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Does college major matter for women's and men's health in midlife? Examining the horizontal dimensions of educational attainment

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ABSTRACT

Studies on how education shapes adult health have largely conceptualized education as the quantity of schooling attained, coined the "vertical dimension" of education. While this dimension is important, heterogeneity *within* levels of education (the "horizontal dimension") may also shape health. Using data from the 2010–2014 American Community Survey on adults aged 45–64 with a Bachelor's degree (N = 667,362), we investigate the association between a key indicator of adult health (physical functioning) and an understudied horizontal dimension of education (college major). We find that physical functioning in midlife varies significantly by college major. For instance, the odds of poor functioning for men who majored in Psychology/Social Work were 1.9 (95% CI: 1.7, 2.1) times greater than for men who majored in Business. However, all college graduates, regardless of major, report better functioning than non-graduates. We also find that inequalities in midlife functioning across majors largely reflect differences in human capital skills and financial returns in the labor market. Taken together our findings suggest that college major is an important component of health stratification and should be integrated into the literature on health inequalities.

1. Introduction

Educational attainment is one of the strongest social determinants of health in the United States (e.g., Galea et al., 2011; Woolf et al., 2007). Adults with more years of education have higher incomes, live in safer and cleaner neighborhoods, have larger and more diverse social networks, are more likely to get and stay married, have better medical care, and live longer and healthier lives. As Hout (2012:396) stated, "Higher education causes good things to happen."

Studies examining the association between education and adult health have almost exclusively conceptualized education as the quantity of schooling attained, termed the "vertical dimension" of education. However, "horizontal dimensions" such as college major (Charles and Bradley, 2002; Gerber and Cheung, 2008) may also shape health. While studies have examined how horizontal dimensions affect labor market outcomes (see review in Gerber and Cheung, 2008), few have investigated how they affect health (for an exception, see Fletcher and Frisvold, 2014). This is an important omission; it could provide critical clues about the pathways linking education and adult health in ways that studies only examining quantity of schooling cannot. The current study begins to address this gap. It investigates how college major is associated with inequalities in health among U.S. men and women in midlife, and evaluates four pathways that might explain the associations.

1.1. Vertical and horizontal dimensions of the education-health association

Research on the education-health association has largely focused on the quantity of schooling obtained. This focus partly reflects theoretical perspectives on why education shapes adult health. From a human capital perspective, quantity is important because more years of schooling mean more training in critical thinking, complex problem solving, reading, writing, synthesizing, specialized knowledge, and non-cognitive skill development. Quantity of schooling is also important from the credentialist perspective (Collins, 1979). Educational credentials send "signals" regarding hard-to-measure characteristics (e.g., economic productivity) and soft skills (e.g., personality traits, preferences) which open doors to jobs, social networks, and other health-promoting resources.

As important as quantity of schooling is for adult health, other aspects may also be relevant. This may be increasingly true as education levels rise in the population. According to the theory of Effectively

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Maintained Inequality (EMI: Lucas, 2001), when a particular education level becomes common (e.g. a Bachelor's degree), horizontal aspects of that level (e.g., college major) become important drivers of inequality (Lucas, 2001). This occurs because, as a greater percentage of the population obtains a postsecondary education, it becomes a less distinguishable status marker. Consequently, new forms of stratification, such as college major, can emerge. Supporting the EMI perspective, the relative importance of horizontal dimensions of postsecondary education, including college major, for generating social and economic inequality appears to be rising (Gerber and Cheung, 2008). How important are horizontal dimensions for generating health disparities? Surprisingly little attention has been given to this question.

1.2. College major

The two main horizontal dimensions at the postsecondary level are institutional factors such as the selectivity of a college, and individual experiences such as college major (Gerber and Cheung, 2008). There is increasing empirical support for the importance of college major for life outcomes (Mayhew et al., 2016). A useful framework for conceptualizing why college major matters was developed by van de Werfhorst and Kraaykamp (2001). They propose that fields of study provide individuals with different *types* of human capital—economic, cultural, communicative, and technical resources—which, in turn, influence labor market opportunities, consumption patterns, lifestyles, and sociopolitical orientation.

Studies of the outcomes associated with college majors have mainly focused on labor market returns. Differences in earnings and unemployment across majors are substantial (Carnevale et al., 2015). Fig. 1 shows the wide range of unemployment levels and median income for 15 college majors among adults aged 35–54. It also illustrates a weak correlation between unemployment and income across college majors, suggesting that majors have complex effects on adult outcomes. For instance, while the median income of majors in Health and the Social Sciences are similar, the unemployment rate of the latter is more than twice the former.

1.3. Potential pathways linking college major and adult health

Just as the pathways from education level to adult heath are complex, so are the potential pathways from college major to adult health. We focus on four pathways that met two criteria. First, the pathways must align with well-established explanations for the association between education level and health (work and economic well-being; psychosocial resources such as marriage; health behaviors). Other pathways, such as non-cognitive skills and access to medical care, appear to contribute a minor amount to that association (Cutler and Lleras-Muney, 2010). Second, the pathways must align with well-established explanations for the association between college major and non-health outcomes (work and economic well-being; human capital; geography). The dataset we chose contains all these characteristics except health behaviors.

The first pathway is economic resources, which is the most important pathway in studies of the association between education level and health (e.g., Mirowsky and Ross, 2003). Economic resources include short-term indicators (e.g., income) and long-term indicators (e.g., home ownership). The income gap across college majors may generate health inequalities as income provides greater access to resources that promote health, such as nutritious foods, safe neighborhoods, and economic security. Home ownership can enhance health by, for example, offering a more stable residential environment, more control over one's living environment such as noise levels, pollution, and crowding.

The second pathway concerns employment-related characteristics, including employment status and the types of human capital skills required and reinforced in certain occupations. Employment may be an important pathway because certain college majors are more likely to be employed than others; and employment can provide material, social, and psychological resources for health. College major also structures the types of occupations within which people are employed. As mentioned above, van de Werfhorst and Kraaykamp (2001) assert that college majors matter largely because they reinforce certain types of human capital. This viewpoint is also consistent with recent studies in economics and urban planning (e.g., Gabe and Abel, 2011), which conceptualize occupations according to the types of human capital that incumbents possess, rather than the structural positions of the occupations or the products they produce. For instance, occupations that require creative skills (e.g., artists, professors, and marketing mangers) may improve health through an enhanced sense of control, while occupations that are physically and emotionally taxing can damage health. In particular, workers in law enforcement and nursing encounter serious occupational health risks and, consequently, have worse musculoskeletal and cardiovascular health than the general population (ANA, 2017; Hartley et al., 2011).

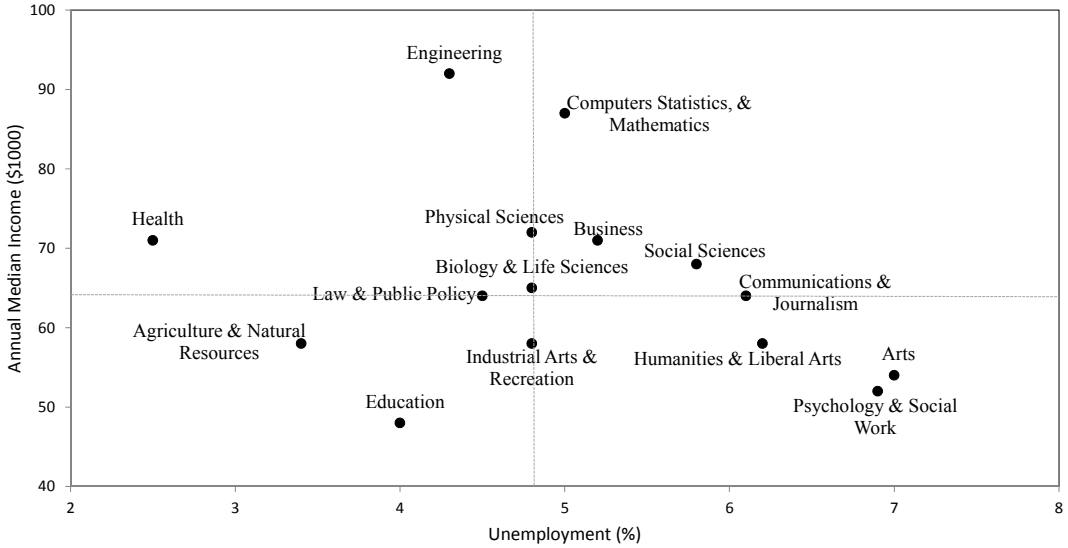

Fig. 1. Median income and unemployment rate among college graduates aged 35–54 years.
Notes: Figure based on data in Carnevale and Cheah (2015) using the 2010–2011 American Community Survey. Grid lines indicate median value.

The third mechanism is psychosocial resources, among which marital status is a key marker and one of the most studied in the association between education and health. Individuals with more education are more likely to get and stay married, and they have been increasingly likely to marry someone with a similar level of education (Schwartz and Mare, 2005). Being married is associated with good health; so is marrying a spouse with a high level of education (Brown et al., 2014). However, as Arum et al. (2008) have pointed out, studies on educational homogamy in marriage have focused on vertical dimensions of education. Horizontal dimensions of education may also shape whether and whom one marries because they shape the types of social, cultural, and economic capital that graduates bring to the marriage market.

Fourth, we consider the geographic distribution of college majors across U.S. Census divisions and the urban-rural continuum. Geography may be important because adult health is shaped by area of residence (Montez et al., 2017) and college majors are unevenly distributed across areas of the country. For instance, Science and Engineering graduates disproportionately live in coastal states, Business graduates are most likely to live in the South, Education graduates disproportionately live in the Midwest, and Arts and Humanities graduates are over-represented in New England (Siebens and Ryan, 2012). This distribution may reflect propensities to obtain certain majors in different areas of the country, as well as migration into areas that offer employment opportunities for particular majors. In addition, some majors (e.g., Business) may be over-represented in urban areas while others (e.g., Agriculture) in rural areas.

We expect that these four pathways are key explanations for differences in midlife health by college major. We also recognize that selection into majors could play some role: cognitive and non-cognitive skills, socioeconomic background, and early-life health may influence which majors students choose. The labor market literature has found that, while selection plays a role, large differences in labor market returns persist even after accounting for selection—measured by pre-college abilities and/or socioeconomic background (e.g., Arcidiacono, 2004; Grogger and Eide, 1995)—with a high earnings premium for Business and Natural Science (e.g., engineering, math) majors (Arcidiacono, 2004). Nevertheless, we take several steps to mitigate potential selection effects. We return to this issue in the discussion.

2. Aims and expectations

The overarching aim of this study is to investigate whether and why college major is associated with health in midlife among U.S. adults. We answer two main questions:

2.1. Is college major associated with health status among midlife adults?

We expect health to vary significantly by major. If this is the case, does accounting for college major and education level improve predictions of adult health compared to using education level alone? Does accounting for college major alter the vertical education-heath gradient? In other words, do some majors have worse health than adults without a college degree, and do some majors have better health than adults with a graduate degree?

2.2. What explains inequalities in health by college major among Bachelor's degree holders?

We expect that all four pathways are important, but the employment and economic pathways are particularly so, given their importance for adult health and evidence they markedly differ across majors. Based on the employment and income data for the 15 majors in Fig. 1, we expect that Engineering and Computers/Statistics/Mathematics are among the healthiest, and Arts and Psychology/Social Work are among the unhealthiest. We do not make predictions beyond this given the paucity of literature and the potential complexity of the pathways.

3. Methods

3.1. Data and sample

The public-use 2010–2014 American Community Survey (ACS) is a nationally representative sample of 15,552,114 individuals. It combines five annual cross-sectional waves, with sample weights adjusted to make it nationally representative. It the best data source for our aims given its size and detailed information on individuals' education level and college major.

Our analytic sample includes U.S.-born adults aged 45–64 years. We restrict the sample to U.S.-born individuals to minimize the chance they obtained their education abroad. The meaning of education and college majors differs across national contexts, and education obtained abroad does not necessarily provide the same health benefits as education obtained domestically (e.g., Walton et al., 2009). We focus on middle-age adults for three reasons. It ensures adults have had several decades for their education to "play out" in shaping lifestyles, economic well-being, and other risks and resources for health. It also captures an age when physical functioning problems start to manifest, yet mortality selection has not adversely altered the sample. Finally, the relatively narrow age range dampens the influence of secular changes in college majors and the meaning of a college education. Our sample contains 3,781,418 U.S.-born adults aged 45–64 years. In most analyses we include the subset of these adults for whom a Bachelor's degree is their highest level of education (N = 667,362).

3.2. Dependent variable: physical functioning

Physical functioning is a key indicator of overall health. The ACS includes three separate measures. Respondents were asked whether, because of a physical, mental, or emotional condition, they had difficulty (1) walking or climbing stairs, (2) dressing or bathing, and (3) doing errands alone such as visiting a doctor's office or shopping. Because so few college graduates report multiple functional problems in midlife, an ordinal specification is not warranted. We dichotomize the measure so that 0 = no problems and 1 = at least one problem. For brevity and ease of discussion, we refer to the measure as "poor health."

3.3. Independent variables: education level and college major

The ACS asks about the highest degree or level of school completed. We collapse the responses into six categories: less than high school (LTHS), a high school credential (HS), some college but no Bachelor's degree (SC), Bachelor's degree (BS), Master's degree (MS), and Professional or Doctorate degree (PhD).

Starting in 2009 the ACS asked respondents with at least a B.S. to list their college major. For respondents listing more than one major, we use the first-mentioned major. The 2010–2014 ACS contains 173 first-mentioned majors. They have been collapsed into 15 major groups by the Center on Education and the Workforce (Carnevale et al., 2015). These groups (and their dominant major, if any) include Agriculture/Natural Resources; Architecture/Engineering; Arts; Biology/Life Sciences (biology); Business; Communications/Journalism (communications and mass media); Computers/Statistics/Mathematics; Education; Health (nursing); Humanities/Liberal Arts; Industrial Arts/Consumer Services/Recreation; Law/Public Policy (criminal justice and fire protection); Physical Sciences; Psychology/Social Work (psychology); and Social Sciences.

3.4. Hypothesized pathways

We assess the extent to which four factors—economic well-being,

employment characteristics, marriage, and geography—account for (the assumed) differential health benefits of certain college majors. For economic well-being we include a measure of current economic circumstances using household *income-to-poverty ratio* deciles, and a binary measure of *home ownership*. The latter captures longer-term economic circumstances and may be less prone to reverse causality where declining health may reduce labor force participation and income.

The employment factor includes *employment status* and *occupational skills*. In the ACS, respondents were asked about their employment status and job activities at the time of survey. If they were not employed they were asked about their job activities (if any) within the preceding five years. By combining responses to these questions, we create a binary indicator of *employment status* within the past five years. We use this 5-year employment instead of current employment to help mitigate concerns that poor health caused a labor force exit. Adults who were employed or had been so in the last five years were then asked, "What kind of work was this person doing?" From these open-ended responses, the ACS identified 498 occupations. To each occupation we assigned seven *occupational skill* scores that quantify the intensity of seven types of skills potentially used on the job. The seven skills include: content, process, complex problem solving, social, resource management, technical, and systems skills. We derived the seven skill scores using data from the U.S. Department of Labor's Occupational Information Network database (O*NET: Peterson et al., 2001) and established procedures (see online appendix for details).

We include three measures of the marriage pathway. A binary measure of *marital status* indicates the respondent was cohabiting or living with their spouse. Among married/cohabiting adults, we include a three-category variable for *partner's education level* (less than B.S., B.S. [omitted reference], more than B.S.). If the partner had a B.S., we include *partner's college major*.

Finally, we include two measures of *geography*. The U.S. Census division is a 9-category variable. Because the ACS does not collect information on urban-rural status, we link the respondent's Public Use Microdata Area (PUMA) code to the MABLE/Geocorr database developed by the Missouri Census Data Center (MCDC, n.d.) The database identifies the percentage of the population within a PUMA who are designated as living in an urban area.

3.5. Analytic strategy

To address the first aim, we estimate Equation (1), which predicts the log-odds of poor health from six education levels. The model adjusts for the covariate matrix $\boldsymbol{b_6}$ containing age (centered at the grand mean), gender (male = reference), and race (non-Hispanic white [reference], non-Hispanic black, non-Hispanic other, Hispanic).

$$log(odds) = b_0 + b_1 LTHS + b_2 SC + b_3 BS + b_4 MS + b_5 PHD + \boldsymbol{b}_6 cov \quad (1)$$

We then add college majors using an internal moderator approach (Mirowsky, 2012). As shown in Equation (2), this entails adding an interaction between the B.S. variable and the 14 college major variables (the largest group, Business majors, are the omitted reference). Adults whose highest level of education is something other than a B.S. will have $BS = 0$, and their terms for $BS\ x\ MAJOR_j = 0$. To illustrate the model interpretation: among average-aged non-Hispanic white males, the log-odds of poor health for Business majors is $b_0 + b_3$. Among average-aged non-Hispanic white males, the log-odds of poor health for Education majors is $b_0 + b_3 + b_{7,Education}$.

$$log(odds) = b_0 + b_1 LTHS + b_2 SC + b_3 BS + b_4 MS + b_5 PHD + \boldsymbol{b}_6 cov + \sum_{j=1}^{14} b_{7,j}(BS{*}MAJOR_j) \quad (2)$$

For aim 2, we restrict the sample to adults for whom a B.S. is their highest level of education. This restriction serves two purposes. It focuses the analysis on the social, economic, and health returns to a B.S. without potential complications resulting from certain majors being more likely to earn graduate degrees. It also helps mitigate potential selection effects from early-life socioeconomic status and health. Early-life socioeconomic status, a key predictor of early-life health, has little influence on college major for individuals with a B.S. only (Torche, 2011). To examine our second aim, we estimate Equation (3), where $\boldsymbol{b_2}$ includes age and race/ethnicity.

$$log(odds) = b_0 + \sum_{j=1}^{14} b_{1j} MAJOR_j + \boldsymbol{b}_2 cov \quad (3)$$

We then add the hypothesized pathways. We test each pathway with the method developed by Karlson, Holm, and Breen (KHB: 2012) to assess mediation in nonlinear probability models. The method (and "khb" Stata command) decomposes the difference in the logit coefficient of a variable, X, between models with and without mediator, Z, into the part attributable to Z and the part attributable to the rescaling of the X coefficient that occurs across nested nonlinear probability models.

All models are stratified by gender to avoid potential confounding of gender-specific selection into college majors and gender-specific labor market dynamics. We do not test gender differences, as theorizing gender-specific processes is outside the scope of this study. The data contain no missing values. All models adjust for sampling weights and are estimated with Stata MP 14.1.

4. Results

Summary characteristics of the sample are shown in Table 1. Among U.S.-born adults aged 45–64 in 2010–2014, 18% had a B.S. as their highest attainment level. The prevalence of poor health in midlife varies considerably across education levels, from 33% of women (28% of men) without a high school credential to 5% of women (3% of men) with a doctorate or professional degree. The prevalence also varies across college majors. Among women, it ranges from 9% among Law/Public Policy and Psychology/Social Work majors to 4% among Architecture/Engineering and Communications/Journalism majors.

4.1. Is college major associated with health status among midlife adults?

The first column of Table 2 illustrates the vertical dimension of schooling. It shows how the odds of poor health differ across education levels, controlling for age, gender, and race/ethnicity. Compared to adults with a high school credential, adults without the credential had 2.5 times the odds of poor health ($p < .001$), adults with a B.S. had 0.33 times the odds ($p < .001$), and adults with a doctorate or professional degree had 0.22 times the odds ($p < .001$).

The second column adds the 15 college majors. Recall that by using an internal moderator approach, the coefficient for B.S. represents the omitted college major, which is Business. Compared to adults with a high school credential, adults with a B.S. in Business had 0.28 times the odds of poor health ($p < .001$). Consistent with our hypothesis, we find substantial differences in health across majors. Two majors are particularly disadvantaged in midlife: the odds of poor health are 1.9 times greater ($p < .001$) among Psychology/Social Work and Law/Public Policy majors compared to Business majors. Also important, this model with vertical and horizontal dimensions of education provides a better fit than the vertical-only model, even after penalizing it for including college majors. The Bayesian Information Criterion (not shown) of the former model is 1226 smaller than the latter; a difference of 10 is strong evidence of improvement in model fit (Raftery, 1995).

The third and fourth columns show the results separately for women and men. The patterns are similar. The two majors with particularly high odds of poor health in the previous model (Psychology/Social

Table 1
Demographic and educational characteristics of U.S.-born adults aged 45–64 years. *Source*: 2010–2014 American Community Survey (N = 3,781,418). All proportions are weighted.

	Proportion of Sample	Proportion of Sample in Poor Health	
		Women	Men
Poor Health	.121	.127	.114
Female	.512	–	–
Race/Ethnicity			
Non-Hispanic White	.803	.112	.101
Non-Hispanic Black	.123	.201	.182
Non-Hispanic Other	.025	.191	.166
Hispanic	.049	.149	.134
Education Level			
Less Than High School	.085	.332	.283
High School	.301	.152	.136
Some College	.321	.125	.108
Bachelor's Degree	.179	.057	.046
Master's Degree	.081	.047	.036
Doctorate or Professional Degree	.032	.045	.031
College Major[a]			
Business	.275	.045	.039
Education	.129	.061	.059
Humanities/Liberal Arts	.085	.063	.060
Architecture/Engineering	.082	.038	.036
Health	.078	.059	.062
Social Science	.066	.064	.050
Psychology/Social Work	.048	.086	.082
Computers/Statistics/Math	.043	.051	.039
Communications/Journalism	.043	.043	.038
Arts	.041	.053	.050
Biology/Life Science	.026	.051	.043
Physical Sciences	.024	.074	.048
Law/Public Policy	.021	.094	.065
Industrial Arts/Recreation	.020	.053	.057
Agriculture/Natural Resource	.019	.049	.037

[a] Among respondents whose highest education level is a Bachelor's degree (N = 667,362).

Work; Law/Public Policy) have the highest odds for women and men.

To better illustrate the patterns, we convert the model results into probabilities of poor health in Fig. 2. The prevalence of poor health generally conforms to the conventional education-health gradient. Adults whose highest attainment is a B.S., regardless of major, are less likely to be in poor health than adults without a B.S., and (generally) more likely to be in poorer health than adults with a graduate degree.

4.2. What explains inequalities in health by college major among Bachelor's degree holders?

We now focus on the subset of adults for whom a B.S. is their highest attainment. The results for women and men are in Tables 3 and 4, respectively. The baseline model 1 in each table estimates the odds of poor health as a function of college major, controlling for age and race/ethnicity. The findings are similar to results for the whole sample in Table 2, suggesting that factors that select individuals into a B.S.-only degree versus a graduate degree do not meaningfully influence our estimates for college majors. Men and women who majored in Business, Communications/Journalism, Architecture/Engineering, or Biology/Life Sciences have a clear health advantage in midlife, particularly compared to peers who majored in Psychology/Social Work or Law/Public Policy. Also advantaged in health are men who majored in Agriculture/Natural Resources and women who majored in Industrial Arts/Recreation.

We examine the extent to which the four pathways account for the health (dis)advantages of certain majors using Models 2–9. Each model shows the odds ratio for every college major, net of the pathway, age,

Table 2
Odds ratios of poor health by education level and college major among U.S.-born adults aged 45–64 years.

	All Adults		Women	Men
Education Level (High School)				
Less Than High School	2.52***	2.52***	2.63***	2.42***
Some College	0.78***	0.78***	0.80***	0.75***
Bachelor's Degree	0.33***	0.28***	0.29***	0.26***
Master's Degree	0.25***	0.25***	0.27***	0.23***
Doctorate or Professional Degree	0.22***	0.22***	0.27***	0.19***
College Major[a] **(Business)**				
Architecture/Engineering		0.91**	0.89	0.92*
Communications/Journalism		1.02	1.02	1.03
Computers/Statistics/Math		1.08*	1.14*	1.07
Agriculture/Natural Resource		0.97	1.15	0.92
Biology/Life Science		1.06	1.10	1.02
Education		1.25***	1.23***	1.34***
Industrial Arts/Recreation		1.25***	1.12†	1.55***
Social Science		1.27***	1.33***	1.22***
Arts		1.20***	1.16**	1.29***
Health		1.32***	1.28***	1.57***
Physical Sciences		1.37***	1.67***	1.20***
Humanities/Liberal Arts		1.39***	1.32***	1.48***
Law/Public Policy		1.89***	2.13***	1.73***
Psychology/Social Work		1.91***	1.87***	1.98***
N	3,781,418	3,781,418	1,950,144	1,831,274

†p < .10; *p < .05; **p < .01; ***p < .001 (two tailed).
Notes: Omitted reference groups are shown in parentheses.
[a] Coefficients for college major are obtained from models using an internal moderator (Mirowsky, 2012). See methods section for details.

and race/ethnicity (full models available by request). In ancillary analyses, we used the KHB method to test whether a given pathway significantly ($p < .05$) attenuates the logit coefficient for each major. If it does, we denote the percent attenuation with superscript "a" if the attenuation is > 67%, "b" if 33–67%, and "c" if < 33%.

4.2.1. Results for women

We find strong support for our expectation that differences in economic well-being across majors help account for differences in women's health across majors. Of the nine majors with a significant health disadvantage compared to Business majors in Model 1, differential economic well-being accounts for a statistically significant portion of the disadvantage for six majors. It fully accounts for the disadvantage for Arts majors (100% attenuation of the logit coefficient for Arts majors using the KHB method); a considerable amount of the disadvantage for Humanities/Liberal Arts (83%), Education (64%), and Social Science (54%); and a smaller but still significant amount for Psychology/Social Work (37%) and Law/Public Policy (24%).

We also find that differences in employment circumstances across majors contribute to disparities in women's midlife health. Differences in occupational skills (model 4) are more important than differences in employment status (model 3). Accounting for occupational skills fully attenuates the health disadvantage of Arts (100%) and Education (93%) majors; a considerable amount for Social Science (56%) and Humanities/Liberal Arts (55%) majors; and a smaller but still significant amount for Psychology/Social Work (18%) and Law/Public Policy (12%) majors.

The other two hypothesized pathways—marriage and geography—are less important contributors to the association between college major and women's health. Of the nine majors with a significant health disadvantage relative to Business major in model 1, accounting for marital status and spousal education attenuated a small but statistically significant amount of the disadvantage for Law/Public Policy (19%) and Psychology/Social Work (8%); accounting for geographic location significantly attenuated the health disadvantage of Education (40%) and Physical Sciences (4%) majors.

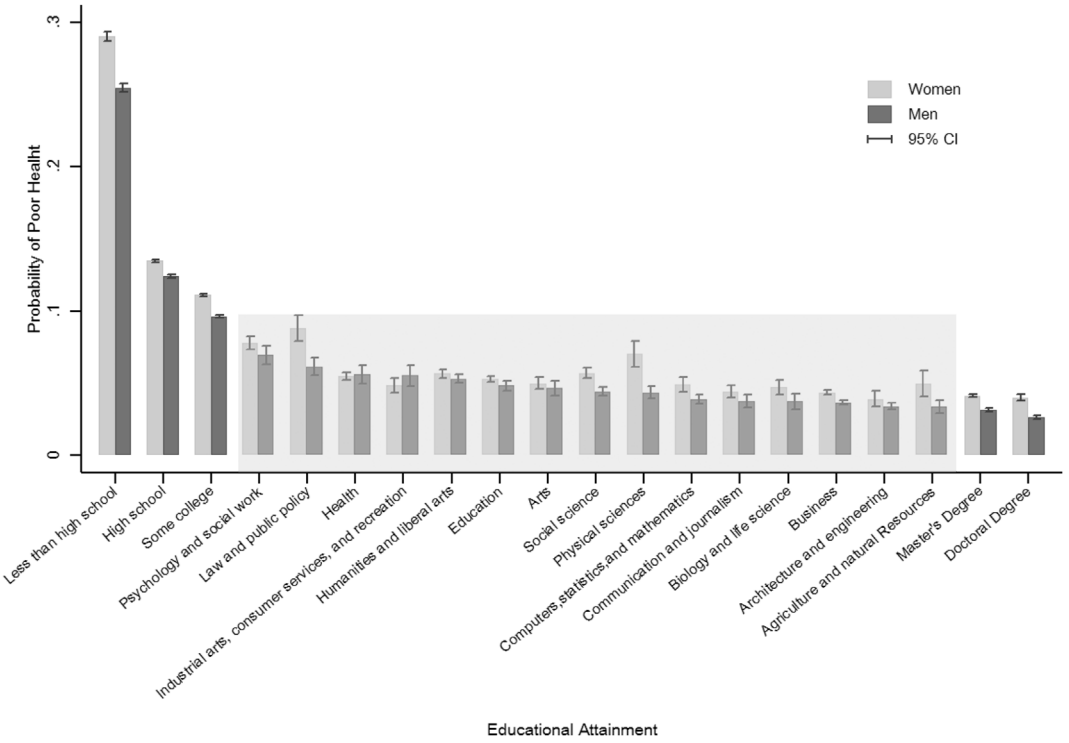

Fig. 2. Probability of poor health and 95% confidence intervals by college major among men and women aged 45–64 years.
Notes: College majors are sorted from highest to lowest probability of poor health among men. Probabilities for college majors are estimated for adults whose highest education level is a Bachelor's degree.

Model 9 includes all four pathways. Of the nine majors that had a significant ($p < .05$) health disadvantage compared with Business majors in model 1, four are no longer significant (Computers/Statistics/Math; Arts; Education; Humanities/Liberal Arts) and another four were attenuated by a significant and sizable amount (68% Social Science; 44% Psychology/Social Work; 37% Law/Public Policy; 29% Physical Sciences). Just one major (Health) persists in both size and significance.

4.2.2. Results for men

Similar to the results for women, economic circumstances and occupational skills are particularly important. However, marriage and geography also play a role. Accounting for marital status attenuated over one-half of men's health disadvantage for Social Science (58%) and Arts (52%) majors, and a nontrivial amount for Physical Sciences (28%), Humanities/Liberal Arts (22%), and Psychology/Social Work (15%). Similar to the results for women, men who majored in Education

Table 3
Odds ratios of poor health by college major for U.S.-born women aged 45–64 whose highest education is a Bachelor's degree.

	Baseline	Economics	Employment		Marriage and Partner's Education			Geography	All
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
College Major (Business)									
Architecture/Engineering	0.92	0.90	0.87*	0.90	0.92	0.96	0.96	0.93	0.90
Communications/Journalism	1.04	0.94	1.00	0.98	1.02	1.05	1.05	1.07	0.97
Biology/Life Science	1.08	1.05	1.03	1.02	1.07	1.10	1.10	1.08	1.03
Industrial Arts/Recreation	1.08	0.98	1.03	0.98	1.10	1.13†	1.12†	1.08	0.98
Computers/Statistics/Math	1.13*	1.19**	1.09	1.09	1.14*	1.16*	1.16*	1.14*	1.13†
Arts	1.14**	0.88* [a]	1.08	1.02 [a]	1.10*	1.14*	1.13*	1.17**	0.92 [a]
Education	1.14***	1.08*[b]	1.09**	1.03 [a]	1.20***	1.21***	1.20***	1.10**[b]	1.02 [a]
Agriculture/Nat Resource	1.18	1.03 [a]	1.23*	1.19†	1.16	1.17	1.16	1.13 [a]	1.07 [a]
Health	1.25***	1.37***	1.31***	1.34***	1.28***	1.28***	1.27***	1.24***	1.34***
Humanities/Liberal Arts	1.26***	1.07† [a]	1.18***[c]	1.13**[b]	1.23***	1.27***	1.26***	1.29***	1.06 [a]
Social Science	1.27***	1.13**[b]	1.17***[c]	1.13**[b]	1.24***	1.27***	1.26***	1.29***	1.10* [a]
Physical Sciences	1.65***	1.52***	1.55***	1.54***	1.64***	1.65***	1.64***	1.63***[c]	1.42***[c]
Psychology/Social Work	1.79***	1.45***[b]	1.72***[c]	1.66***[c]	1.73***[c]	1.74***	1.73***[c]	1.80***	1.41***[b]
Law/Public Policy	2.09***	1.81***[c]	2.08***	1.96***[c]	1.96***[c]	1.92***[c]	1.91***[c]	2.08***	1.68***[b]

†p < .10; *p < .05; **p < .01; ***p < .001 (two tailed).
Notes: All models control for age and race/ethnicity. Model 2 includes home ownership and a household income to poverty ratio. Model 3 includes employment status. Model 4 includes employment status and occupational skills. Model 5 includes marital status. Model 6 includes marital status and partner's education level. Model 7 includes marital status, partner's education level, and partner's college major (if they graduated from college). Model 8 includes percent urban and U.S. Census division. Model 9 includes all variables from Models 1 through 8.
[a] Mediation from model 1 was significant ($p < .05$) and > 67% in size using KHB method.
[b] Mediation from model 1 was significant ($p < .05$) and 33–66% in size using KHB method.
[c] Mediation from model 1 was significant ($p < .05$) and < 33% in size using KHB method.

Table 4
Odds ratios of poor health by college major for U.S.-born men aged 45–64 whose highest education is a Bachelor's degree.

	Baseline	Economics	Employment		Marriage and Partner's Education			Geography	All
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
College Major (Business)									
Architecture/Engineering	0.93†	0.99	0.91*	0.97	0.94	0.95	0.94	0.93†	0.96
Agriculture/Natural Res.	0.93	0.87†	0.95	0.91	0.95	0.96	0.96	0.86†	0.86†
Biology/Life Science	1.01	0.96	1.03	1.00	0.96	0.98	0.98	1.00	0.97
Communications/Journalism	1.05	0.88*	1.07	1.01	0.97	1.00	1.00	1.07	0.94
Computers/Statistics/Math	1.08†	1.10*	1.04	1.07	1.05	1.06	1.06	1.10*	1.06
Social Science	1.19***	1.06 [a]	1.09*	1.06 [a]	1.12**[b]	1.14***	1.15***	1.21***	1.02 [a]
Physical Sciences	1.19**	1.12*	1.07	1.07	1.14*[c]	1.16**	1.16**	1.18**[c]	1.01 [a]
Education	1.28***	1.15**[b]	1.24***	1.12*[b]	1.25***	1.27***	1.26***	1.24***[c]	1.09† [a]
Arts	1.30***	0.93 [a]	1.24**	1.12† [a]	1.14†[b]	1.17*[b]	1.17*[b]	1.33***	0.97 [a]
Humanities/Liberal Arts	1.46***	1.12** [a]	1.34***[c]	1.26***[b]	1.34***[c]	1.36***[c]	1.36***[c]	1.47***	1.10* [a]
Health	1.56***	1.63***	1.60***	1.61***	1.53***	1.54***	1.54***	1.53***[c]	1.52***
Industrial Arts/Recreation	1.56***	1.46***[c]	1.54***	1.42***[b]	1.56***	1.55***	1.54***	1.53***[c]	1.40***[b]
Law/Public Policy	1.71***	1.71***	1.54***[c]	1.44***[c]	1.71***	1.68***	1.67***	1.68***[c]	1.46***[c]
Psychology/Social Work	1.90***	1.47***[b]	1.67***[c]	1.59***[c]	1.74***[c]	1.76***[c]	1.76***[c]	1.91***	1.37***[b]

†p < .10; *p < .05; **p < .01; ***p < .001 (two tailed).

Notes: All models control for age and race/ethnicity. Model 2 includes home ownership and a household income to poverty ratio. Model 3 includes employment status. Model 4 includes employment status and occupational skills. Model 5 includes marital status. Model 6 includes marital status and partner's education level. Model 7 includes marital status, partner's education level, and partner's college major (if they graduated from college). Model 8 includes percent urban and U.S. Census division. Model 9 includes all variables from Models 1 through 8.

[a] Mediation from model 1 was significant ($p < .05$) and > 67% in size using KHB method.

[b] Mediation from model 1 was significant ($p < .05$) and 33–66% in size using KHB method.

[c] Mediation from model 1 was significant ($p < .05$) and < 33% in size using KHB method.

have a health disadvantage partly because of their geographic location (model 8). The final model 9 shows that of the nine majors that had a significant ($p < .05$) health disadvantage in model 1, four are no longer significant (Social Science; Physical Sciences; Education; Arts), and another four were attenuated by a significant and large amount (85% Humanities/Liberal Arts; 50% Psychology/Social Work; 41% Industrial Arts/Recreation; 28% Law/Public Policy). Just one major (Health) persists in both size and significance.

4.3. Supplementary analyses

We replicated model 1 from Tables 3 and 4 for eight 5-year age groups spanning ages 25–64 years (results in online appendix) to glean insights into the potential role of selection. If the association between college major and adult health results in part from health selection (that is, if college students chose their major based in part on their health status), we should find prominent health disparities among young adults. While this is only an indirect test, our findings provide additional assurance that selection does not adversely impact our findings. Overall, they indicate that selection may contribute to the health disadvantage of two majors, but that life course circumstances after college are crucial. For instance, we find no significant health disadvantage among young women who majored in Education, Health, Social Science, Physical Sciences, or Law/Public Policy: their disadvantage emerges after age 40. For the two majors for which women's health disadvantage is apparent in the 25–29 year group (Humanities/Liberal Arts; Psychology/Social Work), the disadvantage more than doubles in size (using the logit scale) by the 45–49 year group. These finding suggest that, while negative selection may play a role for two of the 15 majors, college major has an independent association with adult health.

5. Discussion

Our findings add important new insights into the role of education in adult health disparities. To our knowledge, it is the first study to examine how a horizontal dimension of education—college major—is associated with health disparities among U.S. midlife adults.

Four findings are noteworthy. First, college major is a statistically significant and substantively important predictor of health status in midlife. Consistent with the theory of Effectively Maintained Inequality (Lucas, 2001), college major captures unique information about adult health that education level alone does not. Health differences across college majors are meaningful: compared to adults who majored in one of the most health-advantaged fields (Business), adults majoring in some fields, such as Psychology/Social Work and Law/Public Policy, have nearly twice the odds of poor health.

Second, even though significant differences in adult health exist between college majors, the health status of college majors in relation to other education levels generally conforms to the conventional education-health gradient. That is, college graduates across all majors generally report better health than peers without a B.S., but worse health than peers with a graduate degree. To the extent that obtaining a B.S. is beneficial for health, it seems better to graduate from college with any major than to not attend or not graduate.

Third, a large part of the inequalities in health across college majors reflects different types of human capital skills and economic returns in the labor market. The skills developed in certain majors influence occupations and the pace, stress, and fulfillment of the workday. They also carry over to non-work domains; they shape lifestyles, social networks, and consumption patterns (van de Werfhorst and Kraaykamp, 2001). These work and non-work factors, in turn, shape health. The other two explanations we examined—marriage and geography—played a smaller but nontrivial role. Non-economic explanations have been fairly absent from studies about how horizontal dimensions of education shape adult circumstances (for exceptions, see Arum et al., 2008; Michelmore and Musick, 2014), but should be further examined.

Fourth, some majors were particularly advantaged or disadvantaged in midlife health. Among the four majors with the best health for both women and men (Architecture/Engineering; Biology/Life Sciences; Business; Communications/Journalism), all but Communications/Journalism receive a large earnings premium in the labor market even after accounting for pre-college selection factors (Arcidiacono, 2004). Two majors fall within the broader category of science, technology, engineering, and math (STEM) fields. The economic premiums for STEM graduates in recent decades partly reflects the fact that the supply of these workers has not kept pace with the demand for them (Goldin

and Katz, 2009). While Communications/Journalism majors do not receive the earnings premiums of Business majors, these two majors have somewhat similar occupations and work environments. For instance, most Communications/Journalism majors receive degrees in communications, mass media, advertising, or public relations; and likely work alongside Business majors, among whom many receive their degrees in management or marketing research (Carnevale et al., 2015).

Three majors (Psychology/Social Work; Law/Public Policy; Health) were associated with particularly poor health. This could be expected for Psychology/Social Work, given the high unemployment and lower earnings of these majors shown in Fig. 1. However, incorporating economic circumstances and occupational skills explained only about one-half of their health disadvantage, suggesting that other factors are important. Psychology majors (who comprise most of the group) are not disadvantaged in cognitive ability (College Board, 2017), but they might be disadvantaged in non-cognitive skills. For instance, Psychology majors tend to score high on neuroticism (Vedel, 2016), which is the big five personality trait most robustly associated with poor physical and mental health (Lahey, 2009). For Law/Public Policy majors, we accounted for about one-third of their health disadvantage. The remainder may reflect serious occupational risks. Most of these majors receive their degrees in criminal justice, a key pipeline to law enforcement. Thus, the remainder may reflect the extreme job strains of police officers (e.g., shift work, emotional stress, bursts of strenuous physical activity, exposure to violence) which contribute to their significantly worse mental and physical health compared to the general population (Hartley et al., 2011). Finally, unlike any other major, the health disadvantage of Health majors persisted in size and significance across all models. This group predominately includes nursing majors. Nursing jobs, like law enforcement, often entail shift work and are physically and emotionally taxing. In a recent survey, for instance, 51% reported musculoskeletal pain at work, 25% had been physical assaulted on the job, and 59% work 10 or more hours daily (ANA, 2017). Nurses, in addition, may be more cognizant of, and willing to report, health problems, including problems with physical functioning.

Lastly, we comment on the possible role of selection into majors. We designed the study to minimize the potential for selection to bias our findings. We chose a health measure for which problems before graduation are rare among college graduates and vary little by major (Robst and VanGilder, 2010). We also excluded adults who earned a post-baccalaureate degree to mitigate the potential for selection based on childhood socioeconomic circumstances and health. Prior research shows that early-life socioeconomic status has little influence on college major for individuals with only a Bachelor's degree (Torche, 2011). Selection could also occur from other factors such as cognitive ability and personality. Students with greater ability may not only choose lucrative majors, they may potentially also be better able to garner health-related advantages and avoid health-related risks throughout adulthood. Studies of labor market returns to college majors conclude that after accounting for selection into majors based on ability, large direct effects of college majors persist (e.g., Arcidiacono, 2004). We can glean further insights into ability selection by comparing Scholastic Aptitude Test (SAT) scores provided by the College Board (2017). If college majors with the best health also had the highest SAT scores, this could indicate a strong influence of selection. However, the overall pattern of SAT scores across the 15 majors is rather mixed, indicating that midlife health differences by major are not simply a function of ability. For instance, Psychology/Social Work is associated with poor health and this group also ranks low (14th) in SAT scores, providing indirect evidence for ability selection, but Humanities/Liberal Arts is also associated with poor health yet ranks fairly high (5th) in SAT scores, providing indirect evidence against ability selection. Other patterns are also intriguing. Industrial Arts/Recreation has the lowest SAT scores, yet is a health-advantaged major for women; in contrast, Physical Sciences has the highest SAT scores yet this group is third from the bottom in women's health; Architecture/Engineering, Business, and Communications/Journalism fall in the middle of SAT scores, but they are among the most health-advantaged. In addition to cognitive ability, personality differences exist across majors (Vedel, 2016). Neuroticism is the big five personality trait most robustly associated with poor health (Lahey, 2009). Arts, Humanities, and Psychology majors score particularly high on this trait (Vedel, 2016). In sum, our analyses and extant literature suggest that, while selection should not be ignored, college major has an independent association with adult health.

5.1. Limitations

Despite the many strengths of the ACS, it has a few shortcomings. First, because the data are cross-sectional, we cannot establish that college major has a causal influence on adult health. While the preponderance of evidence shows that a large part of the education-health association is causal (e.g., Montez and Friedman, 2015), we are aware of this limitation and have avoided strong causal statements.

The ACS does not contain information on other potential pathways such as health behaviors or pre-college factors such as family background and cognitive and non-cognitive skills. Therefore, we cannot examine lifestyle as a possible pathway or establish that the pathways we do examine are a consequence of education rather than unobserved characteristics. No single dataset has all of the information needed to address the questions we raised. For instance, datasets that contain pre-college factors typically consist of a single cohort and do not have the sample size required to examine detailed majors. Despite the shortcomings of the ACS, it is particularly well-suited to address our aims. Nevertheless, more studies are needed to validate and extend our findings. While we are careful not to make definitive claims about the reasons for health inequalities by major, our study makes a productive and important step in that direction.

We also note that other classifications of college majors are possible. The one we selected was derived from the Classification of Instructional Program codes of the National Center for Education Statistics (Carnevale et al., 2015) and had better face validity than the primary alternative classification (Siebens and Ryan, 2012). As with any classification scheme, some heterogeneity exists within the groups. Additional studies may want to reclassify or extract specific majors to glean additional insights.

5.2. Conclusions

It is well-established that adult health is stratified by the quantity of education an individual has attained. Our study shows it is also stratified by college major. Different majors develop different types of human capital, and some types are associated with health advantages in midlife. Nonetheless, all Bachelor's degree holders, regardless of major, report better health in midlife than peers who did not complete college. Our findings imply that college major is an important but overlooked input into health disparities and population health.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2018.01.005.

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