RELATIONSHIP OF PERSONAL CHARACTERISTICS TO PAIN THRESHOLD AND TOLERANCE IN A NORMAL POPULATION

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CHAPTER I

INTRODUCTION

Pain--with the exception of a few unusual medical cases--is an experience common to all mankind. The concept and individual behavioral responses to pain have been studied for centuries, yet pain remains a "puzzle" (Melzack, 1973). Pain is puzzling to both layperson and researcher because it is an extremely complex psychophysiologic process (Handwerker, 1983). Pain is a universal experience, but the perception of pain remains unique to each individual.

The study of pain is of particular relevance to the health professions. Pain is cited as the most common and compelling reason for people to seek health care (Zborowski, 1969). Over the past several decades, researchers have studied numerous variables to find those with a significant influence on pain perception. If certain factors could be shown to strongly influence pain perception, it could affect the individual treatment given by health care providers to people in pain. Of the many factors suggested as modifying pain perception, the demographic variables of age, gender, and cultural or ethnic background are among those most frequently cited. These particular variables also lend themselves readily to the categorization of values found in studies of pain, and could be used to determine if particular subjects matched or varied widely from

individuals possessing similar human characteristics. When the focus of the study is the influence that these demographic variables have on pain, it has been suggested that threshold and tolerance should be the pain response parameters of choice for the study (Wolff, 1980). In a study by Chapman and Jones (1944) pain tolerance was seen to increase with age, while Woodrow, Friedman, Siegelaub, and Collen (1972) found a negative relationship between tolerance and age. Woodrow and his colleagues also found pain response to differ when comparing male with female subjects and comparing subjects of one ethnic background with those of another. Other investigators have not found the same differences (Merskey & Spear, 1964).

Pain is a complex concept, and one must sift through a large number of studies to obtain findings that seem reliable. The study of pain induced experimentally has been criticized at times because it may produce an unrealistic image of clinical pain. It has advantages over the study of clinical pain, however, in that it reduces the interfering influences of disease, such as impaired ability to concentrate and clouding of consciousness (Handwerker, 1983). In studies of pain over the years several different methods for inducing pain have been used. Wolff (1980) reviewed the various methods of experimentally inducing pain, and classified them as mechanical, electrical, thermal, chemical and miscellaneous. The anatomical sites used when producing experimental pain have varied from study to study, and these differences must also be taken into consideration when comparing studies.

Recent studies (Campbell, Clark, Tindall, Forehand, & Bennett, 1983; Reynolds, 1981; Rubin, 1981; Yunus, Masi, Calabro, Miller, & Fergenbaum, 1981) have documented the frequent occurrence of certain pain syndromes associated with specific anatomic sites known as tender points or trigger points (the latter term has been used because at times pressure on a tender point could "trigger" pain at a distant site). Fibrositis, a disorder characterized by diffuse aches, pains, and stiffness in the musculoskeletal system, is one such syndrome (Bennett, 1981). Campbell et al. (1983) estimate that perhaps 5% of the population drawn upon for control subjects in their study had undiagnosed fibrositis. Awad (1973) reports that fibrositis was responsible for 11% of the rheumatic consultations at the Mayo Clinic in 1943, while Maganac (1982) found that 16% of the rheumatology patients referred to him in the first year of his practice had fibrositis.

With the use of specific tender points in the diagnosis of fibrositis, Yunus and his colleagues (1981) suggest the need to learn by practice and experience the normal degree of tenderness at the specific points using standard palpation techniques in individuals free of musculoskeletal symptoms. This method would depend totally on a response from the patient such as withdrawal or stating "it really hurts" to ascertain whether a particular point is more tender than "normal." One study has shown that it is possible to establish ranges and mean values of the pressure needed to produce objective tenderness over specific points in fibrositis patients (Campbell et al., 1983). No data have been reported that establish the range or pressure

tolerated on the tender points in the normal population, or how these points may or may not differ from the amount of pressure tolerated over nontender (control) points. Such data would be useful both to those working with fibrositis patients and to nurses wanting information about a patient's pain threshold and tolerance.

Despite the complexity of the concept of pain, its importance makes it essential that further studies be done. New information needs to be gathered to increase our understanding of pain perception, to substantiate or invalidate past findings, and to obtain more objective values for "normal" tenderness or tolerance at specific points. The purpose of this study is to determine if, in a normal population, pain threshold and tolerance levels for specific control and tender points vary to a significant degree with age, gender, and ethnocultural background; and to use the data obtained to develop ranges and mean values of pain threshold and tolerance for those points in normal individuals. The goal is to obtain normative data that may be used by clinicians in the future.

Literature Review

The literature reviewed for the present study will cover current information on the perception of pain. Past studies that suggest a relationship between the variables of age, gender, culture, and pain perception will be included. While more than one of these variables is usually included in the literature reviewed, each variable will be examined separately for the purposes of clarity and ease of study. Studies of fibrositis patients that have produced quantitative data

for the same anatomical sites (tender and/or control points) to be used in the present study will also be reviewed.

Pain Perception

Pain is a complex, subjective experience, believed by Sternbach (1968) to include a "personal, private sensation of hurt; a harmful stimulus which signals current or impending tissue damage; a pattern of responses which operates to protect the organism from harm" (p. 12). McCaffery (1972) defines pain as whatever an individual says it is, when and where s/he says it exists. Melzack (1980), an eminent contributor to the understanding of pain, believes pain to be a "space comprising several sensory and affective dimensions. The space comprises those subjective experiences which have both somatosensory and negative-affective components" (p. 147) and unless an experience elicits a behavioral response aimed at stopping or reducing the stimulus, it cannot be called pain.

In a normal, conscious individual, the brain is constantly aware of the body's environment--both internal and external. The ongoing process of awareness of sensory stimulation is perception, and as the brain receives each new stimulation it uses the information it has on hand to sort, arrange, and interpret that stimulus (Chapman, 1980). When a nociceptive stimulus initiates the transmission of pain impulses toward the spinal cord by the peripheral sensory nerves, those impulses travel over the larger rapidly conducting type A (alpha and beta) myelinated fibers and/or the smaller myelinated A delta and unmyelinated type C nerve fibers that conduct impulses more slowly.

After entering the dorsal horn of the spinal cord, the impulses are transmitted to various centers of the brain by different routes (Dolphin, 1983; Melzack & Casey, 1968).

The perception of pain is thought to involve sensory, motivational, and cognitive factors. The information ascending through the neospinothalamic tract provides the basis for the sensory discriminative dimension of pain and allows localization of the noxious stimuli. Impulses following the "paramedial ascending system" (the spinoreticular, spinomesencephalic, and paleospinothalamic components of the anterolateral somatosensory pathway) to the brain stem reticular formation and the limbic system activate the motivational affective system and trigger the individual to take action. Finally, memories of past experience along with other information are used by the cognitive evaluative processes to influence how the stimulus is perceived and to exert control over both the sensory discriminative and motivational systems (Melzack & Casey, 1968).

All three factors are seen as interacting to produce the response that is measured by the pain researcher. The pain response or pain perception of an individual is most often measured by using the parameters of threshold and tolerance. Pain threshold is the point at which a measured stimulus is first perceived as painful. Pain tolerance is the point at which an individual will withdraw or try to terminate a nociceptive stimulus. Studies discussed by Liebeskind and Paul (1977) in a review of the pain literature suggest that differences in these pain response parameters are influenced by several variables, including those of age, gender, and culture.

Pain Perception and Age

In a study of 258 university students 18 to 28 years of age and 267 residents of a retirement center who ranged from 50 to 90 years of age, investigators in Florence, Italy, measured the cutaneous pricking pain threshold (Procacci, Bozza, Buzzelli, & Della Corte, 1975). The device used to produce a painful stimulus focused radiant energy on ink blackened skin of the volar surface of each forearm of the subjects. They found that the amount of energy needed to produce a painful sensation in a subject progressively increased with advancing age. Statistical significance of the data is not provided, nor is any mention made of how the subjects were selected or of other variables (e.g., illness, mental status) that may have affected the results of the study.

A radiant heat device (developed by Hardy, Wolff, and Goodell) was also used in an earlier study of cutaneous pain sensitivity by Chapman and Jones (1944). Their results led them to conclude that age and race were the only two factors of those under study (i.e., age, gender, race, physical fatigue, mental fatigue, nervous tension, 48-hour fasting, induced acidosis, and alkalosis) to have a marked influence on individual pain perception. Their findings seem to agree with those of Procacci and his colleagues in that pain perception decreased with age (pain sensitivity or perception of a stimulus as painful is said to decrease as the measured pain threshold increases). The 200 subjects involved in the study by Chapman and Jones were found to have a mean cutaneous pain threshold of 0.305 gm cal/sec/cm^2. In order to determine if subjects differed by age, they were grouped into

sex and race matched age ranges of 10 to 22, 23 to 44, and 45 to 85 years. Twenty subjects were in each of the age ranges. The mean pain thresholds for these groups were 0.289, 0.324, and 0.347 gm cal/sec/cm^2, respectively. Information was not provided as to whether the investigators found the differences to be statistically significant.

The use of a radiant heat device as a nociceptive stimulus would present some obstacles for the pain researcher intending to conduct research and utilize findings in a clinical setting. Cost of the device and transporting or handling the device could conceivably hinder its use in a clinical setting. Accurate use of the technique requires very careful laboratory procedures and control of skin temperatures at the stimulus site. The radiant heat device has also been criticized in the literature. Notermans (1966) is uncertain of the validity of assuming a linear relationship between the actual amount of heat and intensity of the stimulus applied--an assumption implied by researchers who used a radiant heat device. The findings of Procacci and his colleagues (1975) and Chapman and Jones (1944) are also somewhat puzzling in light of the report by Liebeskind and Paul (1977) that nociceptors responsive to heat can become sensitized after repeated or prolonged noxious stimulation, thus diminishing the threshold for their activation to levels of intensity that ordinarily would be considered innocuous.

Another method for producing experimental pain has been the use of constant electrical current. Notermans (1966) used a

Tektronix oscilloscope and a multivibrator stimulator to investigate cutaneous pain threshold in subjects ranging from 10 to 65 years of age. In a control series of 64 subjects, the stimulus was applied and measured at 3 different places on every dermatome of the subject's body. Mean values were then calculated. Notermans concluded that individual pain threshold values are fairly uniform over the entire body surface, and that age exerts no distinct influence on those values. Notermans does not provide the data that led him to the latter conclusion, and the only values given are those of 10 subjects ranging from 20 to 37 years of age. Anyone wishing to replicate this study would be confronted with the problems of cost (several hundreds of dollars) and size of the equipment used.

The three studies just mentioned have focused only on the pain response parameter of threshold. In order to study the parameter of pain tolerance, Woodrow et al. (1972) measured the pain tolerance of 41,119 persons participating in a routine screening health examination. Pressure was applied to the Achilles tendon by two motor-driven rods, one on either side of the tendon. The investigators found pain tolerance to decrease with advancing age. This was true for both sexes and all the races studied (Caucasian, Black, Oriental). The most marked decrease in pain tolerance was seen in the white male subjects. Age groups for the 14,606 Caucasian subjects were: less than 20, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, and 70+. The mean pain tolerance values of white male subjects in those age ranges were 36.29, 33.77, 32.14,

30.03, 27.26, 24.58, and 22.33 pounds/square inch respectively, while the female subjects showed less variance (mean values varied from 18.42 down to 13.93). The differences found in pain tolerance by age were stated to be statistically significant, but the exact probability of results occurring by chance was not given and the statistical tests used were not reported. An additional variable studied, years of education, was not found to influence pain tolerance.

Although numerous authors have addressed the problem of pain, few have specifically researched the variation of pain perception with age. When attention is directed at the variable of age, there seems to be a discrepancy in results, depending on what parameter is measured, the technique used, and the source of the noxious stimulus used for the study. There clearly is a need for further study in this area. Careful attention to definition of the parameters measured and standardization of the nociceptive device used would aid in future comparison of studies and application of results.

Pain Perception and Gender

Woodrow and his colleagues (1972) also found a statistically significant difference in the amount of pressure pain tolerated by men from that tolerated by women ($p < .001$). While men (all ages and races included) showed a mean pain tolerance of 28.7 pounds/square inch, the mean for all women was 15.9. In other research using a mechanical pressure device as the nociceptive stimulus, medical students were the subjects in a pain response study conducted by

Merskey and Spear in 1964. The pressure algometer, a device consisting of a plunger with a 0.5 cm flat end mounted on a calibrated spring, was placed against a subject's forehead and pressure was then exerted. The parameters measured were Verbal Report of Pain (VRP--when pain began; pain threshold) and Pain Reaction Point (PRP--when it "hurt a lot"; pain tolerance). Ten white female students had a group pain threshold average of 2.74 while 28 male subjects averaged 3.75 Kg/0.1963 cm^2, statistically significant at $p < .01$. The pain tolerance differences between the two groups were in the same direction (higher in males than females) and also significant ($p < .001$). The disparity in group sizes may have increased the difference found in pain response between male and female subjects.

The data used by Merskey and Spear and Woodrow and colleagues to conclude that women have lower pain thresholds and/or pain tolerance levels than men disagree with findings by Notermans and Tophoff (1967). In a study of 50 psychiatric and 47 normal subjects, Notermans and Tophoff found no significant correlation between pain threshold values and gender when an electrical stimulus was used. When pain tolerance was the parameter measured, men did tend to tolerate more experimental pain than women. However, the trend was not statistically significant.

Disagreement exists in the literature as to whether men and women respond differently to pain. Variation in the relationship of pain response to a subject's gender (as with other variables studied)

often appears to be related to pain stimulus used and parameter measured.

Pain Perception and Culture.

Culture is frequently acknowledged as a major influence on how a person responds to pain, but there are relatively few studies that show a significant correlation. Wolff and Langley (1968) consider it remarkable that there should be so few controlled studies of cultural differences in pain response.

Whenever cultural differences and pain response are discussed in the literature, the classic study by Chapman and Jones (1944) is often the first study reviewed. Out of a sample of 200 normal subjects, Chapman and Jones matched 18 Southern Negroes by age and gender with 18 subjects of Northern European stock for racial comparison. Using a radiant heat device, they found a mean cutaneous pain perception threshold of 0.268 and a reaction (tolerance) threshold of 0.301 gm cal/sec/cm^2 for Negro subjects, with ranges of 0.228 to 0.325 for the former and 0.252 to 0.335 for the latter pain response parameters. Subjects of Northern European stock had a mean perception threshold value of 0.318 and a mean tolerance value of 0.384. The ranges in values were also greater among the Northern European subjects (0.264 to 0.410 and 0.280 to 0.480). Subjects from Ukranian, Jewish, and other Mediterranean races were also included in the study and were found to have pain responses similar to the Negro subjects. Data on the statistical significance of the differences were not provided; however, the investigators concluded that the Black subjects perceived

pain at a lower intensity and were able to tolerate less pain than subjects with a Northern European cultural background.

Woodrow et al. (1972) found racial differences in their study of 41,119 subjects to be consistent in both male and female subjects, but found the differences less marked than those by age and gender. Caucasian subjects, who made up 82.9% of the sample population, showed the highest pain tolerance mean when pressure was applied to their Achilles tendons (16.1 pounds/square inch for females and 29.2 for males). Blacks, 13.1% of the subjects, were intermediate with levels of 15.2 and 26.5 for females and males. Oriental subjects, who comprised only 4% of the sample (n = 1649), had the lowest pain tolerance, with a mean for females of 14.4 and a mean for males of 24.3 pounds/square inch. The differences were found to be statistically significant ($p < .001$), although the statistical tests used were not reported.

In the study by Merskey and Spear (1964), pain was measured when pressure was applied to the subject's forehead or shin with the pressure algometer. No significant differences were found in pain response between 48 white males and 11 Afro-Asian male subjects. A similar lack of significant differences in pain response between races was found by Winsberg and Greenlick (1967). In their study White and Negro obstetrical patients were observed and asked to complete questionnaires for the purpose of determining the role of cultural factors in pain response. The pain experience of 207 white and 158 Negro obstetric patients of similar socioeconomic background was evaluated by the involved physician, nurse, aide, and patient immediately after

the termination of each normal labor and delivery. The pain experience was rated on a scale of 1 to 5--from very severe (1), through average (3), to very mild (5). In any population it is known that some people will have a bias against using the extremes of a scale, and in the data provided for this study it was shown that the hospital staff chose the middle of the scale (3) to rate the patient's pain over 75% of the time. The patients themselves were equally divided between choosing the numbers 2 and 3 to rate their pain experience. The investigators therefore concluded that there were no significant differences in pain response between Negro and White obstetrical patients.

It is difficult to compare the research findings on racial differences in pain response when studies do not use similar subjects or measurement tools or measure the same response parameters. However, with the disparity evident in the literature regarding the relationship between ethnocultural background and pain, further study in this area is warranted.

Use of Anatomical Tender and Control Points

The existence of tender points has been known for several decades and is well documented in the literature (Simons, 1976; Yunus, Masi, Calabro, Miller, & Fergenbaum, 1981). Bennett (1981) states that tender points (also sometimes known as trigger points) are areas found "over muscles and ligamentous bony insertions that are often tender but not painful in healthy persons" (p. 407). Smythe and Moldofsky (1977-78) found tender points to be firmer upon palpation

than nearby non-tender areas, and to be reproducible across ethnocultural boundaries. Melzack (1981) reports that every tender point listed in the Western medical literature has a corresponding acupuncture point.

The control points used in this study are frequently used in studies of pain tolerance (Merskey & Spear, 1964; Morgan & Horstman, 1978; Woodforde & Merskey, 1972).

Pain Perception and Fibrositis

Increasing attention from health care providers is being directed at a condition known as fibrositis, a disorder that has been described as a "major cause of pain and dysfunction in the largest organ [voluntary muscle] of the body" (Travell & Simons, 1983, p. 5). The term fibrositis was first coined by Gowers in 1904. Since that time the disorder has been frequently cited in the literature, but labeled by many usually synonymous names, such as muscular rheumatism, myalgia, myofascial pain syndrome, myofascitis, and pain enhancement syndrome (Bennett, 1981; Travell & Simons, 1983). Fibrositis is a condition which, although not life threatening, certainly produces pain that can diminish the quality of a person's life.

Fibrositis is characterized by axial pain, severe aching and stiffness, morning fatigue, multiple areas of soft-tissue tenderness, and modulation by specific factors (Campbell et al., 1983; Yunus et al., 1981). Routine lab tests performed on patients with primary fibrositis show no abnormalities. Electromyographic

studies of the muscle at rest show no diagnostic abnormality. Thermograms may or may not show increased skin temperature over active tender points in the fibrositis patient (Travell & Simon, 1983).

The etiology of fibrositis is unknown. That and the lack of quantifiable laboratory data to support a diagnosis have led many to conclude that the condition is psychogenic. That conclusion is disputed, however, in a study conducted by Clark, Campbell, Forehand, Tindall, and Bennett (1982). Clark and her colleagues administered three widely used psychological questionnaires (the Beck Depression Inventory, the Spielberger State and Trait Anxiety Inventory, and the SCL-90-R) to 22 fibrositis patients and 22 control subjects selected from a general medical outpatient population. The 2-tailed t-test was used to analyze the results, and no significant differences were found between the groups, leading the investigators to conclude that psychopathology is not the basis of fibrositis.

Although the etiology remains unknown, the presence of multiple, discrete, exquisitely tender points is one criterion that distinguishes patients diagnosed with fibrositis from other individuals. In a study of 50 patients diagnosed as having primary fibrositis matched with 50 normal volunteer controls, the presence of abnormally increased sensitivity of specific tender points was determined by palpation (Yunus et al., 1981). A tender point was included in the statistical data provided only if the patient verbally expressed pain, physically withdrew from the pressure,

showed facial expressions of pain, or recoiled from the palpation out of proportion to the amount of pressure applied. Although no objective measurement was made of the pressure applied to the various tender points, the researchers did find a significant difference in the number of characteristically tender points between the controls and the fibrositis patients ($p < .001$). The patients averaged 12 markedly tender points, while the normal controls averaged only 1.1 such areas. One limitation of the Yunus et al. study is the lack of objective measurement of the subjects' pain. The amount of pressure applied by the hands of an examiner could easily vary from patient to patient, so the amount of pressure deemed critical to produce a positive tender point may be considered subjective or arbitrary.

In another study of pain in fibrositis patients (Campbell et al., 1983), 22 fibrositis patients were matched by age, sex, and race with a control group of 22 patients having medical conditions other than fibrositis, and data were provided to demonstrate that it is possible to objectively measure areas of localized tenderness. Subjective and objective tenderness over the specified points was elicited by use of a dolorimeter (a spring loaded pressure gauge). The amount of pressure applied was given in $Kg/1.54\ cm^2$. Mean subjective tenderness (threshold) values for control points in the control group were given as 7.0 for the upper back, 7.4 for the forearm, 7.6 for the thumb, and 6.6 for the shin. Mean tolerance values for tender points in the fibrositis group ranged from 1.8 over the intertransverse ligament, to 2.6 at the elbow, 3.4 for the

paraspinous tender point, and 4.7 over the lumbar spine. The nonfibrositis patients had mean values of 5.5, 8.4, 7.7 and 6.2 for those same areas. One-tailed t-tests were used to analyze the results, and significant differences were found between the control and fibrositis groups at all tender points ($p < .001$). No statistically significant differences were found at the control points, indicating that fibrositis patients did not have a diffusely increased perception of pain.

The study by Campbell et al. drew on a population of patients with chronic medical conditions and reported pain threshold and tolerance values based on all subjects' responses. An arbitrary measure of tender point tolerance less than or equal to 4 kg of pressure to indicate fibrositis was based on past empiric experience with fibrositis patients. The question is raised as to what pain threshold and tolerance values would be in healthy subjects separated into groups by age, gender, and race. One purpose for the present study was to replicate a portion of the Campbell et al. study using normal healthy subjects.

Conceptual Framework

Pain perception is a concept that is believed to be influenced by several different factors. Although past research has produced conflicting results, age, gender, and ethnocultural background are all variables that have been implicated as being responsible for a large portion of the variation in individual response to pain. There is still speculation, controversy, and debate over the mechanism of how

pain is perceived and influenced by those variables, but the best explanation or partial explanation at this time seems to involve the gate control theory. The introduction of the gate control theory of pain in 1965 by Melzack and Casey has had the effect of a Kuhn paradigm. Research has been stimulated, vigorous debate engendered, and new methods of pain control devised as a result of the theory and its subsequent revisions (Bonica, 1979; Melzack, 1979).

The gate control theory proposes that in the spinal cord exists a system allowing for modulation of pain messages received and acted upon by an individual. Nociceptive stimuli cause impulses to be transmitted at various intensities and frequencies over large and small nerve fibers to three systems of the spinal cord: the substantia gelatinosa of the dorsal horn laminae 2 and 3, the dorsal column fibers that project toward the brain, and the transmission (T) cells of lamina 5 in the dorsal horn. The substantia gelatinosa is believed to be the area that "gates" the amount of information projected to the brain by the T cells. Stimulation of large rapidly conducting nerve fibers can close the gate, while stimulation of small nerve fibers in which conduction is slower will open the gate--once a critical level is reached--and facilitate T-cell activity (Melzack, 1979; Melzack & Casey, 1968).

The position of gate control theorists is that the brain monitors T cell output over a period of time, and triggering of the action system--"those neural areas responsible for the complex, sequential patterns of behavior and experience characteristic of pain" (Melzack & Casey, 1968, p. 426)--is dependent upon the combined

activity of the T-cells of the dorsal horn and the interaction of the central control determinants of pain. Of these determinants, Melzack and Casey believe the sensory discriminative system provides for spatio-temporal analysis of pain; the motivational affective system interprets the pain impulse as unpleasant and provides the tendency toward escape or attack; and the cognitive evaluative system utilizes past experience, the probability of outcome of different preset response strategies, and other information to influence or control the other two systems. Logically, it would seem that any influence on an individual's pain perception by his or her age, gender, or cultural background would be exerted through the cognitive evaluative system.

Assumptions

The assumptions included in the present study are:

1. Pain sensation and affective reactions can be directly communicated by a subject to an investigator.

2. An individual's pain perception can be assessed by using a measured nociceptive stimulus to determine pain threshold and pain tolerance levels.

3. Individuals with low pain threshold and tolerance levels perceive a stressor as more painful than those individuals with high pain threshold and tolerance levels.

Hypothesis

The specific hypotheses tested were:

1. Older adults have higher pain threshold but lower pain tolerance levels than younger adults.

2. Adult females have lower pain threshold and tolerance levels than adult males.

3. Caucasian adults have higher pain threshold and tolerance levels than adults of other ethnocultural backgrounds.

Operational Definitions

Terms used and operationally defined for the present study were:

1. Pain threshold--the point (in Kg of pressure applied with a dolorimeter) at which a stimulus is first perceived as painful and the subject responds with "now."

2. Pain tolerance--the point (recorded in Kg of pressure) at which maximal pain is elicited and a subject requests cessation (says "stop") or moves away from the stimulus.

Implications

Several implications for clinicians are offered by this study. Without data on the pain threshold and tolerance ranges produced by pressure over specified tender points in a normal population, designation of any particular amount of pressure application as a "cutoff" point to aid in the diagnosis of fibrositis or other disorders is arbitrary at best. With normative data, clinicians would be enabled to assess individual pain responses and determine whether the values obtained fell within or outside those ranges found in normal healthy individuals. Knowledge of normal pain responses and their relationship to the variables of age, gender, and cultural background could be used in any setting where nurses must assess individual pain perception and tolerance, and must use that assessment to decide what strategy to use to relieve pain.

CHAPTER II

METHODS

The present work was a descriptive, ex post facto study with no manipulation of the variables, and was designed to develop norms and determine relationships among the variables.

Setting

The setting for obtaining the sample and collecting the data included five sites in a metropolitan area: (a) a university campus; (b) two hospitals; (c) an army reserve training center; and (d) a community senior citizen center. An exam room or office was used at each site to provide the subjects with privacy and a comfortable environment during data collection. The sites were selected because of the availability of a population of healthy individuals and to increase diversity of the sample.

Subjects

The subjects for this study comprised a sample of convenience and were self-selected from an accessible population of university students, army reservists, hospital employees, and senior citizens. Criteria for inclusion were: (a) an ability to read and understand the English language; (b) an absence of routine ingestion of medications such as analgesics, tranquilizers, or muscle relaxants

which might affect the pain response; and (c) an absence of specific medical conditions (i.e., rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythematosus, mixed connective tissue disease, polymyalgia rheumatica, polymyositis, polyarthritis nodosa, untreated hypothyroidism). The specific conditions that would necessitate exclusion from this study have been known to mimic fibrositis in increasing the painfulness of the known tender points (Yunus et al., 1981).

Sixty-eight individuals agreed to participate in the study. Only one volunteer was not Caucasian, and since the literature suggests a relationship between ethnicity and variation in pain perception, the data from the non-Caucasian subject were eliminated from the study. One volunteer listed a tranquilizer as routinely ingested medication, and his data were also eliminated. The data of 66 subjects were analyzed and compared.

Data Producing Instruments

Data producing instruments used in this study were a questionnaire and the dolorimeter.

The questionnaire provided demographic data regarding age, gender, ethnic background, and any diagnosed medical condition. It also contained items used to define possible fibrositis. The item responses required for a diagnosis of possible fibrositis are given in Appendix A. The specified responses would have resulted in exclusion of the subject from the study and referral to his/her primary physician for further evaluation of possible fibrositis. The

questionnaire was developed and used in a recent study of pain perception in fibrositis patients (Campbell et al., 1983).

The dolorimeter (pressure algometer, Chatillon, New York, New York) is a spring loaded gauge with a range of 0-18 kg, and has a protective rubber stopper (1.54 cm^2) attached to the plunger (Appendix B). The dolorimeter is approximately 19 inches long, lightweight, and has a maximum reading pointer to allow for greater accuracy. It has been used to estimate rheumatoid activity, to evaluate the effectiveness of anti-inflammatory therapy in rheumatoid patients, and as the measured pain stimulus in previous studies of pain threshold and tolerance in fibrositis and nonfibrositis patients (Campbell et al., 1983; McCarty, Gatter, & Phelps, 1965). In 48 trials with 4 observers using a dolorimeter to make duplicate determinations, McCarty et al. (1965) found the estimated standard error to be 5.58 points out of a possible 300 points, and the mean intraobserver error to be 0.7 points.

The dolorimeter is similar to the pressure algometer described frequently in pain research literature (Keele, 1954; Merskey, Gillis, & Marszalek, 1962; Woodforde & Merskey, 1972). It should not, however, be confused with the dolorimeter designed by Hardy, Wolff, and Goodell, which is a radiant heat device. The dolorimeter used in the present study meets the criteria described by Keele (1954) for an adequate stimulus used to measure pain threshold and tolerance. Keele's criteria require that the stimulus be measurable, reproducible, controllable, convenient, simple, have an adequate range

to allow tolerance measurement, produce no or at least minimal tissue damage, and produce a clear cut perception of pain by the subject.

Procedure

The meeting between potential subjects and the investigator began with an explanation of the nature of the study and obtaining a signed consent (Appendix C). The subject then completed the questionnaire. No subjects responded to the questionnaire items in a way that would indicate possible fibrositis.

A physical examination was then performed using the dolorimeter to measure pain threshold and tolerance at 15 tender points and 8 control points (Appendix D). Subjects were instructed to say "now" when they first felt a painful sensation, that pressure would continue to be exerted, and they should say "stop" when they found the pressure exerted by the dolorimeter too uncomfortable to continue. Any questions asked by subjects as to what constitutes pain were answered in a way to make it clear the subjects had to define pain for themselves. The control and tender points were then palpated to find the correct area, and pressure over that area was gradually applied with the dolorimeter placed perpendicular to the skin surface (0-18 kg in 5-7 seconds). The amount of pressure in kg applied when the subject said "now" was recorded as the pain threshold for that point. The dolorimeter reading obtained when the subject said "stop" or withdrew from the stimulus was recorded as the pain tolerance level for that point.

Constancy of conditions was maintained by giving the same instructions to all subjects and by using the same dolorimeter, similar examination settings, and the same tender and control points for assessing each subject's pain perception. One investigator collected the data.

Protection of Human Subjects

Informed consent was obtained from every subject who volunteered to participate in the study. Participants were free to withdraw from the study at any point. Confidentiality was maintained through the use of identification numbers. Only the investigator had access to the raw data. There was a risk of some discomfort when the dolorimeter was used, but subjects always controlled the termination of the stimulus.

Analysis of Data

Data preparation and analyses were done using the Statistical Package for the Social Sciences (SPSS) version 9.1 (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975) on a Harris 300 in the biostatistics laboratory of Oregon Health Sciences University. Data from the 66 subjects of this study were analyzed using two-way analysis of variance (2 X 2 ANOVA). The choice of a 2 X 2 ANOVA was made because both independent variables (age and gender) had two levels (younger and older, male and female), and an interaction was expected between age and gender. Statistical significance was defined as $\underline{p} < .05$.

CHAPTER III

RESULTS

Sixty-eight people volunteered to participate in the present study, and 67 subjects met the criteria for inclusion. Only one non-Caucasian participated in the study. Since comparisons on the basis of ethnocultural background would not be possible, and ethnicity has been shown to influence responses to pain, the non-Caucasian subject's data were eliminated. The data from 66 subjects, obtained by use of a questionnaire and physical examination, were analyzed using two-way analysis of variance. The level of significance was set at $p < .05$.

Subjects

The subjects for this study were normal individuals without musculoskeletal or other fibrositis mimicking disorders. The age range of the total sample was 18-69 years, with a mean age of 41 and a median age of 38.5 years. There were 34 females and 32 males in the study. While no subjects with active musculoskeletal disorders were included, 8 subjects did state they had a diagnosed medical condition such as asthma, treated hypothyroidism, or hypertension. Medications ingested the day of their participation in the study included vitamins, hormones, decongestants, and antibiotics.

For the purposes of the study, the subjects were divided into 4 groups for analysis of data. Group 1 was labeled younger females and consisted of 17 females less than or equal to 38 years of age. Group 2 was labeled older females and was made up of 17 females older than 39 years of age. Group 3 was designated younger males and included 16 male subjects less than or equal to 38 years of age. Group 4 was labeled older males and contained 16 males older than 39.

Pain Perception and Age

Hypothesis 1 stated that older adults will have higher pain thresholds but lower pain tolerance levels than younger adults. Pain perception was measured by applying pressure with a dolorimeter at each of 8 control points and 15 tender points (Appendix D) to ascertain each subject's pain threshold and tolerance levels. The means, standard deviations, and ranges for the values of all points are presented in Appendices E-L. The subjects were grouped by age and the mean threshold and tolerance values were analyzed using a 2 X 2 ANOVA (Tables 1-8). Only 4 control points and 2 tender points (thumbs, shin, trapezius) demonstrated age as having a statistically significant ($p < .05$) influence on pain threshold and tolerance. At the right and left thumbs, both pain threshold and tolerance levels were higher in older subjects than in younger subjects. This is contradictory to the expectation predicted from the literature, in which lower tolerance levels were predicted for older subjects. For the right and left trapezius tender points, pain threshold levels were also higher in older than younger subjects. The right and left shin

TABLE 1

PAIN THRESHOLD

CONTROL POINTS, RIGHT SIDE

POINT	SS	df	F
Thumb			
Age	33.76	1	4.06*
Gender	114.55	1	13.76***
Age by Gender	1.69	1	0.20
Error	515.97	62	
Forearm			
Age	8.58	1	0.86
Gender	172.94	1	17.28***
Age by Gender	1.21	1	0.12
Error	620.49	62	
Shin			
Age	11.54	1	0.10
Gender	66.84	1	5.77*
Age by Gender	3.49	1	0.30
Error	718.37	62	
Upper Back			
Age	8.66	1	0.60
Gender	27.94	1	1.94
Age by Gender	14.41	1	1.00
Error	890.36	62	

* $p < .05$
*** $p < .001$

TABLE 2

PAIN THRESHOLD

CONTROL POINTS, LEFT SIDE

POINT	SS	df	F
Thumb			
Age	55.28	1	7.59**
Gender	100.08	1	13.74***
Age by Gender	0.45	1	0.06
Error	451.61	62	
Forearm			
Age	24.36	1	2.79
Gender	86.04	1	9.84**
Age by Gender	13.57	1	1.55
Error	542.27	62	
Shin			
Age	7.47	1	0.69
Gender	155.72	1	14.40***
Age by Gender	0.01	1	0.001
Error	670.61	62	
Upper Back			
Age	2.56	1	0.19
Gender	103.18	1	7.60**
Age by Gender	6.43	1	0.47
Error	842.29	62	

** $p < .01$
*** $p < .001$

TABLE 3
PAIN THRESHOLD
TENDER POINTS, RIGHT SIDE

POINT	SS	df	F
Elbow			
Age	20.74	1	2.37
Gender	42.94	1	4.90*
Age by Gender	32.82	1	3.75
Error	543.19	62	
Costochondral			
Age	4.48	1	0.38
Gender	95.56	1	8.13**
Age by Gender	20.23	1	1.72
Error	728.46	62	
Medial Knee			
Age	0.75	1	0.09
Gender	173.20	1	20.28***
Age by Gender	1.39	1	0.16
Error	520.86	61	
Occipital			
Age	0.10	1	0.01
Gender	104.16	1	13.04***
Age by Gender	4.85	1	0.61
Error	495.31	62	
Trapezius			
Age	76.81	1	7.92**
Gender	44.90	1	4.63*
Age by Gender	13.43	1	1.38
Error	601.50	62	
Paraspinous			
Age	2.56	1	0.18
Gender	134.49	1	9.35**
Age by Gender	0.22	1	0.02
Error	891.64	62	
Gluteal			
Age	34.79	1	2.59
Gender	226.08	1	16.81***
Age by Gender	7.58	1	0.56
Error	820.39	61	

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 4
PAIN THRESHOLD
TENDER POINTS, LEFT SIDE

POINT	SS	df	F
Elbow			
Age	5.70	1	0.68
Gender	28.52	1	3.90
Age by Gender	32.07	1	3.82
Error	520.28	62	
Costochondral			
Age	1.04	1	0.12
Gender	107.97	1	12.81***
Age by Gender	12.19	1	1.45
Error	522.48	62	
Medial Knee			
Age	0.45	1	0.05
Gender	142.89	1	15.15***
Age by Gender	1.76	1	0.19
Error	575.39	61	
Occipital			
Age	7.07	1	0.91
Gender	93.10	1	11.94***
Age by Gender	3.44	1	0.44
Error	483.40	62	
Trapezius			
Age	56.75	1	4.18*
Gender	61.02	1	4.49*
Age by Gender	7.24	1	0.53
Error	842.36	62	
Paraspinous			
Age	1.83	1	0.14
Gender	139.66	1	10.62**
Age by Gender	1.36	1	0.10
Error	815.59	62	
Lumbosacral			
Age	1.58	1	0.14
Gender	194.29	1	16.77***
Age by Gender	9.71	1	0.84
Error	718.20	62	
Gluteal			
Age	1.26	1	0.10
Gender	298.69	1	23.88***
Age by Gender	3.13	1	0.25
Error	775.51	62	

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 5

PAIN TOLERANCE

CONTROL POINTS, RIGHT SIDE

POINT	SS	df	F
Thumb			
Age	41.28	1	4.75*
Gender	222.64	1	25.60***
Age by Gender	0.44	1	0.05
Error	539.16	62	
Forearm			
Age	11.54	1	1.60
Gender	231.86	1	32.14***
Age by Gender	1.63	1	0.23
Error	447.33	62	
Shin			
Age	44.51	1	4.87*
Gender	134.83	1	14.75***
Age by Gender	0.50	1	0.06
Error	566.70	62	
Upper Back			
Age	0.58	1	0.05
Gender	140.12	1	11.63***
Age by Gender	0.54	1	0.04
Error	747.17	62	

* $p < .05$
*** $p < .001$

TABLE 6

PAIN THRESHOLD

CONTROL POINTS, LEFT SIDE

POINT	SS	df	F
Thumb			
Age	37.88	1	4.29*
Gender	239.29	1	27.10***
Age by Gender	0.25	1	0.03
Error	547.54	62	
Forearm			
Age	1.90	1	0.22
Gender	171.10	1	20.19***
Age by Gender	0.00	1	0.00
Error	525.45	62	
Shin			
Age	47.86	1	5.50*
Gender	254.44	1	29.22***
Age by Gender	0.03	1	0.00
Error	539.85	62	
Upper Back			
Age	0.06	1	0.00
Gender	230.28	1	18.94***
Age by Gender	3.66	1	0.30
Error	753.75	62	

* $p < .05$
*** $p < .001$

TABLE 7
PAIN TOLERANCE
TENDER POINTS, RIGHT SIDE

POINT	SS	df	F
Elbow			
Age	2.52	1	0.19
Gender	276.91	1	21.23***
Age by Gender	23.65	1	1.81
Error	808.75	62	
Costochondral			
Age	0.00	1	0.00
Gender	441.91	1	31.13***
Age by Gender	2.01	1	0.14
Error	880.05	62	
Medial Knee			
Age	1.07	1	0.09
Gender	354.08	1	31.28***
Age by Gender	7.31	1	0.65
Error	690.39	61	
Occipital			
Age	6.81	1	0.56
Gender	318.24	1	26.38***
Age by Gender	2.42	1	0.20
Error	748.06	62	
Trapezius			
Age	3.19	1	0.20
Gender	189.04	1	12.04***
Age by Gender	1.66	1	0.11
Error	973.28	62	
Paraspinous			
Age	0.53	1	0.04
Gender	312.04	1	26.14***
Age by Gender	0.01	1	0.01
Error	740.10	62	
Gluteal			
Age	1.48	1	0.14
Gender	420.71	1	40.45***
Age by Gender	1.91	1	0.19
Error	626.72	61	

*** $p < .001$

TABLE 8
PAIN TOLERANCE
TENDER POINTS, LEFT SIDE

POINT	SS	df	F
Elbow			
Age	0.00	1	0.00
Gender	263.22	1	21.66***
Age by Gender	41.80	1	3.44
Error	753.36	62	
Costochondral			
Age	1.04	1	0.09
Gender	388.18	1	34.55***
Age by Gender	8.48	1	0.76
Error	696.50	62	
Medial Knee			
Age	2.60	1	0.24
Gender	366.50	1	24.11***
Age by Gender	1.30	1	0.12
Error	655.43	61	
Occipital			
Age	19.96	1	1.67
Gender	311.09	1	25.97***
Age by Gender	3.14	1	0.26
Error	742.67	62	
Trapezius			
Age	25.35	1	1.61
Gender	198.81	1	12.61***
Age by Gender	6.77	1	0.43
Error	977.56	62	
Paraspinous			
Age	0.46	1	0.04
Gender	325.79	1	25.46***
Age by Gender	0.39	1	0.03
Error	793.37	62	
Lumbosacral			
Age	3.88	1	0.61
Gender	254.91	1	40.11***
Age by Gender	0.72	1	0.11
Error	394.05	62	
Gluteal			
Age	2.29	1	0.24
Gender	347.20	1	36.39***
Age by Gender	7.39	1	0.77
Error	591.60	62	

*** $p < .001$

control points produced tolerance levels that were higher in younger subjects. No other control or tender points showed a significant difference between older and younger subjects. Therefore, the hypothesis that older adults have higher pain threshold but lower pain tolerance levels than younger adults is rejected.

Pain Perception and Gender

Hypothesis 2 stated that adult females will have lower pain threshold and tolerance levels than adult males. The data presented in Tables 1-8 show that a significant interaction ($p < .05$) occurred between a subject's gender and his/her pain threshold levels at 7 control and 14 tender points. As shown in Appendix H, women had higher threshold levels than men at only 1 point (left elbow). Differences in the pain tolerance levels between male and female subjects were significant, with males having higher tolerance values than females, at all control and tender points ($p < .001$). Therefore, the hypothesis that females have lower pain threshold and tolerance levels than males is accepted.

Pain Perception and Culture

Hypothesis 3 states that Caucasian adults will have higher pain threshold and tolerance levels than adults of other ethnocultural backgrounds. Only one non-Caucasian subject volunteered to participate in the present study, making comparisons between differences in mean threshold and tolerance levels on the basis of ethnicity impossible. Therefore, the hypothesis that Caucasians have

higher pain threshold and tolerance levels than non-Caucasians was not tested.

Threshold and Tolerance

Additional analyses of the data were conducted to answer questions raised by the study. Previous studies using the same control and tender points have reported the mean values for threshold and/or tolerance as the average of the matching right and left points for all subjects in a group (Campbell et al., 1983). While averaging the mean values of right and left points would simplify reporting and analyzing of data in the present and future studies, no data to indicate the similarity or difference between the two mean values has been reported in past studies. The 2-tailed *t*-test was used to compare the right with the left control and tender points. It was determined that a $p > .30$ would be required to report and use the average of a point. The thumb control point and paraspinous tender point were the only two points that were consistently close enough to capture a $p > .30$ across all 4 groups of subjects for both threshold and tolerance levels. The elbow tolerance values, medial knee, and trapezius threshold values also reached $p > .30$ across all 4 groups (Table 9). Because of the dissimilar values of the right and left points, the means of all right and all left points are reported for the present study.

The question was also raised as to whether or not a subject's threshold values for a control or tender point would predict the tolerance values for that point. If it could be shown that a high

TABLE 9

SIMILARITY OF RIGHT AND LEFT POINTS

POINT	T-VALUE, PROBABILITY*			
	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Thumb Threshold	0.31, 0.76	0.02, 0.98	0.90, 0.38	0.55, 0.59
Thumb Tolerance	0.92, 0.37	1.07, 0.30	0.04, 0.96	0.86, 0.48
Elbow Tolerance	0.29, 0.77	1.07, 0.30	0.29, 0.77	0.46, 0.65
Medial Knee Threshold	0.21, 0.84	0.09, 0.93	0.27, 0.79	0.33, 0.74
Trapezius Threshold	0.44, 0.67	0.83, 0.42	0.64, 0.53	0.39, 0.70
Paraspinous Threshold	0.64, 0.53	0.29, 0.78	0.43, 0.68	0.48, 0.64
Paraspinous Tolerance	0.24, 0.81	0.72, 0.48	0.14, 0.89	1.01, 0.33

* T values are presented first, probabilities are presented second.

threshold value consistently predicted a high tolerance value, or a low threshold predicted a low tolerance value, it could indicate that an investigator or a clinician would need only to test the subject to pain threshold on any point. A Pearson Correlation was used to compare tolerance with threshold values. It was determined that a value of the Pearson $\underline{r}$ when squared (r^2) would have to be at least .81 to provide confidence in the threshold values alone. No control or tender points produced an r^2 above .72, with the majority of points having an $r^2 < .60$. Therefore, a subject's tolerance level should be tested as well as his/her threshold level.

CHAPTER IV

DISCUSSION

While the perception of pain is unique to every person, pain itself is a universal experience that presents the most compelling reason for individuals to seek out health care providers (Zborowski, 1969). Past studies have suggested that pain perception is significantly influenced by an individual's age and gender (Liebeskind & Paul, 1977). The influence exerted by the variables of age and/or gender may occur through the central control of the cognitive evaluative system (Melzack & Casey, 1968). One study has shown that it is possible to quantify pain perception by establishing mean values of the pressure needed to produce subjective and objective tenderness (pain threshold and tolerance levels) over specific points in patients with diffuse musculoskeletal aches and pains due to a condition known as fibrositis as well as in patients with other medical disorders (Campbell et al., 1983).

The present study was conducted to determine if, in a normal healthy population, age and gender would explain a significant portion of the variability in pain threshold and tolerance levels of individuals as tested at specific control and tender points. Subjects were divided into four groups, which consisted of women less than or equal to 38 years of age (Group 1), women over 39 (Group 2), men less than or equal to 38 years of age (Group 3), and men over 39 (Group 4).

The data from the study showed no significant interaction between age and pain perception variability, but did show a consistently significant interaction between a subject's gender and his/her pain response. These results lend support to the studies which report variability in pain threshold and tolerance with gender, but do not validate those which report significant variability in pain perception with age.

The existing literature presents contradictory findings with regard to the interaction between pain perception and age. The findings of the present study agreed with the conclusion by Notermans (1966) that age exerts no distinct influence on pain threshold values. The present study's finding that no significant relationship exists between a healthy person's age and his/her pain perception may be reflective of the small sample size and the separation of subjects into only two age categories (those less than or equal to 38 and those over 39). Caution must be used, however, when comparing this study with that of Notermans, or those of Chapman and Jones (1944) and Woodrow et al. (1972) who found increasing pain threshold and decreasing tolerance with advancing age. The present study used a different nociceptive stimulus and tested different sites from any of the three studies just mentioned.

As was hypothesized, female subjects in the present study had lower pain tolerance values than male subjects. Pain tolerance is considered by some to be a learned component of pain perception, however, suggesting that men may be taught by family and gender groups the particular behavior pattern of tolerating more pain (Liebeskind &

Paul, 1977). Although the findings of this study do support the conclusions of Woodrow et al. (1972) and Merskey and Spear (1964), in that pain threshold and tolerance levels were found to be higher in males than in females, caution must be applied to comparisons of results. Mechanical pressure devices were used to induce experimental pain in the above studies as well as in the present study, but there were differences between devices used and sites tested. Operational definitions of pain and instructions to subjects also varied between the above two studies. While subjects in the study by Merskey and Spear (1964) were told it was not a test of endurance, and tolerance was labeled as the first sign of withdrawal from the stimulus, subjects in the Woodrow et al. study (1972) were told to try to stand the pressure as long as they could.

Caution must also be used when comparing data from the present study with those from the Campbell et al. (1983) study. Values for control and tender point tolerances in the present study (Appendices I, J, K, L) were higher than those reported by Campbell. There was a restriction of tolerance value ranges in the Campbell study due to a maximum dolorimeter reading of 10 kg, versus a maximum dolorimeter reading of 18 kg in the present study. Additionally, subjects in the Campbell study were matched but not grouped by gender and age and were predominantly female (16:6/group).

CHAPTER V

SUMMARY

Pain is a complex experience common to man, and it has long been suggested that several factors may modify the perception of pain. The purpose of the present study was to examine the interactions between age, gender, ethnicity, and pain threshold and tolerance in a normal population; and to use the data obtained by testing at specific control and tender points to establish normative values for those points.

It has been shown to be possible to objectively measure mean pain threshold and tolerance values over specific points in fibrositis patients and in those with other medical disorders. Conflicting results regarding factors which modify pain perception or expression have been reported by in the literature. It has been reported that pain threshold increases and tolerance decreases with advancing age. It has also been documented that the age of an individual has no significant influence on pain perception. Some studies have shown men to have higher pain thresholds and tolerance levels than women, while others show no difference in the pain response of male and female subjects. It was the goal of this study to partially replicate previous studies in an effort to increase the standardization of use of a specific nociceptive device, to obtain more objective values for "normal" tenderness at specific anatomic sites--normative data that

may be used by future clinicians, and to gather information that would further the understanding of the influence of age, gender, and ethnocultural background on pain perception.

The study used a non-experimental, descriptive design to test and compare the data of 66 subjects. Data from a demographic information sheet and questionnaire were used to eliminate any subjects with possible fibrositis or fibrositis mimicking disorders and to produce 4 subgroups based on age and gender. Pain perception was measured by subjects' pain threshold and tolerance responses when pressure was applied with a dolorimeter to specific non-tender (control) and tender points.

The results of the study showed only 6 out of 23 control and tender points to have any significant interaction between age and pain perception. There were, however, significant differences related to gender between the mean pain thresholds at all but 2 of the control points. Significant differences related to gender were found between pain tolerance levels at all non-tender and tender points.

Limitations of the Study

The non-experimental design and small sample size of this study limits the generalization of the results. The study subjects comprised a small convenience sample, with 16 males in each of 2 groups and 17 females in each of 2 groups. Since the subjects were self-selected, it is possible that individuals with lower pain threshold and tolerance values than those studied chose not to volunteer.

Although control and tender points on the right side did not consistently have higher or lower values than those on the left side, examining all points in the same order for every subject may have resulted in a bias exerted by the order of events. Another area of possible bias may have occurred due to the investigator's gender. It is possible that differences between male and female threshold and tolerance values were influenced by the presence of a female investigator. Pain is a complex phenomenon, and the data obtained may be confounded by factors not measured in the present study (e.g., normal variations in biorhythms, hormonal influences, seasonal changes, etc.).

Implications for Nursing

Nurses frequently are required to assess individuals' responses to pain, and may be the health care providers most likely to have long term contact with patients who must deal with pain. Understanding the relationship of various factors to pain perception, having tools to provide objective information on that perception, and having normative data for comparison can assist the clinician when performing an assessment and when teaching clients about their pain condition and/or methods of ameliorating the pain.

Nurses often must decide the strength of an analgesic to give to a patient in pain. If familiar with the dolorimeter, the nurse could choose to use it to obtain more objective information in addition to the subjective statement of pain. The dolorimeter could be useful in assessing how much pain relief a patient expects or desires. Both

nurse and patient could benefit from a preoperative assessment of pain threshold and tolerance to help plan for postoperative pain management. In addition to planned pharmacological pain relief measures, a patient could be taught certain cognitive mechanisms to diminish pain perception (e.g., distraction, guided imagery, etc.) and by using the dolorimeter while the patient practices a specific technique, the nurse could demonstrate to the patient the effectiveness of the technique.

Further evaluation of patients by comparison to normative data could also provide the nurse with valuable information. Measuring which patients are hyposensitive to pain and which are hypersensitive can assist the nurse in deciding when further immediate investigation is required if a patient complains of pain, and when investigation is not urgent (i.e., a hyposensitive patient who complains of fairly severe pain may have a serious problem, while a patient who is hypersensitive to pain may not require immediate attention).

In addition to understanding differences in pain perception, which occur even in healthy individuals, recognition of the existence and location of specific tender points found in fibrositis or other painful myofascial conditions could be very important to both client and nurse. Tender points which produce persistent severe pain due to an unrecognized cause can be very threatening. Campbell et al. (1983) estimated that 5% of patients seen in one university hospital outpatient clinic had undiagnosed fibrositis. Individuals exhibiting symptoms of undiagnosed fibrositis may be concerned that they have a very serious illness or degenerative disease, yet because diagnostic procedures for musculoskeletal problems are limited, they may have been

labeled malingerers or told the cause of their condition was psychological. Careful assessment by the nurse who listens to the patient and doesn't disregard what the patient is saying about the pain may help to prevent a misdiagnosis, prevent delay of treatment, and reduce the suffering of the patient.

Suggestions for further investigations developed from the results of the present study are:

1. Replication of the study using a larger population, with the inclusion of non-Caucasian subjects for the purposes of determining interactions between ethnicity and pain perception.

2. Replication of the study using a male investigator or assistant to collect the data.

3. Randomization of the order of examination of control and tender points to control for possible bias in future studies using these anatomical points for testing threshold and tolerance.

4. Replication of the study, using subjects as their own controls, to test the ability to obtain reproducible results.

5. Replication of the study using both healthy volunteers and fibrositis patients as their own controls to determine if atmospheric pressure changes result in variation in pain threshold and/or tolerance.

6. Replication of the study using repeated measures to determine if diurnal variations occur in pain perception.

7. Replication of the study, using female subjects, to examine the effect of hormonal variations throughout the menstrual cycle on pain perception.

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APPENDIX A

ITEMS ON THE QUESTIONNAIRE USED TO DEFINE POSSIBLE FIBROSITIS

1. Exercise makes me feel better.
2. I sleep well at night.
3. I feel well rested when I get up in the morning.
4. I wake up frequently at night.
5. I tire easily.
6. I am too tired during the day to do what I want to do.
7. I have pain in my neck and shoulders.
8. I am stiff in the morning.
9. I have pain in my muscles and joints.
10. I ache in the morning.
11. Pain wakes me up at night.
12. Heat (such as a heating pad) helps my pain.
13. My pain is affected by the weather.
14. I have more pain when I am emotionally upset.
15. My pain is worsened by noise.

Subjects were asked to answer these questions on a four point scale: Never, Sometimes, Often, and Almost Always.

The diagnosis of <u>possible fibrositis</u>, which would result in exclusion from the study, required:

1. Questions 7 or 9 - Often or Almost Always

   plus

2. Questions 8 or 10 - Often or Almost Always

   plus

3. Question 3 - Never or Sometimes

   plus

4. Questions 1, 12-15 (any 2) - Often or Almost Always.

APPENDIX B

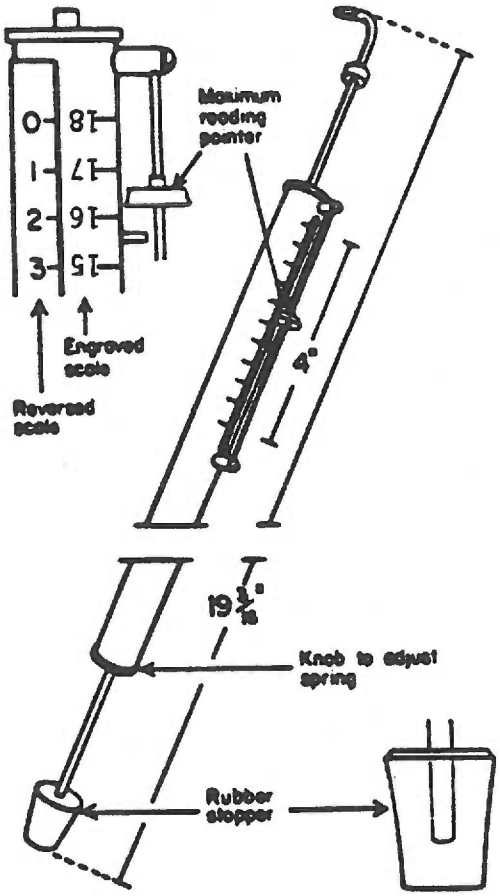

Fig. 1.--A push-pull gauge, used widely in industry, has been adapted as a dolorimeter by (1) reversing the pound scale engraved on the instrument by placing a strip of suitably marked adhesive tape over it and (2) inserting the tip of the plunger into a No. 1 black rubber stopper. (McCarty et al., 1965)

APPENDIX C

OREGON HEALTH SCIENCES UNIVERSITY
CONSENT FORM

I, _____, agree to serve as a subject in the investigation titled "Population Survey of Fibrositis" conducted by Linda Andregg, RN, BSN, under the direction of Robert Bennett, M.D. This research aims to determine if people differ in the ranges of scores on tender and nontender areas based on age, sex, culture, and certain feelings.

I understand my participation will involve:

1. Answering a questionnaire related to feelings and symptoms I might have.
2. Having a brief physical examination. I may experience a slight discomfort from the application of pressure to certain points using a spring-loaded gauge.
3. This device is widely used to measure pain. I understand I can request the test for pain tolerance be stopped at any time.

This will take approximately 30 minutes on one occasion.

I may not receive direct benefit from participation in this study, but the information gained from my participation may help in the understanding of pain.

The information obtained will be kept confidential and will be available only to those directly involved in this study.

Linda Andregg has offered to answer any questions about my participation in this study. I understand that I may refuse to participate or withdraw from this study at any time without affecting my relationship with the Oregon Health Sciences University.

"It is not the policy of the Department of Health and Human Services or any other agency funding the research project in which you are participating, to compensate or provide medical treatment for human subjects in the event the research results in physical injury. The Oregon Health Sciences University, as any agency of the State, is covered by the State Liability Fund. If you suffer any injury from the research project, compensation would be available to you only if you establish that the injury occurred through the fault of the University, its officers or employees. If you have further questions, please call Dr. Michael Baird, M.D. at (503) 225-8014."

I have read the foregoing and agree to participate in this study.

Signature _____

Date _____ Witness _____

APPENDIX D

LOCATIONS OF TENDER AND CONTROL POINTS*

Tender Points

Elbow: 1-2 cm distal to lateral epicondyle over or distal to insertion of finger extensors.

Costochondral: upper border of second rib just lateral to costochondral junction

Medial Knee: between joint line and adductor tubercle

Occiput: 2 cm below occipital crest, 1 cm lateral to midline

Trapezius: midpoint of upper border

Paraspinous: 3 cm lateral to midline at the level of the mid-scapula

Lumbar Spine: midline over L4-S_1 interspinous ligaments

Gluteus: over upper half of mid-gluteus medius

Control Points

Thumb: over thumbnail with thumb placed on flat surface

Forearm: volar aspect of mid-forearm

Shin: over mid-tibia

Upper back: 4 cm medial to trapezius tender point

*With the exception of the lumbar spine, all points were tested on both the right and left sides. The precise location was determined by lightly palpating for the point of maximal tenderness; the locations given here are approximate.

APPENDIX E

PAIN THRESHOLD

CONTROL POINTS, RIGHT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Thumb	4.0-18.0	9.25 (3.20)	7.11 (2.27)	8.85 (3.19)	10.06 (3.15)	11.16 (2.85)
Forearm	5.0-18.0	10.09 (3.52)	8.29 (2.49)	8.75 (3.21)	11.26 (2.69)	12.26 (4.07)
Shin	5.0-18.0	9.99 (3.51)	9.66 (3.14)	8.38 (3.17)	11.21 (3.25)	10.85 (4.02)
Upper Back	4.4-18.0	8.91 (3.81)	8.37 (4.15)	8.19 (3.56)	8.74 (3.26)	10.43 (4.10)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX F

PAIN THRESHOLD

CONTROL POINTS, LEFT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Thumb	3.8-18.0	9.22 (3.06)	7.19 (2.09)	8.86 (3.95)	9.49 (1.92)	11.49 (2.27)
Forearm	4.4-18.0	10.01 (3.20)	8.74 (2.04)	9.07 (3.80)	10.11 (2.09)	12.26 (3.45)
Shin	4.2-18.0	9.77 (3.58)	8.62 (2.83)	7.93 (3.30)	11.68 (3.41)	11.03 (3.60)
Upper Back	3.4-18.0	9.34 (3.83)	8.24 (4.12)	8.02 (3.61)	10.11 (3.31)	11.15 (3.62)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX G

PAIN THRESHOLD

TENDER POINTS, RIGHT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Elbow	3.2-17.8	7.11 (3.14)	6.45 (2.89)	6.20 (3.35)	6.65 (2.15)	9.23 (3.28)
Costochondral	2.2-18.0	6.89 (3.61)	6.00 (4.14)	5.45 (2.72)	7.30 (2.78)	8.96 (3.84)
Medial Knee	3.8-18.0	8.51 (3.30)	6.94 (2.35)	6.86 (2.51)	9.91 (3.21)	10.43 (3.49)
Occipital	3.0-18.0	6.74 (3.05)	5.74 (3.65)	5.29 (1.47)	7.71 (3.41)	8.35 (2.20)
Trapezius	2.4-18.0	8.01 (3.37)	6.56 (2.31)	7.85 (4.25)	7.31 (2.14)	10.40 (3.25)
Paraspinous	3.2-18.0	9.18 (3.98)	7.66 (3.90)	7.94 (3.84)	10.40 (3.91)	10.91 (3.50)
Gluteal	2.8-18.0	10.49 (4.13)	8.29 (4.19)	9.11 (3.44)	11.33 (3.39)	13.51 (3.56)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX H

PAIN THRESHOLD

TENDER POINTS, LEFT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Elbow	3.2-17.2	6.98 (3.00)	6.73 (3.01)	5.96 (2.97)	6.65 (1.64)	8.68 (3.59)
Costochondral	3.0-18.0	7.04 (3.15)	6.09 (3.45)	5.51 (2.19)	7.79 (2.58)	8.93 (3.22)
Medial Knee	3.8-18.0	8.46 (3.36)	7.07 (3.61)	6.91 (1.81)	9.71 (3.27)	10.21 (3.24)
Occipital	2.8-18.0	6.78 (3.01)	5.52 (3.51)	5.73 (1.96)	7.44 (3.17)	8.56 (2.24)
Trapezius	3.4-18.0	7.92 (3.86)	6.38 (2.76)	7.59 (4.48)	7.64 (3.21)	10.18 (4.04)
Paraspinous	2.4-18.0	9.18 (3.84)	7.46 (3.58)	8.08 (3.87)	10.66 (3.69)	10.70 (3.33)
Gluteal	2.8-18.0	10.02 (4.07)	8.03 (4.02)	7.88 (2.60)	11.85 (3.62)	12.57 (3.76)
Lumbosacral	3.4-18.0	10.69 (3.77)	8.81 (3.62)	9.25 (3.13)	13.01 (3.56)	11.91 (3.28)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX I

PAIN TOLERANCE

CONTROL POINTS, RIGHT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Thumb	6.0-18.0	13.88 (3.52)	11.39 (3.52)	12.81 (3.34)	14.90 (2.96)	16.65 (1.44)
Forearm	6.0-18.0	15.02 (3.26)	13.78 (2.82)	12.64 (3.65)	17.21 (1.47)	16.70 (2.23)
Shin	6.8-18.0	13.85 (3.39)	13.36 (3.50)	11.55 (3.10)	16.05 (2.43)	14.59 (2.93)
Upper Back	6.0-18.0	12.96 (3.70)	11.55 (3.74)	11.54 (3.35)	14.65 (3.58)	14.28 (3.18)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX J

PAIN TOLERANCE

CONTROL POINTS, LEFT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Thumb	6.2-18.0	13.61 (3.56)	10.94 (3.15)	12.58 (3.50)	14.88 (3.22)	16.26 (1.57)
Forearm	7.3-18.0	14.81 (3.28)	13.08 (2.98)	13.42 (3.64)	16.30 (2.56)	16.64 (2.21)
Shin	6.0-18.0	13.06 (3.60)	11.99 (3.22)	10.33 (2.98)	15.96 (2.42)	14.21 (3.09)
Upper Back	4.2-18.0	13.01 (3.90)	11.46 (3.87)	10.94 (3.56)	14.73 (3.46)	15.15 (2.96)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX K

PAIN TOLERANCE

TENDER POINTS, RIGHT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Elbow	5.0-18.0	11.91 (4.14)	10.31 (3.74)	9.54 (3.44)	13.21 (3.49)	14.84 (3.76)
Costochondral	3.8-18.0	10.50 (4.51)	8.16 (3.89)	7.82 (2.74)	12.99 (4.12)	13.35 (4.19)
Medial Knee	5.2-18.0	12.33 (4.06)	10.23 (3.85)	9.83 (2.91)	14.24 (3.32)	15.18 (3.28)
Occipital	4.2-18.0	10.43 (4.07)	8.16 (3.75)	8.44 (2.77)	12.18 (3.80)	13.21 (3.50)
Trapezius	3.8-18.0	11.77 (4.24)	9.76 (4.08)	10.51 (4.54)	13.46 (3.50)	13.58 (3.60)
Paraspinous	5.0-18.0	12.87 (4.02)	10.86 (3.99)	10.66 (3.73)	15.19 (2.81)	15.04 (3.10)
Gluteal	4.6-18.0	14.02 (4.05)	11.28 (4.50)	11.91 (3.28)	16.72 (2.09)	16.66 (2.16)

* Means are presented first, standard deviations are presented in parentheses.

APPENDIX L

PAIN TOLERANCE

TENDER POINTS, LEFT SIDE

(kg/1.54 cm^2)

POINT	RANGE	MEANS (S.D.)*				
		TOTAL SAMPLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Elbow	5.2-18.0	11.72 (4.04)	10.56 (3.88)	9.01 (2.66)	12.96 (3.52)	14.60 (3.78)
Costochondral	3.8-18.0	10.74 (4.10)	8.86 (3.74)	7.92 (2.48)	13.00 (3.70)	13.49 (3.36)
Medial Knee	5.0-18.0	12.25 (4.00)	9.97 (4.41)	9.85 (2.17)	15.00 (3.13)	14.31 (2.92)
Occipital	3.8-18.0	10.06 (4.07)	7.62 (3.43)	8.29 (2.29)	11.53 (4.37)	13.08 (3.50)
Trapezius	4.0-18.0	11.60 (4.31)	9.61 (3.98)	10.22 (4.22)	12.44 (4.08)	14.34 (3.54)
Paraspinous	4.6-18.0	13.13 (4.15)	10.97 (3.97)	10.99 (3.73)	15.26 (3.53)	15.59 (2.97)
Gluteal	4.6-18.0	13.80 (3.82)	11.44 (4.28)	11.72 (2.70)	16.70 (2.03)	15.64 (2.84)
Lumbosacral	7.4-18.0	14.62 (3.17)	12.86 (3.37)	12.58 (2.65)	17.00 (1.62)	16.30 (2.01)

* Means are presented first, standard deviations are presented in parentheses.

AN ABSTRACT OF THE THESIS OF

LINDA ANDREGG

For the MASTER OF NURSING

Date of Receiving this Degree: June 1986

Title: RELATIONSHIP OF PERSONAL CHARACTERISTICS TO PAIN THRESHOLD AND TOLERANCE IN A NORMAL POPULATION

Approved: _____

Sharon R. Clark, R.N., M.N., FNP, Thesis Advisor

A descriptive study of 66 adults was undertaken to determine if in a normal healthy population pain threshold and tolerance levels for specific control and tender points vary to a significant degree with age and gender, and to establish normative values for those points.

The 66 subjects were obtained from five sites in a metropolitan area: a university campus; two hospitals; an army reserve training center; and a community senior citizen center. All subjects completed a brief demographic information sheet and questionnaire. Pain threshold and tolerance were measured with a dolorimeter at 8 control (non-tender) and 15 tender points.

Two-way analysis of variance was used to analyze the interactions between the variables, and statistical significance was defined as $p < .05$. The results of the study showed no significant interaction

between age and pain perception. Significant differences related to gender were found, however, between pain tolerance levels at all non-tender and tender points. The non-experimental design and small sample size of this study limit the generalization of the results.

Several implications for practice are offered by this study. With normative data, clinicians could use objective information for comparison purposes when assessing individual pain responses and deciding which strength of an analgesic to administer. The use of the dolorimeter could provide patients with more objective or concrete terms to use when expressing their pain perception and the degree of relief they expect or desire. The tool could also be used to demonstrate to patients the effectiveness of specific pain relief measures.