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Beyond Black vs White: race/ethnic disparities in chronic pain, including Hispanic, Asian, Native American, and Multiracial Groups.

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Despite the existence of a large literature on race/ethnicity and pain, important fundamental facts regarding chronic pain disparities in the general adult U.S. population have not been established. In part, this reflects the focus of much prior research on Black-versus-White comparisons [7; 15]. However, even this narrowly-defined comparison has yielded somewhat inconsistent results: some studies find no difference between Blacks and Whites [23]; some find higher prevalence of pain among Blacks [27; 29; 45; 59]; others find the opposite [26; 65; 67; 68]; and some studies report both patterns within one analysis, depending on the specific pain measure used [12; 18; 40; 41; 50]. Further, although Hispanics now constitute the largest non-White group, comprising over 21% of the total U.S. population [57], limited attention has been given to their experiences of pain. Even rarer are studies focused on Asian American and Native American adults. Finally, to the best of our knowledge, pain in multiracial Americans has never been systematically studied. This is troubling given that the multiracial population is the fastest-growing racial subgroup in the U.S., projected to more than double between 2020 to 2050, from 9.5 to 20.5 million [56]. Additionally, prior work on racial/ethnic pain disparities has rarely tested whether or how estimates vary across different pain operationalizations. This is a critical gap given not only the inconsistent results for the Black-White disparities cited above, but also considering that the pain definitions across epidemiological studies of chronic pain are "highly inconsistent, with virtually no two studies … using the exact same criteria" [53, p. 2092]. The existing research gaps thus neglect major segments of the U.S. population and potential differences in disparity patterns across pain severity levels.

This study makes three primary contributions to our understanding of U.S. racial/ethnic differences in chronic pain. First, we use large, up-to-date, nationally representative data to characterize pain prevalence not only among Whites and Blacks, but also among Hispanic,

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Asian American, Native American, and multiracial adults, as well as specific by 'main racial background' mentioned by multiracial adults. Second, we analyze whether the observed racial/ethnic differences are explained by key demographic and socioeconomic factors known to impact chronic pain at the population level, such as immigrant status, education, and family income [23; 24; 67]. And third, we present pain prevalence estimates for six commonly used pain operationalizations: severe pain, high-impact chronic pain, widespread pain, persistent pain over 3 months, persistent pain over 6 months, and 'any pain.' This enables us to document racial/ethnic disparities at differing levels of pain severity, to potentially reconcile the mixed findings comparing White and Black adults, and, generally, to clarify whether different pain measures lead to different conclusions regarding racial/ethnic disparities.

Overall, these three contributions generate a more complete picture of U.S. racial/ethnic disparities across a range of widely-used pain definitions. We identify groups at particularly high risk of chronic pain, highlighting potential unmet needs for pain prevention and treatment efforts. We also identify groups at relatively low risk, inviting further exploration of protective characteristics.

METHODS

Data

The analyses are based on data from the large, repeated cross-sectional National Health Interview Survey (NHIS). The NHIS is a leading source of data about health and health disparities in the U.S. population. With this aim in mind, the survey is representative of the U.S. non-institutionalized population in aggregate, as well as of major population subgroups such as main racial/ethnic categories. Detailed information on the sampling design of the NHIS and guidelines for analysts regarding sampling weights and variance estimation are publicly available [22; 37; 39].

We use information collected in the 2010 through 2018 waves. This range was selected to maximize sample size and yield up-to-date information while minimizing changes in sampling design and questionnaire wording. The year 2010 is when the NHIS began asking global pain questions, while 2018 is the most recent year data was available at the time of the writing, as well the last year before a major redesign in 2019, which could affect comparability to prior years. We used NHIS data harmonized by Integrated Public Use Microdata Series (IPUMS, https://ipums.org/), which is the optimal version for analyzing NHIS data from multiple years [52]. The data are publicly available at https://nhis.ipums.org/nhis/ and de-identified; as such, this analysis is exempt from IRB approvals.

The target population comprises community-dwelling adults age 18 and older. Proxy responses (fewer than 0.5 percent NHIS sample adults) were excluded as pain responses are inherently subjective; thus, proxy's reports cannot be substituted for self-reports. Sample sizes, which range from N=57,518 for high-impact chronic pain to 273,972 for 'any pain' and widespread pain, are shown in Table 1; additional details on their derivation is in the Supplement. Briefly, for all 6 pain definitions, over 99% of respondents provided valid

answers to necessary pain and race/ethnicity questions; fewer than 1% were excluded from analyses.

Variables

We analyze six pain measures: severe pain, high-impact chronic pain, widespread pain, persistent pain over 3 months, persistent pain over 6 months, and any pain. Table 1 summarizes the wording of questions, years of collection, and coding for all measures.

'Any pain' is constructed from questions about pain in five anatomical sites, chosen in NHIS for being the most common and/or disabling types [48]. These were posed in each year from 2010–2018 to all sample adults. Four questions were of the form: "During the past three months, did you have [low back pain, neck pain, severe headache or migraine, or facial or jaw ache or pain]?" The fifth site (joint pain) was collected with two items. Respondents were asked whether they had "any symptoms of pain, aching, or stiffness in or around a joint" and if they did, whether the onset was at least 3 months prior. We used a positive response to this follow-up question as an indicator of chronic joint pain so that all pain measures have a 3-month horizon. Respondents who indicated pain in at least one site are coded as having 'any pain,' following precedent [65; 67], while respondents who indicated pain in at least three sites are categorized as having widespread pain.

Since 2010, a subset or all respondents were also asked, "In the past 3 months, how often did you have pain? Would you say never, some days, most days, or every day?" Following established precedent, we dichotomized this measure as never or some days versus most or every day [40; 63]. This measure is referred to as chronic or persistent pain (3 months). Those who said they had pain on at least some days were also asked "Thinking about the last time you had pain, how much pain did you have? Would you say a little, a lot, or somewhere in between?" We used these two questions to construct a measure of severe pain, which is "a lot" of pain on most or every day.

In 2016 and 2017, the NHIS included a pain frequency item with respect to the last 6 months, worded similarly to the 3-month persistent pain item. Adults who had pain on at least some days were then asked how often the pain limited their life or work activities. We dichotomized the answers as never or some days versus most or every day, where the latter operationalized high-impact chronic pain [12; 68].

The key independent variable is race/ethnicity.—This variable, which combines racial and Hispanic-ethnicity self-identifications, was generated from two questions, which follow the post-1997 Office of Management and Budget standard. First, respondents self-identified as Hispanic or not Hispanic. Second, all respondents were asked to self-identify as White, Black/African American, American Indian/Alaskan Native (AIAN), Asian, or multiple race. We combined these two variables into a single racial/ethnic categorization, following prior empirical precedent [30] and theoretical justification [61]. The variable is thus coded as White (reference in regression models), Black, Hispanic, Asian, Native American (or AIAN: American Indian/Alaskan Native), and multiracial. All groups other than Hispanic are non-Hispanic; we omit the adjective for parsimony.

Covariates include demographic and socioeconomic characteristics.—Year of interview is included in all models as a continuous covariate centered on 2017. Age is in single years. Because of nonlinearities in the age-pain association [8; 18], age is centered on 60 and a quadratic term is added to capture nonlinearities. Gender is included with male as reference. Nativity status is captured with a 3-level variable, which categorizes respondents as U.S.-born, foreign-born but in U.S. for 15 or more years, and foreign-born and in the U.S. for less than 15 years. The threshold of 15 years is based on data availability, literature on immigrants' health [13; 49], and sensitivity checks, which showed it to be an optimal split for the duration in the U.S. in pain analyses. Language of interview is dichotomized as English or other language. Marital status is coded as married, previously married, and never married; and the number of children that reside with a respondent is coded as no children, one child, and two or more children. Finally, we include three measures of socioeconomic status. Education is categorized as less than a high school diploma, high school diploma, some college, associate degree, bachelor's degree, and master's or more advanced degree. High school equivalency (General Educational Development or GED) diploma recipients are included with the lowest education category based on prior work [64]. Family income is categorized as $0–34,999, $35,000–74,999, $75,000–99,999, and $100,000 or more. The last measure is home ownership (owns home, rents, or other arrangement), as a proxy for wealth and long-term financial wellbeing and stability [55].

Missingness.

The quality of data collected by the NHIS is high, with low missingness. As described in the Supplement, 99.2% to 99.9% of participants who were asked the race and various pain questions provided valid answers. Missingness on covariates was generally also low. Age, gender, year of interview, region of residence, and children had no missing values. Language of interview was missing for 0.004% (12 out of 273,972 total cases), and home ownership was missing for 0.2%; we included the missing cases with "other" levels. Marital status, immigrant status, and education were missing in 0.2–0.4% of cases, and only income had higher proportion of missing values, at 6.8%. For these four variables, we include a "DK" category in all regression models, although findings are very similar for a complete-case analysis.

Approach

We first estimate the weighted prevalence of each of the six pain definitions in all racial/ethnic categories (Table 2). We also test whether the prevalence differs significantly by race/ethnicity using design-adjusted F-tests equivalent to chi-squared tests with correction for the complex sampling design [43]. We then conduct the same analytic steps separately for men and women (Supplement Table S1); as well as by the main racial background listed by multiracial adults for further understanding of this complex category (Supplement Table S2). We also list the number of respondents of each race/ethnicity across the analytic samples, which differ across the pain definitions, to show that all racial/ethnic categories include a sufficient number of respondents for reliable estimates (Supplement Table S3). The third descriptive step summarizes the distribution of all covariates in the total sample and for the six racial/ethnic groups, and tests for differences in their distribution by race/ethnicity using the same approach as above (Table 3).

Next, we examine whether and how the pain disparities are influenced by the different distributions of covariates across race/ethnicity, by estimating a series of five Poisson regression models with robust standard errors (also referred to as modified Poisson models) for each of the six pain measures, net of different covariate sets. The modified Poisson is appropriate for dichotomous outcomes and preferred over logistic regression because the latter yields odds ratios, which are hard to interpret. The modified Poisson regression estimates prevalence ratios, which are more easily understood and communicated, especially to non-specialists [3; 54].

The omitted racial category is White as the largest population group, following precedent [18; 20; 23; 26; 62]. We control only for the year of interview in Model 1; we add age, age squared, gender, and region of residence in Model 2, nativity and language in Model 3, marital status and children in Model 4, and, finally, we add the three socioeconomic measures in Model 5. For parsimony, Table 4 shows only the prevalence ratios associated with race/ethnicity in the document below; the full models showing all coefficients are in Supplemental Table S4.

We also estimated logistic models for readers who wish to consult these results; the findings are in Supplemental Table S5 (parsimonious presentation with only the odds ratios for race/ethnicity, analogous to Table 4 in the manuscript) and Supplemental Table S6 (complete results, analogous to Supplemental Table S4). The two approaches yield comparable pictures of pain disparities although as expected the odds ratio point estimates are larger in size than the prevalence ratio estimates, especially for the more highly prevalent pain definitions.

These results frame the disparities in relative terms, using prevalence ratios. To visualize the findings and show the disparities in absolute terms for each group, rather than vis-à-vis the omitted White category, we also calculate average predicted probabilities of each pain level from the demographics-adjusted Model 2; the estimates and their 95% confidence intervals are in Figure 1. We also visualize the predicted probabilities from the fully adjusted models – that is, net of all demographic and socioeconomic characteristics shown in Table 4 Model 5 – and show the resulting set of plots in Supplemental Figure 1.

Finally, we attend to the fact that the analyses include all ages 18 and older. Age has a major impact on pain levels [18], as well as the distribution of most pain covariates [65]. However, the models above force the effect of race/ethnicity to be equal across the full adult age range. As a final step, we therefore examine how the racial/ethnic patterns in each pain measure differ by age. To do so in a flexible, data-driven way, we estimate race/ethnicity-stratified semiparametric partial-linear models of the form $P_i = \alpha + f(a_i) + \gamma x_i$, where P_i is the presence of pain (yes=1 versus no=0); x_i is a vector of covariates (we control for year and gender); and a_i captures age, using the plreg command in Stata [31]. The smooth function of age $f(a_i)$ is estimated by the lowess procedure [10]. This model thus estimates the level of pain across age for each racial/ethnic group, while additively including other covariates. The results are plotted as line graphs of pain across age in Figure 2.

The analytic steps outlined above thus summarize the gross pain disparities by race/ethnicity and show the disparities net of important potential confounders. The findings are presented

in relative terms, as prevalence ratios comparing each non-White group vis-à-vis Whites, and in absolute results, as predicted probabilities of pain in each racial/ethnic group. Jointly, the analysis yields a comprehensive portrait of the racial/ethnic distribution of chronic pain in U.S. adults.

RESULTS

Table 2 shows the weighted prevalence of pain in the total sample as well as in the six racial/ethnic groups for all six definitions of pain. The prevalence for each pain indicator is color-coded for easier interpretation, ranging from green (for the group with the lowest prevalence for a given pain measure) to red (highest prevalence). Additionally, the six pain measures are ordered, left to right, from the highest to lowest total prevalence.

Several findings regarding the estimated prevalence in the total adult U.S. population stand out. First, the aggregate prevalence rates range widely across the six pain definitions, from 6.4% (95%CI 6.2,6.7) for severe pain and 7.7% (95%CI 7.4, 8.0) for high-impact pain to 51.0% (95%CI 50.7, 51.4) for 'any pain.' Widespread pain and persistent pain are experienced by about 12% and 20% of American adults, respectively. Second, the prevalence of persistent pain is effectively identical between the 3-month versus 6-month horizon (19.6% versus 20.0%). This finding is consistent with prior reports, in which 3- versus 6-month time horizons "appear to have little or no effect on prevalence estimates" [53] perhaps because of imprecise recall of the onset and duration of the pain [4; 44]. It suggests that estimates from either question may be treated as comparable, which may be important for pain scholars who only have access to one of these two measures in population surveys.

With respect to racial/ethnic disparities, the comparisons are fairly consistent across all pain definitions. By far the lowest prevalence of pain is among Asian Americans. The two groups with the highest prevalence, in contrast, are Native American and multiracial adults. White, Black, and Hispanic groups fall in between these two extremes. The disparities are tremendous. Severe pain is reported by 2.4% of Asian Americans (95%CI 1.8,3.0), 5.0% of Hispanics (95%CI 4.5,5.5), 6.8% of Whites (95%CI 6.5,7.1), 7.6% of Blacks (95%CI 6.9,8.3), 8.7% of multiracial adults (95%CI 6.9,10.6), and 11.1% of Native Americans (95%CI 7.5,14.7). In other words, Hispanics have double the prevalence of severe pain compared to Asian Americans, multiracial adults have 3.6 times the prevalence, and Native Americans have an astonishing 4.6 times the prevalence.

High-impact chronic pain occurs in 3.5% of Asian Americans, but 14.7% of Native Americans (4.2 times higher) and 12.0% of multiracial adults (3.5 times higher). Again, White, Black, and Hispanic adults are between these extremes, with 8.3%, 7.9%, and 6.3% prevalence, respectively. Similar patterns are evident for the less stringent pain operationalization, although the differences become smaller in relative terms and larger in absolute terms. For instance, multiracial adults have 'only' 1.6 times the prevalence of 'any pain' compared with Asian Americans, but this difference translates to almost 22 percentage points difference in absolute terms (57.1% among multiracial Americans versus 35.3% among Asian Americans).

The final note from Table 2 is that the relative 'position' of White adults changes from the most to the least impactful pain operationalizations: for the most severe definitions, Whites have less or equal prevalence of pain than Black adults and only modestly more than Hispanic adults. For the least restrictive definition (any pain), Whites have substantially higher pain relative to all non-White groups – not only higher than Black and Hispanic groups, but equal to that of Native Americans and only slightly less than multiracial adults. The shading in Table 2 highlights this pattern: as the pain definitions progress from the most to the least stringent, the shading indicates increasingly higher prevalence among Whites relative to the total population.

Supplemental Table S1 shows that these patterns hold for both genders: Asian men and women have the lowest pain prevalence across all six pain definitions, while Native American and multiracial men and women have the highest prevalence. The results also corroborate the well-established pattern of higher pain among women compared to men [5]. In all but three of 42 available comparisons across groups and pain definitions, women have higher pain prevalence than men, and in many cases, the difference is substantively large. For instance, the prevalence of severe pain is 5.3% among men in aggregate (95%CI 5.0,5.6) but 7.5% (95%CI 7.4,8.2), among women. The largest relative excess pain for women compared with men is for widespread pain. For this pain definition, women across the six racial/ethnic categories have about 1.3 to 1.9 times the prevalence of their male counterparts. Finally, we note that the intersection of gender and race/ethnicity produces enormous disparities. For instance, severe pain is experienced by only 2.2% of Asian American men, but 12.9% of Native American women (5.9 times the prevalence), and high-impact pain is experienced by 3.2% of Asian American men but 12.8% of both Native American and multiracial women (4 times the prevalence).

Supplemental Table S2 adds nuance to the racial/ethnic comparisons by disaggregating the multiracial category by the main racial background reported by multiracial respondents Overall, there is statistically significant heterogeneity across these subgroups for severe, widespread, and both persistent pain measures, although not for high-impact pain or 'any pain.' The most noteworthy finding is that multiracial adults who listed Native American as their main racial background have by far the highest pain prevalence of any group for all pain measures: 13.2% reported severe pain (95%CI 7.2,19.3), 22.8% reported high-impact chronic pain (95%CI 11.6,33.9), and 31.6% reported widespread pain (95%CI 25.5,37.6), in comparison to 6.4%, 7.7%, and 11.6% in the total U.S. population, respectively. The multiracial adults who reported their main racial group as White also have relatively high pain across a number of pain measures, while the pain prevalence of other groups varied. A part of this variability may be due to the relatively modest sample sizes (although Supplemental Table S3 shows that the number of respondents in each subcategory exceeded 100 for all but multiracial Asian adults for high-impact and persistent pain over 6 months), but the findings clearly warrant additional research into pain among multiracial adults.

Table 3 summarizes the characteristics of the target population across race and ethnicity. This table is relevant because some of the racial/ethnic group differences described above may be attributed to different sociodemographic characteristics if their distribution varies across groups. Indeed, we found that every covariate differed statistically significantly across

the groups (p<.001). For instance, Whites were older (mean age 49.0 years) than all other groups, while Hispanic (40.8) and multiracial (40.4) adults were the youngest. For the other two basic demographic factors, sex differences were more modest across groups but region of residence differed substantially. Another significant area of difference was immigrant status, where well over 90% of White, Native American, and multiracial adults were U.S.-born, while only 42.9% of Hispanic and 22.1% of Asian Americans were. Correspondingly, nearly all White, Native American, and multiracial adults conducted the interview in English, compared with only 64% of Hispanics. Among Asian Americans, despite the high proportion of immigrants in their population (especially those with less than 15 years in the U.S.), nearly 93% completed the interview in English. Finally, socioeconomic status (SES), whether captured with education, family income, or home ownership, differed markedly as well. In terms of education and family income, Asian Americans had the highest rates, while Hispanic and Native Americans had the lowest. For home ownership, Whites had the highest rates, while Black Americans had the lowest.

The next step, therefore, was to adjust the gross comparisons of pain for these sociodemographic differences. Table 4 summarizes findings from a series of Poisson regressions with robust standard errors for each of the six pain measures, gradually adjusted for all covariates. For parsimony, the table only shows prevalence ratios for each racial/ethnic group compared to the reference group (Whites), across all models and pain measures. The full results showing the effects of all covariates are in Supplemental Table S4. For reference, we also show findings from analogous logistic regression models in Supplemental Tables S5 and S6; the findings are comparable to those shown in the main manuscript.

Asian Americans' have significantly lower pain vis-à-vis the reference category (White) across all pain outcomes and net of all covariate sets (Models 1 through 5). Controlling for age, gender, and region of residence in Model 2, Asian Americans have 60% lower prevalence of severe pain, 52% lower prevalence of high-impact pain, and 59% lower prevalence of widespread pain, compared to Whites. Controlling for the high proportion of immigrants among Asian Americans, as well as differences in family composition and socioeconomic status in Models 3–5, the absolute size of the differences attenuate (the prevalence ratios become closer to 1) but remain statistically significant and substantively large across all pain measures.

At the other end of the pain spectrum are Native American and multiracial adults. Net of age, gender, and region of residence, Native Americans have nearly 1.8 times the prevalence of high-impact pain and 2 times the prevalence of severe pain, compared with Whites (PR=1.78, p<.001 and PR=1.95, p<.001, respectively). The pain 'excess' is also evident and statistically significant for widespread pain and persistent pain over 3 months, although not for persistent pain over 6 months and 'any pain.' Nativity and family composition (Model 3) do not change these patterns meaningfully and marital and parent status (Model 4) have only modest impact. Importantly, however, when we control for socioeconomic status (Model 5), the Native Americans' excess pain relative to Whites becomes not significant for all pain outcomes, and the point estimates attenuate toward 1. In fact, for widespread, persistent (6 months), and any pain, the point estimates fall slightly below 1, in the direction of lower

pain for Native Americans, although as we noted the difference is not significant. That is, the higher pain among Native Americans, relative to Whites, is explained by the Native Americans' lower SES.

Among multiracial adults, the pain comparison vis-à-vis Whites is significant in 27 out of 30 models across all six pain definitions and most covariate sets, indicating excess pain. Moreover, the pain 'gap' is large in substantive terms: multiracial adults have 61% higher prevalence of severe pain, and 84% higher prevalence of high-impact pain, compared to Whites, net of year, age, gender, and region in Model 2 (PR=1.61, p<.001 and PR=1.84, p<.001, respectively). Unlike among Native Americans, this pain excess remains statistically significant and substantively large even net of SES, although about half of the excess is explained by the covariates. That is, even in the fully adjusted Model 5, multiracial Americans have 25% higher prevalence of severe pain (p<.05), 43% higher prevalence of high-impact pain (p<.001), and 34% higher prevalence of widespread pain (p<.001), compared to Whites.

Hispanic Americans have either significantly lower pain than Whites (for most pain measures and across most models) or the difference between the two groups is not statistically significant. Net of age, gender, and region of residence (Model 2), Hispanic adults have 11% lower prevalence of severe pain (PR=0.89, p<.05), 18% lower prevalence of widespread pain (PR=0.82, p<.001), up to 32% lower prevalence of persistent pain over 3 months (PR=0.68, p<.001). For high-impact pain, Hispanics have similar prevalence as Whites. The Hispanics pain 'advantage' tends to be smallest in Model 3 and Model 4 where we control for immigrant status, language of interview, and marital and parental status. However, controlling for the Hispanics' lower SES vis-à-vis Whites (Model 5), makes the Hispanic advantage larger again, with prevalence ratio estimates not dissimilar to those obtained in Model 2. That is, Hispanics, despite their lower SES, report significantly less pain than Whites, suggesting that the Hispanic advantage stems from factors other than those we included in the analysis.

Finally, the comparison between Black and White adults varies among the six pain measures. The most stringent pain measure, severe pain, shows Black adults have significantly more pain compared to Whites (PR=1.19, p<.01, Model 2). However, this estimate flips in direction if we take into account the Black-White SES differences. That is, net of education, family income, and home ownership in Model 5, Black Americans have significantly *less* severe pain (PR=0.85, p<.01). For the second most stringent pain measure, high-impact chronic pain, Black and White adults have effectively identical pain prevalence (PR close to 1, not significant in Models 1–4), until we control for the Black adults' lower SES: If we compare Blacks and Whites holding SES constant, Blacks have significantly less pain (PR=0.77, p<.001, Model 5). For the remaining four less stringent pain operationalizations, Black adults have statistically significantly less pain than Whites, no matter what characteristics we control for across the models.

In addition to the racial/ethnic differences, the models yield several important results with respect to the covariates (shown in Supplement Table S4). In particular, they corroborate well-recognized patterns, wherein pain increases with age, but at a decreasing rate (that

is, there may be a plateau or even decline in pain at older ages in these cross-sectional models; although it is important to remember that this pattern may be a function of selective mortality or differences across successive cohort, rather than true age patterns [8; 18]). As expected based on prior research, women report significantly more pain than men and immigrants report significantly less pain than native-born adults. The models also show the powerful association between socioeconomic status and pain: for all pain measures, each of the three SES measures (education, family income, and home ownership) have independent significant effects on pain in the expected direction.

We visualized the average predicted probabilities of each pain measure across the race/ethnic groups in Figure 1 and Supplemental Figure S1. Figure 1 shows the probability of pain net of year, age, gender, and region of residence (Model 2); Supplemental Figure S1 shows the probability of pain net of all covariates (Model 5). The figures show the differences across the groups in absolute terms, highlighting the high pain prevalence among Native American and multiracial adults, and the low pain prevalence among Asian Americans.

Finally, we examined the pain prevalence in each racial/ethnic group across age, using a semiparametric approach with a flexible function for age and visualizing the resulting age curves in Figure 2. The main finding is that the results described above are generally valid across the adult life span. That is, there is little evidence of systematic ‘crossovers,’ whereby the overall results would only be valid for some but not other parts of the life span. The differences across race/ethnic groups are relatively small at age 18 because pain prevalence is relatively low for all groups in early adulthood. The prevalence, as well as racial/ethnic differences, increase until early older ages (roughly age 60), when at least some groups and at least some pain measures show a plateau or a decline in prevalence with advanced ages. These results corroborate prior research with cross-sectional data where pain prevalence may appear to decrease at older ages [9; 18] but, as mentioned above, it is critical to consider the possibility that this apparent plateau or decrease is an artifact of mortality selection or differences across birth cohorts in pain experience and/or reporting. Interestingly, Asian Americans show no evidence of a plateau or even decelerating increase with age: pain prevalence in this group increases almost linearly between 18 and 84. In contrast, multiracial adults have the most pronounced apex around age 60 and lower pain at ages beyond that threshold. Other groups are in between, evidencing some combination of steady increases, plateauing, or decreases in pain at the oldest ages.

DISCUSSION

Our analysis provides the first comprehensive portrait of pain prevalence across all major U.S. racial/ethnic groups, including the fastest-growing multiracial category, for an array of six pain measures ranging from ‘severe’ and ‘high-impact’ pain to the broadly defined ‘any pain.’ The findings build on prior work on racial/ethnic differences in pain, especially among Black and White adults, and provide new understanding of pain among Hispanic, Asian American, Native American, and multiracial groups.

Asian Americans have the lowest pain prevalence of all groups, with a statistically significant and substantial pain ‘advantage.’ That is, they have less than half the prevalence of pain compared with the U.S. average for most pain measures except ‘any pain,’ where they have about one third lower prevalence (35% prevalence among Asian Americans versus 51% U.S. average). This pattern aligns with the few prior population studies that included Asian American and other groups [35; 68]. Additionally, our analysis shows that Asian Americans’ low prevalence is observed across all pain severity levels, and persists net of demographic and socioeconomic factors.

In contrast, Native American (AIAN) and multiracial adults have higher pain levels than all other groups. Native Americans have by far the highest prevalence of severe pain and high-impact pain, 11.1% and 14.7%, respectively, versus overall U.S. averages of 6.4% and 7.7%. These estimates substantially expand the limited body of scholarship documenting Native Americans’ high pain levels [14; 25; 46; 51]. Compared to Whites, this pain prevalence remains significantly higher, even net of age, sex, and immigrant, marital, and parental status. However, when we account for socioeconomic status differences, the pain disadvantage becomes not significant. That is, the excess pain among Native Americans can be attributed to their disadvantaged socioeconomic position vis-à-vis Whites. As Meghani [34] cautions, this result does not mean that there is no racial disparity, but rather that the societal conditions that produce the pain disparities are inextricably grounded in the “lack of equality of social opportunities” (p. 2224).

Americans self-identifying as multiracial also suffer disproportionately from pain. They have the highest or second-highest prevalence on all pain measures. Unlike among Native Americans, moreover, controlling for SES attenuates but does not explain is excess pain. That is, multiracial Americans experience significantly more pain than Whites, and the causes lie beyond their lower SES or other considered characteristics. Moreover, we discovered a racial ‘intersectionality’ effect [42]: the intersection of being multiracial and identifying Native American as one’s main racial background is associated with the highest pain prevalence of any group by far. Little is known about multiracial individuals’ health: research is limited, and focuses on adolescents’ mental health and health behaviors, not on adults’ health, let alone pain [6]. Our troubling findings should serve as impetus for focused examination of pain in this rapidly growing U.S. group.

White, Black, and Hispanic adults fall between these extremes. Of the three groups, Hispanics have the lowest pain prevalence for all pain measures -- significantly less than, or comparable to, Whites. This echoes some prior work describing lower pain among Hispanics than Whites [21; 26; 35; 65] but contradicts other research that found higher pain in this group [18; 45]. The majority of Hispanic American adults are foreign-born (57%). The socially disadvantaged status of immigrants, some have theorized, predisposes them to increased pain [11]. However, empirical work has shown that U.S. immigrants have *less* pain than the U.S.-born [19; 65], a pattern our analyses corroborated. Correspondingly, controlling for immigrant status attenuated the pain ‘advantage’ for Hispanics. However, it did not fully ‘explain’ the lower pain prevalence of Hispanics relative to Whites. That is, only a minor part of the Hispanic pain advantage appears linked to the high proportion of

immigrants; much of the difference remains unexplained by the factors considered in our study.

Finally, the comparison between Black and White Americans is particularly important for two reasons. First, their comparison dominates scholarship on racial/ethnic pain disparities, yet the pain differences between these two groups are modest relative to disparities across other groups. It is unclear why Black Americans, who have a much higher prevalence of physical health problems than Whites [61], don't have correspondingly higher levels of pain as well; this question should be addressed in future research (perhaps a clue lies in Blacks' lower rates of some *mental* health problems [33]). Second, the Black-White differences are complex, in that they depend on the pain definition. For the least stringent 'any pain' and persistent pain measures, Blacks have significantly less pain than Whites, about 10–17% lower prevalence, net of age and sex. For high-impact pain, Blacks and Whites have statistically the same prevalence, and for the most stringent pain definition of severe pain, Black adults have significantly more: 19% *higher* prevalence than Whites. This pattern echoes prior work that reported higher prevalence of severe pain for Blacks but lower prevalence for mild pain [12; 40; 66]. Our set of results clarifies that such seemingly inconsistent findings may reflect differences in pain operationalizations. Reasons for this pattern are unclear. Perhaps Blacks are less likely than Whites to report milder pain, but more likely to report severe pain. However, an equally valid interpretation is that Whites are particularly likely to report some pain, including mild pain, but less likely to experience/report more severe pain. Indeed, this interpretation is better supported by our findings, which show Whites increasingly likely to report pain vis-à-vis all Americans for milder pain definitions. One additional point about the Black-White disparities is the critical role of SES. If we compare adults at the same SES levels, Blacks have less pain than Whites across all six pain measures, even severe pain. This finding highlights the inextricable role of social factors in pain and pain disparities; however, it also leaves open the question of why Blacks at comparable levels of SES report systematically lower pain than Whites. This is another important direction for further research.

Of note, our findings regarding population pain prevalence are somewhat at odds with the literature on experimental pain, which often finds Black, Asian, and Hispanic participants to have greater pain sensitivity than Whites [2; 16; 28; 38], while the prevalence of naturally occurring pain in the population is lower. Paradoxically, Native Americans do not seem to have higher pain sensitivity than whites [47], yet they have higher prevalence, as we just described. This pattern of results suggests that findings from experimental pain research may not provide accurate indications of pain disparities in the general population.

We point out several limitations of our study. Although the NHIS includes more detail about respondents' race and ethnicity than many other data sources, important information is lacking. For instance, for multiracial adults, only the "main" racial background is available, not the complete self-identification. This is an important omission because prior studies showed that the specific combinations of race/ethnicity, not only the "main" background, matter for health [6]. With respect to pain specifically, Nahin [36] disaggregated the Hispanic category into 30 groups interacting specific Hispanic ethnicities and main racial background of the respondents, and found a tremendous variability within the

"Hispanic" category. Future studies should examine variability within other main racial/ethnic categories as well, such as across Asian American ethnicities. Furthermore, important groups such as Americans of Middle Eastern and North African ancestry (MENA, or the overlapping Arab Americans) are not categorized in NHIS, despite longstanding efforts by the U.S. Census and activists and the large number of MENA Americans that exceeds 3 [32; 58]. This group has experienced sharply increased discrimination and stigmatization since 9/11 [1], which may increase susceptibility to chronic pain [11]. Moreover, the NHIS data lacks information about perceived discrimination and other race-related stressors, which could be additional important risk factors for pain in racial minority adults. For instance, multiracial Americans are subject to unique forms of discrimination, such as that based on a racial categorization that does not match the individual's self-identity [17] – a type of discrimination associated with particularly poor health outcomes [60]. Future studies should collect data on perceived discrimination that could shed light on these processes.

The biopsychosocial model of pain predicts that that people "marginalized by social conditions" would have more pain [11]. Our foundational results show more nuanced patterns, in which some minoritized groups have higher pain prevalence than Whites, while others have lower prevalence. We hope these findings motivate further in-depth studies of drivers of racial/ethnic differences in pain risk, to inform policy, prevention, and intervention efforts. Indeed, given that pain is arguably the most prevalent and costly public health condition in the U.S., enhanced knowledge of racial and ethnic disparities in pain is urgently needed to inform policy decisions and focus efforts at population-level prevention and intervention. Pain epidemiology must become more comprehensive—moving beyond a focus on Black-White comparisons—to characterize and understand pain disparities in the increasingly diverse U.S. population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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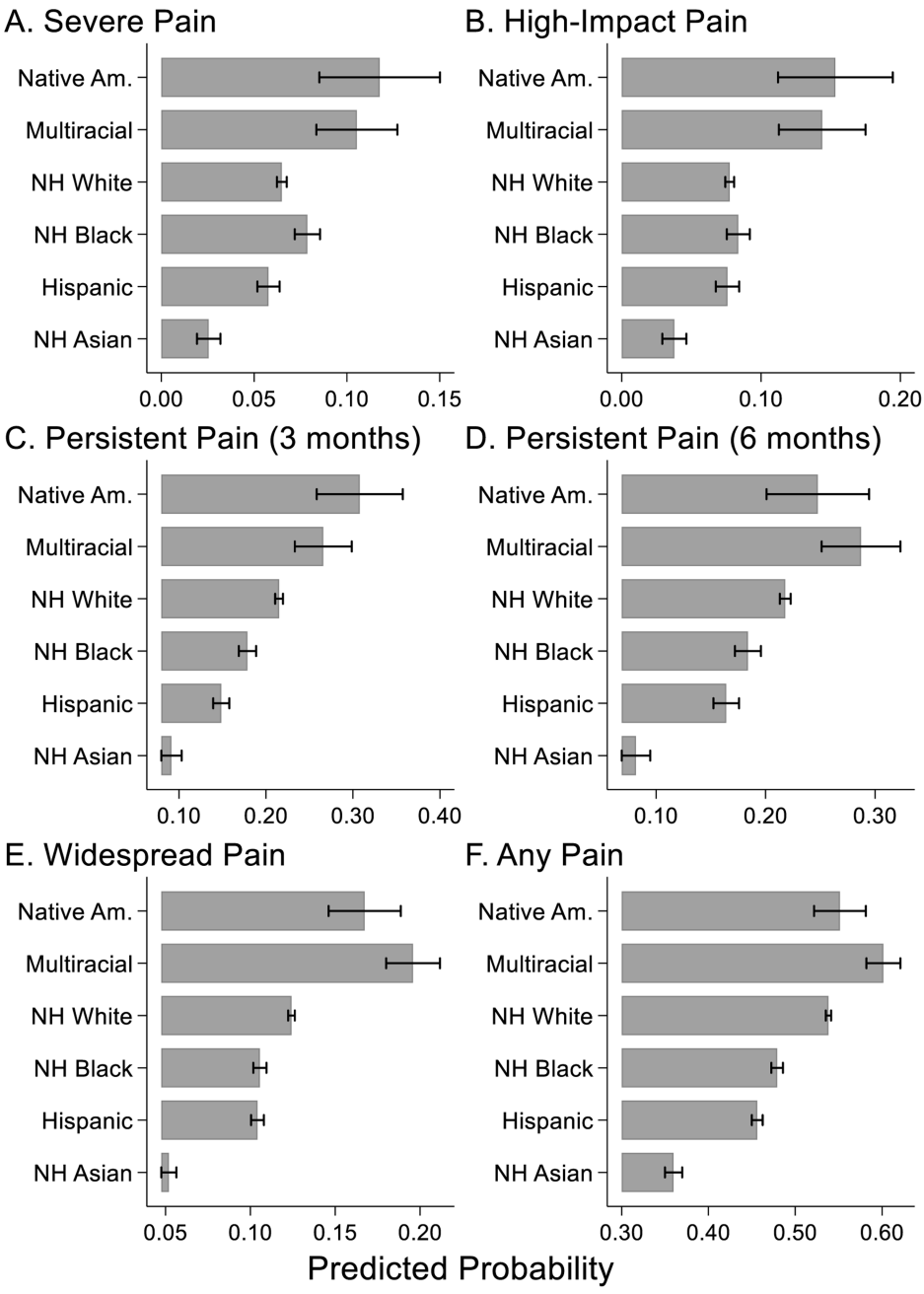

Figure 1. Average predicted probabilities, from age, sex, and year-adjusted models (Model 2 Table 4)

Note. Average predicted probabilities calculated from complex-survey-adjusted logistic models of each pain measure as a function of race/ethnicity, year of interview, age (centered about 60) and age squared, gender, and region (Model 2 in Table 4)

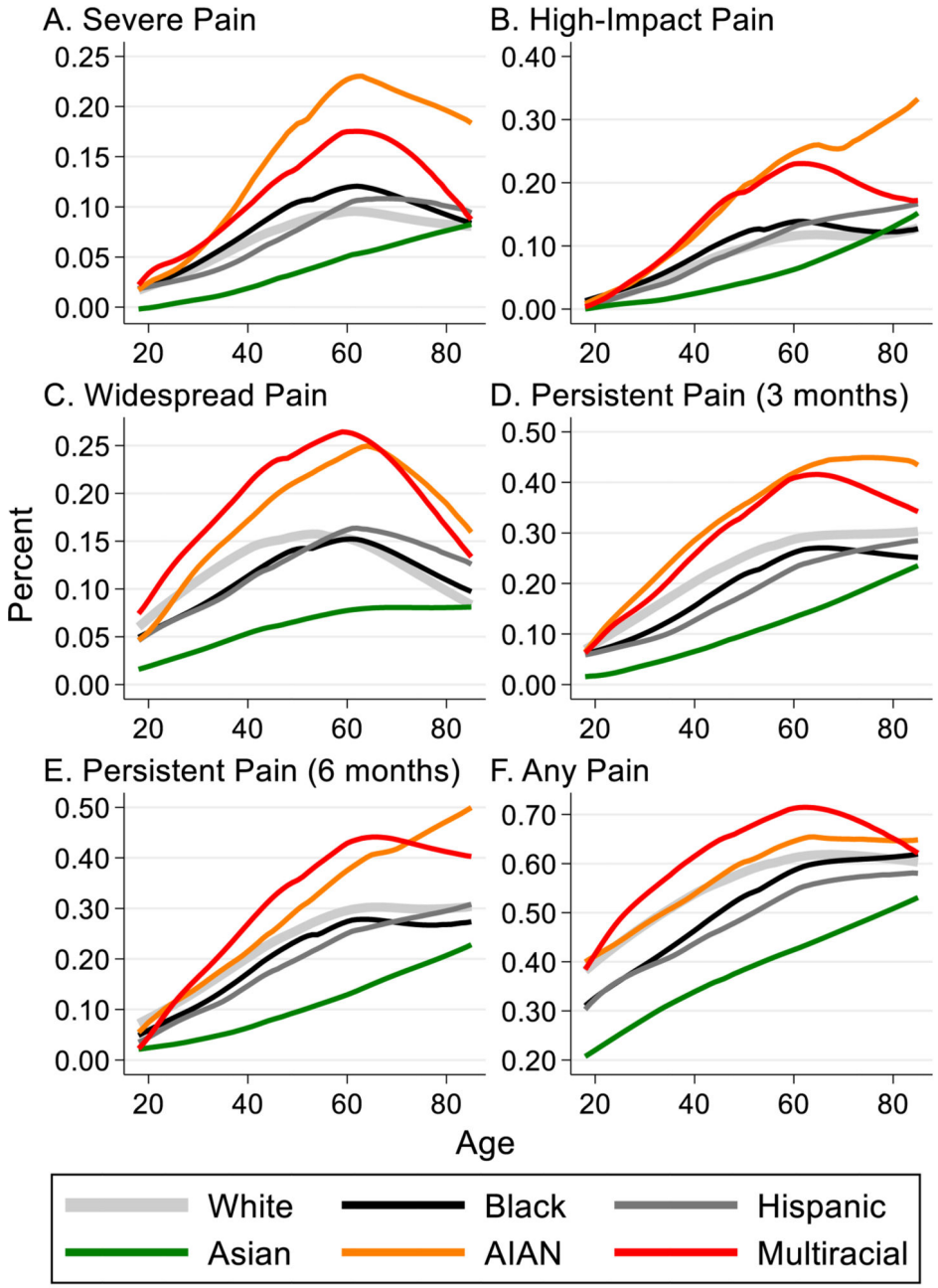

Figure 2. Estimated pain levels by age for each race/ethnic group.

Note. The figure is based on semiparametric models of each pain definition, net of year of interview and gender and a flexibly estimated age function.

Table 1.

The six pain definitions, sample sizes, years when available, wording of questions, and coding. NHIS 2010–2018.

Pain definition and sample size	Years	Question wording	Coding (all dichotomized)	Original NHIS variables
Severe pain (N=103,349)	2010–2015 and 2018	Level of pain, last time had pain: a little, a lot, or somewhere in between (also uses paifreq3mo item)	"A lot of pain," on most or every day (using painfreq3mo)= 1; otherwise 0	painfeelevl
High-impact pain (N=57,518)	2016, 2017	How often did pain limit life or work activities: never, some days, most days, every day	Never or some days=0 Most or every day =1	painlmt6mo
Widespread pain (N=273,972)	2010–2018	No specific questions, based on items for 'any pain'	Positive response to 3 or more sites with pain=1; otherwise 0	See 'any pain' below
Persistent (3 mos) (N=103,439)	2010–2015 and 2018	Frequency of pain in last 3 months: never, some days, most days, every day	Never or some days=0 Most or every day =1	painfreq3mo
Persistent (6 mos) (N=57,541)	2016, 2017	Frequency of pain in last 6 months: never, some days, most days, every day	Never or some days=0 Most or every day =1	painfreq6mo
Any pain (N=273,972)	2010–2018	During the past 3 months, did you have [low back, neck, facial/ jaw, headache/migraine, joint] pain?	Positive response to either site=1; negative response to all =0	facepain3mo lbpain3mo migrain3mo neckpain3mo joint3mo

Table 2.

Population prevalence of pain (weighted percent and 95% CI) for six pain definitions, by race/ethnic categories, US adults age 18+.

	Severe pain		High-impact		Widespread		Persistent (3 mo)		Persistent (6 mo)		Any pain	
Total	6.4	(6.2,6.7)	7.7	(7.4,8.0)	11.6	(11.4,11.8)	19.6	(19.2,20.0)	20.0	(19.4,20.6)	51.0	(50.7,51.4)
Race/ethnicity												
White	6.8	(6.5,7.1)	8.3	(7.9,8.6)	12.6	(12.4,12.8)	22.5	(22.0,23.0)	22.8	(22.1,23.5)	54.7	(54.3,55.1)
Black	7.6	(6.9,8.3)	7.9	(7.1,8.7)	10.6	(10.1,11.0)	17.1	(16.1,18.1)	17.6	(16.2,19.0)	47.2	(46.4,48.0)
Hispanic	5.0	(4.5,5.5)	6.3	(5.4,7.1)	9.8	(9.4,10.2)	12.9	(12.0,13.7)	14.2	(12.9,15.5)	42.9	(42.1,43.6)
Asian	2.4	(1.8,3.0)	3.5	(2.6,4.4)	5.2	(4.8,5.7)	8.7	(7.6,9.7)	7.7	(6.6,8.9)	35.3	(34.2,36.5)
AIAN	11.1	(7.5,14.7)	14.7	(10.5,18.9)	17.0	(14.8,19.3)	29.3	(24.7,33.9)	24.2	(18.7,29.6)	54.7	(50.9,58.5)
Multiracial	8.7	(6.9,10.6)	12.0	(9.4,14.5)	18.2	(16.6,19.7)	22.7	(19.8,25.7)	25.2	(21.9,28.4)	57.1	(54.9,59.2)

AIAN=American Indian/Alaska Native, or Native American.

The cells show weighted percentages (i.e., estimated population percentages) with pain; the 95% confidence intervals estimation uses appropriate variance adjustment due to the complex sampling design.

The six pain definitions are ordered from the lowest prevalence in the total population (severe pain 6.4%) to highest prevalence (any pain 51.0%). Within each column, the cells are color-coded from red=high percentage with pain to green=low percentage.

All race/ethnic categories, other than Hispanic, are Non-Hispanic.

Persistent pain (3 mos) was asked with respect to the past 3 months; persistent pain (6 mos) was asked with respect to the past 6 months.

Table S1 shows the pain prevalence stratified by gender; S2 shows the pain prevalence for multiracial adults by main racial background, and S3 displays sample sizes for the analyses.

We also tested whether the variation by race/ethnicity is statistically significant, using design-adjusted F-test equivalent to chi-squared tests. All six pain measures vary across race/ethnicity at p<.001.

Table 3.

Characteristics of the target population in aggregate and by race/ethnic group (NHIS 2010–2018, US adults 18 and older)

	Total	White	Black	Hispanic	Asian	AIAN	Multi-racial
Age (mean, s.d.)	46.8	49.0	44.3	40.8	44.4	44.5	40.4
Female	51.8	51.5	55.2	49.7	53.1	55.1	52.9
Region							
Northeast	17.7	19.0	16.0	13.6	20.3	5.5	10.8
North Central	22.8	27.9	16.9	9.2	12.9	15.9	21.4
South	36.3	33.4	59.0	37.0	22.8	33.9	33.5
West	23.2	19.7	8.1	40.2	43.9	44.7	34.3
Nativity							
US-born	81.9	94.7	87.0	42.9	22.1	93.7	92.9
In US 15+ years	11.7	3.8	7.5	37.3	46.0	3.7	5.8
In US <15 year	6.1	1.4	5.3	18.9	31.1	2.6	1.1
DK	0.3	0.1	0.3	1.0	0.9	0.1	0.2
Language of interview							
English	93.8	99.7	99.7	64.0	92.4	99.4	99.9
Other	6.2	0.4	0.3	36.0	7.6	0.6	0.1
Marital status							
Married	53.4	56.9	33.7	51.6	64.8	40.0	36.9
Previously married	19.6	20.4	23.8	15.7	10.8	24.0	20.4
Never married	26.8	22.6	42.3	32.5	24.3	35.8	42.5
DK	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Children at home							
No children	61.0	65.2	59.9	46.7	52.4	56.8	67.3
One child	17.2	16.1	19.2	19.3	21.2	18.6	14.9
Two or more	21.8	18.7	20.9	34.0	26.4	24.6	17.9
Education							
Less than HS or GED	15.6	10.9	18.6	35.4	9.2	25.2	14.1
HS diploma	22.4	22.3	26.0	22.8	14.6	23.0	20.4
Some college	19.7	20.0	23.1	17.5	13.7	23.8	28.2
Associate degree	11.2	12.0	10.8	9.1	7.5	11.3	11.7
Bachelor’s degree	19.6	22.0	14.0	10.1	31.3	10.5	16.2
Master’s or more	11.2	12.6	7.0	4.2	23.2	5.1	9.3
DK	0.4	0.3	0.5	0.8	0.6	1.0	0.2
Family income							
$0–34,999	28.5	23.9	42.6	38.4	23.0	45.6	35.7
$35,000–74,999	28.5	28.3	28.2	31.7	23.4	26.8	26.6
$75,000–99,999	11.6	12.7	8.5	9.3	11.8	9.1	11.1
$100,000+	23.7	27.6	12.6	13.1	33.0	11.2	20.9
DK	7.6	7.5	8.1	7.6	8.9	7.4	5.8

	Total	White	Black	Hispanic	Asian	AIAN	Multi-racial
Home ownership							
Owns home	66.0	73.8	47.2	49.8	60.8	55.9	54.5
Rents	31.7	23.9	49.9	48.0	37.0	41.0	41.9
Other	2.4	2.3	2.9	2.2	2.2	3.1	3.6
N	273,972	172,782	36,357	43,160	15,289	1,920	4,464

Weighted percent shown for all variables except age where weighted mean is shown.

Design-adjusted F-tests show that all variables differ significantly across the race/ethnic groups at p<.001.

All racial categories other than Hispanic are Non-Hispanic. AIAN=American Indian/Alaska Native, or Native American.

Table 4.

Prevalence ratios from Poisson models of six pain indicators as a function of race and covariates

White=reference	Model 1	Model 2	Model 3	Model 4	Model 5
Severe pain					
Black	1.12*	1.19**	1.22***	1.12*	0.85**
Hispanic	0.73***	0.89*	1.11	1.08	0.82*
Asian	0.36***	0.40***	0.56***	0.56***	0.62***
AIAN	1.63**	1.78***	1.78***	1.68**	1.12
Multiracial	1.29*	1.61***	1.62***	1.51***	1.25*
High-impact pain					
Black	0.96	1.07	1.11	1.01	0.77***
Hispanic	0.76***	0.96	1.16	1.12	0.87
Asian	0.43***	0.48***	0.68**	0.69**	0.72*
AIAN	1.79***	1.95***	1.96***	1.78***	1.22
Multiracial	1.45***	1.84***	1.86***	1.76***	1.43***
Widespread pain					
Black	0.84***	0.86***	0.88***	0.84***	0.71***
Hispanic	0.78***	0.82***	0.98	0.96	0.83***
Asian	0.41***	0.41***	0.55***	0.55***	0.60***
AIAN	1.35***	1.30***	1.30***	1.25**	0.99
Multiracial	1.44***	1.55***	1.56***	1.50***	1.34***
Persistent pain (3 months)					
Black	0.76***	0.83***	0.85***	0.82***	0.71***
Hispanic	0.57***	0.68***	0.84***	0.83***	0.72***
Asian	0.38***	0.42***	0.57***	0.57***	0.60***
AIAN	1.29**	1.41***	1.41***	1.37***	1.10
Multiracial	1.00	1.23**	1.24**	1.20**	1.09
Persistent pain (6 months)					
Black	0.77***	0.84***	0.87***	0.83***	0.71***
Hispanic	0.62***	0.74***	0.91	0.89*	0.76***
Asian	0.34***	0.37***	0.51***	0.51***	0.54***
AIAN	1.06	1.12	1.13	1.07	0.86
Multiracial	1.10	1.31***	1.33***	1.30***	1.15*
Any pain					
Black	0.86***	0.90***	0.91***	0.90***	0.86***
Hispanic	0.78***	0.84***	0.94***	0.94***	0.90***
Asian	0.65***	0.66***	0.76***	0.77***	0.78***

White=reference	Model 1	Model 2	Model 3	Model 4	Model 5
AIAN	1.00	1.01	1.01	1.01	0.94
Multiracial	1.04*	1.12***	1.12***	1.12***	1.08***

*** p<.001

** p<.01

* p<.05

The table shows partial results from survey-adjusted Poisson regression model with robust standard errors of each pain outcome as a function of race/ethnicity (White as reference), net of five sets of covariates. Only the prevalence ratios associated with race/ethnicity are shown for parsimony; the complete results are in the supplemental Table S4.

All racial categories other than Hispanic are Non-Hispanic. AIAN=American Indian/Alaska Native, or Native American.

Model 1 only adjusts for the year of interview.

Model 2 additionally adjusts for age, age squared, gender, and region of residence. Age is in decades and centered about 60.

Model 3 additionally adjusts for immigrant status and language of interview.

Model 4 additionally adjusts for marital status and presence of children.

Model 5 is fully adjusted; it additionsally adjusts for education, family income, and home ownership.