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The Relationship between Education and Pain among Adults Aged 30–49 in the United States

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Abstract

Pain is a major health problem among US adults. Surprisingly little, however, is known about educational disparities in pain, especially among the nonelderly. In this study, we analyze disparities in pain across levels of educational attainment. Using data from the 2010–2017 National Health Interview Survey among adults aged 30–49 (N=74,051), we estimate logistic regression models of pain prevalence using a dichotomous summary pain index and its five constituent pain sites (low back, joint, neck, headache/migraine, and facial/jaw). We find a significant and steep pain gradient: greater levels of educational attainment are associated with less pain, with two important exceptions. First, adults with a high-school equivalency diploma (GED) and those with ‘some college’ have significantly higher pain levels than high school graduates despite having an equivalent or higher attainment, respectively. Second, the education-pain gradient is absent for Hispanic adults. After taking into account important covariates including employment, economic resources, health behaviors, physical health conditions, and psychological wellbeing, educational disparities in pain are no longer statistically significant except for the GED and ‘some college’ categories, which still show significantly higher pain levels than high school graduates. We thus document the overall education-pain gradient in most younger US adult populations, and identify groups where pain is higher than expected (certain educational

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categories) or lower than expected (e.g., less-educated Hispanics). Understanding the causes of these anomalous findings could clarify factors shaping pain prevalence and disparities therein.

PERSPECTIVE

Over 50% of US adults age 30–49 report pain. Overall, more educated Americans report substantially less pain than the less educated. However, adults with a GED and ‘some college’ report more pain than other groups. Understanding the causes could help illuminate the mechanisms through which social factors influence pain.

Keywords

Educational attainment; pain; disparities; US adults; population; NHIS

INTRODUCTION

Pain is strongly influenced by social characteristics such as educational attainment.¹⁹ Indeed, education is one of the most powerful determinants of health in general.⁴⁷ While an extensive literature has documented educational disparities for various health outcomes,^{9, 50, 66} research on the relationship between education and pain is surprisingly limited.

Several studies have found that greater levels of completed schooling are correlated with lower pain prevalence.^{12, 22, 34, 81} Research in this area, however, leaves five crucial gaps. First, prior work has used samples that are nonrepresentative,¹⁷ that include only older adults,^{22, 29} and/or that are relatively small.⁵⁷ Perhaps because of these limitations, some studies have found no clear association between education and pain.^{14, 18, 20, 29} Also, none have disaggregated findings by sex, race/ethnicity, or age. Second, studies have relied on older data, prior to 2010.⁷⁵ The educational landscape has changed drastically in the United States over the past two decades⁶, necessitating more current estimates. Third, studies have often focused on only one pain site, such as back pain,^{12, 17, 33, 37} leaving it unclear whether patterns are similar across sites. Fourth, little has been done to explain the relationship between education and pain by considering potential mediators and/or confounders such as employment and economic resources, health behaviors, physical health conditions, and psychological well-being—all of which are associated with both education^{3, 10, 32, 55} and pain.^{29, 34, 45, 54, 62}

Finally, prior studies have categorized education in only two to four levels, obscuring potential heterogeneity within these coarse groups. This is problematic because of the diversity at the secondary²⁶ and postsecondary levels² and the recently-described anomalies in education-health patterns within these groups.^{63, 73, 76, 79} Over 10% of US high school completions are via GED,²⁶ the General Educational Development certificate designed as an equivalent to the high school diploma. However, GED recipients appear to have significantly worse health outcomes^{41, 72, 73} than high school graduates. At the postsecondary level, adults with some college (but no postsecondary degree) have more schooling than high school graduates, and those with an associate degree have an additional credential. However, the ‘some college’ adults seem to have comparable⁷⁶ or even somewhat worse⁷⁹ health than

high school graduates, and even those with an associate degree sometimes fail to enjoy health benefits from their credential.^{63, 79}

We analyze educational disparities in pain using a large, nationally-representative survey of US adults age 30–49 collected in 2010–2017. We fill the noted gaps by answering the following questions: First, what is the relationship between (multi-category) education and (multi-site) pain? Second, how do sex, race/ethnicity, and age moderate this relationship? And third, what is the education-pain association when we take into account a wide range of relevant covariates? While our cross-sectional data do not permit causal analyses, we conduct exploratory, associational analyses assessing how employment, economic resources, health behaviors, and physical and mental health conditions influence the education-pain association.

METHODS

Data

We used data from the 2010–2017 National Health Interview Surveys (NHIS),⁴ a large annual cross-sectional survey that is nationally representative of the noninstitutionalized US population. The NHIS includes well-designed questions about pain, detailed information about educational attainment, and a rich set of items about social and medical conditions. It is adequately powered to support race/ethnicity-specific and sex-specific analyses.

Sample was defined as respondents aged 30 to 49 who lived in the US for at least 15 years at the time of interview and were interviewed between January 2010 and December 2017. A random subsample of 43% of all adult NHIS respondents were asked detailed questions about pain and key covariates we use in the analysis. The age of 30 is a threshold below which over 13% of US adults are still enrolled in postsecondary schooling and thus do not have a completed education, as compared to less than 7% at ages 30–34.⁵² The upper-age threshold was chosen as a balance between maximizing sample size so that group-specific analyses are adequately powered and minimizing time since completed schooling because postsecondary opportunities were markedly different prior to recent decades.⁶ The goal of restricting the sample to US-born respondents or immigrants who lived in the US for at least 15 years was to include adults who likely completed schooling in the US. The length of residence threshold, 15 years, was a function of the levels for this variable provided by NHIS. These sample restrictions yielded 74,300 respondents. We then excluded 192 respondents (0.3%) who did not provide information about their educational attainment and 57 (0.08%) who failed to answer at least one pain question. Thus, the total analytic sample size was 74,051.

Ethics statement.—This study is a secondary analysis of publicly-available, fully de-identified data. As such there are no human subjects and no need for Institutional Board Approval.

Variables

Outcome is pain.—NHIS asked about pain with respect to five bodily sites. Four items were ascertained with the following prompt: “During the past three months, did you have

...” 1) low back pain, 2) neck pain, 3) severe headache or migraine, or 4) facial ache or pain in the jaw muscles or the joint in front of the ear. A fifth item assessed “any symptoms of pain, aching, or stiffness in or around a joint” that started more than 3 months ago. We also created a summary indicator (“any pain”) in which those who responded affirmatively to any of the five pain measures were coded as having pain versus no pain. The first four items are likely to capture both chronic pain, commonly defined as pain lasting 3 months or more, and pain of shorter duration. We consider both types of pain worthy of study, since even pain lasting less than 3 months can be highly consequential for daily functioning, health, and well-being.⁵⁹ Findings for joint pain, which is defined as lasting over 3 months, are extremely similar to those for the other pain sites. This suggests our results are not highly sensitive to more or less stringent temporal criteria for chronic pain.

Pearson correlations among the five individual pain sites range from 0.18 to 0.41 (tetrachoric correlations: 0.37–0.67), indicating that respondents reporting pain at any one site were more likely to report pain at other sites as well, a known pattern for pain experience,⁸ but also that each measure contributed independent information. Thus the indicators could be meaningfully analyzed individually or jointly using the binary summary indicator.

Key independent variable is highest level of completed education. The variable was collected by NHIS with the following categories: less than high school completion, GED (General Educational Development), high school diploma, some college but no postsecondary degree, technical/vocational associate degree, academic associate degree, bachelor’s, and master’s or higher degree. We distinguish between adults with a GED and high school graduates because prior studies show that these two groups have significantly different health outcomes.⁷⁸ We used the maximum detail about educational attainment available in NHIS at the levels between high school and college completion, which represent 75% of the target population. We collapsed years 0–11 as having less than high school completion, and MA with professional and doctoral degrees.

Demographic variables are age (30–49 years, included as continuous), sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), region of residence (Northeast, Midwest, South, and West), place of birth (US-born versus foreign-born), and language of interview (English vs. other). We use the term sex rather than gender throughout because the term sex better captures the simple dichotomous measure available in NHIS than the more complex if overlapping notion of gender.⁵ Year of interview is included as a continuous covariate to adjust for potential secular changes in pain prevalence in the US population.⁸¹

Additional covariates include family characteristics, employment, economic resources, health behaviors, physical conditions other than pain, and mental wellbeing. Family characteristics are marital status (categorized as married or cohabiting, divorced or separated, widowed, or never married) and the number of children currently residing in the household. Employment covers current status (employed, unemployed, not in labor force), employment during the previous year (12 months, 1–11 months, or 0 months), and occupation for all respondents who ever worked, coded by NHIS into one of 100 categories. We assigned each occupation the Nam-Powers-Boyd Occupational Status Score.⁵¹ This

widely-used score assigns each occupation a value reflecting its prestige status, ranging from 100 for physicians and dentists to less than 10 for cleaners or agricultural workers. Economic resources were captured with the household income-to-poverty ratio (an inflation-corrected measure that adjusts income for household composition and is categorized as <1, 1–1.99, 2–3.99, and 4+), home ownership (owns, rents, or other), and home type (apartment or home versus trailer or other structure).

Health behaviors include smoking (current, former, or never), alcohol use (never, former, current moderate, and current excessive drinking that includes binge and heavy drinking¹⁵), and BMI (<18.5, 18.5–24.9, 25–29.9, 30–34.9, 35–39.9, and 40+) as an indirect measure of diet and physical activity. Physical chronic conditions were assessed using the prompt: “Have you ever been told by a doctor or other health professional that you had ...?” The conditions are respiratory (chronic bronchitis or emphysema), heart (angina pectoris, CHD, heart attack, and other heart conditions), arthritis, cancer, diabetes, hypertension, kidney disease, liver condition, and stroke. Finally, mental health was measured using the Kessler Scale (K6), which captures manifestations of six dimensions of psychological distress during the past month. This scale, widely-used to measure population mental health,^{35, 58} has a 0–24 range; higher scores indicate more severe symptoms.

Approach

We estimated the distribution of pain and sociodemographic characteristics for the study population and by each category of educational attainment (Table 1). Next we estimated logistic regression models of the summary pain measure, adjusting for demographic covariates, for the total sample and separately by sex, race/ethnicity, and age group (Table 2). The rationale for the stratified analyses was that many health outcomes differ across these characteristics, as does the education-health association.^{1, 40, 48, 74} We therefore needed to examine whether the education-pain association differs by sex, race/ethnicity, and age as well. Third, we estimated logistic regression models of the summary pain index, fully adjusted for all covariates (Table 3). Finally, to visualize the pain differences by education, we calculated the predicted probability of pain and 95% confidence intervals at each educational-attainment level, controlling for demographic characteristics, as well as all covariates (Figure 1).

All analyses were estimated on pooled 2010–2017 data and took into account the complex sampling structure of NHIS. Sampling weights were adjusted for pooling across multiple years following recommendations to divide the weights by the number of waves used.⁵³ Variance adjustment was based on Taylor series linear approximation. All analyses were estimated in Stata 15.1.⁶⁹

Missing data.—Variable missingness was low, with most variables missing at rates of 0%–0.2%. Exceptions were smoking (missing for 1.1%), K6 distress (1.1%), BMI (2.8%), occupational prestige score (4.2%), and income (5.9%). Models in Table 2 included only variables that happened to have no missing values, so imputation was unnecessary. To estimate the fully-adjusted models in Table 3 and Panel B of Figure 1, we employed multiple

imputation via chained equations.⁶⁴ We created 10 imputed datasets and used Rubin's rules for combining the regression results.⁶⁵

Additional analyses—We conducted extensive auxiliary analyses and robustness checks to examine the sensitivity of results to different model and variable specifications.

Supplemental Online Tables show results from the subset of these analyses that are of substantive interest and complementary to the main tables. They include respondent counts and unweighted proportions with pain, as well as weighted proportions with pain by sex, race/ethnicity, and age group (Tables S1a and S1b). Complementary to Table 2 are results from (otherwise identical) models using probit, linear probability, and Poisson regressions with robust standard errors⁴⁶ to examine the robustness of our findings to different specifications (Tables S2a–S2c), as well as results from logistic models of each individual pain indicator to supplement results for the summary pain index (Tables S2d–S2h). Complementary to Table 3 are results from linear probability models (Table S3a) and logistic models for each pain site (Table S3b). Finally, Supplemental Online Figure S1 shows predicted probabilities of pain by education separately for each racial/ethnic group.

Additional robustness checks included: 1) re-estimation of regression models without NHIS sampling weights; 2) models including only US-born adults; 3) models including all immigrant NHIS respondents, even those who arrived less than 15 years before the survey; 4) models including occupation category as a series of dummy variables; 5) models including occupation as a random effect; 6) complete-case analysis with listwise deletion for all cases with any missing information; 7) models examining the linearity of the association between age and pain by estimating semiparametric models with flexibly-specified age separately for each education category (to confirm that a linear specification is adequate); 8) models including proxy respondents; and 9) models estimated on data spanning 2002–2017 NHIS waves. All results are available on request. Overall, we found no meaningful variation across different model specifications compared to the results shown below.

RESULTS

Table 1 summarizes key characteristics of the target population in aggregate and by educational attainment. In this age group (30–49), 50.2% of US adults report pain in at least one body site. Among individual sites, the most common are low back pain (experienced by 29.4%) and joint pain (24.0%). Headache/migraine, neck pain, and facial/jaw pain are experienced by 19.7%, 16.3%, and 5.2%, respectively. Pain prevalence differs across levels of education: adults with a GED report the highest level of pain for all measures (61.8% report any pain), followed by adults with some college (56.4%) and vocational AA (53.3%), high school dropouts with no credential (51.5%) and high school graduates (50.9%). Adults with a BA and MA+ report considerably lower prevalence of pain (45.0% and 43.9%, respectively). The differences across educational attainment levels are statistically significant at $p < .001$ for all pain outcomes.

Table 2 shows how educational attainment is associated with the summary pain measure controlling for basic demographic characteristics, for the full sample and by sex, race/ethnicity, and two 10-year age groups. The reference educational category is high school. In

the full sample, less than high school is associated with 27% higher odds of reporting pain compared to high school, while bachelor's and postgraduate levels are associated with 27% and 31% lower odds of pain, respectively. Adults with a GED have the highest odds of pain—60% greater than their HS counterparts. At the subbaccalaureate level, the findings are complex. Adults with some college but no degree have significantly higher odds of reporting pain than HS graduates (OR=1.20, $p<.001$). The odds of experiencing pain for those with a vocational associate degree are statistically comparable to the odds for those with a high school diploma (OR=1.03), while academic associate degree is associated with 10% lower odds of reporting pain compared with HS ($p<.05$). The model also includes basic demographic covariates, and indicates that being older, female, white, US-born, English-speaking, and a resident of the West are all associated with significantly higher odds of reporting pain.

The group-specific findings in Table 2 reveal many similarities across groups in overall education-pain patterns, and some differences as well. The overall pattern is statistically comparable for men and women at all levels of education, meaning that in pooled models with gender-by-education interactions, none were statistically significant. The gradient is also relatively similar for white and black adults, with only one education level significantly different between the two groups: bachelor's degrees, vis-à-vis HS diplomas, are less protective against pain for blacks than for whites (OR=.84, $p<.05$ for blacks; OR=0.69, $p<.001$ for whites, shown as a bolded coefficient in the Table). Hispanic adults stand out, however: in this group, there are no significant differences in pain prevalence by educational attainment. Models with race/ethnicity-by-education interactions confirm that the pattern among Hispanics is significantly different from that for whites. The absence of educational disparities in pain among Hispanic adults is primarily due to less educated Hispanics having relatively low pain, in contrast to the elevated pain rates found among less educated whites and blacks (see Supplemental Figure S1 and Supplemental Table S1b). Finally, education-pain patterns are similar for adults 30–39 and those 40–49, except that the OR for pain in the 'some college' group relative to high school is statistically significantly larger in the younger group (OR=1.29, $p<.001$ in the group aged 30–39 and OR=1.11, $p<.05$ in the group aged 40–49).

Table 3 shows results from fully-adjusted models for the full sample and across major population subgroups. Several findings are noteworthy. First, with respect to the full-sample models: 1) After the inclusion of all covariates, high school dropouts and recipients of vocational and academic AAs, BAs, and MAs do not significantly differ from the reference high school graduates, with odds ratios very close to 1. 2) Two attainment levels remain associated with significantly more pain than the high-school reference group: GED recipients and adults with some college. GED recipients have 20% higher odds of pain ($p<.01$)—a significant but considerably smaller effect size than in the demographics-only-adjusted model, where it was 60% ($p<.001$). Adults with some college also remain significantly more likely to report pain than high school graduates (OR=1.18, $p<.001$), with the effect size largely unchanged from the model in Table 2 (OR=1.20, $p<.001$).

Across sex, race/ethnicity, and age groups, we found additional important results. First, in all groups, the education-pain association became statistically non-significant at all schooling

levels except the GED and ‘some college’ groups. Second, GED remained associated with significantly higher odds of reporting pain compared with high school for women, black adults, and adults 30–39, but not for men, white or Hispanic adults, and adults 40–49. Third, the significantly greater odds of reporting pain for adults with some college vis-à-vis high school graduates remained statistically significant in all groups except Hispanics, and the odds ratios were largely unchanged from the demographics-only-adjusted models in Table 2.

Figure 1 displays the predicted probability of pain for the full sample from the demographics-only-adjusted model (Panel A) and the fully-adjusted model (Panel B). The overall education-pain gradient is evident in Panel A, along with the anomalously high probability of reporting pain for adults with a GED and those with some college or a vocational AA. Panel B shows the attenuated pain differences when socioeconomic, health-behavioral, psychological, and chronic-condition covariates are taken into account. The predicted probabilities of pain here are similar across all education levels except that adults with a GED and some college report significantly more pain than all other education groups.

DISCUSSION

This study described educational disparities in pain among US adults age 30–49 using the 2010–2017 NHIS, a large, current, nationally-representative survey. We analyzed the association between detailed educational attainment categories and pain in the full sample; by sex, by race/ethnicity, and by age; and both before and after controlling for individuals’ economic resources, health behaviors, physical conditions, and psychological wellbeing.

Overall, pain prevalence is high: about half of Americans age 30–49 report pain in at least one body site. Low back pain is most frequently reported (29%), followed by joint pain (24%), headache/migraine (20%), neck pain (16%), and facial/jaw pain (5%). Across all five pain sites, adults with higher levels of education generally report less pain. The pain gradient is steep: compared to high school graduates, high school dropouts have nearly 30% higher odds of reporting pain, while college graduates have about 30% lower odds.

This pattern conforms to the well-documented education gradient in health and mortality.^{9, 49, 66, 77} Educational attainment shapes access to a wide range of financial and nonpecuniary resources that individuals can use to maximize health. Why might education be linked to pain? While the cross-sectional NHIS data do not permit strong causal analyses, we examined the pain-education association after controlling for factors widely understood to link education and health, including family characteristics, employment and economic wellbeing, health behaviors, and chronic physical and mental conditions.⁹ These factors jointly statistically account for pain disparities across most educational categories. Our results suggest that in general educational attainment may influence pain through a combination of socioeconomic, health-behavioral, social, and medical factors.

We identified important anomalies in the overall gradient for three educational categories: GEDs, ‘some college,’ and vocational AA degrees. Although the GED is intended to be equivalent to a high school diploma,²⁶ rates of pain are far from equivalent in the two groups: GED recipients report the highest pain prevalence of *any* educational category at all

five body sites. Adults with ‘some college,’ who by definition have more education than those who only completed high school, could be expected to have less pain—but instead have about 20% higher odds of pain. Finally, adults with a vocational/technical associate degree have not only more schooling but an additional credential compared to high school graduates, yet they report statistically comparable rates of pain, not less pain. We note that millions of American adults fall into these three educational categories: GEDs represent over 10% of secondary credentials,²⁶ and ‘some college’ and vocational AAs represent over 18% and 4% of the population aged 25–34, respectively.⁷⁰ The unexpectedly high rates of pain in these groups is thus important to both research and policy.

These are novel findings in pain research. Prior work has either not mentioned the GED, ‘some college’, or AA groups at all,⁵⁶ or has combined them with adjacent educational categories.^{11, 29, 56} We know of only two studies in which ‘some college’ was analyzed as a separate category, albeit pooled with AA degrees: one found slightly lower pain prevalence among adults in this group than among HS graduates,¹¹ while the other found somewhat higher prevalence (the authors did not comment on this finding beyond noting that that pain lacked a “consistent relation” with education³¹). However, several recent studies of other health outcomes concluded that compared to HS graduates, adults with some college—and technical AA where data allowed such disaggregation—have similar or higher rates of chronic conditions,^{63, 79} elevated biomarker risk factors,⁷⁶ and poorer health behaviors.^{63, 67} Similarly, the GED disadvantage vis-a-vis HS has been described for chronic conditions and disability in several prior studies.^{7, 41, 72, 73} Our findings thus contribute to this emerging research on important but neglected educational endpoints and health, while also identifying these potentially vulnerable groups to pain researchers and clinicians.

Why did anomalously high pain prevalence persist for the GED and ‘some college’ groups even in the fully-adjusted model? The explanation likely lies in the complex circumstances and pathways through which individuals end up with these attainment levels. Both GED and ‘some college’ adults have failed to complete the educational credentials they started (at secondary or postsecondary levels, respectively). This could increase psychological stress due to unrealized expectations⁶⁰, stigma related to being a ‘dropout’,^{27, 39} and/or financial stress due to poor job prospects²⁶ or accumulated student loans.⁴² Such factors may in turn increase distress and depression, factors linked closely to pain.³⁶ Alternatively, students could drop out of high school or college due to health conditions that cause pain, rendering the associations we report endogenous to physical detriments. Finally, characteristics of the family of origin or psychosocial factors such as conscientiousness or persistence could also confound the relationship.²⁴ While we cannot test these possibilities with NHIS data, our findings point to the importance of further research to understand the causes of these anomalies in the educational gradient in pain.

Group-specific analyses show that these education-pain patterns, both the regularities and the anomalies, are consistent across most major population subgroups, including men and women, whites and blacks. The striking exception was Hispanics, who demonstrated no significant differences in pain prevalence across levels of education. Unlike white and black Americans, among whom pain increases steeply at lower levels of education, less-educated Hispanics seem to suffer little pain ‘penalty.’ This finding echoes research examining other

health outcomes that also found better-than-expected health among lower-SES Hispanics compared to other groups.⁸⁰ The result underscores the importance of studying intersections of education and other social categories, such as race/ethnicity, in social epidemiological studies of pain – something rarely done in current research.³⁰ Future research should explore psychosocial or economic factors (such as coping styles, family support, or occupational characteristics) that could explain the favorable pain profile of less-educated Hispanics. Such research could shed light on potential interventions to reduce pain for low-SES adults in other racial/ethnic groups.

Our study's key limitation is the mismatch between what we would ideally like to learn (what causes the education-pain gradient, both the regularities and the anomalies) and what we can demonstrate with cross-sectional data (correlations between education and pain, with and without adjustment for potential covariates). Cross-sectional observational studies cannot determine the causal direction between theorized predictors and outcomes, and we cannot reject the possibility that educational attainment was influenced by health conditions that also produced pain.²³ However, we captured pain at ages 30–49, while educational attainment is typically completed in the early 20s and determined by a complex interplay of socioeconomic, psychological, and institutional influences.^{44, 71} We also lacked many potentially important variables such as childhood conditions or pain severity and causes; as well as sufficient detail for some variables. For instance, we found that in fully-adjusted models, occupation as coded in NHIS did not have an independent significant association with pain. That contradicts our understanding of the importance of occupation for pain,^{38, 43} although other studies also found no pain-occupation association once other SES measures are controlled for.³⁰ A more in-depth examination of specific occupations is needed and could reveal particularly 'pain-prone' occupations. Finally, socioeconomic differences in pain experience, assessment, management, and treatment^{21, 25, 61} may also contribute to the patterns documented here. Adults with low education may experience or report pain differently, or their pain may be managed and treated less effectively. Research shows that education impacts how adults evaluate their general health,¹³ and that there are socioeconomic differences in medical treatments for various conditions,^{16, 68} but our understanding of these patterns in the context of pain is currently limited.²⁵ Despite such limitations, our correlational analysis yields new and important insights into the links between education and pain.

Conclusion

The 2017 Federal Pain Research Strategy lists research on social disparities in pain (and underlying mechanisms thereof) among its “most impactful” research priorities.²⁸ Our results demonstrate a strong educational gradient in pain among adults age 30–49, while they also bring to light two dimensions of social disparities in pain that have been previously unacknowledged: (1) strikingly high pain prevalence among those with GEDs or incomplete college education, and (2) lack of an educational gradient in pain among Hispanics. We urge researchers and clinicians to treat the GED and subbaccalaureate groups – both of which are numerically large – as vulnerable populations. We also urge further research on the absence of pain ‘penalty’ at low levels of education among Hispanic Americans, to potentially help reduce social disparities in pain in other groups as well. Our findings highlight the need for

further broader inquiry to illuminate the causal mechanisms through which social factors influence pain among US adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- There are steep inequalities in pain by educational attainment in US adults 30–49.
- However, adults with GED and ‘some college’ report more pain than other groups.
- Also, Hispanic adults have no significant pain disparities by education.
- Understanding these anomalies could help alleviate pain levels and disparities.

Figure 1. Predicted Probability of Pain by Education

The figure shows probability of reporting pain and 95% confidence intervals for adults age 40. Panel A controls for demographics; Panel B for all covariates. The prediction is calculated with all covariates at their mean.

Table 1.

Select characteristics of US adults age 30–49 by educational category, NHIS 2010–2017

	LHS	GED	HS	SC	AAv	AAa	BA	MA+	Total
% of total	10.5	3.3	19.6	17.7	8.5	4.6	22.7	13.3	100.0
Pain									
Any pain	51.5	61.8	50.9	56.4	53.3	50.4	45.0	43.9	50.2
Joint	25.1	33.5	25.9	27.8	27.7	24.7	19.7	17.6	24.0
Back	35.1	41.1	31.5	34.2	32.8	29.7	23.6	20.6	29.4
Neck	17.7	21.9	15.9	18.8	18.4	17.4	14.0	13.1	16.3
Headache	23.0	27.1	19.0	24.1	21.5	21.3	15.3	16.4	19.7
Face/jaw	5.3	7.7	4.4	6.5	6.1	5.8	4.4	4.5	5.2
Demographics									
Age (mean)	40.3	39.4	40.3	39.5	39.7	39.5	39.4	39.6	39.7
Female	47.2	44.9	45.1	53.0	53.1	58.7	51.8	55.4	50.9
Race/ethnicity									
NH White	37.3	62.1	63.0	65.1	70.2	71.1	75.3	75.2	66.0
NH Black	12.9	14.2	15.5	16.2	12.5	11.4	9.5	8.7	12.6
Hispanic	46.3	20.3	17.2	14.2	13.6	12.6	7.9	6.2	15.7
Other	3.5	3.4	4.4	4.5	3.7	4.9	7.4	9.9	5.7

Source: National Health Interview Survey Sample Adults, pooled 2010–2017 data. N=74,051. Weighted estimates. The “age” row shows the mean age in each educational category. All other rows present the percentage of adults within each educational category with the characteristic; the percentages thus do not add to 100 across rows or columns except for the first row.

LHS=Less than a high school degree, GED=General Educational Development diploma; HS=high school diploma; SC=some college but no degree; AAv=vocational/technical associate degree; AAa=academic associate degree; BA=bachelor’s degree; MA+=master’s, professional, or doctoral degree. NH= non-Hispanic.

All variables differ statistically at $p<.001$ across educational-attainment categories, tested using an F-test for all variables except age, where a regression-based estimate for differences across educational categories was used.

Table 2.

Logistic models of ‘any pain’ by education, for full sample and by sex, race/ethnicity, and age group, US adults age 30–49, NHIS 2010–2017.

	Full sample	Sex		Race/ethnicity			Age group	
		Men	Women	White	Black	Hispanic	30–39	40–49
Education								
Less than HS	1.27 ***	1.23 ***	1.32 ***	1.43 ***	1.46 ***	1.09	1.29 ***	1.25 ***
GED	1.60 ***	1.50 ***	1.75 ***	1.66 ***	1.75 ***	1.23	1.71 ***	1.51 ***
HS=reference								
Some college	1.20 ***	1.15 **	1.24 ***	1.18 ***	1.30 ***	1.10	1.29 ***	1.11 *
AA(vocational)	1.03	0.99	1.06	0.97	1.09	1.15	1.04	1.02
AA(academic)	0.90 *	0.80 **	1.00	0.88 *	0.95	0.92	0.94	0.88
BA	0.73 ***	0.73 ***	0.73 ***	0.69 ***	0.84 *	0.97	0.72 ***	0.74 ***
MA+	0.69 ***	0.64 ***	0.74 ***	0.66 ***	0.75 **	0.87	0.70 ***	0.68 ***
Age	1.02 ***	1.02 ***	1.02 ***	1.02 ***	1.03 ***	1.02 ***	1.02 ***	1.02 ***
Female	1.38 ***			1.33 ***	1.62 ***	1.47 ***	1.40 ***	1.35 ***
Race/ethnicity (NH white=ref)								
NH Black	0.73 ***	0.65 ***	0.79 ***				0.71 ***	0.74 ***
Hispanic	0.74 ***	0.71 ***	0.76 ***				0.76 ***	0.71 ***
Other	0.76 ***	0.80 ***	0.72 ***				0.75 ***	0.76 ***
Non-English	0.72 ***	0.67 ***	0.78 **	0.67	0.67	0.80 ***	0.67 ***	0.77 ***
Foreign-born	0.72 ***	0.70 ***	0.75 ***	0.81 **	0.72 **	0.69 ***	0.75 ***	0.71 ***
Region (NE=ref)								
Midwest	1.06	1.03	1.09 *	1.08 *	1.07	0.95	1.05	1.06
South	1.04	1.03	1.06	1.06	1.11	0.95	0.99	1.09 *
West	1.20 ***	1.25 ***	1.16 ***	1.26 ***	1.43 ***	1.02	1.18 ***	1.21 ***
Interview year	1.00	1.00	1.00	1.01	1.00	0.98	1.00	1.00

*
p<.05,

**
p<.01,

***
p<.001

Source: National Health Interview Survey Sample Adults, pooled 2010–2017 data. N=74,051.

Odds ratios shown. Models adjust for complex sampling design of NHIS.

The 5 bolded coefficients identify instances of statistically significant differences (p<.05) across groups in the education-pain gradient, based on additional logistic models with the same covariates as in Table 2 plus education-by-group interactions. The reference categories were HS for education and men, white, and 30–39 for the population subgroups, respectively. NH=non-Hispanic

Table 3.

Fully-adjusted logistic models of ‘any pain’ by education, for full sample and by sex, race/ethnicity, and age group, US adults age 30–49, NHIS 2010–2017.

	Full sample	Sex		Race/ethnicity			Age group	
		Men	Women	White	Black	Hispanic	30–39	40–49
Education								
Less than HS	1.01	0.97	1.05	1.02	1.11	1.04	1.03	1.01
GED	1.20 **	1.16	1.23 *	1.14	1.60 **	1.09	1.28 *	1.12
HS=reference								
Some college	1.18 ***	1.15 **	1.22 ***	1.18 ***	1.24 *	1.08	1.25 ***	1.11 *
AA(vocational)	1.05	1.00	1.12	1.00	1.09	1.21	1.04	1.07
AA(academic)	0.98	0.85	1.11	0.97	1.01	0.91	1.01	0.96
BA	0.96	0.96	0.98	0.93	1.07	1.13	0.94	1.00
MA+	0.98	0.89	1.09	0.97	0.98	1.18	0.99	1.00
Age	1.01 ***	1.01 **	1.01 **	1.01 ***	1.01	1.00	1.01	1.00
Female	1.27 ***			1.22 ***	1.39 ***	1.36 ***	1.27 ***	1.27 ***
Race/ethnicity (NH white=ref)								
NH Black	0.77 ***	0.74 ***	0.78 ***				0.73 ***	0.80 ***
Hispanic	0.81 ***	0.80 ***	0.83 ***				0.85 **	0.77 ***
Other	0.84 **	0.83 *	0.86				0.81 *	0.87
Non-English	0.79 ***	0.74 **	0.87	0.73	0.68	0.86 *	0.76 *	0.85
Foreign-born	0.94	0.84 **	1.05	0.91	1.15	0.90	0.97	0.93
Region (NE=ref)								
Midwest	1.03	1.02	1.02	1.05	1.04	0.97	0.99	1.05
South	1.04	1.04	1.04	1.06	1.18	0.94	0.98	1.09
West	1.19 ***	1.26 ***	1.12 *	1.27 ***	1.36 *	1.01	1.17 **	1.20 **
Interview year	0.99	1.00	0.99	0.99	1.01	0.98	1.00	0.99
Marital status (married)								
Previously married	0.97	0.97	0.96	0.91 *	1.08	1.04	0.97	0.96
Never married	0.88 ***	0.83 ***	0.92	0.89 **	0.97	0.83 *	0.93	0.82 ***
Children at home (0)								
One child	1.06	1.02	1.08	1.03	1.10	1.09	1.07	1.04
Two or more	1.02	1.07	0.98	1.01	1.12	1.04	1.08	0.95
Income-to-poverty ratio (4 times=ref)								
2–3.9 times	1.03	1.03	1.03	1.05	0.86	0.99	1.07	1.00
1–1.9 times	1.18 ***	1.17 **	1.17 **	1.25 ***	1.00	1.02	1.20 **	1.15 *
Below poverty	1.12 *	1.12	1.10	1.19 **	0.86	1.03	1.17 *	1.07
Home (owns)								
Rents	1.03	0.99	1.07	1.02	1.02	1.06	1.04	1.02
Other	1.09	1.03	1.15	1.14	1.01	1.01	1.12	1.06

	Full sample	Sex		Race/ethnicity			Age group	
		Men	Women	White	Black	Hispanic	30–39	40–49
Employed (yes)								
Unemployed	0.90 [*]	0.90	0.92	0.88	0.97	0.89	0.98	0.83 [*]
Not in labor force	1.12 ^{**}	1.35 ^{***}	1.06	1.09 [*]	1.24 [*]	1.15	1.12 [*]	1.11
Occupation prestige	1.00	0.98	1.01	1.00	0.96	1.01	1.02	0.98
Smoking (never)								
Former smoker	1.19 ^{***}	1.19 ^{***}	1.19 ^{***}	1.19 ^{***}	1.21	1.20 [*]	1.14 ^{**}	1.24 ^{***}
Current smoker	1.34 ^{***}	1.37 ^{***}	1.31 ^{***}	1.37 ^{***}	1.33 ^{***}	1.23 [*]	1.39 ^{***}	1.28 ^{***}
Alcohol use (never)								
Former	1.43 ^{***}	1.56 ^{***}	1.35 ^{***}	1.47 ^{***}	1.44 ^{**}	1.34 ^{**}	1.35 ^{***}	1.50 ^{***}
Current moderate	1.45 ^{***}	1.48 ^{***}	1.48 ^{***}	1.49 ^{***}	1.51 ^{***}	1.43 ^{***}	1.43 ^{***}	1.47 ^{***}
Current excessive	1.56 ^{***}	1.67 ^{***}	1.48 ^{***}	1.58 ^{***}	1.82 ^{***}	1.60 ^{***}	1.50 ^{***}	1.61 ^{***}
BMI (18.5 to 24.9)								
Less than 18.5	0.79 [*]	0.58 [*]	0.86	0.86	0.36 [*]	1.55	0.96	0.63 ^{**}
25–29.9	1.07 ^{**}	1.00	1.13 ^{**}	1.11 ^{**}	1.04	0.90	1.06	1.08 [*]
30–34.9	1.28 ^{***}	1.25 ^{***}	1.26 ^{***}	1.32 ^{***}	1.26 [*]	1.08	1.27 ^{***}	1.28 ^{***}
35–39.9	1.28 ^{***}	1.21 [*]	1.31 ^{***}	1.24 ^{**}	1.39 ^{**}	1.28 [*]	1.27 ^{***}	1.28 ^{***}
40 and above	1.42 ^{***}	1.22 [*]	1.54 ^{***}	1.41 ^{***}	1.42 ^{**}	1.54 ^{**}	1.48 ^{***}	1.34 ^{***}
Arthritis	5.81 ^{***}	5.24 ^{***}	6.40 ^{***}	5.74 ^{***}	5.47 ^{***}	6.06 ^{***}	5.48 ^{***}	6.03 ^{***}
Cancer	1.32 ^{***}	1.16	1.40 ^{***}	1.36 ^{***}	0.94	1.09	1.50 ^{***}	1.23 ^{**}
Diabetes	1.00	0.98	1.03	0.95	0.99	1.11	1.05	0.99
Hypertension	1.24 ^{***}	1.23 ^{***}	1.24 ^{***}	1.20 ^{***}	1.21 ^{**}	1.36 ^{***}	1.31 ^{***}	1.19 ^{***}
Kidney disease	1.40 [*]	1.29	1.48 [*]	1.48 [*]	1.04	1.78 [*]	1.54 [*]	1.33
Liver disease	1.51 ^{**}	1.28	1.99 ^{**}	1.80 ^{**}	0.92	1.15	1.38	1.63 ^{**}
Stroke	1.29 [*]	1.09	1.54 [*]	1.51 [*]	0.84	1.59	1.68 [*]	1.17
Respiratory disease	1.82 ^{***}	2.06 ^{***}	1.68 ^{***}	1.79 ^{***}	2.09 ^{***}	1.88 ^{***}	2.00 ^{***}	1.74 ^{***}
Heart disease	1.50 ^{***}	1.42 ^{***}	1.59 ^{***}	1.41 ^{***}	1.87 ^{***}	1.89 ^{***}	1.80 ^{***}	1.34 ^{***}
K6 distress score	1.16 ^{***}	1.16 ^{***}	1.17 ^{***}	1.17 ^{***}	1.17 ^{***}	1.15 ^{***}	1.16 ^{***}	1.16 ^{***}

^{*} p<.05,

^{**} p<.01,

^{***} p<.001

Source: National Health Interview Survey Sample Adults, pooled 2010–2017 data. N=74,051.

Odds ratios shown. Models adjust for complex sampling design of NHIS; multiply-imputed models.

The 5 bolded coefficients identify instances of statistically significant difference (p<.05) across groups in the education-pain gradient, based on additional logistic models of pain with the same covariates as in Table 3 plus education-by-group interactions. The reference categories were HS for education and men, white, and 30–39 for the population subgroups, respectively. NH=non-Hispanic.