J. Afr. Ass. Physiol. Sci 5 (2): 121-127, December 2017

Journal of African Association of Physiological Sciences

Official Publication of the African Association of Physiological Sciences
http://www.jaaps.aapsnet.org

Research Article

INDIVIDUAL DIFFERENCES IN PERCEPTION AND RESPONSE TO EXPERIMENTAL PAIN IN A YOUNG NIGERIAN POPULATION

A.H. Umar, K. Aliyu, O.I. Jimoh, A.A. Isyaku and N.M. Saleh

Department of Human Physiology, Ahmadu Bello University, Zaria

Keywords:
Pain; cold pressor test; ischemic pain; catastrophizing

ABSTRACT

Background: Pain is a protective sensation that alerts an individual to injury from the environment. Experience of pain is characterised by robust individual differences and complex environmental and genetic factors lead to individual variations in pain. Studies of experimental pain are free from the confound of disease progression, but can be highly relevant to clinical pain states. The aim of this study is to evaluate individual differences in perception and response to experimental pain among young Nigerian population. **Methods:** One hundred and thirty apparently healthy subjects (age 12 to 20 years) were used. Pain was accessed using cold pressor test and ischemic pain models. VAS and VRS were used to access pain catastrophizing. Data were presented as mean ± SD. Differences and statistical significance between the means were determined using *t* test. Values of $P < 0.05$ were considered significant. **Results:** The results showed significant differences among the study population in experimental pain threshold and tolerance. **Conclusion:** The study proved that there is variation in perception and response to experimental pain among secondary school students in Zaria, Northern Nigeria.

INTRODUCTION

Historically, the study of individual differences has been an area of research relatively separate from experimental psychology. While experimental psychology has focused on the processes that determine performance in specific experimental situations, the field of individual differences has studied the stable differences among people, particularly those that generalize across diverse situations. The behavioural differences that have received the most attention in this regard have been personality traits and cognitive abilities (Williams *et al.,* 2008). Thus, study of individual differences in physiological parameters is of paramount importance. Sex and gender differences in pain sensitivity response may be due to biological factors such as blood pressure, gonadal hormones and body size, and psychological factors such as fear of pain, catastrophizing, depression and anxiety (Alabas et al., 2012; Forsythe et al., 2011).

*
Address for correspondence:
E-mail: ahumar@abu.edu.ng

Sex is defined as the classifications of living things as male or female according to their reproductive organs and function assigned by the chromosomal complement. Gender, on the other hand, is a person's self-representation as male or female, or how that person is responded to by social institutions on the basis of the individual's gender presentation (Hurley and Adams, 2008). Sex differences in pain perception has oftenly been reported in the literature, but most commonly in adult pain. Numerous literatures have provided evidence of greater prevalence rates of acute and chronic pain and greater sensitivity to experimental pain in women than men (depending on modality, outcome measures and time points) (Boerner et al., 2014), yet, it is still considered to be a controversial point. A meta-analysis by Alabas et al. (2012) found that gender role was related to response to experimentally induced pain in healthy human participants, with masculinity positively associated with pain threshold and pain tolerance. Several painful conditions are more prevalent in women than men including temporomandibular disorders, migraine, tension-type headache, fibromyalgia and irritable bowel

syndrome (Alabas *et al.,* 2012). Females report more severe pain, more frequent bouts of pain, more anatomically diffuse and longer-lasting pain than males with similar disease processes (Hurley and Adams, 2008). Animal study shows that matured male rats well tolerated pain stimuli from tail flick and hot plate models of evaluation by having increase in pain reaction time (Oyekunle et al., 2009).

Gender differences may influence attention to, elaboration of, and emotional responses to pain. Although anxiety and emotion are known to co-vary with gender and may impact pain experience, no significant gender differences were observed in mean pain rating and score after noxious thermal stimulation (Ochsner et al., 2006). Femininity is associated with greater sensitivity to painful stimuli and this may be one of the factors contributing to a greater proportion of women presenting with clinical pain (Alabas et al., 2012)

Difference in pain perception among parturients in Nigeria has been reported to depend on pain threshold, culture, social status, education, counselling, support and medical intervention (Aduloju, 2013). Perception of pain is influenced by ethno-cultural practices. Amount of pain may depend on expectation and pre-existing knowledge. People with strong belief in their ability to handle the pain may feel less than those with a tendency to ''catastrophize''. Study reported that African-American and Latina women had greater postsurgical pain and related symptoms than White women (Everslay *et al.,* 2005). Understanding factors that determine experimental pain sensitivity in normal healthy people will be of value in understanding some chronic pain states. It affords the ability to incorporate pain stimuli with different temporal and sensory characteristics. This study was designed to evaluate differences in pain perception by investigating differences in response to experimental pain among secondary school students in Zaria, Nigeria.

MATERIALS AND METHODS

Apparently healthy volunteers were used for the study. Informed consent was obtained from the subjects, as well as ethical approval from the Ahmadu Bello University Teaching Hospital Scientific and Health Research Ethics Committee (ABUTH/HREC/TRG/36) prior to the study. Subjects were excluded if they have significant psychiatric comorbidity, prior or present alcohol abuse, use daily analgesics, have a disorder that would interfere with pain perception and pain report (e.g. neuropathy), or any symptoms or signs of any neurological or inflammatory disease that could interfere with pain perception. Observational cross-sectional study was used for this evaluation. Responses of individual subject to pain stimuli were observed and recorded.

Experimental procedure

The subjects were introduced to completion of questionnaire and a brief interview. Cold-pressor test was conducted first, followed by a 10-minute rest period before conduction of ischaemic pain procedures in separate sessions, to avoid carry-over effect.

Cold pressor pain:

The cold pressor test procedure results in a gradually increasing cold pain, and it has been widely used as a nociceptive stimulus in experimental studies on adults and children (Koenig *et al.,* 2013). Cold pressor pain was assessed by having the subjects immerse their left hand up to the wrist in cold water at 5°C. The subjects were asked to keep their hand in the water for as long as possible, until the pain becomes intolerable, were they can remove their hand at any time. Cold-pressor pain threshold was determined to be the time when the subject say "pain" and tolerance was recorded when the hand was withdrawn from the water (Rahim-Williams *et al.,* 2007).

Ischaemic pain procedure:

Ischemic pain was induced using a modified submaximal effort tourniquet procedure (Moore *et al.,* 1979). The left arm was exsanguinated by elevating it above heart level for 30 sec. The arm was then occluded using segmental blood pressure cuff inflated to 200 mmHg. Subjects were asked to perform 20 handgrip exercises of 2 seconds duration at 4 seconds intervals. They were asked to say 'pain' when they first feel pain (threshold) and to continue until the pain becomes intolerable (tolerance). The time for pain threshold and pain tolerance were recorded.

Pain catastrophizing:

Pain catastrophizing was assessed using the verbal rating scale, which comprises a list of adjectives (no pain, mild pain, moderate pain and severe pain) used to denote increasing pain intensities (Williamson and Hoggart, 2005).

Data obtained from the study were presented as mean ± SD. Group differences were analysed using *t* test and Mann-Whitney test. Analysis was carried out using SPSS software (SPSS Inc, Chicago). Values of $P < 0.05$ were considered significant.

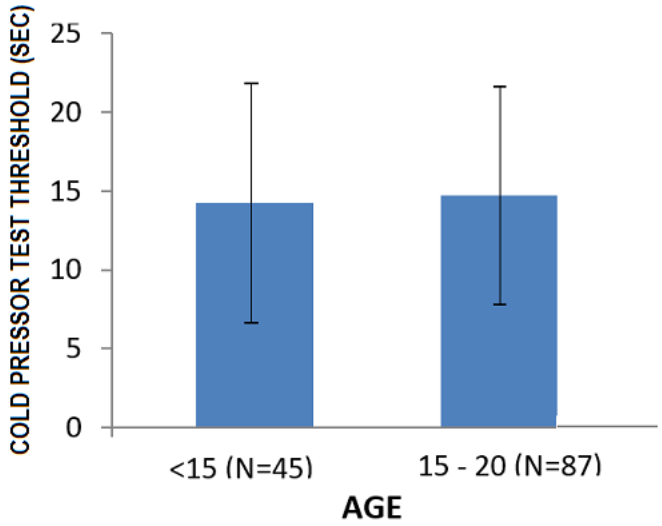
RESULTS

One hundred and thirty two subjects participated in the study. Table 1 showed that 45% of the subjects were

males and 55% females, with 34% below the age of 15 and 66% between 15 and 20 years. Age differences in the cold pressor test threshold were not statistically significant between the studied age groups (Fig. 1), but difference in cold pressor pain tolerance was statistically significant (Fig. 2), with the higher age group (15 – 20) showing increased tolerance than the lower (<15).

Table 1: sociodemographic characteristics of subjects

Characteristic	Frequency	Percentage (%)
Sex		
Male	60	45
Female	72	55
Age		
<15 year	45	34
15 – 20 years	87	66



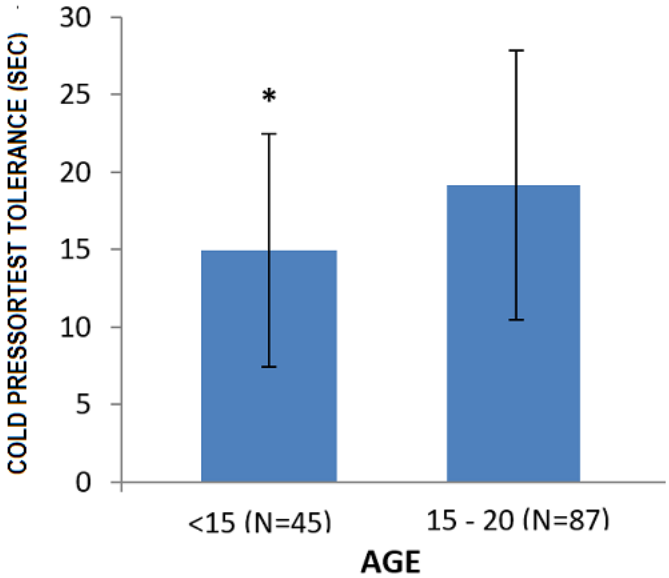
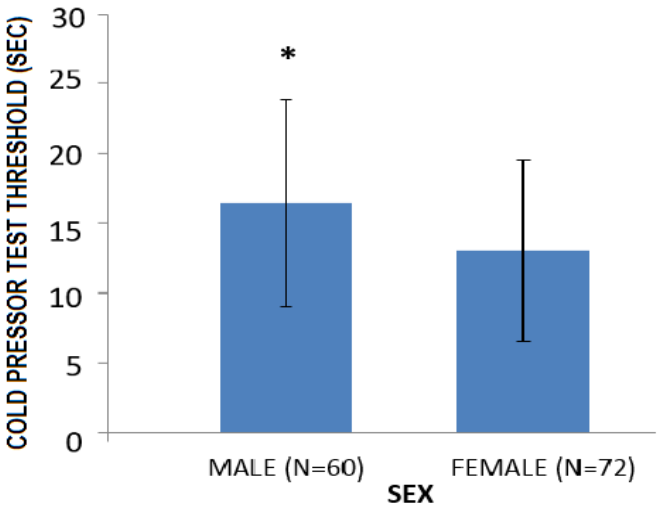


Fig. 1 (upper) and **Fig. 2** (lower): Mean (±SD) values for age differences in cold pressor test threshold and cold pressor test tolerance. Asterisk denotes statistically significant difference



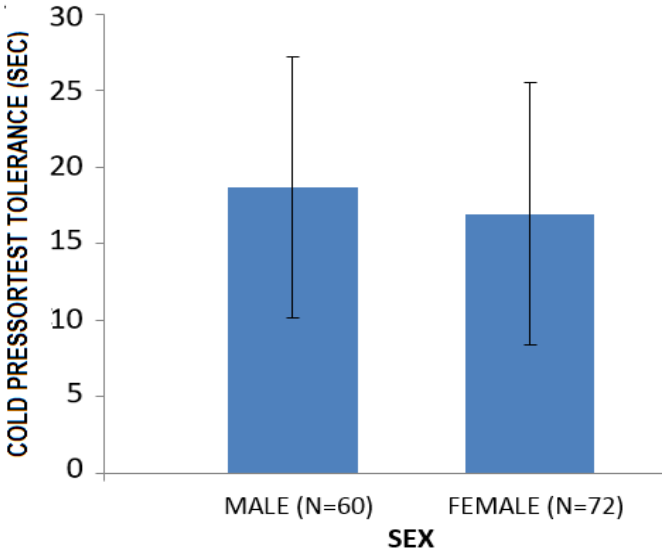


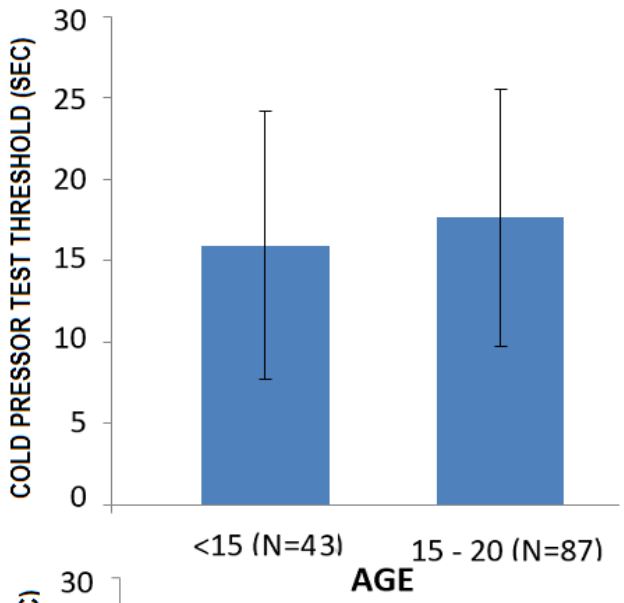
Fig. 3 (upper) and **Fig. 4** (lower): Mean (±SD) values for sex differences in cold pressor test threshold and cold pressor test tolerance. Asterisk denotes statistically significant difference

When the result was analysed by sex, there was statistically significant increase in cold pressor pain threshold in males than in females (Fig. 3), but sex difference in cold pressor pain tolerance does not show statistically significant difference (Fig. 4).

Result of ischemic pain test showed no statistically significant difference in threshold and tolerance by age (Fig.s 5 and 6), but there was statistically significant difference by sex, with males having higher ischemic pain threshold than females (Fig. 7), though not in tolerance (Fig. 8).

DISCUSSION

Although sex differences in pain sensitivity have been partly attributable to social conditioning and to psychosocial factors, many laboratory studies of humans have described sex differences in sensitivity to noxious stimuli. It has been suggested that biological mechanisms underlie sex differences in pain.



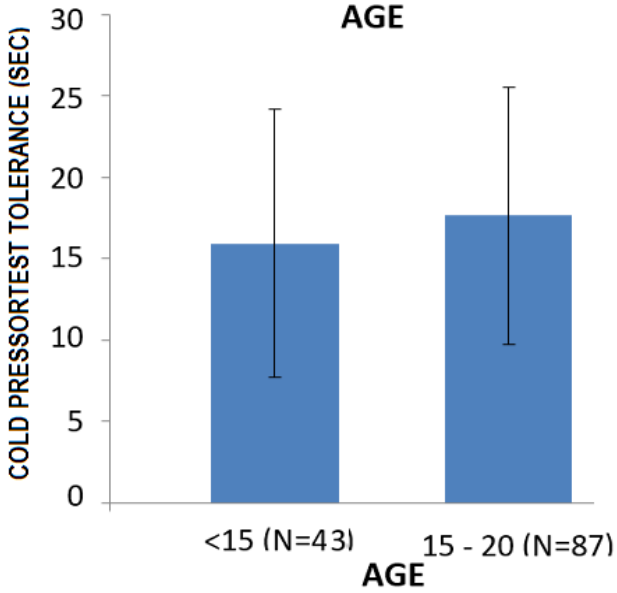
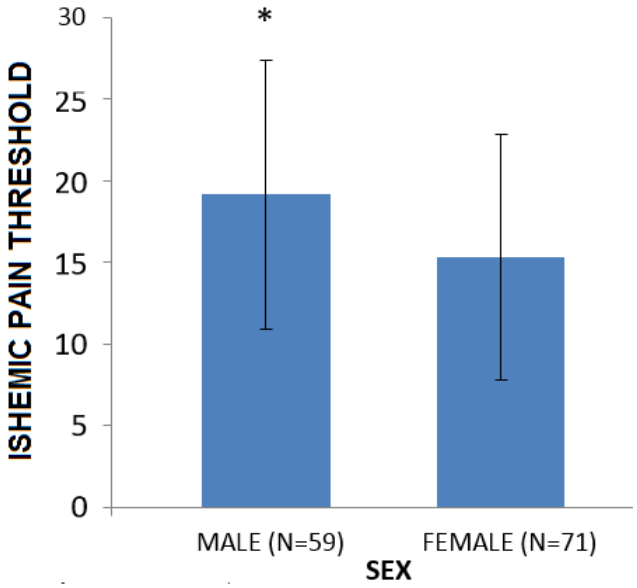


Fig. 5 (upper) and **Fig. 6** (lower): Mean (±SD) values for age differences in ischemic pain threshold and ischemic pain tolerance.



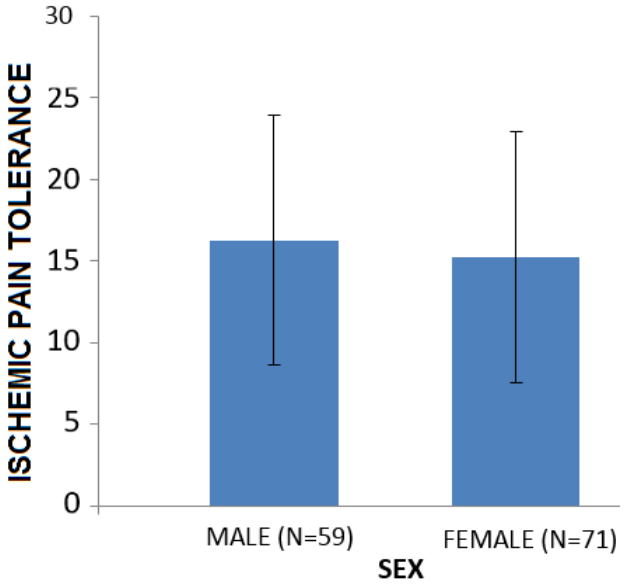


Fig. 7 (upper) and **Fig. 8** (lower): Mean (±SD) values for sex differences in ischemic pain threshold and ischemic pain tolerance.

Also, sex hormones have been suggested to influence pain sensitivity as pain threshold and pain tolerance in women vary with the stage of the menstrual cycle (Wiesenfeld-Hallin, 2005). In this work, significant difference has been observed in the threshold for cold pressor pain, with males showing higher pain threshold than females. Cold pressor tolerance also has show inter-individual variability, with subjects in older age group showing higher tolerance than those in the younger age group. When experimental pain test was carried out using ischemic pain procedure, pain threshold was found to be significantly higher in males than in females, though no significant difference was observed in the tolerance.

It has been reported that women exhibit greater sensitivity to noxious stimuli in the laboratory compared with men (Fillingim, 2000), though Ochsner et al. (2006) reported no significant gender difference using thermal pain stimulus. Higher cortisol levels has been reported to be associated with lower pain reactivity among boys compared with girls, while higher cortisol levels were related to a higher pain response in girls than in boys (Allen et al., 2009). Fear of pain and anxiety sensitivity could also influence the pain response by modulating responses in pain processing systems or the attentional and emotional processes (Ochsner et al., 2006).

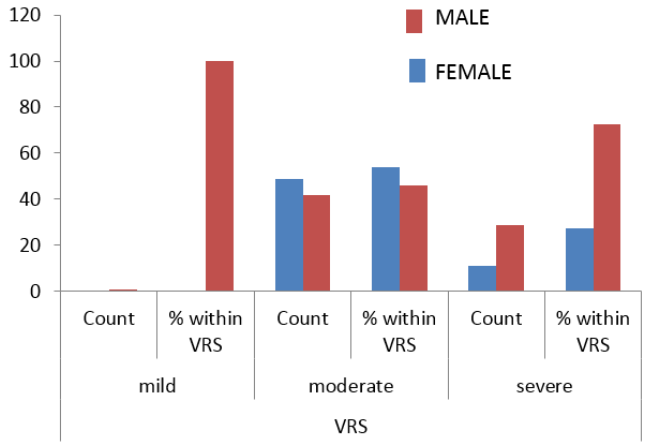


Fig. 9: sex differences in pain catastrophizing using VRS

According to the biopsychosocial model of pain, pain perception and response is influenced by a complex interaction of psychosocial, cultural and biological variables, including individual differences in nociceptive processing (Anderson *et al.,* 2009), sex role beliefs, pain coping strategies, mood, and pain-related expectancies. Sex hormones are also known to affect pain responses, which may mediate the sex differences (Fillingim, 2000). Evidence also suggests that genotype and endogenous opioid functioning play a causal role in these disparities (Bartley and Fillingim, 2013). In studies that reported correlations between masculine and feminine personality traits and response to noxious cold, pressure and electrical stimuli, participants who considered themselves more masculine and less feminine exhibited higher pain thresholds and tolerances (Alabas et al., 2012). Investigations have revealed that there is a less efficient diffuse noxious inhibitory control (DNIC; a descending inhibitory mechanism that modulate pain processing at the spinal cord level) in women than men, though other studies did not detect sex differences in DNIC (Popescu et al., 2010).

Cultural patterns of behaviour have been found to determine perceived sensitivity to pain. The impact of culture on pain sensitivity has been reported to occur well before the acquisition of language. Various studies using diverse methods suggest that culture plays a crucial role in the individual experience of pain (IASP, 2001). Ethnic norms for appropriate pain behaviour influence pain perception, interpretation, and response (IASP, 2002).

Though they have identical genomes, males and females are distinctly dimorphic, with dissimilar disease susceptibilities. These dimorphism results mainly from differences in the expression of genes present in both sexes (Gershoni and Pietrokovski, 2017). From the result of pain catastrophizing using VRS, more females reported severe pain than males, while more males reported moderate pain than females (Fig. 9). These finding indicate sex differences in pain reporting among the test group and agree with that of Edward *et al.* (2004), who reported that women reported greater level of catastrophizing than men. This may be due to psychosocial processes, including pain coping and early-life exposure to stress, in addition to stereotypical gender roles, which may explain sex differences in the expression of pain (Bartley and Fillingim, 2013).

Effect of sex of the experimenter on pain response has been rendered unlikely in this study as the study group is made of only one female who was given the task of taking the height and weight of the participants, thus, does not engage in taking data for pain responses. Most studies reviewed reported no interaction between pain response and sex of the experimenter, though Gijsbers and Nicholson (2005) reported that male participants who were tested by female investigators reported higher pain thresholds compared with those tested by male investigators.
Relationship between gender role and pain response has been reported in many studies. Pressure pain threshold has been reported to be significantly correlated with Masculinity-Femininity among men but not women.

CONCLUSION

Though there are limitations, findings from this work suggest individual differences in responses to multiple experimental pain modalities. It has also provided further evidence for existence of individual differences in experimental pain perception. There is need for further research to elucidate mechanism underlying sex differences and inter-individual variability in pain perception and response, as well as their clinical relevance.

ACKNOWLEDGEMENTS

We acknowledge the contributions of Mal. Ya'u Bello and Mal. Umar Muhammad of the animal house section, department of Human Physiology, for supplying and taking care of the animals during the period of the research.

CONFLICT OF INTEREST

The authors hereby declare that there is no conflict of interest regarding the publication of this paper.

REFRENCES

Aduloju, O.P. (2013). Pain perception among parturients at a University Teaching Hospital, South-Western Nigeria.*Nigerian Medical Journal,* 54 (40): 211-216.

Alabas, O.A., Tashani, O.A., Tabasam, G. and Johnson, M.I. (2012). Gender role affects experimental pain responses: A systematic review with meta-analysis. *European Journal of Pain,* 16: 1211–1223

Allen, L.B., Lu, Q., Tsao, J.C.I., Worthman, C.M. and Zeltzer, L.K. (2009). Sex Differences in the Association Between Cortisol Concentrations and Laboratory Pain Responses in Healthy Children. *GENDER MEDICINE,* 6:193 – 207

Anderson, K.O., Green, C.R. and Payne, R. (2009). Racial and Ethnic Disparities in Pain: Causes and Consequences of Unequal Care. The Journal of Pain, 10(12): 1187-1204

Bartley, E.J., and Fillingim, R.B. (2013). Sex differences in pain: a brief review of clinical and experimental findings. *British Journal of Anaesthesia,* 111(1): 52-58. doi:10.1093/bja/aet127

Boerner, K.E., Birnie, K.A., Caes, L., Schinkel, M. and Chambers, C.T. (2014). Sex differences in experimental pain among healthy children: A systematic review and meta-analysis. *PAIN,* 155: 983–993

Edwards, R.R., Haythornthwaite, J.A., Sullivan, M.J. and Fillingim, R.B. (2004). Catastrophizing as a mediator of sex differences in pain: differential effects for daily pain versus laboratory-induced pain. *Pain,* 111(3): 335-41.

Everslay, R., Estrin, D., Dibble, S., Wardlaw, L., Pedrosa, M. and Favila-Penney, W. (2005). Post-treatment symptoms among ethnic minority breast cancer survivors. *Oncology of Nursing Forum,* 32: 250-256.

Fillingim, R.B. (2000). Sex, gender, and pain: women and men really are different. *Current Review on Pain,* 4(1): 24-30.

Forsythe, L.P., Thorn, B., Day, M., Shelby, G. (2011). Race and sex differences in primary appraisals, catastrophizing, and experimental pain outcomes. *Journal of Pain,* 12: 563–572.

Gershoni, M. and Pietrokovski, S. (2017). The landscape of sex-differential transcriptome and its consequent selection in human adults. Bio Med Central Biology, 15(1): doi:10.1186/s12915-017-0352-z.

Gijsbers, K. and Nicholson, F. (2005). Experimental pain thresholds influenced by sex of experimenter. *Perceptual and Motor Skills,* 101: 803–807.

Hurley, R.W. and Adams, C.B. (2008). Sex, gender, and pain: an overview of a complex field. *Anaesthesia and Analgesia,* 107: 309–317.

International Association for the Study of Pain (IASP) (2001). Ethnicity and Pain. *Pain clinical updates,* 8(4).

International Association for the Study of Pain (IASP) (2002). Culture and Pain. *Pain clinical updates,* 10(5).

Koenig, J., Jarczok, M.N., Ellis, R.J., Bach, C., Thayer, J.F. and Hillecke, T.K. (2013). Two-Week Test–Retest Stability of the Cold Pressor Task Procedure at two different Temperatures as a Measure of Pain Threshold and Tolerance. *Pain Practice,* 1530-7085/13/$15.00

Moore, P.A., Duncan, G.H., Scott, D.S., Gregg, J.M. and Ghia, J.N. (1979). The submaximal effort tourniquet test: its use in evaluating experimental and chronic pain. *Pain,* 6: 375–382.

Otto, M.W. and Dougher, M.J. (1985). Sex differences and personality factors in responsivity to pain. *Perceptual and Motor Skills,* 61: 383–390.

Oyekunle, O., Ibironke, G., Ige, S., Udoh, U. and Okojie, A (2009). Linear Relationship Exists Between Plasma Testosterone Level And Acute Pain Reaction Time In Male Rat. *The Internet Journal of Pain, Symptom Control and Palliative Care,* 8(1): 1 – 5

Popescu, A., LeResche, L., Truelove, E.L. and Drangsholt, M.T. (2010). Gender differences in pain modulation by diffuse noxious inhibitory controls: A systematic review. *PAIN,* 150: 309–318

Rahim-Williams, F.B., Riley III, J.L., Herrera, D., Campbell, C., Hastie, B.A. and Fillingim, R.B. (2007). Ethnic identity predicts experimental pain sensitivity in African-Americans and Hispanics. *Pain*, 129(1-2): 177-184.

Wiesenfeld-Hallin, Z. (2005). Sex differences in pain perception. *Gender medicine,* 2(3): 137 – 145

Williams, B., Myerson, J. and Hale, S. (2008). Individual Differences, Intelligence, and Behavior Analysis. *Journal of the experimental analysis of behaviour*, 90(2): 219–231.

Williamson, A. and Hoggart, B. (2005). Pain: a review of three commonly used pain rating scales. *Journal of Clinical Nursing,* 14: 798–804.