0.57***	0.63***	0.71	0.99
Some college	0.52***	0.50***	0.54***	0.67	0.77
College or more	0.38***	0.39***	0.40***	0.61	0.58*
Sexual orientation (ref: Heterosexual)					
Gay/Lesbian	0.62	0.73	/	/	/
Bisexual	0.63	0.97	/	/	/
Education*Sexual orientation					
Gay/Lesbian*High school or GED	1.16	1.48	/	/	/
Gay/Lesbian*Some college	1.27	1.58	/	/	/
Gay/Lesbian*College or more	1.55	1.54	/	/	/
Bisexual*High school or GED	1.80	1.70*	/	/	/
Bisexual*Some college	1.69	1.66*	/	/	/
Bisexual*College or more	1.61	1.82*	/	/	/
Gender (ref: Men)					
Women	/	/	0.90**	1.14	1.26
Education*Gender					
Women*High school or GED	/	/	0.88***	1.07	0.85
Women*Some college	/	/	0.88**	1.12	0.90
Women*College or more	/	/	0.92	0.89	1.04

***p < .001, **p < .01, *p < .05; All models include state and year of survey along with all the control variables.

Table 3 include all additional covariates (e.g., socioeconomic variables, health behaviors, bad mental health days), some of which likely serve as both mediators and confounders for the relationship between education and health. We present these results to shed more light on the complex

association between education and self-rated health by gender and sexual identity, encouraging future research to address the specific roles of potential mediators. We produced figures based on results from the corresponding models. For example, Fig. 1A corresponds to Model 1 of

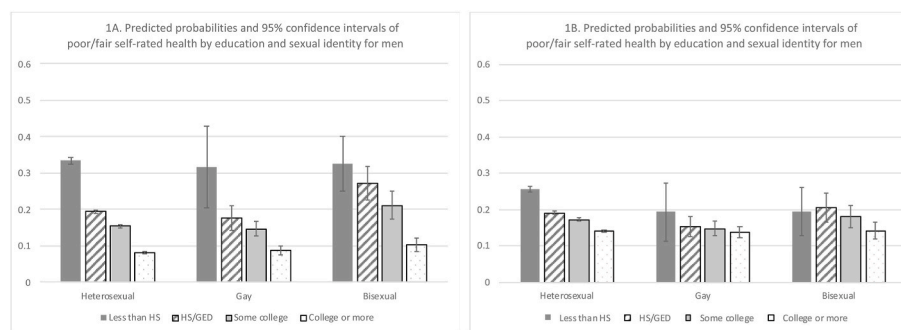


Fig. 1. A. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and sexual identity for men. B. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and sexual identity for men.

Table 2; Fig. 1B reflects results in Model 1 of Table 3.

Looking first at men in Model 1 (Table 2), we see that the association between education and health might be weaker for bisexual men than heterosexual men. Fig. 1A shows that for heterosexual men, those with a high school degree had a much lower probability of poor-to-fair SRH than those with less than high school education, and that for bisexual men the predicted probabilities for these two education groups were more similar. The overall educational gradients in health seem to be more similar for heterosexual men and gay men, although the latter had bigger confidential intervals for predicted probabilities. Fig. 1B shows that including the covariates drastically reduced probabilities of poor-to-fair SRH across all groups, but we still see a stronger decline in poor-to-fair SRH with increasing education among heterosexual men than bisexual men and gay men. Such decline draws attention to the high probabilities of poor health for heterosexual men without a high school degree. Differences in poor-to-fair self-rated health seen between those with some college and those with a college degree were very similar between heterosexual and bisexual men, while the pattern was flatter for gay men. This result offers some support to the resource multiplication perspective (H1b).

Turning now to women (see Fig. 2A, based on Model 2 of Table 2), we see that bisexual women had higher predicted probabilities of poor health than heterosexual and lesbian women across almost all educational levels. Also, the health gradient by education was less steep among bisexual women than heterosexual women. Based on Model 2 of Table 3, which controlled for all covariates, Fig. 2B also shows a less prominent educational gradient in health among bisexual women than heterosexual women – again because among heterosexuals, there was a steeper decline in the probability of poor-to-fair SRH with the attainment of a high school diploma or GED. The association between education and health seem generally more similar between lesbian and heterosexual women in Fig. 2A and B. Overall, results from the comparisons of heterosexual and bisexual women offer some evidence for the resource multiplication perspective (H1b).

Next, we tested Hypotheses 2a and 2b by examining gender differences in the associations between education and self-rated health within each sexual orientation group. For heterosexual adults in Fig. 3A (based on Model 3 of Table 2), education appears to be more strongly related to poor-to-fair SRH for heterosexual women than heterosexual men. Specifically, the difference in probabilities of reporting poor-to-fair SRH between those with and without a high school degree was larger for heterosexual women than for heterosexual men. Adding covariates to the model drove most of the reduction of education’s association with health for heterosexual men and women (see Model 3 of Table 3 and Fig. 3B).

Turning to Fig. 4A (Model 4 of Table 2), we find education to be more negatively associated with poor-to-fair SRH for lesbian women than gay men, especially when comparing probabilities of poor health between those with a college degree and those who attended college without graduating. However, the association between education and health

appears to be similar for gay men and lesbian women in the fully adjusted model (Model 4 of Table 3, Fig. 4B). For bisexual adults, education generally acted in a similar manner by gender (see Model 5s and Fig. 5s).

Additionally, we ran supplementary models to test roles of the covariates in the relationship between education and health. In models for all men, all women, and all the heterosexual adults (e.g., Models 1, 2, 3 in Table 3), almost all covariates were significant likely due to large sample sizes. Socioeconomic variables (e.g., employment status, income, missed care due to cost) accounted for the most reduction in the association between education, sexual identity, and health for men and women. SES covariates and health behaviors (e.g., exercise, drinking, smoking) drove the most reduction in education’s association with health for heterosexual men and women. Turning to models on gay, lesbian, and bisexual adults, we see that SES covariates (e.g., income, missed care due to cost), health behaviors (e.g., exercise), and mental health were significant predictors of health.

Lastly, we tested for differences in education across sexual orientation and within gender (e.g., comparing education coefficients between lesbian and heterosexual women) and within sexual orientation and across gender (e.g., comparing education coefficients between bisexual men and bisexual women) using the test detailed by Clogg et al. (1995) (see Appendix B). These results generally show similar patterns as results from Tables 2 and 3—some evidence was found for H1b (resource multiplication), especially when comparing education’s association with health between heterosexual women and bisexual women. Education’s association with health appear to differ for heterosexual men and women, which may support H2a (resource substitution).

Discussion

This study sought to understand if the relationship between education and self-rated health is equivalent across sexual orientation groups, and if these associations differ for men and women. It was motivated in part by broader debates over intersectionality, and how individuals with both marginalized and non-marginalized identities have unique health benefits or face additional challenges in improving health, including the theoretical debate of whether education acts as a resource substitution or multiplication for health. Below, we discuss our contributions in detail.

First, to test Hypotheses 1a and 1b, we compared gay, lesbian, and bisexual adults to their same-gender heterosexual counterparts. Among women, we found that the positive relationship between education and health was more prominent among *heterosexual* than sexual minority women, especially *bisexual women*, offering support to the resource multiplication perspective (H1b). Notably, results from the fully adjusted model show that among those with a college degree, bisexual women still had higher probabilities of poor health than heterosexual women (18.58% VS 12.85%). Intersectionality scholars argue that social positions create a matrix of domination such that identities including

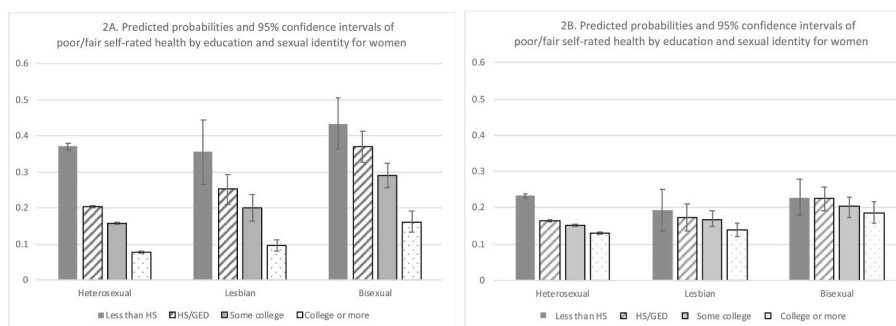


Fig. 2. A. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and sexual identity for women. B. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and sexual identity for women.

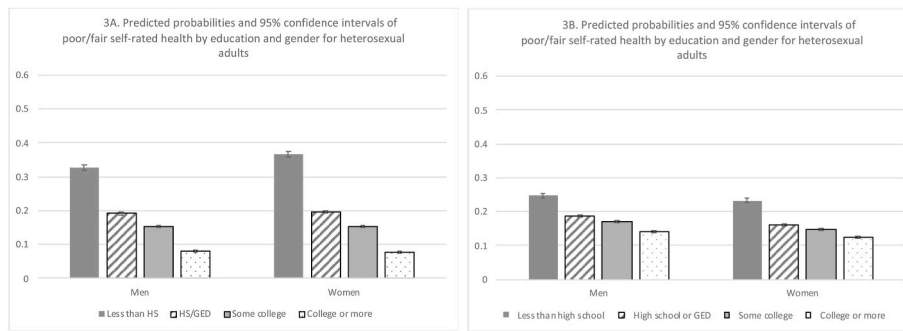


Fig. 3. A. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for heterosexual adults. B. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for heterosexual adults.

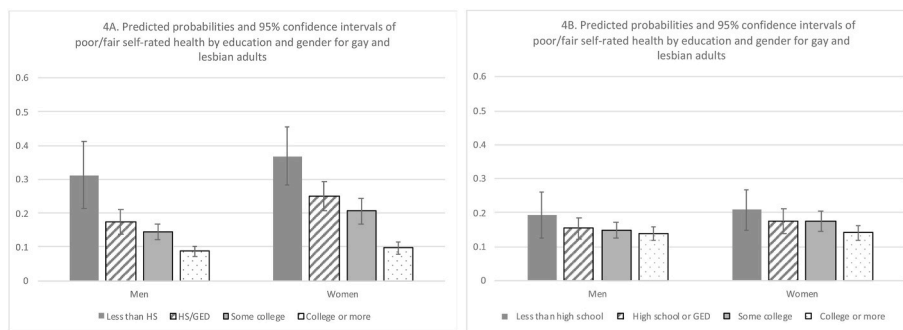


Fig. 4. A. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for gay and lesbian adults. B. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for gay and lesbian adults.

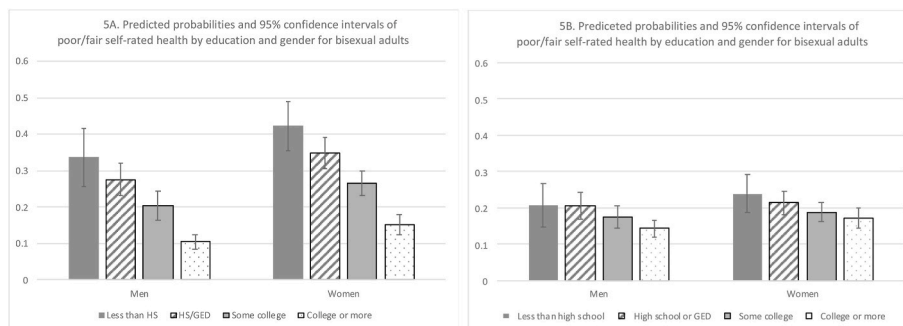


Fig. 5. A. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for bisexual adults. B. Predicted probabilities and 95% confidence intervals of poor/fair self-rated health by education and gender for bisexual adults.

gender and sexual orientation are experienced simultaneously by individuals with resulting combinations of health advantages and disadvantages (Bowleg, 2012). Bisexual women are “double minorities” and are in subordinate positions to men as well as heterosexual and gay/lesbian adults (Gorman et al., 2015). Previous work has shown that bisexual women experience a number of disadvantages in employment, poverty, and physical and mental health (Conron et al., 2010; Dilley et al., 2010; Gorman et al., 2015). Bisexual women may also face higher levels of stigma than gay and lesbian adults, which can contribute to their weaker association between education and health.

Similar to results for women, we also see a stronger decline in poor-to-fair self-rated health with increasing education for *heterosexual men* than *bisexual men*, again offering some support to the resource multiplication perspective (H1b). Notably, this may highlight a health disadvantage experienced by heterosexual men without a high school diploma rather than the diminished educational returns to health among bisexual men. Additional descriptive analysis (available upon request) shows that for those without a high school degree, heterosexual men

reported similar levels of self-rated health and health indicators (i.e., likelihoods of missing medical care due to cost and having a personal doctor) as bisexual men. Moreover, heterosexual men without a high school degree had much lower employment rates and lower incomes than their peers with more education. Prior work has discussed ties between socioeconomic achievement and masculinity, showing that unemployment and other aspects of diminished economic success are sources of stigma and stress for men (Courtenay, 2000; Dolan, 2011). Heterosexuality and lower levels of education are both associated with adherence to dominant masculinity norms (Connell & Messerschmidt, 2005; Courtenay, 2000; Davis & Greenstein, 2009), and as such heterosexual men without a high school diploma, who likely fail to conform to the masculine norm of economic prowess, may experience elevated stress and stigma and thus have higher probabilities of poor health.

Next, we found that education has overall more similar associations with poor-to-fair self-rated health for *gay and lesbian adults* than it does for their *same-gender heterosexual counterparts*. Fig. 2B seems to suggest that considering all covariates, education’s association with health

among gay men may be less prominent than among heterosexual men. This may support the resource multiplication perspective (H1b), but the evidence is less conclusive because of large confidence intervals for values for gay men. These results were somewhat surprising given that gay men and lesbian women reported worse or similar health to their heterosexual counterparts yet had more education, which would imply that gay men have lower returns on education than heterosexuals (Gorman et al., 2015; Herek et al., 2010; also see Table 1). However, previous work also found equivalent self-rated health between gay and heterosexual adults controlling for education (Gorman et al., 2015). This implies that while gay and lesbian adults are more likely to attend college than heterosexual adults, their health may be roughly equivalent within each level of educational attainment.

Altogether, these findings support intersectionality arguments that health status is shaped by the unique intersections of social positions (Bowleg, 2012); in other words, specific positions face specific health advantages and disadvantages that do not summarize easily. It was neither solely a queer women identity (lesbian and bisexual) nor a bisexual identity (bisexual men and women) that had the strongest evidence of resource multiplication. Rather, among all groups, the association between education and health was significantly weakened among bisexual women, and to a lesser extent, among bisexual men. Gay men and lesbian women, in contrast, may have similar associations for education and health compared to heterosexual men and women. Additionally, we found that heterosexual men without a high school diploma, who occupy both privileged and marginalized social positions, may face unique health challenges.

Finally, this paper tested Hypotheses 2a and 2b—whether and how education's association with health varies by gender across sexual orientation groups. Overall, educational gradients in health appear to be quite similar for men and women across all sexual orientation groups (see Figs. 3s to 5s). For heterosexual adults, we found that women experienced a stronger association of education with self-rated health compared to men in Fig. 3A, offering some support to resource substitution perspective (H2a). However, the gender differences in education's association with health became more similar in the fully adjusted model (Fig. 3B). This corresponds to the descriptive results (Table 1), which show more significant differences in the sociodemographic and health covariates between heterosexual men and women than sexual minority men and women. In addition to the smaller differences across gender in other measures of socioeconomic status and health indicators for LGB adults compared to heterosexual adults (Table 1), research shows that gay and lesbian adults tend to adhere less to gender norms, perhaps influencing their career trajectories (Ellis et al., 2012; Moore, 2006). In sum, the relationship between education and health by gender may differ slightly for heterosexual adults (also see Appendix B), but it appears to be mostly similar for gay, lesbian, and bisexual adults.

Limitations

Although an important step forward, this work has several key limitations. First, we have respondents from only 43 states and one territory and so our sample is not nationally representative. While we do have respondents from states as varied as Utah, Texas, California, and New York, the findings may misstate patterns that occur at a national level. Second, we were not able to include those identified with "other" sexual identity in the analysis. The sample size of this group is limited and BRFSS questionnaires do not differentiate the mono-sexual from the others, making it impossible for theoretically-driven investigation. Third, our sample contains different cohorts of sexual minority adults who likely experience distinct sociopolitical events and coming-out pathways, which may complicate the relationship between education and health. We ran sensitivity analyses and found suggestive evidence that education's association with health might differ by gender, sexual identity, and cohort. Despite the potential insights, we decided not to include these results because of problematic power and limited space.

Fourth, our data is cross-sectional. Thus, we cannot contribute to the debate regarding whether higher education leads to better health (causation) or whether the healthy achieve more education (selection) (Lynch & Von Hippel, 2016). Lastly, we were not able to follow prior research (Mize, 2019) and test the second differences of predictive probabilities (e.g., whether the difference in probabilities of poor health between those with and without a high school degree among *men* is different from that among *women*), because the relevant command cannot be used for multiply imputed data. Therefore, we use extra caution when interpreting our results. We encourage future research to address these issues.

Conclusion

In closing, there is much room for future work in this area, including *why* education functions as a resource substitution, resource multiplication, or neutral resource for different groups, and *how* a person's specific intersectional identity (based on gender, sexual orientation, and other social positions) may influence education's association with health. As women have become an increasingly large part of the college-educated population, and sexual minority adults experience broader acceptance, researchers should also seek to understand if education's relationship with health differs based on time period or region studied.

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Ethical statement

All procedures followed were in accordance with the ethical standards of responsible social science research. We have received an IRB exempt from Rice University because we use data from large national surveys. Respondents in the study are not identifiable.

CRediT authorship contribution statement

Zhe Zhang: Conceptualization, Methodology, Data curation, Writing - original draft. **Alexa Solazzo:** Conceptualization, Methodology, Data curation, Writing - review & editing, Funding acquisition. **Bridget K. Gorman:** Conceptualization, Methodology, Writing - review & editing.

Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Risk Factor Surveillance System Survey Data, Salt Lake City, UT: Utah Department of Health, [2011-2015]; West Virginia BRFSS office; and Wisconsin BRFSS program.

Appendix A. Behavioral Risk Factor Surveillance System (BRFSS) states/territories and interview years, 2011–2017

State	Data years
Alaska	6 (2011–14, 16, 17)
Arizona	2 (2011–12)
California	6 (2011–14, 16, 17)
Colorado	5 (2011–13, 15, 17)
Connecticut	3 (2015–17)
Delaware	4 (2014–17)
Florida	2 (2012, 17)
Georgia	3 (2015–17)
Hawaii	4 (2014–17)
Idaho	6 (2011–16)
Illinois	4 (2013, 15–17)
Indiana	5 (2011, 2014–17)
Iowa	5 (2012, 14–17)
Kansas	2 (2014, 15)
Kentucky	2 (2014, 16)
Louisiana	3 (2014, 16, 17)
Maine	3 (2011–13)
Maryland	2 (2014–15)
Massachusetts	7 (2011–17)
Michigan	3 (2011–2013)
Minnesota	4 (2014–17)
Mississippi	2 (2016, 17)
Missouri	2 (2015, 16)
Montana	5 (2011–14, 17)
Nevada	4 (2014–17)
New Mexico	7 (2011–17)
New York	4 (2014–17)
North Carolina	6 (2011–14, 16, 17)
North Dakota	2 (2011, 12)
Ohio	7 (2011–17)
Oklahoma	1 (2017)
Oregon	6 (2011–16)
Pennsylvania	4 (2014–17)
Rhode Island	5 (2013–17)
South Carolina	1 (2017)
Texas	3 (2015–17)
Utah	5 (2011–15)
Vermont	3 (2014, 16, 17)
Virginia	4 (2014–17)
Washington	7 (2011–2017)
West Virginia	1 (2014)
Wisconsin	7 (2011–17)
Wyoming	1 (2014)
Guam	2 (2016, 17)
Total	169

Appendix B. Odds Ratios for Education Predicting Poor-to-Fair Self-Rated Health by Sexual Orientation and Gender

	Panel 1: Men				
	Model 1	Model 2	Model 3	Model 4	Model 5
<i>Heterosexual (N=495,723)</i>					
Grade 12 or GED (ref: less than HS)	0.46***	0.60***	0.48***	0.48***	0.61***
Some College	0.34***	0.51***	0.38***	0.36***	0.52***
College or more	0.16***	0.32***	0.21***	0.18***	0.38***
<i>Gay (N=9,598)</i>					
Grade 12 or GED (ref: less than HS)	0.45**	0.57	0.56	0.55*	0.73
Some College	0.35***	0.54*	0.46**	0.45**	0.70
College or more	0.19***	0.44**	0.29***	0.27***	0.61
<i>Bisexual (N=5,050)</i>					
Grade 12 or GED (ref: less than HS)	0.72	0.77	0.75	0.86	0.88
Some College	0.49**	0.61*	0.54**	0.59*	0.70
College or more	0.21***	0.35***	0.27***	0.27***	0.47**

	Panel 2: Women				
	Model 1	Model 2	Model 3	Model 4	Model 5
<i>Heterosexual (N=692,683)</i>					
Grade 12 or GED (ref: less than HS)	<i>0.42***</i>	<i>0.55***</i>	0.45***	<i>0.44***</i>	0.57***
Some College	<i>0.30***</i>	0.47***	0.36***	<i>0.31***</i>	0.50***
College or more	<i>0.13***</i>	0.32***	0.20***	<i>0.16***</i>	0.39***
<i>Lesbian (N=7,732)</i>					
Grade 12 or GED (ref: less than HS)	0.56*	0.79	0.63	0.54*	0.77
Some College	0.40***	0.68	0.48**	0.44**	0.72
College or more	0.17***	0.49**	0.25***	0.21***	0.57*
<i>Bisexual (N=7,732)</i>					
Grade 12 or GED (ref: less than HS)	0.68*	0.78	0.73	0.72	0.80
Some College	0.46***	0.69	0.50***	0.50***	0.70
College or more	0.22***	0.51**	0.31***	0.27***	0.63*

***p < .001, **p < .01, *p < .05; **Bolded** coefficients represent significant (p<.05) Clogg test comparisons to same-gender heterosexuals; *Italicized and gray-shaded* coefficients represent significant (p<.05) Clogg test comparisons to same-sexual orientation men.

Model 1 controls for socio-demographics as well as state and year of survey;
 Model 2 add employment, income, health insurance, and missed care due to cost to Model 1;
 Model 3 adds health indicators and health behaviors to Model 1;
 Model 4 adds mental health to Model 1;
 Model 5 includes all controls.

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