American Pain Society
RESEARCH
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TREATMENT
ADVOCACY
PUBLISHED BY ELSEVIER

The Journal of Pain, Vol 15, No 3 (March), 2014: pp 272-282
Available online at www.jpain.org and www.sciencedirect.com

Age and Race Effects on Pain Sensitivity and Modulation Among Middle-Aged and Older Adults

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Abstract: **This study tested the effects of aging and race on responses to noxious stimuli using a wide range of stimulus modalities. The participants were 53 non-Hispanic blacks and 138 non-Hispanic white adults, ages 45 to 76 years. The participants completed a single 3-hour sensory testing session where responses to thermal, mechanical, and cold stimuli were assessed. The results suggest that there are selected age differences, with the older group less sensitive to warm and painful heat stimuli than middle-aged participants, particularly at the knee. This site effect supports the hypothesis that the greatest decrement in pain sensitivity associated with aging occurs in the lower extremities. In addition, there were several instances where age and race effects were compounded, resulting in greater race differences in pain sensitivity among the older participants. Overall, the data suggest that previously reported race differences in pain sensitivity emerged in our older samples, and this study contributes new findings in that these differences may increase with age in non-Hispanic blacks for temporal summation and both heat and cold immersion tolerance. We have added to the aging and pain literature by reporting several small to moderate differences in responses to heat stimuli between middle- and older-age adults.**

Perspective: ***This study found that the greatest decline in pain sensitivity with aging occurs in the lower extremities. In addition, race differences in pain sensitivity observed in younger adults were also found in our older sample.***

Key words: *Aging, race, threshold, temporal summation, conditioned pain modulation.*

It is often reported that older adults experience greater prevalence of pain, greater pain intensity, and pain at more sites than younger adults.[5,18,23,34,35,38,42] It has long been thought that the increase in the prevalence of pain among older adults is partly due to the progressive musculoskeletal degeneration that accompanies aging.[16,20,27] Another explanation for increased pain in older populations has been that aging is associated with greater sensitivity to painful stimuli that results from changes in the structure and function of the nociceptive system.[11]

The strongest data documenting age-cohort differences in laboratory-induced pain come from thermal heat stimuli.[12] Stevens and Choo provided extensive body maps of thermal thresholds at various ages and found that the greatest decline in sensitivity occurs in the extremities, with a greater change at the calf and

Received April 1, 2013; Revised October 29, 2013; Accepted October 31, 2013.

R.B.F. has received consulting fees, speaking fees, and/or honoraria from WebMD and Algynomics (less than $10,000 each) and owns stock or stock options in Algynomics.

R.S. has received consulting fees, speaking fees, and/or honoraria from Pfizer (less than $10,000).

The current study was supported by NIH/NIA grant R01AG033906 and R01AG039659. This publication was also made possible by the UF Clinical and Translational Science Institute (UL1TR000064) and the UAB Center for Clinical and Translational Science (UL1TR000165).

Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIH.

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1526-5900/$36.00

http://dx.doi.org/10.1016/j.jpain.2013.10.015

thigh than the forearm.[40] Using more sophisticated experimental pain testing methods, some but not all studies have found age differences in temporal summation of pain, suggesting an age-related increase in pain facilitation.[8,10,17,25] Moreover, loss of inhibition has been demonstrated among older adults using conditioned pain modulation (CPM) models.[6,24,37,49] One study suggests that some pain inhibitory mechanisms start declining at middle age, although this has not been replicated, and establishing this effect is one of the aims of this study.[24]

Race and ethnicity are another set of psychosocial factors that are associated with increased pain across most settings and all types of pain.[13,36,39] As with age, it has been hypothesized that increased sensitivity to pain in minority race groups may contribute to the greater severity of clinical pain among minority adults.[3,9,33] Typically the largest differences in experimental pain sensitivity between non-Hispanic black (NHB) and non-Hispanic white (NHW) healthy young adults occur for pain tolerance, suprathreshold pain ratings, and temporal summation.[33] A potential weakness of laboratory-based pain studies of aging is that the samples were often not racially/ethnically diverse. Consequently, studies reporting on age differences in pain have not directly tested the confluence of race and aging on pain processing.

Therefore, the primary hypothesis of this study is that older adults will show higher pain thresholds, increased temporal summation, and decreased pain inhibition compared to a middle-aged cohort. We also expect that the effects of aging will be stronger in the knee (distal site) compared to the forearm. Given that both age and race are risk factors for increased pain sensitivity, we hypothesize an interaction between age and race such that race differences become more pronounced with older age. It is also expected that NHBs will exhibit decreased pain tolerance, increased suprathreshold pain ratings, and greater temporal summation of pain. The relatively large and racially diverse sample, allowing us to test groups of middle-aged and older adults across a range of stimulus modalities, sites, and pain measures, is the main strength of this study.

Methods

Subjects

The participants were 53 NHB and 138 NHW adults between the ages of 45 and 76 years, with a mean age of 57.6 (standard deviation [SD] = 7.9). There were 89 participants who were ages 45 to 56, and 102 who were ages 57 to 76. Other demographic and health variables are presented in Table 1. All subjects were recruited as part of a larger multisite study examining race differences in knee osteoarthritic pain (Understanding Pain and Limitations in Osteoarthritic Disease [UPLOAD]) and received the same protocol.

These data were collected at the clinical research centers of the University of Florida and University of Alabama at Birmingham. The institutional review board at each participating center approved the study, and written informed consent was obtained from each participant prior to enrollment as per the Declaration of Helsinki for the involvement of humans in research. Participants were compensated for their participation.

Recruitment and Sampling

A total of 693 individuals responded to study recruitment material. The same methods were used for recruiting NHB and NHW participants: local media ads, posted ads, and word of mouth. The recruitment of NHB participants was open for longer to fulfill the targeted stratification. Three hundred fifty-three were not eligible following a telephone screening or in-person health assessment, leaving 340 who completed the study experimental testing session. The sampling design included a non-knee osteoarthritic (OA) control group (n = 116). For this set of analyses, 75 participants with mild levels of knee OA who scored as Grade 1 (low pain–low disability) on the Graded Chronic Pain Scale were included to increase the generalizability of our findings, as many adults of this age range experience knee pain. Forty-five percent of the non-knee OA control group also received a Grade of 1, which requires having had "any pain" in the past 6 months that resulted in no more than mild interference with daily activities. An earlier paper from UPLOAD has demonstrated that individuals in the low-symptomatic OA group exhibited experimental pain responses similar to the non-knee pain control group.[21]

Study Procedures

Potential participants who passed the telephone screening completed a health assessment session that included vital signs and a comprehensive health history. In addition, participants completed the study questionnaires described below. Demographic characteristics, socioeconomic status, and health data were self-reported as part of the health history. The study inclusion criteria included self-identification as "Black or African American" or "white, Caucasian, or European," and non-Hispanic with a chronological age between 45 and 85 years. We selected the arbitrary cut point of 57 years of age to keep our middle-aged group similar to that used by Larivière and colleagues[24] (40–55 years of age) and allow direct comparisons to older samples from Larivière (60–75 years of age), as well as the studies by Edwards and Fillingim[7] (older group 55 to 67 years of age) and the study by Lautenbacher and colleagues[25] (mean age 65, age range not reported). In addition, this cut point resulted in a 50–50 split for the NHB sample. The results did not differ substantively when cut points of 55 and 60 years of age were tested.

Potential participants were excluded if they had uncontrolled hypertension (greater than 150/95), a history of acute myocardial infarction, peripheral neuropathy, systemic rheumatic disorders, daily opioid use, cognitive impairment (Mini-Mental Status Exam score of $\leq$22), excessive anxiety regarding protocol