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PSYCHOLOGY, PSYCHIATRY & BRAIN NEUROSCIENCE SECTION

Review Article

A Quantitative Review of Ethnic Group Differences in Experimental Pain Response: Do Biology, Psychology, and Culture Matter?

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Abstract

Objective. Pain is a subjectively complex and universal experience. We examine research investigating ethnic group differences in experimental pain response and factors contributing to group differences.

Method. We conducted a systematic literature review and analysis of studies using experimental pain stimuli to assess pain sensitivity across multiple ethnic groups. Our search covered the period from 1944 to 2011, and used the PubMed bibliographic database; a reference source containing over 17 million citations. We calculated effect sizes; identified ethnic/racial group categories, pain stimuli, and measures; and examined findings

regarding biopsychosociocultural factors contributing to ethnic/racial group differences.

Results. We found 472 studies investigating *ethnic group differences and pain*. Twenty-six of these met our review inclusion criteria of investigating *ethnic group differences in experimental pain*. The majority of studies included comparisons between African Americans (AA) and non-Hispanic Whites (NHW). There were consistently moderate to large effect sizes for pain tolerance across multiple stimulus modalities; AA demonstrated lower pain tolerance. For pain threshold, findings were generally in the same direction, but effect sizes were small to moderate across ethnic groups. Limited data were available for suprathreshold pain ratings. A subset of studies comparing NHW and other ethnic groups showed a variable range of effect sizes for pain threshold and tolerance.

Conclusion. There are potentially important ethnic/racial group differences in experimental pain perception. Elucidating ethnic group differences has translational merit for culturally competent clinical care and for addressing and reducing pain treatment disparities among ethnically/racially diverse groups.

Key Words. Ethnicity/Race Differences; Experimental Pain; Pain Disparities; Pain Threshold/Tolerance; Pain Treatment

Introduction

The experience of pain is characterized by immense inter-individual and group variability [1,2] with one likely contributing factor being ethnicity; a subjective construct infused with definitional debate. Synergistically, pain and ethnicity are multidimensional, malleable, and shaped by culture [3]. Although there is no consensus regarding the underlying mechanisms, ethnic group differences inevitably reflect a holistic influence of biological, social, cultural, and psychological factors; the biopsychosociocultural model of pain. To elucidate these mystifying, yet integrated mechanisms, researchers have undertaken both clinical

Experimental Pain and Ethnic Group Differences

and experimental pain studies to document the pain experience. For example, evidence exists for ethnic group differences in clinical pain, with African Americans (AA) demonstrating greater severity of clinical pain and higher levels of pain-related disability [4,5]. Similarly, ethnic group differences have also been reported in experimental pain studies [6,7], with a majority of these studies [8–11] examining variability among AA and non-Hispanic Whites (NHW; Figures 1–4). A handful of other studies (Table 2) have included comparisons of different ethnic groups. Take, for example, studies that have included Hispanics, AA, and NHW [6,7]. Other studies [12] have included a broader range of study participants such as AA, Caucasians, Indian, Asians, and Hispanics. Still other investigations have examined group differences among Danish

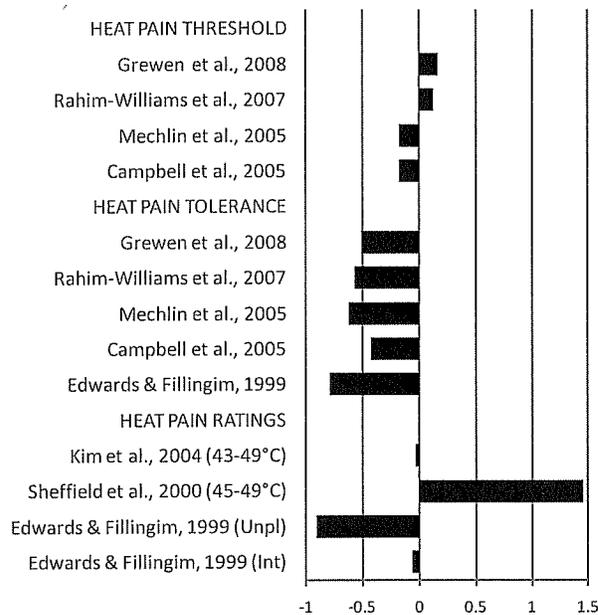


Figure 1 Effect sizes for ethnic group differences in heat pain responses for studies comparing African American (AA) to non-Hispanic White (NHW) subjects. Bars reflect Cohen's *d*. Bars greater in length to the left indicate greater values for NHW compared with AA, while bars increasing in length to the right indicate greater values of that measure for AA vs NHW. Greater values for pain threshold and pain tolerance reflect lower pain sensitivity, while greater values for pain ratings indicate higher pain sensitivity. * The Edwards and Fillingim effect sizes are difficult to interpret as these values reflect differences in the slope of the stimulus response function rather than differences in heat pain ratings. Unpl = unpleasantness ratings; Int = intensity ratings.

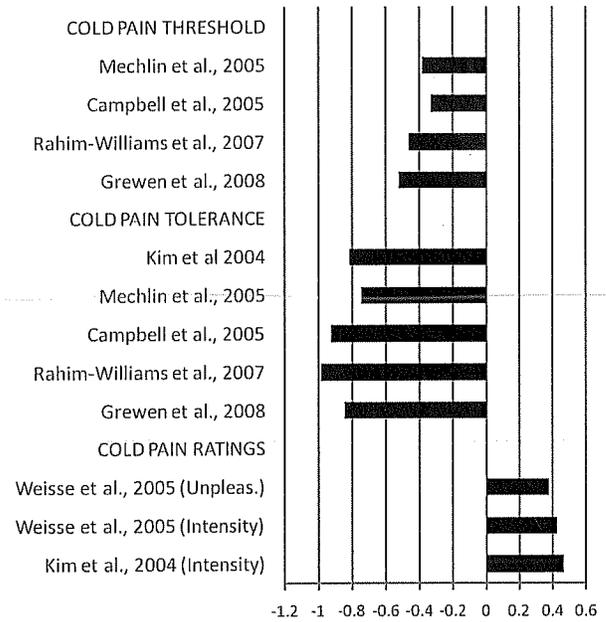


Figure 2 Effect sizes for ethnic group differences in cold pain responses for studies comparing African American (AA) to non-Hispanic White (NHW) subjects. Bars reflect Cohen's *d*. Bars greater in length to the left indicate greater values for NHW compared with AA, while bars increasing in length to the right indicate greater values of that measure for AA vs NHW. Greater values for pain threshold and pain tolerance reflect lower pain sensitivity, while greater values for pain ratings indicate higher pain sensitivity.

Whites and South Indians [13]; across Chinese, Malay, and Indians [14]; and among Alaskan Indian, Eskimo, and NHW [15], and Nepalese porters and Occidentals [16]. Many of these experimental pain studies, reporting ethnic group differences, have used laboratory pain modalities such as thermal, cold pressor, ischemic, mechanical, and electrical stimuli (Figure 2), and have included measures such as pain threshold, tolerance, and ratings of the intensity and unpleasantness suprathreshold stimuli.

Although experimental pain does not fully duplicate the sensory and affective qualities that characterize clinical pain, ethnic differences in experimental pain sensitivity may contribute to ethnic differences in the experience of clinical pain [1–5]. Therefore, evaluating ethnic differences in experimental pain models may not only provide information about underlying mechanisms but may also predict or explain group differences in clinical pain [5,13]. If such findings continue to be scientifically supported, laboratory results applied to ethnic differences in the experience of clinical pain may have translational merit. The aim of this structured review and analysis was to examine

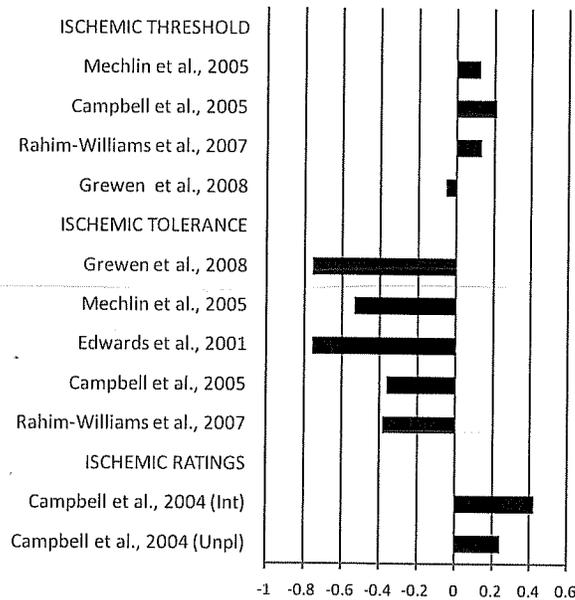


Figure 3 Effect sizes for ethnic group differences in ischemic pain responses for studies comparing African American (AA) to non-Hispanic White (NHW) subjects. Bars reflect Cohen's *d*. Bars greater in length to the left indicate greater values for NHW compared with AA, while bars increasing in length to the right indicate greater values of that measure for AA vs NHW. Greater values for pain threshold and pain tolerance reflect lower pain sensitivity, while greater values for pain ratings indicate higher pain sensitivity. Unpl = unpleasantness ratings; Int = intensity ratings.

published, peer-reviewed studies that investigated ethnic group differences in experimental pain responses and mechanisms reported to contribute to these differences.

Methods

Database Search

The systematic review of literature on experimental pain and ethnicity/race was conducted using the PubMed bibliographic database; a reference source containing over 17 million citations with access to full text for biomedical articles. Our broad-based, keyword search strategy included terms such as experimental pain; ethnic group differences and pain sensitivity/perception; culture and experimental pain; ethnicity and experimental pain; culture, ethnicity and pain, ethnic group differences and experimental pain; and covered the period from 1944 to 2011. The last search of the PubMed database was performed in October 2011, and identified 472 studies investigating *ethnic group differences and pain*. We narrowed

and focused our review on 25 studies specifically investigating *ethnic/racial group differences and experimental pain*. Experimental, or laboratory pain testing, uses several methodologies (see Table 3) to artificially introduce pain as a means of examining, identifying, and understanding pain variations.

Inclusion and Exclusion Criteria

We included studies for this structured review and analysis if they focused specifically on comparing racial/ethnic groups and if experimental pain stimuli (e.g., thermal, cold, ischemic, mechanical, and electrical) were used. While gender represents another important demographic variable related to pain, given the availability of numerous recent reviews on this topic [17–19], we elected to focus exclusively on ethnic group differences in the present analysis. Of the 472 studies we identified, 25 articles met our specific inclusion criteria. Studies investigating only gender and pain, clinical pain studies, and/or studies without a mention of ethnic group comparisons were not included. Fifteen of the 25 articles had a primary objective of comparing experimental pain responses among AA and NHW. The remaining 10 studies evaluated experimental pain responses for various racial/ethnic groups; AA and Hispanics; Hispanics and NHW; Alaskan Indian; Eskimos and Whites; Danish Whites and South Indians; White British individuals and South

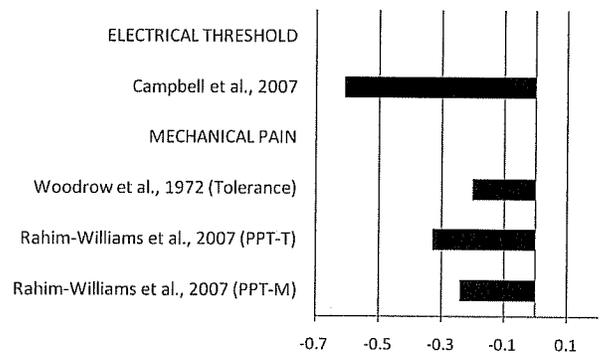


Figure 4 Effect sizes for ethnic group differences in electrical and mechanical pain responses for studies comparing African American (AA) to non-Hispanic White (NHW) subjects. Bars reflect Cohen's *d*. Bars greater in length to the left indicate greater values for NHW compared with AA, while bars increasing in length to the right indicate greater values of that measure for AA vs NHW. Greater values for pain threshold and pain tolerance reflect lower pain sensitivity, while greater values for pain ratings indicate higher pain sensitivity. PPT-T = pressure pain threshold-trapezius; PPT-M = pressure pain threshold-masseter.

Table 1a Differences in thermal pain sensitivity: studies comparing African Americans with Whites

Author/Year Threshold	Sample Size		Age Range (Mean)	Mean (SD)		Effect Size†
	AA	NHW		AA	NHW	
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	43.2 (3.3)	42.7 (2.6)	0.16
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18–53	42.1 (3.2)	41.7 (3.2)	0.12
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	42.3 (4.2)	43.1 (4.8)	-0.18
Chapman and Jones, 1944 [25]	18 ^a	18 ^a	18–44	0.27 (0.02)	0.32 (0.04)	-1.75
Edwards and Fillingim, 1999 [27]	18 (10F, 8M)	30 (16F, 14M)	18–47	44.8 (5.1)	46.2 (1.6)	-0.48
Mechlin et al., 2005 [12]	50 (26F, 24M)	44 (23F, 21M)	(26)	43.1 (3.3)	43.6 (2.8)	-0.17
Wang et al., 2010 [58]	10 (5F, 5M)	10 (5F, 5M)	19–47	45.0 (3.5)	45.8 (1.9)	-0.30
				Mean effect for thermal threshold—Unweighted		-0.37
				Mean effect for thermal threshold—Weighted		-0.24

Tolerance						
	AA	NHW		AA	NHW	
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18–53	46.2 (2.5)	47.6 (2.5)	-0.56
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	46.6 (3.3)	48.1 (3.7)	-0.43
Chapman and Jones, 1944 [25]	18 ^a	18 ^a	18–44	0.30 (0.03)	0.38 (0.05)	-2.13
Edwards and Fillingim, 1999 [27]	18 (10F, 8M)	30 (16F, 14M)	18–47	47.1 (5.5)	49.6 (2.2)	-1.14
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	47.1 (2.5)	48.2 (1.8)	-0.50
Mechlin et al., 2005 [12]	50 (26F, 24M)	44 (23F, 21M)	(26)	47.6 (3.0)	49.1 (2.2)	-0.61
				Mean effect for thermal tolerance—Unweighted		-0.83
				Mean effect for thermal tolerance—Weighted		-0.72

^a Data for gender/sex by ethnicity/race unavailable.

† Effect size calculated such that a negative number reflects a higher threshold or tolerance for the NHW group.

AA = African Americans; NHW = non-Hispanic White; SD = standard deviation.

Asians; Japanese and Belgium participants; Afro-Asians and White, Nepalese and Occidentals; Japanese and Americans and European Canadian and Chinese.

Our review identified two additional studies [14,20] investigating *intra-ethnic* group differences and experimental pain that we did not include. First, the study by Yosipovitch et al. [14] investigated thermal pain among Asian participants (Chinese, Malay, and Indians). The study did not provide the standard deviation (SD) data required for calculating effect sizes included in Tables 1 and 2; articles comparing AA and NHW, and NHW and other ethnic groups. The second intra-ethnic group study, by Awad and colleagues [20], investigated irritable bowel syndrome (IBS) using electronic barostat and included only Hispanics.

Table 3 identifies the total 25 articles dating from 1944 to October 2011 we included in the review.

Scope of the Studies Reviewed

Review of the studies included the following:

- Racial/ethnic group(s) identification.
- Identification of the type of experimental pain stimuli/measures used.
- Pain protocol procedures used.
- Age and sex/gender of participants.
- Sample size.
- Mean/SD.
- Factors affecting differential pain response.

Analysis

As in our previous meta-analysis of sex differences in experimental pain [19], we followed the guidelines for meta-analysis as reported by Wolf [21]. We calculated effect sizes (Cohen's *d*) for each pain measure compared across ethnic groups within each study. Each effect size was computed individually as the difference between the mean for AA and NHW, and for NHW and the secondary ethnic groups, divided by the pooled SD (e.g., $d = [\mu \text{ African Americans} - \mu \text{ non-Hispanic Whites}] / \text{Pooled standard deviation}$) to provide quantitative information regarding ethnic group differences in experimental pain responses. Effect sizes were computed by subtracting the mean for NHW from the mean for AA (or other non-White ethnic groups), such that negative effect sizes indicate a lower value for the pain measure in AA. For measures of threshold and tolerance, negative effect sizes indicate greater sensitivity among AA, while for pain ratings, positive values indicate greater sensitivity⁷ for AA. The majority of the studies provided means and SDs or standard errors, and we used these data to calculate a pooled SD for each study separately. When these data were not available, we called or emailed the author to obtain the means and SDs. When the study author was unavailable, where possible we measured figures to estimate means and standard error bars. For comparisons of pain ratings, we only included studies that reported pain ratings in response to a standardized pain stimulus. Studies that collected pain

Table 1b Differences in thermal pain ratings: studies comparing African Americans with Whites

Author/Year	Sample Size		Age Range (Mean)	Mean (SD)		Effect Size [‡]
	AA	NHW		AA	NHW	
Intensity Ratings						
Kim et al., 2004 (43–49°C) [28]	130 ^a	344 ^a	16–66	35.1 (22.7)	36.0 (21.0)	–0.03
Sheffield et al., 2000 (45–49°C) [11]	24 (12F, 12M)	27 (13F, 14M)	20–73	92.4 (13.4)	72.6 (13.5)	1.45
Campbell et al., 2005 (49°C) [8]	61 (40F, 21M)	58 (24F, 34M)	(20)	13.3 (5.0)	10.7 (4.8)	0.53
Campbell et al., 2005 (52°C) [8]	60 (40F, 20M)	58 (24F, 34M)	(20)	16.7 (4.8)	13.3 (4.6)	0.72
Edwards and Fillingim (1999) [†] [27]	18 (10F, 8M)	30 (16F, 14M)	18–47	29.9 (17.6)	26.3 (18.3)	0.20
				Mean effect for thermal intensity—Unweighted		0.57
				Mean effect for thermal intensity—Weighted		0.28
Unpleasantness Ratings						
Edwards and Fillingim (1999) [27]	18 (10F, 8M)	30 (16F, 14M)	18–47	32.1 (19.6)	24.1 (17.7)	0.44
Campbell et al., 2005 (49°C) [8]	61 (40F, 21M)	58 (24F, 34M)	(20)	13.3 (5.0)	10.7 (4.8)	0.58
Campbell et al., 2005 (52°C) [8]	60 (40F, 20M)	58 (24F, 34M)	(20)	15.5 (5.3)	12.2 (5.1)	0.64
				Mean effect for thermal intensity—Unweighted		0.55
				Mean effect for thermal intensity—Weighted		0.58

^a Data for gender/sex by ethnicity/race unavailable.

[†] Means provided by author.

[‡] Effect size calculated such that a negative number reflects higher pain ratings and higher slopes for the NHW group.

AA = African Americans; NHW = non-Hispanic White; SD = standard deviation.

Table 1c Differences in cold pain sensitivity: studies comparing African Americans with Whites

Author/Year	Sample Size		Age Range (Mean)	Mean (SD)		Effect Size [†]
	AA	NHW		AA	NHW	
Threshold						
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	6.4 (2.8)	9.1 (7.9)	–0.52
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18–53	14.0 (11.0)	20.0 (15.1)	–0.46
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	9.8 (6.3)	11.9 (6.4)	–0.33
Mechlin et al., 2005 [12]	51 (27F, 24M)	44 (23F, 21M)	(26)	10.0 (8.0)	15.0 (19.0)	–0.38
				Mean effect for cold threshold—Unweighted		–0.42
				Mean effect for cold threshold—Weighted		–0.41
Tolerance						
Forsythe et al., 2011 [29]	60 ^a	95 ^a	(19.5)	64.8 (78.8)	115.9 (105.8)	–0.53
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18–53	43.0 (54.0)	133.1 (120.3)	–0.98
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	21.0 (15.0)	68.1 (53.0)	–0.92
Mechlin et al., 2005 [12]	51 (27F, 24M)	44 (23, 21M)	(26)	25.0 (42.0)	79.0 (107.0)	–0.74
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	13.8 (7.0)	45.8 (71.1)	–0.84
Kim et al., 2004 [28]	130 ^a	344 ^a	16–66	39.7 (42.6)	86.5 (63.5)	–0.81
				Mean effect for cold tolerance—Unweighted		–0.80
				Mean effect for cold tolerance—Weighted		–0.79
Cold Pain Intensity Ratings						
Kim et al., 2004 [28]	130 ^a	344 ^a	16–66	75.4 (23.3)	64.4 (24.1)	0.46
Weisse et al., 2005 [30]	97 ^a	193 ^a	17–43	17.0 (3.96)	15.5 (3.9)	0.39
				Mean effect for cold pain intensity—Unweighted		0.43
				Mean effect for cold pain intensity—Weighted		0.43

^a Data for gender/sex by ethnicity/race unavailable.

[†] Effect size calculated such that a negative number reflects higher values for threshold, tolerance and pain ratings for the NHW group.

AA = African Americans; NHW = non-Hispanic White; SD = standard deviation.

Table 1d Differences in ischemic pain sensitivity: studies comparing African Americans with Whites

Author/Year	Sample Size		Age Range (Mean)	Mean (SD)		Effect Size [‡]
	AA	NHW		AA	NHW	
Threshold						
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	187.3 (127.5)	195.3 (148.2)	-0.05
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18-53	208.3 (186.2)	185.3 (163.0)	0.13
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	149.2 (144.0)	117.0 (160.3)	0.21
Mechlin et al., 2005 ^a [12]	49 (25F, 24M)	42 (21F, 21M)	18-47	333 (324)	297 (265)	0.12
				Mean effect for ischemic threshold—Unweighted		0.10
				Mean effect for ischemic threshold—Weighted		0.13
Tolerance						
Rahim-Williams et al., 2007 [6]	63 (42F, 21M)	82 (32F, 50M)	18-53	446.4 (276.0)	550.0 (268.3)	-0.38
Campbell et al., 2005 [8]	62 (41F, 21M)	58 (24F, 34M)	(20)	356.0 (290.0)	469.0 (352.2)	-0.36
Edwards et al., 2001 [10] [†]	68 (33F, 35M)	269 (100F, 69M)	16-66	296.0 (194.3)	525.0 (332.0)	-0.75
Mechlin et al., 2005 ^a [12]	51 (25F, 24M)	42 (21F, 21M)	18-47	452.0 (356.0)	653.0 (397.0)	-0.53
Grewen et al., 2008 [26]	25 (25F)	23 (23F)	(27)	281.4 (199)	479.8 (332.0)	-0.75
				Mean effect for ischemic tolerance—Unweighted		-0.55
				Mean effect for ischemic tolerance—Weighted		-0.59
Ischemic Pain Ratings						
Campbell et al., 2004-Unpl [31]	72 (38F, 34M)	63 (21F, 42M)	25-45	6.2 (2.9)	5.3 (2.1)	0.33
Campbell et al., 2004-Intens [31]	72 (38F, 34M)	63 (21F, 42M)	25-45	10.1 (2.3)	8.8 (2.4)	0.54
				Mean effect for ischemic ratings		0.44

^a Means provided by author.

[†] Data are from a clinical sample.

[‡] Effect size calculated such that a negative number reflects higher values for threshold, tolerance and pain ratings for the NHW group. AA = African Americans; NHW = non-Hispanic White; SD = standard deviation.

ratings at the time of pain tolerance were not included in the analysis, as this approach fails to standardize the pain stimulus across individuals. Effect size values represented small (0.2 and below), moderate (0.3-0.5), and

large (0.6 and above). Sample sizes (N) ranged from quite small (e.g., N = 5-6 per group), as in the study by Clark and Clark [16], to extremely large (N = 37,470), as in the study by Woodrow et al. [22]. Tables 1 and 2

Table 1e Ethnic differences in mechanical and electrical pain sensitivity: studies comparing African Americans with Whites

Author/Year	Sample Size		Age Range (Mean)	Mean (SD)		Effect Size*
	AA	NHW		AA	NHW	
Pressure Pain Threshold						
Rahim-Williams et al., 2007 [6]						
Pressure pain-masseter	63 (42F, 21M)	82 (32F, 50M)	18-53	2.9 (1.1)	3.2 (1.4)	-0.24
Pressure pain-trapezius	63 (42F, 21M)	82 (32F, 50M)	18-53	5.9 (2.2)	6.7 (2.5)	-0.33
				Mean effect for pressure pain threshold		-0.29
Pressure Pain Tolerance						
Woodrow et al., 1972 [22]	5,393 (3,336F, 2,057M)	34,077 (19,471F, 14,606M)	20-70	21.0 (7.1)	23.0 (8.1)	-0.20
				Mean effect for pressure pain tolerance		-0.20
Electrical Pain Threshold						
Campbell et al., 2007 [32]	26 (13F, 13M)	27 (14F, 13M)	20-36	14.99 (8.98)	20.95 (10.45)	-0.61
				Mean effect for electrical pain threshold		-0.61

* Effect size calculated such that a negative number reflects higher pain threshold and tolerance for the NHW group. AA = African Americans; NHW = non-Hispanic White; SD = standard deviation.

Table 2a Ethnic differences in thermal pain sensitivity, non-Hispanic White vs other Ethnic Groups

Author/Year	Sample Size		Age Range (Mean)	"Whites" Mean (SD)	Other Group Mean (SD)	Effect Size [†]
Threshold						
Meehan et al., 1954 [15]	NHW	Indian	Indian 12–78*	274 (44)	273 (40)	-0.02
Meehan et al., 1954 [15]	NHW	Eskimo	Eskimo 10–70*	274 (44)	319 (45)	1.01
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	41.7 (3.2)	41.4 (3.5)	-0.09
Watson et al., 2005 [33]	White British 20M	South Asian 20M	28–40	45.2 (3.5)	41.7 (4.02)	-0.92
Mean effect for thermal threshold—Unweighted						-0.01
Mean effect for thermal threshold—Weighted						0.06
Tolerance						
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	47.6 (2.5)	46.1 (3.0)	-0.59
Mean effect for thermal tolerance						-0.59

* Age data not provided for the NHW group.

† Effect size calculated such that a negative number reflects a higher threshold or tolerance for the White group. NHW = non-Hispanic White; SD = standard deviation.

provide data on sample sizes, means, SDs, and effect sizes. For each subset of studies reviewed, we also computed both unweighted and weighted mean effect sizes. Unweighted mean effect sizes reflect the simple arithmetic mean of the effect sizes observed for a given

subset of studies. Weighted mean effect sizes take study sample size into account, weighting larger studies more heavily than smaller ones. To compute weighted mean effect sizes, we applied the method proposed by Hedges [23,24].

Table 2b Ethnic differences in cold pain sensitivity, non-Hispanic White vs other ethnic groups

Author/Year	Sample Size		Age Range (Mean)	"Whites" Mean (SD)	Other Group Mean (SD)	Effect Size [†]
Threshold						
Hsieh et al., 2010 [53]	European Canadian	Chinese	17–27	11.3 (13.0)	12.5 (11.3)	0.1
	80 (41F, 39M)	80 (42F, 38M)				
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	19.8 (15.1)	20.5 (36.5)	0.02
	82 (32F, 50M)	61 (34F, 24M)				
Watson et al., 2005 [33]*	White British 20M	South Asian 20M	28–40	11.9 (5.4)	15.8 (7.1)	-0.62
Mean effect for cold threshold—Unweighted						-0.17
Mean effect for cold threshold—Weighted						-0.02
Tolerance						
Hsieh et al., 2010 [53]	European Canadian	Chinese	17–27	111.5 (62.7)	71.4 (61.5)	-0.64
	80 (41F, 39M)	80 (42F, 38M)				
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	133.1 (120.3)	73.3 (97.1)	-0.54
	82 (32F, 50M)	61 (34F, 24M)				
Nayak et al., 2000 [34]	United States	Indian	18–24	60.9 (57.4)	81.9 (68.0)	0.33
	107 (54F, 53M)	119 (59F, 60M)				
Mean effect for cold tolerance—Unweighted						-0.28
Mean effect for cold tolerance—Weighted						-0.2

* The effect size value was reversed for this study, because the cold threshold was measured in °C, such that a lower threshold reflects lower sensitivity.

† Effect size calculated such that a negative number reflects a higher threshold or tolerance for the White group. NHW = non-Hispanic White; SD = standard deviation.

Table 2c Ethnic differences in ischemic pain sensitivity, non-Hispanic White vs other ethnic groups

Author/Year	Sample Size		Age Range (Mean)	"Whites" Mean (SD)	Other Group Mean (SD)	Effect Size*
Threshold						
Rahim-Williams et al., 2007 [6]	NHW 82 (32F, 50M)	Hispanic 61 (34F, 24M)	18–53	185.3 (162.9)	175.5 (158.5)	–0.06
	Mean effect for ischemic threshold					–0.06
Tolerance						
Rahim-Williams et al., 2007 [6]	NHW 82 (32F, 50M)	Hispanic 61 (34F, 24M)	18–53	550.0 (268.3)	463.4 (277.1)	–0.31
	Mean effect for ischemic tolerance					–0.31

* Effect size calculated such that a negative number reflects a higher threshold or tolerance for the White group. NHW = non-Hispanic White; SD = standard deviation.

Results

The studies in this review reported threshold, tolerance, intensity, unpleasantness, and/or suprathreshold ratings for thermal, cold, ischemic, mechanical/pressure, or electrical stimuli. Several studies reported more than one measure within a stimulus modality (e.g., heat pain *threshold* and heat pain *tolerance*), and some studies included multiple stimuli (e.g., thermal and pressure pain, thermal and cold pain, heat, cold and pressure pain, or thermal, cold, and ischemic). This structured review begins with findings by stimulus modality comparing our primary group comparisons: AA and NHW. We follow with findings by stimulus modality from our secondary group of studies comparing NHW and various ethnic groups. We next discuss the findings for our primary and secondary group of studies, and report on biological, psychological, sociocultural, and methodological factors affecting study outcomes.

AA and NHW: Experimental Pain Effects

Thermal Pain Stimuli

Threshold and Tolerance. Seven studies comparing AA and NHW reported heat pain threshold and six reported heat pain tolerance. The overall mean effect size was moderate for heat pain threshold for the seven studies providing means and SDs for effect size calculations (Table 1a). However, the study by Chapman and Jones [25] produced an unusually large effect relative to others. With the Chapman and Jones [25] study, the unweighted mean effect for threshold was moderate (–0.37) and the weighted mean effect size was small (–0.24). The Chapman and Jones [25] study was conducted more than 60 years ago and used vastly different technology to induce thermal pain; a “1,000-watt tungsten filament lamp, focused by two 4-inch plano-convex lenses through an aperture 2.5 cm.” Researchers focused this heat radiating equipment on the middle of the participants’

forehead. They found that there were “narrow margins” in which variations occurred between participants in pain threshold and tolerance. Thus, they acknowledged a possible significant effect of age and ethnicity.

For heat pain tolerance, a total of six studies [6,8,12,25–27] produced a large mean effect. As found with thermal threshold, the Chapman and Jones [25] study again produced an unusually large effect size (–2.12). The unweighted mean effect size was large (–0.83), and the weighted effect size was only slightly smaller (–0.72). Thus, evidence indicates the existence of small ethnic group differences in thermal pain threshold but large differences in thermal pain tolerance.

Suprathreshold Ratings. Four studies [8,11,27,28] reported suprathreshold intensity and/or unpleasantness ratings for thermal pain and produced effect sizes ranging from small to large (Table 1b). First, in the study by Edwards and Fillingim [27] that included healthy college-aged adults, effect sizes were small for ratings of intensity and moderate for pain unpleasantness. Sheffield and colleagues [11] found that compared with NHW individuals, AA rated heat pain as more unpleasant and more intense. These studies produced consistently large effect sizes across most temperatures tested. Campbell et al. [8] used a temporal summation protocol for inducing suprathreshold heat pain, which involved brief, repetitive heat pulses in contrast to the more sustained and intermittent heat stimuli used by other authors. Based on this approach, effect sizes were generally moderate, with AA reporting greater pain intensity and unpleasantness than NHW. Lastly, the suprathreshold study by Kim and colleagues [28] reported consistently small effect sizes across all temperatures (43–49°C) and found no significant differences for thermal stimuli. Taken together, ethnic group differences in intensity ratings showed a moderate unweighted mean effect size, but a small weighted effect size, while moderate unweighted and weighted effects sizes emerged for pain unpleasantness.

Table 2d Ethnic differences in mechanical pain sensitivity, non-Hispanic White vs other ethnic groups

Author/Year	Sample Size		Age Range (Mean)	"Whites" Mean (SD)	Other Group Mean (SD)	Effect Size*
Pressure pain threshold						
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	3.2 (1.4)	3.2 (1.5)	0
<i>Masseter</i>	82 (32F, 50M)	61 (34F, 24M)				
Rahim-Williams et al., 2007 [6]	NHW	Hispanic	18–53	6.7 (2.5)	6.0 (2.2)	–0.29
<i>Trapezius</i>	82 (32F, 50M)	61 (34F, 24M)				
Komiyama et al., 2007 [36]	Belgian	Japanese	20–31	169.1 (51.0)	164.3 (45.0)	–0.1
<i>Masseter</i>	44 (22F, 22M)	44 (22F, 22M)				
Komiyama et al., 2007 [36]	Belgian	Japanese	20–31	324.3 (106.8)	308.3 (76.5)	–0.17
<i>Thenar</i>	44 (22F, 22M)	44 (22F, 22M)				
Komiyama et al., 2009 [37]	Belgian Caucasian	Japanese	20–35	169.0 (60.2)	169.7 (46.3)	0.01
<i>Masseter</i>	28 (14F, 14M)	28 (14F, 14M)				
Komiyama et al., 2009 [37]	Belgian Caucasian	Japanese	20–35	347.4 (77.9)	335.4 (71.8)	–0.16
<i>Thenar</i>	28 (14F, 14M)	28 (14F, 14M)				
Merskey and Spear, 1964 [35]	White (28M)	Afro-Asian (11M)	18–30	3.75 (0.82)	3.84 (1.01)	0.1
Gazerani and Arendt-Nielsen, 2005 [13]	Danish Caucasian	South Indians	19–42	222.9 (30.3)	205.2 (23.0)	–0.66
<i>Right frontalis muscle</i>	16M	16M				
Gazerani and Arendt-Nielsen, 2005 [13]	Danish Caucasian	South Indians	19–42	225.3 (35.7)	219.3 (45.0)	–0.15
<i>Left frontalis muscle</i>	16M	16M				
				Mean effect for pressure pain threshold—Unweighted		–0.16
				Mean effect for pressure pain threshold—Weighted		–0.13
Filament pin-prick threshold						
Komiyama et al., 2007 [36]	Belgium	Japanese	20–31	5.66 (0.4)	5.3 (0.5)	–0.82
<i>Thenar</i>	44 (22F, 22M)	44 (22F, 22M)				
Komiyama et al., 2007 [36]	Belgium	Japanese	20–31	5.04 (0.25)	4.77 (0.35)	–0.92
<i>Tongue tip</i>	44 (22F, 22M)	44 (22F, 22M)				
Komiyama et al., 2007 [36]	Belgium	Japanese	20–31	5.34 (0.26)	5.28 (0.25)	–0.23
<i>Maxillary gingiva</i>	44 (22F, 22M)	44 (22F, 22M)				
Komiyama et al., 2007 [36]	Belgium	Japanese	20–31	5.54 (0.38)	5.12 (0.37)	–1.18
<i>Cheek skin</i>	44 (22F, 22M)	44 (22F, 22M)				
				Mean effect for mechanical pin-prick threshold		–0.79
Pressure pain tolerance						
Merskey and Spear, 1964 [35]	White (28M)	Afro-Asian (11M)	18–30	6.0 (1.2)	5.8 (1.3)	–0.14
Woodrow et al., 1972 [22]	NHW 34,077 (19,471F, 14,606M)	Oriental 1,649 (900F, 749M)	20–70	22.6 (8.1)	19.4 (7.1)	–0.37
Komiyama et al., 2007 [36]	Belgium	Japanese	20–31	367.6 (82.7)	333.4 (72.1)	–0.44
<i>masseter</i>	44 (22F, 22M)	44 (22F, 22M)				
				Mean effect for mechanical tolerance—Unweighted		–0.32
				Mean effect for mechanical tolerance—Weighted		–0.37

* Effect size calculated such that a negative number reflects a higher threshold or tolerance for the White group. NHW = non-Hispanic White; SD = standard deviation.

Cold Stimuli

Threshold and Tolerance. Four studies [6,8,12,26] comparing AA and NHW reported cold pain threshold, while six studies [6,8,12,26,28,29] reported tolerance (Table 1c). Overall, moderate unweighted (–0.42) and

weighted (–0.41) effect sizes emerged for cold pain threshold and large effect sizes for cold pain tolerance (–0.80 unweighted, –0.79 weighted). Across the four studies, AA demonstrated lower thresholds and tolerances to cold stimuli compared with NHW individuals.

Table 2e Ethnic differences in electrical pain sensitivity non-Hispanic white vs other ethnic groups

Author/Year	Sample Size		Age Range (Mean)	"Whites" Mean (SD)	Other Group Mean (SD)	Effect Size†
Threshold						
Chapman et al., 1982 [38]	American 20 (10F, 10M)	Japanese 20 (10F, 10M)	18–36	12.0 (6.5)	9.0 (4.8)	–0.53
Clark and Clark, 1980* [16]	Occidental 5	Nepalese 6	Occidental, 30–68 Nepalese, 23–42	35 (11.9)	64.5 (12.5)	2.42
Komiyama et al., 2009 [37]	Belgian Caucasian 28 (14F, 14M)	Japanese 28 (14F, 14M)	20–35	17.1 (4.1)	14.8 (3.7)	–0.59
				Mean effect for electrical threshold—Unweighted		0.43
				Mean effect for electrical threshold—Weighted		0.2
Tolerance						
Clark and Clark, 1980 [16]	Occidental 5	Nepalese 6	Occidental, 30–68 Nepalese, 23–42	58.8 (12.1)	82.8 (12.7)	1.93
				Mean effect for electrical tolerance		1.93

* Data for gender/sex by ethnicity/race unavailable.

† Effect size calculated such that a negative number reflects a higher threshold or tolerance for the White group.

SD = standard deviation.

Suprathreshold. Two studies [28,30] reported suprathreshold ratings for cold pain comparing AA and NHW (Table 1c). Kim and colleagues [28] conducted a study consisting of 130 AA and 344 NHW. For ratings of suprathreshold intensity, both studies produced a moderate effect, with AA reporting higher cold pain intensity. Weisse et al. [30] also reported findings of similar magnitude for pain unpleasantness (data not shown).

Overall, cold pain studies yielded large effects for tolerance, and moderate effects for cold threshold and suprathreshold ratings.

Ischemic Stimuli

Threshold and Tolerance. Four studies [6,8,12,26] reported ischemic pain threshold and five [6,8,10,12,26] reported ischemic tolerance. Table 1d lists the four studies producing small effect sizes for ischemic pain threshold. Three of these four studies reported higher pain thresholds in AA compared with NHW. Studies assessing ischemic pain tolerance produced moderate to large effect sizes, with AA showing lower tolerance. Of note, the study by Edwards et al. [10] used a sample of chronic pain patients for experimental testing.

Suprathreshold. Only one study [31] reported suprathreshold ratings for unpleasantness and intensity for ischemic pain. Suprathreshold ratings yielded a small effect size for unpleasantness and a moderate effect size for intensity.

Across the majority of the studies reporting ischemic pain, we noted a small mean effect for threshold, and moderate effects for tolerance and suprathreshold ratings. On the average, AA demonstrated higher pain threshold and suprathreshold ratings, and lower ischemic pain tolerance than NHW.

Mechanical Pressure Stimuli

Threshold and Tolerance. Two studies [6,22] comparing AA and NHW reported mechanical pain using different pain induction procedures and measures (Table 1e). Rahim-Williams et al. [6] reported pressure pain threshold on the left upper trapezius and left masseter using a hand-held algometer having a 1 cm diameter tip. Woodrow et al. [22] assessed pressure pain tolerance at the Achilles heel (ankle tendon) using a custom-built, motor-driven instrument that measured pounds per square inch. Results revealed that AA demonstrated lower pressure pain threshold and tolerance relative to NHW, although the effect sizes were small.

Electrical Stimuli

Threshold. Campbell et al. [32] was the only study investigating the nociceptive flexion reflex (NFR), a pain-related spinal muscle reflex, comparing AA and Whites (Table 1e). Participants included 29 AA and 28 NHW individuals. The authors found significant ethnic group differences, with AA demonstrating lower NFR thresholds compared with NHW. Study results yielded a moderate effect size.

Studies Comparing NHW and Other Ethnic Groups: Experimental Pain Effects

Several studies have investigated experimental pain responses across a variety other ethnic groups. Given the multiple ethnic groups that have been studied and the resultant number of potential comparisons, it is difficult to produce meaningful effect sizes for all possible group differences. However, given that the most frequent group comparisons involved NHW (in North America or Europe) compared with another ethnic group, we have computed

Table 3a List of review studies: experimental pain

Primary Group Comparisons

Researchers	Ethnic/Racial Groups Studied	Pain Testing Procedures	Pain Induction Method	Test Area
Forsythe et al., 2011 [29]	AA, NHW	Cold (TOL)	Container with ice and water, 0–2°C (~36°F)	Nondominant forearm
Wang et al., 2010 [58]	AA, NHW	Thermal (THR)	Contact thermode, 12 cm ² Capsaicin	Left/right volar forearm
Grewen et al., 2008 [26]	AA, NHW	Thermal (THR, TOL, Int, Unpl)	Contact thermode, 1 cm diameter	Volar forearm
		Cold (THR, TOL)	Container with ice and water, 4°C (~39F)	Hand up to wrist
Rahim-Williams et al., 2007 [6]	AA, NHW	Ischemic (THR, TOL)	Tourniquet cuff	Forearm
		Thermal (THR, TOL)	Contact thermode, 1 cm diameter	Ventral forearm
Campbell et al., 2007 [32]	AA, NHW	Cold (TH, TOL)	Refrigeration unit, 5°C	Left hand up to wrist
		Ischemic (THR, TOL)	Tourniquet cuff	Left forearm
Campbell et al., 2005 [8]	AA, NHW	Electrical (electromyographic)	Electrode	Biceps femoris muscle of left leg; lateral epicondyle of femur
		Thermal (THR, TOL, Int, Unpl)	Contact thermode	Left ventral forearm
Mechlin et al., 2005 [12]	AA, NHW	Cold (THR, TOL, Int, Unpl)	Refrigeration unit, 5°C	Left hand up to wrist
		Ischemic (THR, TOL, Int, Unpl)	Tourniquet cuff	Left arm
Weisse et al., 2005 [30]	AA, NHW	Thermal (THR, TOL)	Contact thermode, 1 cm diameter	Left volar forearm
		Cold (THR, TOL)	Container with ice and water, 4°C	Hand up to wrist
Kim et al., 2004 [28]	AA, NHW	Ischemic (THR, TOL)	Tourniquet cuff	Arm
		Cold (TOL, Intensity, Unpl)	Styrofoam bucket with ice water; 0–2°C	Arm up to the elbow
Campbell et al., 2004 [31]	AA, NHW	Heat (THR, TOL, Intensity)	Thermode probe, 1 cm diameter	Volar forearm
		Cold (THR, TOL, Intensity)	Insulated bucket filled with iced water; 2–4°C	Hand up to the wrist
Edwards et al., 2001 [10]	AA, NHW	Ischemic (Intensity, Unpl)	Blood pressure cuff	Dominant upper arm
Sheffield et al., 2000 [11]	AA, NHW	Ischemic (TOL)	Blood pressure cuff/Tourniquet	Dominant arm
Edwards and Fillingim, 1999 [27]	AA, NHW	Thermal (Intensity, unpleasantness)	9.3 mm square probe	Right volar forearm
Woodrow et al., 1972 [22]	AA, NHW	Thermal (THR, TOL, Intensity, Unpl)	9 cm ² contact probe	Left volar forearm
Chapman and Jones, 1944 [25]	AA, NHW	Mechanical (TOL)	Two motor-driven rods with "1/4" & "1/8" tip	Ankle tendon
		Thermal (THR, TOL)	1,000 W tungsten filament lamp (intensities of light)	Forehead

AA = African American; NHW = non-Hispanic White.

Table 3b List of review studies: experimental pain

Secondary Group Comparisons

Researchers	Ethnic/Racial Groups Studied	Pain Testing Procedures Threshold (THR)/Tolerance (TOL)	Pain Induction Method	Administration Site
Hsieh et al., 2010 [53]	Chinese, European Canadian	Cold (THR/TOL, Intensity)	Cold pressure machine: double-bucket with built-in refrigeration unit; 2–3°C	Nondominant arm up to elbow
Komiyama et al., 2009 [37]	Japanese, Belgian Caucasian	Mechanical (THR) Electrical (THR, Intensity)	Pressure algometer, 1 cm probe diameter Filament-prick; surface stimulation electrodes	Masseter muscles Left cheek skin overlying masseter muscles; tip of tongue
Komiyama et al., 2007 [36]	Japanese, Belgian White	Mechanical (THR, TOL)	Pressure algometer, 1 cm probe diameter	Masseter muscles
Gazerani and Arendt-Nielsen, 2005 [13]	Danish Whites, South Indians	Mechanical (THR, Intensity)	Hand-held electrical algometer; 1 cm diameter	Frontalis muscles bilaterally
Watson et al., 2005 [33]	White British, South Asian	Heat (THR, Intensity, Unpl) Cold (THR, Intensity, Unpl)	Contact thermode Contact thermode	Volar surface of forearm
Nayak et al., 2000 [34]	United States, India	Cold (TOL, Intensity)	Bucket of ice water at room temperature	Nondominant hand up to wrist
Chapman et al., 1982 [38]	American, Japanese	Electrical (THR, Intensity)	Conductive rubber disc electrode (cathode); 3.5 mm	Unfilled central incisor
Lark and Clark, 1980 [16]	Occidentals, Nepalese	Electrical (THR)	Carbon electrodes	Left wrist over median nerve, and left forearm
Merskey and Spear, 1964 [35]	Afro-Asian, White	Mechanical (THR, TOL)	Algometer; 0.5 cm diameter	Forehead and tibia shin
Meehan et al., 1954 [15]	Indian, non-Hispanic White	Thermal (THR)	Radiometer/dolorimeter	Back of hand

THR = threshold; TOL = tolerance; Inst = intensity; Unpl = unpleasantness; AA = African American; NHW = non-Hispanic White.

effects sizes for these comparisons (i.e., White vs non-White) across the pain modalities included in the studies.

Thermal Stimuli

Threshold and Tolerance. Three studies [6,15,33] expanded investigations of ethnic group differences in thermal pain sensitivity (Table 2a). For example, Rahim-Williams et al. [6] compared Hispanics and NHW and a moderate effect size emerged for pain threshold, while a small to moderate effect was observed for pain tolerance. Lower thresholds and tolerances were observed among Hispanic Whites. Meehan et al. [15] used radiant heat in

comparing Indians and Eskimos to NHW. The study reported that Eskimos had higher pain thresholds compared with Whites. The study produced a large effect. On the other hand, using the same methodology, Indians and Whites demonstrated almost identical pain thresholds (small effect). In a study conducted in the United Kingdom, Watson et al. [33] compared heat pain threshold among Whites and South Asians in the United Kingdom and found a large effect, with higher thresholds among Whites. Thus, for White compared with non-White groups, these three studies evidenced an overall small mean effect size for threshold (unweighted, -0.01; weighted, 0.06) and a moderate effect from one study of tolerance (-0.59).

Cold Stimuli

Threshold and Tolerance. Three studies [6,33,34] expanded investigations of ethnic group differences in cold pain sensitivity (Table 2b). The Rahim-Williams et al. [6] study compared Hispanics and NHW, reporting a small (0.02) effect size for cold threshold, but a moderate (-0.54) effect size for tolerance, with Hispanics having lower values for both measures. Nayak et al. [34] found a small to moderate (0.33) effect size for cold pain tolerance, with Whites tested in the United States showing lower tolerance compared with Indians tested in India. In contrast, the Watson team [33] found a large (0.62) effect size for cold threshold comparing White British and South Asians, with Whites showing lower thresholds, which reflect lower sensitivity (i.e., Whites required a lower temperature to elicit cold pain). Overall, the studies averaged a small effect size for threshold (unweighted, 0.18; weighted, 0.04) and tolerance (unweighted, -0.28; weighted, 0.20).

Ischemic Stimuli

Threshold and Tolerance. Rahim-Williams et al. [6] compared ischemic pain threshold and tolerance in Hispanics and NHW. These researchers demonstrated small (0.06–0.31) mean effect sizes for both measures with Hispanics showing lower pain threshold and tolerance than NHW (Table 2c).

Mechanical Stimuli

Threshold. Five studies [6,13,35–37] investigating pressure pain threshold together produced variable results with a small (-0.40) mean effect size. The Rahim-Williams et al. [6] research compared NHW and Hispanic, college-aged adults, and applied pressure to the masseter and trapezius muscles. The study yielded small effect sizes (0.0 and -0.29). The Gazerani and Arendt-Nielsen [13] study compared Danish Caucasians and South Indians participants who ranged in age from 19 to 42. Researchers applied pressure to the right and left frontalis muscles. Results revealed that pain threshold was lower in South Indians compared with Danish Whites, and effect sizes ranged from small to moderate (from -0.15 to -0.59) depending on the test site. The third study by Merskey and Spear [35] compared Afro-Asians and non-Hispanic White medical students under the age of 30. Students were tested on the forehead and over the tibia. Alone, this study produced a small effect size (0.10). Next, the Komiyama et al. [36] study, comparing Belgian Whites and Japanese, assessed tolerance for mechanical pressure pain using an algometer pressed onto the masseter muscle. The study produced a very small effect for pressure pain threshold. However, a later study by Komiyama [37] using the same populations and same testing procedures produced no effect (Table 2d). These investigators also compared pin-prick mechanical thresholds in these ethnic groups using monofilaments and reported large effect sizes, with Belgian subjects showing higher thresholds [34].

Tolerance. Three studies [27,35,36] assessed mechanical pain tolerance and produced varying effects; small to large (Table 2d). The Merskey and Spear [35] study of Afro-Asians and NHW produced a small effect using mechanical pressure applied to the forehead and tibia. The study reported that Afro-Asians demonstrated a lower tolerance to mechanical pressure compared with White individuals. Woodrow et al. [22] compared pressure pain tolerance in Orientals with NHW, reporting moderate effects (-0.37). Notably, this study included a very large sample size of several thousand participants. Komiyama and colleagues [36] included a much smaller sample size but produced a similar effect size for pressure pain tolerance (-0.44). Effects were in the direction of higher mechanical pain tolerance for Belgian Whites compared with Japanese participants.

Electrical Stimuli

Three studies investigated electrical threshold and tolerance among multi-ethnic groups (Table 2e). Clark and Clark [16] compared "Occidentals" (of European designation) with Nepalese porters in Nepal, finding a large effect for pain threshold (5.68) and tolerance (4.53), such that Nepalese porters had higher threshold and tolerance than Occidentals. Chapman et al. [38] used electrical acupuncture comparing American and Japanese individuals, and found a moderate (-0.53) effect size for electrical threshold, with higher threshold among Americans (Whites). Komiyama [37] comparing Belgian Whites and Japanese assessed electrical pain threshold in the trigeminal region and found lower thresholds among Japanese participants compared with Belgian Whites, and the study produced a moderate effect size.

Results Summary

Our review of ethnic group differences in experimental pain indicates generally consistent evidence regarding ethnic group differences in experimental pain responses, especially for studies comparing AA and NHW. AA reported more robust perceptual responses to painful stimuli, particularly lower pain tolerance and higher ratings of suprathreshold stimuli. However, evidence is less clear regarding the mechanisms underlying these differences. That ethnic differences emerge across all stimulus modalities argues against peripheral mechanisms, and several studies point to both psychosocial variables as well as endogenous pain inhibitory responses as important contributors. Our discussion highlights potential mechanisms believed to affect ethnic group differences in experimental pain outcomes.

Discussion

The studies reviewed spanned a period of approximately 67 years (1944–2011) and examined experimental pain responses across multiple ethnic groups, with the majority comparing AA and NHW. We organized the studies into two main categories, AA compared with NHW (primary

comparison groups), and NHW compared with other groups of varying ethnicities (secondary category).

The Reviewed Ethnic Group Studies: Methodological Considerations

Evidence from our review of 15 studies comparing AA and NHW provides support for ethnic group differences in pain sensitivity. These diverse studies measured pain stimuli across multiple modalities (thermal, cold, ischemic, electrical, and/or mechanical), and while the direction of group differences was consistent, the magnitude of group differences varied substantially across stimulus modalities and pain measures. We also examined studies comparing NHW to other ethnic groups (e.g., Japanese, Nepalese, Asian, Eskimo, Alaskan, and Hispanic). Given the wide range of ethnic groups included, these studies similarly revealed variation in pain response.

Ethnic group differences in response to experimental pain perception/sensitivity may be influenced by several methodological considerations, including sample characteristics (sample size, age, gender, etc.), geographical location of testing, pain induction methods, site of pain stimulation, and experimenter characteristics. For example, in their study comparing electrical pain responses in Nepalese porters to Occidentals, Clark and Clark [16] stated; "... the six Nepalese did not speak English, had little schooling, were devout Buddhists, and some were illiterate . . . were accustomed to carrying 77-pound packs at high altitudes wearing only light clothing, even at freezing temperatures." This example embodies the fact that ethnic group represents a proxy for a typically unknown and varied set of individual difference characteristics that extend well beyond biogeographical ancestry, including language, education, religious and cultural beliefs, and life experiences. In this study of Nepalese porters, stoicism may have been an important contributing factor, such that pain may be experienced but not reported [16].

Although our review focused on inter-ethnic group differences between NHW and other "minority" ethnic groups, other studies have investigated *intra*-group differences in pain perception. For example, Yosipovitch and colleagues [14] found no significant between-group differences in thermal pain thresholds among Asian subgroups (Chinese, Malay, and Indian) by race/ethnicity, gender/sex, or skin type. However, these researchers do state an influence of age and education on thermal pain threshold outcomes, and recommend that these factors be considered in experimental pain studies. The study by Awad and team [17] assessing sensory pain thresholds in visceral afferent sensation among Hispanic IBS patients and Hispanic healthy controls in Mexico was a different type of study than those included in our review. The Awad team [17] reported results by health status; heightened visceral hypersensitivity for IBS patients compared with healthy controls. In a study of American "housewives" of European descent, Sternbach and Tursky [39] reported lower electrical pain tolerances in "Italians" compared with "Yankees" and "Jews." Such intra-ethnic group differ-

ences reflect the heterogeneity of ethnic categories and should receive further empirical attention in the future.

Another important consideration could be the role of geographic region as a factor contributing to ethnic/racial group differences in experimental pain outcomes. Although most studies tested both ethnic groups in the home country of the NHW participants (i.e., Europe or the United States), others [16] tested in the home country of the non-White participants, while still other researchers [34,36] tested each ethnic group in its own home country. Examining the data from this perspective, it appears that ethnic group differences may be smaller or even in the opposite direction when non-White groups are tested in their home country. This raises the possibility that being a minority group may be an important determinant of laboratory pain responses, although this is admittedly highly speculative given the small number of studies that have tested non-White groups in their home country.

Factors Contributing to Ethnic Group Differences in Experimental Pain

Ethnic group differences in experimental pain sensitivity are inevitably determined by multiple mechanisms: socio-cultural, psychological, and biological. We highlight these factors in the context of experimental pain testing.

Social and Cultural Factors

Multiple sociocultural factors could affect pain sensitivity, including beliefs and attitudes, language, and expressiveness, gender/sex, medication practices, and beliefs, spirituality, social roles and expectations, cultural group membership, socialization of pain expression, perceived discrimination, socioeconomic status, acculturation, age, and environmental factors [9,28,40-51]. More than half a century ago, Zborowski [50] suggested that a knowledge of group attitudes toward pain is extremely important for understanding individual reactions because members in different cultures may assume differing attitudes (e.g., pain expectancy and pain acceptance) toward various types of pain. Authors such as Morris [3], Lasch [44], and Zborowski [50] provided further discussion regarding multiple sociocultural variables potentially associated with ethnic group differences in *clinical* pain. Unfortunately, direct analysis of such factors is uncommon in experimental studies.

While all studies included in this analysis reported the race/ethnicity of participants, the majority of studies did not provide specific information as to how "race" or "ethnicity" was assessed. Studies followed two reporting procedures: that participants "self-identified" their race/ethnicity or reported the race/ethnicity without stating how race/ethnicity was determined. However, Rahim-Williams et al. [6] reported that *ethnic identity* contributed to group differences in pain response and included a definition for "ethnic identity." Ethnic identity is that part of an individual's self-concept that is derived from his or her knowledge of membership in a social group together with the value

and emotional significance attached to that membership [3,52]. Ethnic identity is a predictor of locus-of-control coping style, which has been found to influence experimental and acute pain response [46]. In the Rahim-Williams et al. [6] study, AA and Hispanics who reported stronger identification with their ethnic group, also exhibited greater pain sensitivity.

Given the importance and fluidity of sociocultural and environmental influences, it is difficult to compare the Chapman and Jones [25] study, conducted more than 60 years ago, to more recent research. Clearly, the cultural context in the United States was dramatically different then, which likely influenced multiple aspects of the research. Such findings suggest a contribution of sociocultural variables to ethnic differences in pain sensitivity. However, not all researchers agree on the influence of racial and ethnic group differences in discriminating painful stimuli. Perhaps this is due to thoughts that as both a scientific concept and a cultural fact, ethnicity is wrought with pitfalls and perils [3]. Thus, this continued debate on the influence of ethnicity on pain response and sensitivity suggests relevance for continued research to increase understanding of the variability in ethnicity and pain sensitivity.

Psychological Factors

Psychological factors such as pain coping strategies, mood, and hypervigilance have likewise been found to contribute to ethnic group differences in pain response [8,10,27,53]. For example, AA have consistently reported higher levels of catastrophizing [43,54] and passive coping [8], which have been associated with greater pain sensitivity [7,55,56]. Similarly, Campbell et al. [8] found that scores on measures of hypervigilance were higher among AA, and while passive coping did not account for the ethnic group differences in experimental pain response, controlling for hypervigilance rendered group differences in heat and ischemic pain sensitivity nonsignificant. Klatzkin and colleagues [57] found that a history of mood disorder was associated with greater sensitivity to cold pain, but only among AA. Moreover, interpersonal influences may influence ethnic differences in pain responses. For instance, Black subjects reported cold pressor pain to be more intense and unpleasant when tested by a female than a male experimenter [31]. Thus, multiple psychological processes may contribute to ethnic differences in pain responses.

Biological Factors

From a more biological perspective, ethnic differences in pain sensitivity may be related to alterations in endogenous pain control mechanisms. Mechlin and colleagues [12] reported that stress-induced cardiovascular and neuroendocrine responses were more strongly associated with pain inhibition among Whites than AA, providing evidence for ethnic differences in endogenous pain modulation. More recently, Mechlin and colleagues [12] found that

Whites had higher oxytocin levels than AA, and oxytocin partially accounted for the ethnic group difference in ischemic pain tolerance [26]. Moreover, recent evidence suggests a significant genetic contribution to experimental pain responses [58–61], although the extent of genetic variance in pain sensitivity continues to be uncertain [3,61]. For example, Kim et al. [28] found that allele frequencies for single nucleotide polymorphisms (SNP) of potential candidate pain genes differed across ethnic groups, and *TRPV1* genotype was associated with cold pain withdrawal time only among White women. In addition, the rare allele of the *OPRM1* A118G SNP has been associated with reduced pain sensitivity in predominantly White subject samples [59,61] and this allele is substantially less frequent among AA than Whites [62,63]. These findings suggest that genetic factors may contribute to ethnic group differences in pain perception. However, Nielsen et al. [61] recommended caution in generalizing genetic findings from one pain modality to another (e.g., cold pressor and contact heat pain) because of the distinct phenomena measured by these modalities. Given the paucity of research directly investigating genetic contributions to pain in multi-ethnic samples, more studies are needed addressing the contribution of genetic factors to ethnic differences in pain responses. It is promising that the research on genetics of pain may provide more targeted therapies to improve pain treatment. However, it is important for researchers to stay mindful of the intricate ways in which human pain, no matter the genetic substrate, is shaped, modified, and continuously re-shaped by culture [3].

Given the diversity of methodological, sociocultural, psychological, and biological considerations, one definitive and all inclusive explanation for ethnic group differences in experimental pain response is not possible. Yet, from our review, race/ethnicity does contribute significantly to variability in pain responses across most pain stimulus modalities. The most consistent evidence indicates that compared with NHW, ethnic minority groups demonstrate lower pain tolerances and, to a lesser degree, higher pain ratings and lower pain thresholds.

In summary, explanations of ethnic group differences in experimental pain are as varied as the researchers conducting the studies, the methods used, and the individuals studied. It is noteworthy that the studies reviewed spanned several decades, and that there was no evidence that the magnitude of the ethnic group differences in pain response has changed systematically over this relatively long time period, despite substantial societal changes. This highly tentative observation suggests that factors in addition to sociocultural influences may contribute to ethnic group differences in pain; however, this speculation requires further empirical confirmation. Given the increasing diversity of most western populations, we believe there is a clear need for continued research and a cross-cultural dialogue to inform our understanding and enliven our discussions regarding the mechanisms underlying ethnic group differences in pain responses.

Limitations

This structured review acknowledges several limitations. First, we found 15 studies focusing on ethnic differences in experimental pain among AA and NHW. Such limited information suggests the need for additional studies investigating ethnic differences in response to experimental pain. Furthermore, although we identified and included studies that investigated ethnic differences among populations such as Hispanics, Asians, Alaskan Indians, Eskimos, Danish, and South Indians, it is difficult to draw general conclusions across these studies not only due to the multiple ethnic groups involved, but also the different pain modalities tested across studies, and because socio-demographics of the compared groups were often not matched. These factors limit the interpretation of findings and may preclude comparisons across studies. Moreover, while our analysis was primarily limited to comparisons of the two main ethnic groups in the United States (AA and NHW), we are aware that there is great intra-ethnic variation within groups. Also, insufficient numbers of studies available limits meaningful pairwise comparisons of any other ethnic groups. Furthermore, studies in this analysis included participants who were primarily healthy, young adults. As such, it is not clear whether these results generalize to older or less healthy populations. Also, as with most areas of research, publication bias may favor the reporting of significant ethnic group differences, which may inflate observed effect sizes. Moreover, many of the studies included multiple pain modalities and therefore conducted multiple statistical tests, often with no error correction. Therefore, there is a risk for increased type 1 error in some studies.

Implications

Although transient experimental pain studied in the laboratory does not replicate many features of clinical pain (e.g., tissue injury, personal relevance, and threat to the organism), experimentally induced pain may have relevance as a useful surrogate measure for clinical pain [28,55]. For example, quantitative sensory testing has value for predicting acute procedural pain, has been associated with pain treatment outcomes, and may provide valuable information for formulating mechanism-based diagnostic categories for pain disorders [55]. Similarly, diffuse noxious inhibitory control (DNIC), a laboratory measure of endogenous pain inhibition, predicts risk for developing chronic postsurgical pain [64]. Moreover, one recent study reported a reduced DNIC response among AA compared with NHW [32]. Thus, experimental pain measures may facilitate identification of biological, psychological, and sociocultural contributions to ethnic differences in pain processing, which we posit can then be applied to elucidate ethnic group differences in clinical pain conditions.

Future Directions

Based on our review, we offer the following recommendations to help guide future research regarding ethnic

group differences in laboratory pain responses. First, there is a need for translational research investigating the ethnic group differences in both clinical and experimental pain within the same populations in order to determine the clinical relevance of ethnic group differences in pain sensitivity. Second, future experimental pain studies examining ethnic group differences should assess both threshold and suprathreshold measures of pain perception, as well as include multiple stimulus modalities to assess pain and pain responses. We also recommend that future studies expand their laboratory pain measures to include ethnic group comparisons of endogenous pain inhibitory (e.g., DNIC) and facilitatory (e.g., temporal summation) responses. Third, given that many previous studies have enrolled healthy young samples, there is a need for research comparing ethnic group differences among older, community-dwelling populations, which would be more representative of many clinical populations. Fourth, delineation of ethnic groups for study requires assessing variations in intra-ethnic acculturation and assimilation, which can affect group demarcation and may influence pain behavior [65]. As such, future studies should report their methods for assessing ethnic group membership and should also identify and reference ethnic subgroup categories and any influence such groups may have upon study outcomes. In identifying and referencing group categories, we recommend a consistency in the use of terms such as race, ethnicity, and culture. Anthropological insights may provide a foundation upon which to draw. We also believe that the use of standardized measures of acculturation or ethnic identity is important. We recognize that an interdisciplinary approach is required as research teams are multidisciplinary. Moreover, extremely limited information is available regarding ethnic group differences in pain treatment outcomes, which represents an important area of future research. Finally, there is a need for a biopsychosociocultural model for studying ethnic differences in pain sensitivity, which can guide future studies and offer mechanistic hypotheses to be tested.

Conclusion

Our review indicates that biology, psychology, culture, and environment (complex interface of biopsychosociocultural factors) contribute to ethnic group differences in experimental pain responses. Research that continues to identify and elucidate mechanisms underlying ethnic group differences will lead the way in advancing our knowledge and our science, with the ultimate translational goal of reducing ethnic disparities in pain and improving pain management for all individuals.

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Correction made after online publication March 5, 2012: References 30 and 31 have been transposed.