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The *Journal of the National Society of Allied Health* is a fully refereed scholarly publication of the National Society of Allied Health. The aim and scope of the *Journal* is to provide educators, students, practitioners, federal and state government officials, and the public with the latest research and trends affecting the health care status of African Americans and all disadvantaged populations.

The *Journal* is devoted to scholarly writing that addresses:

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The Short-Term Effects of Low Level Laser on Subjects with Acute Ankle Injuries: A Pilot Study

Michael Rabel Ray Moore III Benjamin Stewart Darlene Jackson-Bowen

Abstract

Background: Ankle injuries often cause a significant decrease in function and lost time in work and/or athletics. There seems to be limited and conflicting research concerning the efficacy of laser on acute soft tissue recovery. The purpose of this study was to examine the short-term effects of a multi-phase wavelength specific low-level laser protocol on acute ankle injuries.

Subjects and Methods: Five subjects (mean age 24.6 ± 6.1 years) who recently sustained an ankle injury were studied. Assessments were recorded for pain, range of motion (ROM), disability, and edema prior to each session. Subjects attended 3 sessions within a 10-day period and received laser during the first 2 sessions

Results: Wilcoxon matched-pairs signed-rank test results indicated significant improvements in pain, range of motion, and disability between sessions 1 and 3.

Conclusion: Low-level light (laser) may improve pain, ROM, and disability for patients with acute ankle injuries.

Key Words: ankle sprain, low-level laser, light therapy

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Introduction

Ankle sprains are one of the most common injuries seen in young athletes and military service members (Waterman, Belmont, Cameron, Deberardino, & Owens, 2010). Over 25,000 ankle sprains occur daily in the United States and make up 10% of all Emergency Room (ER) visits (Man, Morrissey, & Cywinski, 2007). Ankle sprains comprise 15-23% of all sports-related injuries and 15% lead to chronic instability (Pugia et al., 2001). Most ankle sprains tend to involve a plantar flexion and supination movement, potentially damaging the anterior talofibular, calcaneofibular, and/or the posterior talofibular ligaments. Approximately 85% of ankle sprains involve at least one of these ligaments (Pugia, et al., 2001).

Despite the prevalence of ER ankle sprain cases, follow up care in the form of exercise, bracing or referral to physical therapy rarely occurred (Boyce, Quigley, & Campbell, 2005). It has been estimated that 68% of those who sustain an ankle sprain do not seek medical attention or rehabilitation services (McKay, Goldie, Payne, & Oakes, 2001). Standard medical advice for an

ankle sprain is protection, rest, ice, compression, elevation and pain-free movement (Ivins, 2006). This type of injury may be perceived as a benign condition but inadequate treatment can lead to chronic issues such as reduced range of motion, pain, and instability (Wolfe, Uhl, Mattacola, & McCluskey, 2001).

Injury to the ligament(s) and surrounding soft tissue will result in a physiological inflammatory response characterized by redness, swelling, heat, and pain. If prolonged, this can hinder the healing process and lead to reduced functional mobility (Man, et al., 2007). Edema can decrease the H-reflex excitability of muscles around the ankle joint and can lead to an increased susceptibility to re-injury (Man, et al., 2007). Improved healing time means a faster recovery to normal gait and baseline functional activities/sports competition. Modalities (ultrasound, electrical stimulation and ice) are routinely utilized to speed tissue recovery but few studies have focused on the use of low intensity laser therapy (LILT) to treat ankle injuries.

The energy produced by LILT is absorbed at a cellular level by photo acceptors, causing a photochemical energy conversion process. This facilitates chemical reactions in the surrounding area, stimulating tissue repair (el Sayed & Dyson, 1996; Young, Bolton, Dyson, Harvey, & Diamantopoulos, 1989). The wavelength of light determines the biological response and the depth of tissue penetration (da Silva, da Silva, Almeida, Lombardi Junior, & Matos, 2010).

After LILT was administered to the temporomandibular joint area of healthy subjects, an increased local vasodilation and blood flow was detected. These effects occurred both initially and 10 minutes post radiation (Makihara & Masumi, 2008). The increase in blood flow may improve cellular recruitment and activation, facilitating tissue healing.

Kulekcioglu and colleagues (2003) investigated the clinical use of LILT on the individuals with temporomandibular disorders (TMD). Subjects were randomized and received either laser or placebo laser in

addition to an exercise routine and education about the disorder. A single diode (904 nm, 17 mw Gallium Arsenide) laser with a frequency of 100 Hz was used to deliver a total dosage of 3J/cm² during 15 treatment sessions. Only the laser group experienced a significant improvement in active and passive mandibular depression and lateral deviation, with a reduction in the number of tender areas. Another TMD study was performed by Conti et al., (1997) and similar results were found.

The analgesic effect of laser has been studied on patients with myofascial pain syndrome and chronic pain. Hakguder et al., (2003) found that after ten treatment sessions, only those subjects who received laser treatment in conjunction with exercise had significant reductions in algometry and thermography scores. Walker (1983) also worked with chronic pain patients and administered laser to the skin overlying four nerves in the arms and legs or at remote locations (sham). After 10 weeks, 19 of the 26 patients with trigeminal neuralgia, post-herpetic neuralgia, sciatica and osteoarthritis experienced pain relief without medication. Patients who received sham treatment reported no analgesia. Laser was not as effective in reducing pain in patients with diabetic sensorimotor polyneuropathy (Zinman et al., 2004). Although not significant, only the group that received laser displayed a reduction in pain intensity.

One study has examined the immediate effect of laser treatment for less than 4 minutes on pain, edema, and function after an acute ankle sprain (de Bie et al., 1998). After 12 laser treatments, no difference in the primary outcome measure of pain was reported between the laser and placebo groups. The placebo group displayed significant improvements in functional measures within the first two weeks after the study was initiated. The authors concluded that laser was not an effective treatment for individuals recovering from an ankle sprain.

Limited and conflicting evidence exists concerning the efficacy of laser in the treatment of acute musculoskeletal disorders. Additional research is needed to determine

the best protocol and laser parameters for tissue repair (da Silva, et al., 2010; Tumilty et al., 2010). Hardly any research has focused on different laser wavelengths. Therefore, the purpose of this study was to examine the effects of a wavelength specific multi-phase, low-level laser treatment protocol on range of motion, edema, and function/quality of life in individuals after sustaining an acute ankle injury.

Methods

Subject Selection

Four healthy females and one male between 19 and 35 years of age who had recently sustained an ankle injury were recruited and participated in this one-group, repeated measures study. Subjects were from local orthopedic clinics and the student health office at the University of Maryland Eastern Shore. Exclusion criteria included a history of systemic illness or compromised immune system, prior surgical procedure to the involved foot/ankle, sustained a current fracture or tested positive on the Ottawa Ankle/Foot Assessment, (or could not begin the study within 5 days from the date of injury. All subjects were initially seen by healthcare providers and given standard medical advice for ankle sprains; no other formal or routine healthcare interventions were provided. Medication use included only non-prescription anti-inflammatory drugs. All participants gave their written, informed consent to participate in the study, which was approved by the University of Maryland Eastern Shore's Institutional Review Board.

Protocol

Subjects attended a total of 3 treatment sessions within a 10-day period time period. Measures were taken at the beginning of each session. Subjects were assessed for changes in range of motion, swelling, pain, function, and medication/modality utilization. Low intensity laser therapy was applied during the first 2 sessions, as per the study protocol, to the injured ankle of all subjects.

Range of Motion

Active plantarflexion and dorsiflexion ROM was assessed with a standard goniometer. This measure has been reported to be a reliable indicator of ankle impairment (Wilson et al., 1998). Subjects were seated with the knees resting in 90° of flexion and performed the desired movement task until the initial onset of pain. Test-retest reliability for this technique was established and produced an intraclass correlation coefficient (ICC) of 0.88. The Standard Error of Measurement (SEM) (square root of the within-subjects mean square) was less than 2°.

Volumetrics

Volumetric displacement has been shown to be a reliable measure to quantify edema in the extremities (Farrell, Johnson, Duncan, Offenbacher, & Curry, 2003; Man & Morrissey, 2005). A foot volumeter was filled to capacity with water at room temperature (70-80°F). While seated, the subject completely submerged his/her foot into the volumeter. The displaced water was collected and measured until the water flow rate was less than 1 drop/second. Test-retest reliability for this technique was established and produced an ICC of 0.96. The standard error of measurement (square root of the within-subjects mean square) was 19.6 ml.

Self-Report Questionnaires

Pain Intensity

The visual analog scale (VAS) has been shown to be a valid and reliable instrument used to measure pain intensity (McCormack, Horne, & Sheather, 1988; Price, McGrath, Raffi, & Buckingham, 1983). A 10-cm visual scale, with written descriptors at 0 ("no pain") and 10 ("maximum pain"), was used to estimate pain intensity. At the initial session, subjects were asked to rate their average pain intensity during the past week or from the date of injury, if they had been injured less than 1 week. During subsequent sessions, subjects were instructed to rate their average pain intensity, since the last session, using the same VAS method.

Disability

The Lower Extremity Functional Scale (LEFS) has been shown to be a valid and reliable outcome measure with excellent responsiveness to change (Binkley, Stratford, Lott, & Riddle, 1999; Martin & Irrgang, 2007; Watson et al., 2005). It is used to assess functional variations in patients with lower extremity disorders, including foot/ankle pain (Riddle, Pulisic, & Sparrow, 2004). This questionnaire consists of 20 region-specific items and utilizes a 5-point scale (0-4) for a highest possible score of 80 with a minimal clinically important difference of 9 points (Binkley, et al., 1999). Higher scores indicate greater levels of function.

Low-level laser therapy

Low-level laser therapy was administered with the BioFlex System (Meditech International, Inc.; Toronto, Canada). All investigators were trained and certified to use the laser technology. The LILT protocol was developed with the assistance of the manufacturer, based on the type of injury under investigation. The protocol included the sequential application of a red superluminous diode light array (660nm), an infrared superluminous diode array (840nm), and an infrared laser probe (830nm).

The light array was placed around the injured ankle and secured. The red light array was utilized first, followed by the infrared light array, followed by the application of the laser probe. The laser probe was applied to the tissue surrounding the injury and moved to a new point every 10 seconds. Treatment parameters and energy densities for each type of light are listed in **Table 1**. Duration of laser irradiation varied according to the skin melanin content. Safety precautions were observed according to manufacturer guidelines and control measures in the Laser Safety Guide (Marshall, Sliney, & Laser Institute of America, 2000).

Statistics

Data analyses were performed using SPSS for Windows 17.0. The formula ($SD \times \sqrt{(1-ICC)}$) was used to calculate the SEM for ROM and volumetrics (Portney L & M,

2008). The nonparametric Wilcoxon matched-pairs, signed-ranks test was used to compare the values pre- and post-laser therapy for pain, range of motion, edema, and function. The level for statistical significance was set at $P < 0.05$.

Results

Detailed characteristics for the 5 subjects such as ethnicity, baseline outcome measures, and the use of other interventions are provided in **Tables 2** and **3**. Three African American and two Caucasian subjects with a mean age of 24.6 ± 6.1 years and body mass index 27.6 ± 7.5 kg/m². There was average time duration of 2.6 ± 1.8 days between injury and session 1 and 6.0 ± 0.7 days between session 1 and 3. Subjects displayed an average initial LEFS score of 36.0 ± 15.7 points, volume of $1,200 \pm 109.5$ ml, dorsiflexion ROM of $-5.4 \pm 10.3^\circ$ and plantarflexion ROM of $41.8 \pm 9.6^\circ$. A significant decrease in pain intensity scores (18% and 28%, respectively) was identified between sessions 1 and 2 ($p=0.03$) and sessions 1 and 3 ($p=0.04$). Dorsiflexion ROM was significantly greater ($p=0.04$) between the first and last session while plantarflexion did not significantly change ($p=0.67$). A significant decrease of 30.3% in disability occurred between sessions 1 and 3 ($p=0.04$). In contrast, a significant increase in volume was identified during the same time period ($p=0.04$). These data are summarized in **Table 4**.

Discussion

The acute phase of tissue healing ranges from 4 to 6 days (Kellelt, 1986). In this research, the mean time between ankle injury and the first laser treatment session was 2.6 days. Therefore, the intervention was administered during the acute inflammatory phase of the healing process. The therapeutic effects of laser have been shown to be most powerful during the early phase of tissue healing. During this time, cellular activity peaks in order to clear debris from the site of injury (el Sayed & Dyson, 1996; Karu, 2005; Young, et al., 1989).

Type of light	↓ Melanin (minutes)	↑ Melanin (minutes)	Energy Density (J/cm ²)	
			↓ Melanin	↑ Melanin
Red Array	10	14	3.9	5.5
Infrared Array	15	19	8.2	10.4
Infrared Probe	5	7	18/pt (30 points)	18/pt (42 points)

Ethnicity		
African American	3	
Caucasian	2	
Baseline	Injured Ankle	Uninjured Ankle
Volume (ml)	1200.6 ± 109.5	1178.6 ± 114.0
DF ROM (°)	-5.4 ± 10.3	15.2 ± 4.3
PF ROM (°)	41.8 ± 9.6	57.6 ± 6.2

*Data are mean ± SD

	NSAIDs *	Ice	Crutches
Session 1	3	4	4
Session 2	1	2	1
Session 3	1	0	0

* Abbreviations: NSAIDs, Non Steroidal Anti-inflammatory drugs (over the counter, taken as needed).

Our subjects experienced significant improvements in pain intensity, pain free active range of motion, and functional mobility. The significant change in pain occurred after the first session and in all other measures, after the third session. In addition to pain, significant improvements occurred between sessions 1 and 3 (mean time = 6 days), in ankle dorsiflexion ROM and the LEFS score. The change in disability was clinically significant because the subjects improved by a mean of approximately 24 points, on an 80-point scale, within a relatively short period of time. Therefore, as often observed clinically, pain relief is accompanied by improvements in functional mobility.

A limitation of this study involves the absence of a control group. However, a similar study, performed by de Bie and colleagues (1998), utilized a placebo group (N=71). A mean pain relief of 0.3 on the VAS was identified five days following session 1. Subjects in our study demonstrated a significant mean pain relief of 1.8 after an average of 3 days following session 1, 2 days earlier than the placebo group. This suggests that laser may be effective in reducing short-term pain after an acute ankle injury.

In a study by Wilson et al., (1998), 13 collegiate athletes, who suffered an ankle sprain, were assessed at day 3 and day 10 post-injury. These subjects did not receive an intervention and ROM was measured over similar time intervals, using a similar technique. Seven days following the initial measurement (10 days post-injury), subjects experienced a mean increase of 4.7° of total pain free sagittal plane passive ROM, including both DF and PF. Subjects in our study experienced an average increase of 11.4° of pain free DF active ROM within a mean of 6 days following the initial session.

In addition, a 24.2 mean point increase in the disability score was observed in our participants. The minimal detectable change in LEFS values was 9 scale points. The improvement between sessions 1 and 3 (mean of 6 days) was well over the minimal detectable benchmark, indicating a 30.3% increase in functional mobility. de Bie et al.,

(1998) reported a 12.3% functional improvement in their placebo group 5 days following the initial session. Our subjects displayed a greater mean improvement in function within a similar period of time. Additionally, laser treatment has been shown to increase blood flow and cause vasodilation of the superficial temporal artery in healthy subjects (Makihara & Masumi, 2008). Laser therapy also increases the permeability of cell wall membranes to promote the transfer of ions and fluid in damaged tissue (Conti, 1997; Karu, 2005; Young, et al., 1989). Laser therapy can provide an optimal or accelerated healing environment via these inflammatory agonistic mechanisms.

Our subjects displayed a significant increase in edema from session 1 to 3. This may not be unusual because during the first 4-6 days following acute injury, the body responds with increased localized edema, secondary to released histamine and blocked lymphatic drainages (Kellett, 1986; Movat, 1897). In addition, the increase in volume could signify that the laser was enhancing/facilitating the tissue healing process. Other modalities, such as neuromuscular electrical stimulation, had no significant effect on the ankle volume after an acute injury (Man, et al., 2007).

It is important to recognize that other research has shown no correlation between swelling and self-assessed ankle function, perhaps the most clinically important indicator of healing or recovery (Man & Morrissey, 2005). The increase in edema experienced by our subjects may have been a normal part of the recovery process and occurred as functional mobility improved. More research is needed to understand the mechanisms and clinical effects of laser therapy on various musculoskeletal pathologies.

Conclusion

Applying laser with one wavelength at a time has been suggested as a more optimal protocol, producing effective clinical outcomes (Kahn, 2006). In our study, three different wavelengths of laser were

sequentially applied yielding a total energy density that exceeded most other laser therapy studies. After three sessions, significant improvements in pain, ROM, and disability were identified. These improvements surpassed the clinical and functional outcome results of placebo groups

in similar studies. This type of low-level light protocol may assist in the initial short-term recovery of acute ankle sprains. Additional research is warranted to assess if these positive results would extend to a larger sample and beyond the short-term period.

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Effects of Estrogen on Pregnant Women with Multiple Sclerosis: A Systematic Review

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Abstract

Multiple Sclerosis (MS) is an autoimmune disease affecting the central nervous system. It is more common in women than men. Current evidence indicates that there is a decrease in the MS relapse rates during the third trimester of pregnancy, and an increase in MS exacerbation rates in the post-partum period. Using the Oxford Centre of Evidence-Based Medicine Levels of Evidence, a systematic review was completed. The researchers hypothesized that hormonal therapy interventions could decrease exacerbations of the clinical manifestations of relapse-remitting multiple sclerosis (RRMS). The results show that different forms and levels of estrogen and progesterone may decrease MS disease activity, and could provide beneficial effects for women diagnosed with RRMS. The authors conclude that estrogen replacement therapy would significantly reduce the exacerbations of MS in women with RRMS, leading to an increased quality of life.

Keywords: *multiple sclerosis, pregnancy, hormones, estrogen, progesterone, relapse rates, post-partum, and experimental autoimmune encephalomyelitis.*

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Introduction

Background

Multiple Sclerosis (MS) is an autoimmune disease, which affects the central nervous system, and is characterized by chronic damage to the myelin sheaths, focal inflammation, and axon degeneration (El-Etr et al., 2010). Multiple Sclerosis is the most common disabling neurological disease of young adults. It most often appears when people are between 20 to 40 years old. (National Institute of Neurological Disorders [NINDS], 2012). There are approximately 250,000 to 350,000 people in the United States who have been diagnosed with MS. However, it is difficult to determine exactly how many people are actually affected by the disorder because: symptoms are not identical in all patients; there are different types of MS; and early symptoms may mimic other neurological pathologies (National Multiple Sclerosis Society [NMSS], 2011a; British Medical Journal Group [BMJG], 2012).

The McDonald's Criteria are considered the gold standard of diagnostic tools, due to their high degree of sensitivity and specificity, with the aid of magnetic resonance imaging (MRI). These criteria are used by physicians for the early diagnosis of MS (Polman et al., 2011). The criteria include one lesion in at least two of the four areas of the CNS seen on a MRI. A relapse of MS is classified by the manifestation or increase of dysfunctional neurologic symptoms lasting more than 24 hours; fatigue alone is not regarded as a relapse (Confavreux et al., 1998).

Caucasians have the highest incidence of MS; and women are twice as likely as men to be diagnosed with the disease (NMSS, 2011b). According to research conducted by Dr. Brian Weinshenker (cited in Kantarci et al., 2005), high levels of interferon gamma play a key role in the predisposition of MS. He argued that women are afflicted more than men because of their higher levels of interferon gamma. In 2004, Cree et al. published a retrospective study involving 375 African Americans and 427 Caucasians, with similar ratios of men and women, diagnosed with MS. The results showed that African Americans were more likely to be diagnosed at a later age, had more aggressive symptoms, and were likely to develop more motor mobility dysfunction than their Caucasian counterparts (Olek, 2012; Stachowiak, 2009).

Multiple sclerosis is a chronic condition, which is very costly. Since MS patients are typically affected in the prime of life, most of the total costs (57%) are related to indirect costs such as lost income, equipment and alterations, and formal (paid) and informal (unpaid) care. Multiple sclerosis is more costly than other debilitating diseases, such as stroke or Alzheimer's disease, that generally occur later in life (Prescott et al., 2007). Approximately 25% to 30% of people diagnosed with MS in the US rely on Medicare as their primary source of health care coverage (My-MS.org, 2008). Others rely on insurance provided by a union or employer. Individuals, who are unable to work due to their physical limitations, are often entitled to Supplemental Security Income (SSI) or Social Security Disability Insurance (SSDI) benefits. In addition, the National MS Society offers funding resources and support as well as counseling, for those in need (NMSS, 2011b). Multiple sclerosis affects all aspects of a person's life including relationships with significant others. Although many people with MS maintain their careers long after diagnosis, some quit immediately upon knowing the diagnosis or upon their first major exacerbation. The decision to give up work is often made too soon. The Americans with Disabilities Act is

in place to protect individuals from discrimination within the workplace (U.S. Department of Justice, 2013). There are innovative technologies, disease-modifying drugs, other community resources, and symptom management like physical therapy in order to help people with MS maintain their jobs (NMSS, 2011b). In addition to the multifarious physical symptoms associated with MS, other aspects of an individual's life may be affected, including quality of life, healthcare costs, and psychosocial issues.

Although MS is rarely terminal, a diagnosis often requires major life-style modifications. While the disease is most often diagnosed in young adults, most people with MS have a normal life expectancy (NINDS, 2012). Women with MS are not discouraged from becoming pregnant, because MS does not present health risks to the development of the fetus. However, the mother's physical health could lead to difficulties in her role as a parent (NINDS, 2012). Research studies identify a decrease in relapse rates in women diagnosed with MS during the third trimester of pregnancy, and an increase in exacerbations post-partum. During these times, abrupt changes in hormone levels, specifically the sex hormones estrogen and progesterone have been documented (Niino et al., 2009).

Types of Multiple Sclerosis

There are four types of MS: primary progressive MS (PPMS), secondary progressive MS (SPMS), relapsing-remitting MS (RRMS), and progressive-relapsing MS (PRMS) (NINDS, 2012). Primary progressive MS has the onset of disease without any remissions or clinical attacks. Secondary progressive MS is irreversible neurological damages without relapses, while relapse-remitting MS has periods of exacerbations followed by complete or incomplete remissions. Progressive-relapsing MS is like RRMS with relapse periods, but during these periods the person still experiences disease progression (NINDS, 2012). During the beginning stages of RRMS, re-myelination of axons is possible, but disease progression may cause

insufficient re-myelination resulting in neurodegeneration, impaired axon conduction, and worsening of symptoms (El-Etr et al., 2010).

The exact pathogenesis of MS is unknown, but it is related to the production of CD4⁺ T cells, which aid the destruction of myelin sheaths. CD4⁺ T cells play a central role in immune function throughout the human body by recruiting neutrophils, eosinophils and basophils to sites of infection and inflammation (Correale, Arias, and Gilmore, 1998). Correale et al. noted that people with MS have CD4⁺ T cells, which are characterized by a predominance of Th1/ pro-inflammatory or Th2/ anti-inflammatory cytokines, depending on the severity of the MS activity. The authors also found that the majority of myelin antigen-specific T cells isolated during relapsing disease activity secrete the Th1-like cytokines interferon (IFN- α), interleukin (IL-12), and tumor necrosis factor (TNF- α). While during remission, IL-4, 5, 6, 8, 10, and IL-13 producing Th2-like cells appear (Correale, Arias, & Gilmore, 1998; Neuteboom et al., 2009; Vukusic et al., 2009). Interleukin (IL-12) and TNF- α are the chief pro-inflammatory cytokines that stimulate nitric oxide synthesis and inflammatory mediators that control chronic inflammatory responses. The excessive production of these two cytokines plays a key role in tissue damage and inflammatory activity seen in organ-specific autoimmune diseases, such as MS.

The maternal-fetal interface is a dynamic site that encompasses multiple cellular interactions in an environment rich in cytokines and hormones (Houser, 2012). Estrogen and other hormones secreted during pregnancy at the maternal interface have been shown to inhibit the production of IL-12 and TNF- α by monocytes and macrophages both in vitro and ex vivo. While estrogen promotes a Th2 environment that impacts systemic function, it is not the only hormone affecting the cytokine shift from Th1/pro-inflammatory to Th2/anti-inflammatory (Elenkov et al., 2001). Testosterone and progesterone are other hormones that are involved in the pathogenesis of MS. In this study, the

hormone estrogen hormone was explored.

Because human subjects are not readily available for observation from the time of the disease onset, research in this area has incorporated the use of animals, specifically mice. Experimental autoimmune encephalomyelitis (EAE) is an animal model that has served as the paradigm in studying the MS disease process in humans. Experimental autoimmune encephalomyelitis is injected into animals to induce an autoimmune response, which is similar to the response of MS in the human body (Jones, 2011). During the inflammatory response the cytokines produced are linked to Th1 cytokines, IL-2, IFN- α , and TNF- α . The recovery of the disease process are linked to Th2 cytokines, IL-4, 5, 6, and 13. Researchers have concluded that these cellular responses were similar to the Th1 and Th2 cells produced in patients with MS. (Van den Broek et al., 2005).

Estrogen and Progesterone

Hormones are thought to play a role in the disease activity of MS. There are three major forms of estrogen that occur naturally in the human body: 1) estrone (E1); 2) estradiol (E2); and 3) estriol (E3). Estrone is found in women after menopause. Estradiol is the predominant estrogen form in non-pregnant women, with its peak level right before ovulation. Estriol is produced by the placenta (Niino et al., 2009; Rhoades & Bell, 2009). Progesterone is secreted throughout the first trimester of pregnancy until childbirth (Rhoades & Bell, 2009).

Attention has been directed towards E2, E3, and progesterone, because these hormones are secreted at high levels during pregnancy, at a time when the clinical symptoms of MS are reduced (Niino et al., 2009). Elenkov and his colleagues (2001) conducted a study of hormonal changes during the late pregnancy and early post-partum stages in pregnant women who were not diagnosed with MS. They found a decrease in the monocytic production of the Th1 type or pro-inflammatory cytokines IL-12 and TNF- α , and a four-fold increase in the secretion of estrogen (E2), progesterone, and other pregnancy related hormones during

pregnancy. They discovered that following childbirth, when these hormones returned to their pre-pregnancy levels, the removal of their inhibitory effects produced a rebound of IL-12 and TNF- α production and a shift back to Th1/pro-inflammatory cytokine production (Elenkov et al., 2001).

Confavreux et al. (1998) produced a landmark study observing the relapse rates of pregnant women diagnosed with MS. They found that the rates of relapse during the first and second trimesters were slightly lower than the women's pre-pregnancy rates. During the third trimester, the relapse rates were significantly lower. However, for the first three months post-partum, the relapse rates were higher (Confavreux et al., 1998).

Terms and Definitions

Cytokines - are any of a number of substances that are secreted by specific cells of the immune system which carry signals locally between cells, and thus have an effect on other cells. They include immunoregulatory proteins, such as interferon or interleukin (Post-partum, 2012).

Exacerbation - is a sudden worsening of MS symptoms, or the appearance of new symptoms that lasts for at least 24 hours. It is also called a relapse, flare-up, or attack (NINDS, 2012).

Post-partum - is the period after a neonate has been delivered until a woman conceives again (Cytokine, 2010).

Relapse - is the appearance or exacerbation of neurologic dysfunction symptoms (in addition to fatigue) lasting more than 24 hours (Confavreux et al., 1998).

Remission - is the decrease or inactivity of disease severity; patients may experience fatigue and/or symptoms of neurologic dysfunction lasting less than 24 hours (NMSS, 2011a).

Rationale/Purpose of the Study

Eighty-five percent of MS cases start with a relapse-remitting course, and women are affected twice as often as men (NMSS, 2011b; Yan & Greer, 2008; Yates, Li, Chlebeck, & Offner, 2010). This study will

focus on women diagnosed with RRMS. The Pregnancy in Multiple Sclerosis (PRIMS) study was the first large prospective study which aimed to assess the possible influence of pregnancy and delivery on the clinical course of multiple sclerosis (Vukusic et al., 2004). In the PRIMS study, it was found that during the first three months following childbirth, women diagnosed with MS are at higher risks for a relapse of symptoms. The results indicated no significant difference in the relapse rate during the 4 to 25 months following birth, compared to the women's pre-pregnancy years (Vukusic et al., 2004). Despite that seminal study, the mechanism of reduced relapse rates during pregnancy remains idiopathic and perplexing (Zhu, Lu, Huang, Link, & Xiao, 2007).

The purpose of this study was to further investigate the role of estrogen in pregnant women diagnosed with MS, using the Oxford Centre for Evidence Based Medicine - Levels of Evidence as a research tool. Estrogen is the primary focus of this literature review due to its ameliorating effects on MS and EAE. During pregnancy, there is a cytokine shift from Th1- to Th2- in order to naturally suppress the mother's immune system for the prevention of fetal rejection; this same shift has been seen in various EAE studies. Estriol (E3) is a specific type of estrogen, which is produced by the fetal placental unit. Estriol increases progressively during pregnancy, peaks in the third trimester, and most beneficially affects patients with RRMS. However, estriol levels decrease dramatically during the post-partum period, when MS relapse rates rebound (Soldan, Retuerto, Sicotte, & Voskuhl, 2003). Given this information, the researchers of this study believe that estrogen hormone therapy could be used to promote anti-inflammatory or Th2-like activity at pregnancy associated concentrations to reduce exacerbations. The researchers hypothesize that the improvement in the disease activity of women diagnosed with MS during pregnancy is attributable to variations of hormonal levels. A literature review was conducted to determine if the

hypothesis could be confirmed. Confirmation of the hypothesis could support the use of hormone therapy to treat patients with MS.

Research Question and Hypothesis

It is hypothesized that interventions using hormonal therapy, specifically estrogen, will provide decreased exacerbations of the clinical manifestations of relapse-remitting multiple sclerosis. To determine if hormonal therapy would lead to an increased quality of life and facilitate an increase in the efficacy of therapeutic intervention, the following research question was developed: Does estrogen have immunomodulatory effects on pregnant women who have been diagnosed with multiple sclerosis?

Materials and Methods

Four databases were used in this literature review: Academic Search Premier; PubMed; EBSCOhost; and CINAHL with Full Text. Keywords used were multiple sclerosis, pregnancy, hormones, estrogen, progesterone, relapse rates, post-partum, and experimental autoimmune encephalomyelitis. The inclusion criteria for articles included: 1) they were written in the English language; 2) they were published within the last 15 years, and 3) they had strength of at least 3b according to the Oxford Centre for Evidence-Based Medicine Levels of Evidence (OLE) (See Figure 1).

More than 100 articles were retrieved and reviewed. The number of articles was narrowed to 20, based on their ability to provide an answer to the research question. The strength of the articles was determined by using OLE (Figure 1). The authors searched for a relationship between the decrease of MS disease activity and specific hormones. The focus was on pregnancy, hormones (specifically forms of estrogen) and related outcomes of MS. The articles were organized by the following categories: author; title; level of evidence; publication

date; purpose; population; and results/conclusion. Using OLE, the researchers determined the strength of the articles and included those most pertinent to addressing the research question.

Results

The summary of the reviewed articles is reported in Figure 2. The literature review highlighted the physiological effects of estrogen on cytokines. Previous researchers have concluded that estrogen affects the immune system by altering several cellular components, including T- cells. Small clinical trials have shown that E3 given orally to non-pregnant women had a protective effect against MS. Women diagnosed with RRMS showed a decrease in lesions after they were given a treatment using E3 (Niino et al., 2009). Estrogen, secreted during pregnancy at the maternal interface, has been shown to inhibit the production of IL-12 and TNF- α by monocytes and macrophages both in vitro and ex vivo, and to promote a Th2 environment that impacts systemic function (Elenkov, 2001). In EAE, when estrogen is administered before immunization, it impedes symptoms and disease activity and inhibits the production of inflammatory cytokines (El-Ert et al., 2010). This information was important to answer the research question: Does estrogen have immunomodulatory effects on pregnant women diagnosed with multiple sclerosis? An analysis of the literature review suggests that estrogen has physiological effects on the clinical manifestations of MS and EAE. In addition, the increased production of estrogen may cause a shift from Th1 pro-inflammatory cytokines to Th2 anti-inflammatory cytokines (Elenkov et al., 2001). The combination of estrogen and other hormones may have an immunomodulatory effect, by decreasing the inhibitory effects of Th1/pro-inflammatory cytokines (Vukusic et al., 2009).

FIGURE 1
Oxford Centre for Evidence-based Medicine Levels of Evidence

Level	Therapy/ Prevention, Aetiology/ Harm	Prognosis	Diagnosis	Differential diagnosis/symptom prevalence study	Economic and decision analyses
1a	SR (with homogeneity*) of RCTs	SR (with homo-geneity*) of inception cohort studies; CDR† validated in different populations	SR (with homogeneity*) of Level 1 diagnostic studies; CDR† with 1b studies from different clinical centres	SR (with homogeneity*) of prospective cohort studies	SR (with homogeneity*) of Level 1 economic studies
1b	Individual RCT (with narrow Confidence Interval‡)	Individual inception cohort study with > 80% follow-up; CDR† validated in a single population	Validating** cohort study with good††† reference standards; or CDR† tested within one clinical centre	Prospective cohort study with good follow-up****	Analysis based on clinically sensible costs or alternatives; systematic review(s) of the evidence; and including multi-way sensitivity analyses
1c	All or none§	All or none case-series	Absolute SpPins and SnNouts††	All or none case-series	Absolute better-value or worse-value analyses ††††
2a	SR (with homogeneity*) of cohort studies	SR (with homo-geneity*) of either retrospective cohort studies or untreated control groups in RCTs	SR (with homogeneity*) of Level >2 diagnostic studies	SR (with homogeneity*) of 2b and better studies	SR (with homogeneity*) of Level >2 economic studies
2b	Individual cohort study (including low quality RCT; e.g., <80% follow-up)	Retrospective cohort study or follow-up of untreated control patients in an RCT; Derivation of CDR† or validated on split-sample§§§ only	Exploratory** cohort study with good††† reference standards; CDR† after derivation, or validated only on split-sample§§§ or databases	Retrospective cohort study, or poor follow-up	Analysis based on clinically sensible costs or alternatives; limited review(s) of the evidence, or single studies; and including multi-way sensitivity analyses
2c	"Outcomes" Research; Ecological studies	"Outcomes" Research		Ecological studies	Audit or outcomes research
3a	SR (with homogeneity*) of case-control studies		SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies
3b	Individual Case-Control Study		Non-consecutive study; or without consistently applied reference standards	Non-consecutive cohort study, or very limited population	Analysis based on limited alternatives or costs, poor quality estimates of data, but including sensitivity analyses incorporating clinically sensible variations.
4	Case-series (and poor quality cohort and case-control studies§§)	Case-series (and poor quality prognostic cohort studies***)	Case-control study, poor or non-independent reference standard	Case-series or superseded reference standards	Analysis with no sensitivity analysis
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on economic theory or "first principles"

Produced by Bob Phillips, Chris Ball, Dave Sackett, Doug Badenoch, Sharon Straus, Brian Haynes, Martin Dawes since November 1998. Updated by Jeremy Howick March 2009.

Notes: Users can add a minus-sign "-" to denote the level of evidence that fails to provide a conclusive answer because: EITHER a single result with a wide Confidence Interval OR a Systematic Review with troublesome heterogeneity. Such evidence is inconclusive, and therefore can only generate Grade D recommendations.

*	By homogeneity we mean a systematic review that is free of worrisome variations (heterogeneity) in the directions and degrees of results between individual studies. Not all systematic reviews with statistically significant heterogeneity need be worrisome, and not all worrisome heterogeneity need be statistically significant. As noted above, studies displaying worrisome heterogeneity should be tagged with a "-" at the end of their designated level.
†	Clinical Decision Rule. (These are algorithms or scoring systems that lead to a prognostic estimation or a diagnostic category.)
‡	See note above for advice on how to understand, rate and use trials or other studies with wide confidence intervals.
§	Met when all patients died before the Rx became available, but some now survive on it; or when some patients died before the Rx became available, but none now die on it.
§§	By poor quality cohort study we mean one that failed to clearly define comparison groups and/or failed to measure exposures and outcomes in the same (preferably blinded), objective way in both exposed and non-exposed individuals and/or failed to identify or appropriately control known confounders and/or failed to carry out a sufficiently long and complete follow-up of patients. By poor quality case-control study we mean one that failed to clearly define comparison groups and/or failed to measure exposures and outcomes in the same (preferably blinded), objective way in both cases and controls and/or failed to identify or appropriately control known confounders.
§§§	Split-sample validation is achieved by collecting all the information in a single tranche, then artificially dividing this into "derivation" and "validation" samples.
††	An "Absolute SpPin" is a diagnostic finding whose Specificity is so high that a Positive result rules-in the diagnosis. An "Absolute SnNout" is a diagnostic finding whose Sensitivity is so high that a Negative result rules-out the diagnosis.
‡‡	Good, better, bad and worse refer to the comparisons between treatments in terms of their clinical risks and benefits.
†††	Good reference standards are independent of the test, and applied blindly or objectively to applied to all patients. Poor reference standards are haphazardly applied, but still independent of the test. Use of a non-independent reference standard (where the 'test' is included in the 'reference', or where the 'testing' affects the 'reference') implies a level 4 study.
††††	Better-value treatments are clearly as good but cheaper, or better at the same or reduced cost. Worse-value treatments are as good and more expensive, or worse and the equally or more expensive.
**	Validating studies test the quality of a specific diagnostic test, based on prior evidence. An exploratory study collects information and trawls the data (e.g. using a regression analysis) to find which factors are 'significant'.
***	By poor quality prognostic cohort study we mean one in which sampling was biased in favour of patients who already had the target outcome, or the measurement of outcomes was accomplished in <80% of study patients, or outcomes were determined in an unblinded, non-objective way, or there was no correction for confounding factors.
****	Good follow-up in a differential diagnosis study is >80%, with adequate time for alternative diagnoses to emerge (for example 1-6 months acute, 1 - 5 years chronic)

Grades of Recommendation

A	Consistent level 1 studies
B	Consistent level 2 or 3 studies or extrapolations from level 1 studies
C	Level 4 studies or extrapolations from level 2 or 3 studies
D	Level 5 evidence or troublingly inconsistent or inconclusive studies of any level

"Extrapolations" are where data is used in a situation that has potentially clinically important differences than the original study situation.

FIGURE 2
Summaries of Literature Review

Author(s)	Title	Level of Evidence	Pub. Date	Purpose	Population	Results/ Conclusion
Elenkov, I., Wilder, R., Bakalov, V., Link, A., Dimitrov, M., Fisher, S., Crane, M., Kanik, K., Chrousos, G.	IL-12, TNF-alpha, and Hormonal Changes during Late Pregnancy and Early Post-Partum: Implications for Autoimmune Disease Activity during these times	1a	2001	To observe the production of IL-12 and TNF-alpha after stimulation of lipopolysaccharide whole blood cultures ex vivo and to measure the levels of catecholamines, cortisol, 1,25-dihydroxyvitamin D3, progesterone, and E2 in women during gestation week 33-36 and 3-6 weeks postpartum .	18 healthy pregnant women between the ages of 20-40 years, and 18 age-matched, healthy, non-pregnant women.	A decrease of Th1 type pro-inflammatory cytokines IL-12 and TNF-alpha, and an increase in the secretion of norepinephrine, cortisol, and 1,25-dihydroxyvitamin D3 in the 3rd trimester of pregnancy were found. When these hormones return to normal during post-partum, the removal of their inhibitory effects may induce a rebound of IL-12 and TNF-alpha production as well as Th1 shift.
Vukusic, S., Ionescu, I., El-Etr, M., Schumacher, M., Baulieu, E. E., Cornu, C., et al.	The Prevention of Post-Partum Relapses with Progesterin and Estradiol in Multiple Sclerosis (POPART ^{MUS}) trial: Rationale, objectives and state of advancement	1a	2009	To evaluate the clinical activity of relapses in women with MS during the post-partum phase, when treated for three months immediately post-delivery with a progestin combined with a low dose of estradiol, compared to a placebo-controlled group.	300 women post-partum diagnosed with MS, divided into treatment and placebo groups. From those patients, a subgroup of 100 patients, half treatment and placebo, to partake in the MRI follow up; another subgroup of 60 patients partaking in a standardized biological follow-up.	Within 24 hours post-delivery, 5 mg of Lutenyl (19 nor-progesterone derivative) was given to the patients daily for two weeks; the dose was increased to 10 mg for the remaining 10 weeks. Starting on the 15th day post-delivery, a 75 µg patch of Dermestril Septum is applied once a week until the end of the 12 weeks; f/b a 12 week non-treatment period. The treatment with estradiol and progestin may prevent the relapses of MS post-partum and during pregnancy. Experiment is ongoing.
Zhu, W-H, Lu, C-Z, Huang, Y-M, Link, H, Xiao, B-G	A putative mechanism on remission of multiple sclerosis during pregnancy: estrogen-induced indoleamine 2,3-dioxygenase by dendritic cells	1b	2007	The possible role estrogen (17β-estradiol) may have in the decreased relapse rates during pregnancy. Also how DCs affect immune responses during pregnancy.	24 patients diagnosed with MS according to acceptable criteria	Estrogen decreased the ability of DCs to create T-cells and inhibited Th1 and Th2 cytokine creation by T cells. MS is affected during pregnancy according to the estrogen-DC-IDO chain.

Neuteboom, R.F., Verbraak, E., Voerman, J.S., van Meurs, M., Steegers, E.A., de Groot, C.J., et al.	First trimester interleukin 8 levels are associated with postpartum relapse in multiple sclerosis	1b	2009	To determine whether pregnancy-induced changes of interleukin 8 correlated with periods of increased and diminished disease activity.	36 women diagnosed with MS with a relapsing-remitting disease course who were able to walk.	IL-8 levels were significantly higher during the first trimester compared to the third trimester. Women who had high interleukin 8 serum levels during the first trimester were at a high risk for postpartum relapse.
Vukusic, S., Hutchinson, M., Hours, M., Moreau, T., Cortinovis-Tournaire, P., Adeleine, P., et al.	Pregnancy and multiple sclerosis (the PRIMS study): clinical predictors of post-partum relapse	1b	2004	To report the follow-up results of the women who participated in the PRIMS study two years post-partum and aimed to analyze predictive factors of relapse during the three months following delivery.	227 women diagnosed with MS based on Poser's criteria and who had full-termed pregnancies.	There was a slight reduction in the relapse rate but it did not differ significantly from the recorded rates during their pre-pregnancy year. The women who had high disease activity in the pre-pregnancy and pregnancy years had higher chances of relapse.
Sicotte, N.L., Liva, S.M., Klutch, R., Pfeiffer, P., Bouvier, S., Odesa, S., Wu, J., and Voskuhl, R.R.	Treatment of multiple sclerosis with the pregnancy hormone estriol	1b	2001	The purpose of this article is to determine if the hormone estriol can lessen the manifestations of MS.	12 female patients with clinically diagnosed MS	For patients with RRMS, clinically significant improvements were seen. The study outcomes are consistent with previous studies. If administered for long periods, estriol should be given with progesterone to avoid uterine endometrial hyperplasia. There was no correlation between increased MRI disease activity and the cessation of estriol. There were no significant increases of relapses during the post-treatment period.
Confavreux, M.C., Hutchinson, M.M., Hours, M.M., Cortinovis-Tournaire, M.P., Moreau, M.T., Group, T.P.	Rate of Pregnancy-Related Relapse in Multiple Sclerosis	1b	1998	Prospective study investigated the relapse rate per trimester of pregnancy as well as the effects of breast-feeding and epidural analgesia during the first three months post-partum.	254 women diagnosed with MS according to the Poser et al classification system	Relapse rates decreased significantly during the third trimester of pregnancy and increased to higher than pre-pregnancy rates within the first three months post-partum.

Soldan, S. S., Retuerto, A. I., Sicotte, N. L., & Voskuhl, R. R.	Immune Modulation in Multiple Sclerosis Patients Treated with the Pregnancy Hormone Estriol	2a	2003	To determine if treatment with oral estriol would be beneficial in patients with MS, and whether those benefits were interrelated with "changes in cytokine profiles consistent with an anti-inflammatory, Th1 to Th2, shift in stimulated peripheral blood mononuclear cells (PBMCs)"	A total of ten female patients between the ages of 28 - 50 years diagnosed with MS; six patients were diagnosed with RRMS and four patients with SPMS	During the oral estriol treatment phase of the study, the results were a decrease of CD4+, CD8+, and memory T cells; an increase of naïve T cells and CD19+ B cells; no change in CD64+ monocytes/macrophages. In vivo estriol treatment showed a cellular alteration of an increase in IL-5 and IL-10 cells, with a decrease in secreted TNF- α cell; greater effects were noticed in patients with RRMS. The study shows a partial shift in Th1 and Th2 stimulated PBMCs suggesting that estriol may have an anti-inflammatory effect on diseases.
Nociti V, Cianfoni A, Mirabella M, et al.	Clinical characteristics, course and prognosis of spinal multiple sclerosis	2b	2005	The purpose of this retrospective study is to define the clinical characteristics, clinical course with and without treatment, and outcome for patients with spinal MS.	13 patients with clinically diagnosed MS	Patients with PPMS showed a more rapid rate of deterioration at a later age of onset while those with RRMS showed a slower disease progression at an earlier age of onset. Disability prognosis of MS seems to rely heavier on the age of onset and disease course than the site of the lesion.
Correale, J., Arias, M., and Gilmore, W.	Steroid Hormone Regulation of Cytokine Secretion by Proteolipid Protein-Specific CD4+ T cell Clones Isolated from Multiple Sclerosis Patients and Normal Control Subjects	2b	2011	To determine whether other pregnancy associated steroid hormones; estrone (E1), estriol (E3), progesterone, and dexamethasone are capable of similar activity.	10 patients with clinically definite MS (6 relapse remitting, 4 progressive) and 2 control subjects	The datum indicated that estrone, estriol, progesterone, and glucocorticoids act selectively to affect the secretion of individual cytokines regardless of the Th subset identity.

Niino, Masaaki, Hirotoni, Makoto, Fukazawa, Toshiyuki, Kikuchi, Seiji, Sasaki, Hidenao	Estrogens as Potential Therapeutic Agents in Multiple Sclerosis	2c	2009	Discusses the evidence available, both in vitro and in vivo, that focuses on a link between MS and estrogen. It also examines the potential therapeutic effects of estrogen on MS.	Patients with MS and mice with EAE	E3 is at its highest levels during pregnancy and E2 significantly increases during the third trimester of pregnancy. E2 is able to alter the amounts of both anti- and pro-inflammatory immune cells activities. In EAE, E3 can reduce inflammatory cytokines levels, including IL-2, IL-6, and IFN γ , and TNF. Estrogen had the potential to aid in treatment of MS, but currently the estrogens available for use are considered more risky than beneficial due to their side effects
Yates, M.A., Li, Y., Chlebeck, P.J., Offner, H.	GPR30, but not estrogen receptor-alpha, is crucial in the treatment of experimental autoimmune encephalomyelitis by oral ethinyl estradiol.	3b	2009	The purpose of this experimental study was to determine the impact of the G-protein coupled estrogen receptor (GPR30) and estrogen receptor-alpha (ERa) on the ability of ethinyl estradiol (EE) for the treatment of EAE.	Mice with EAE	GPR30 may play a vital role in the alteration of disease. This is most likely related to the production of IL-10. The responsiveness of EE-ERKO indicates that ERa is not a vital contributor to the decrease of disease severity with EE treatment.
Kim, S., Liva, S.M., Dalal, M A., Verity, M.A., Voskuhl, R.R.	Estradiol ameliorates autoimmune demyelinating disease: Implications for multiple sclerosis	3b	1999	The purpose of this article was to determine if the hormone estradiol can cause immune changes similar to those seen in pregnancy and therefore, alleviate the clinical manifestations of MS and EAE in mice.	Mice with EAE	Estradiol was found to be the primary cause for the reduction of severity of EAE during the late stages of pregnancy. Despite previous reports that progesterone causes increases in IL-4, an anti-inflammatory cytokine for EAE, the researchers observed no affect of progesterone on the clinical course of the disease.

McClain, M. A., Gatson, N. N., Powell, N. D., Papenfuss, T. L., Glenapp, I. E., Shawler, T. M., et al	Pregnancy Suppresses Experimental Autoimmune Encephalomyelitis (EAE) through Immunoregulatory Cytokine Production	3b	2007	To determine if EAE had an effect on the gestational stages of mice, and to understand why there is a drastic decrease of disease activity in the 3rd trimester and a rapid increase in the postpartum. Researchers investigated whether the disease suppression during gestation was the result of immunoregulatory cytokine production or a Th2 bias.	Age-matched SJL/J and C57BL/6 mice that were pregnant and non-pregnant injected with EAE	EAE stimulated late pregnancy results in a positive effect on the disease process. Postpartum EAE stimulation has a negative effect on the disease process. Immunizations of Ag peptides, PLP-139, PLP-151, and CPA, during the latter part of pregnancy showed a reduction in the clinical signs of EAE with a more protective mechanism observed within the mice.
El-Ert, M., Ghoumari, A., Sitruk-Ware, R., and Schumaker, M.	Hormonal Influences in Multiple Sclerosis: New Therapeutic Benefits for Steroids	3b	2010	To discuss the influences of sex steroids on MS, and the role of estradiol and progesterone in myelination; and to provide clinical trials of the effects estrogens and progestins have in MS.	The journal article did not provide a specific population.	EAE studies showed that estradiol and progesterone exert multiple beneficial effects on autoimmune responses, neuroinflammation, the viability of neurons, the integrity of axons and the re-formation of myelin sheaths.

Discussion

The altered immune system caused by the hormonal changes which occur during pregnancy demonstrates the positive effects estrogen has on MS disease activity. Based on the evidence gathered in this literature review, it is postulated that estrogen, more specifically estriol, has significant effects on immunomodulatory alterations of disease activity in pregnant women diagnosed with MS. Estrogen has demonstrated the ability to shift T-cells from pro-inflammatory to anti-inflammatory status. Other pregnancy hormones, such as the combination of progestin and estradiol, may eventually be found to play a role in the post-partum relapses of MS disease activity (Vukusic et al., 2009). The therapeutic use of estrogen for women with MS may lead to a decrease in the number of exacerbation/relapse episodes. This could support a better quality

of life for women diagnosed with MS and increase the efficacy of medical and other therapeutic interventions. Additional research is indicated to find an optimal dosage of estrogen and/or other hormones in order to provide a shift from Th1 pro-inflammatory cytokines to Th2 anti-inflammatory cytokines. The conduction of additional studies, using human subjects of different ethnicities, may facilitate the progression of research into the effects of long-term estrogen therapy use in patients with MS.

Limitations

While this review elicited valuable information, the analysis in this study was limited to pregnant women who had the RRMS form of MS. Only the third trimester of pregnancy and the post partum period of three months were considered. In addition, the lone hormone considered was estrogen.

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Is There a Link Between Estimated Physical Activity and Mean Arterial Pressure in Individuals With and Without Hypertension?

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Abstract

Purpose: The purpose of this study was to examine the relationship between physical activity and mean arterial pressure in individuals with and without hypertension.

Methodology: This study utilized secondary data from the 2003-2004, 2005-2006 cycles of the National Health and Nutrition Examination Survey. From the available data, the following parameters were utilized: demographics; estimated physical activity levels; blood pressure measurements; history of hypertension; and use of hypertensive medications. The data were analyzed using the SPSS 18 statistical software package.

Results: 71% of all the individuals in the sample reported they were performing light physical activity levels. 79.5% of subjects with hypertension reported normal MAP levels; 70.2% of individuals with hypertension were able to maintain normal MAP levels with medication use and light physical activity. 83.5% of the individuals without hypertension had desirable mean arterial pressure levels; 73.4% of those individuals with desirable mean arterial pressure levels also reported light participation in physical activity.

Conclusion: The results of this study indicated that light levels of regular physical activity were linked to lower mean arterial pressure levels in most subjects in the sample, regardless of hypertensive status. However, further research is warranted to examine cause and effect relationships between physical activity and mean arterial pressure.

Key Words: Physical activity, hypertension, mean arterial pressure.

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Introduction

Hypertension (HTN) is the most important cardiovascular risk factor worldwide. It contributes to half of the coronary heart disease and approximately two thirds of the cerebrovascular disease burdens (Cutler et al., 2008). Untreated HTN can lead to myocardial infarction, stroke, end-stage renal disease, and congestive heart failure. Major risks for HTN include family history, male gender, advancing age, tobacco smoking, obesity, sedentary lifestyle, and elevated cholesterol in the blood. Based on the National Health and Nutrition Examination Survey (NHANES) data (1999–2002), the prevalence of HTN in the United States (US) was 28.6%. It is estimated that nearly one billion people are affected by HTN worldwide, and this figure is predicted to increase to 1.5 billion by 2025 (Hajjar, Kotchen, & Kotchen, 2006). In a

National Institute of Health study (Spurgeon, 2004), HTN was shown to be especially problematic in women 70 years and older, African Americans, Mexican Americans, individuals with diabetes mellitus and chronic kidney disease. Women and men aged 70 years and older were considerably less likely to control their HTN than those aged 60-69. Also, women ages 70 and older were noticeably less aware of their HTN and thus were undiagnosed or untreated.

HTN is classified as having an elevated blood pressure over 140 mmHg (systolic) and over 90 mmHg (diastolic) that is abnormally sustained at rest (Harris, Caspersen, DeFries, & Estes, 1989). During each heart cycle, the blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure. Individual systolic or diastolic pressure measurements may also be affected by time of day, diet, the “white coat syndrome” increased sympathetic activity, age, central obesity, and specific pathophysiology of HTN (Mohrman & Heller, 2006).

The mean arterial pressure (MAP) usually serves as an expression of the patient’s overall blood pressure, instead of using solely systolic blood pressure (SBP) and diastolic blood pressure (DBP). It is a critically important cardiovascular variable because it is the average effective pressure that consistently drives blood through the systemic organs (Mohrman & Heller, 2006). It is also viewed as a measure of tissue perfusion. All changes in the MAP result exclusively from changes in either cardiac output or total peripheral resistance (Mohrman & Heller, 2006). Desirable MAP ranges are 70-100 mmHg. Ideal MAP is defined as 93 mmHg which is equivalent to a 120/80 blood pressure reading (National Center for Health Statistics, 2002a). MAP is defined as the average blood pressure in a single cardiac cycle. Because of the SBP/DBP variability and MAP’s inherent consistency, authors have concluded that the mean arterial pressure is a better indicator for HTN (Aubuchon, 2009).

Pharmacotherapy has become the rule rather than the exception in the treatment of these risk factors, whereas, conservative

methods such as diet modification and physical activity are not consistently utilized. Thus, lifestyle modification directed at the underlying risk factors constitutes a complementary and more fundamental approach to reducing the burden of illness (Aubuchon, 2009; Whelton, 1994). Recent studies (Klabunde, 2007; Williams, 2008) have shown that lifestyle changes such as physical activity, weight loss and dietary changes yield good results in decreasing blood pressure.

Physical activity has had a positive effect on SBP, with SBP dropping by at least 10 mmHg (Jones et al., 2007). Walking an extra 30 minutes is associated with a lower mean blood pressure among African American adults recently diagnosed with HTN (LaPier, Kinney R.J, & Swislocki, 2001). It has also been observed that an accumulation of physical activity throughout the day is more beneficial than a single continuous session of physical activity in decreasing blood pressure (Madden, Lockhart, Cuff, Potter, & Meneilly, 2009). There is no literature available at this time that examines the relationship of MAP to physical activity. The purpose of this study was to examine the relationship between MAP and physical activity in individuals with and without HTN, using secondary data from NHANES.

Methodology

This study utilized data extracted from the 2003-2004, 2005-2006 NHANES cycles. NHANES is a US Government population-based survey designed to collect information on the health and nutrition of the civilian non-institutionalized US population (National Center for Health Statistics, 2007). NHANES utilizes a complex, stratified, multistage probability sample (National Center for Health Statistics, 2007). NHANES usually over-samples certain at-risk segments of the population such as low-income persons, adolescents 12-19 years, persons 60 years of age and older, African Americans and Mexican Americans (National Center for Health Statistics, 2007). Every year, approximately 7,000 people

representing all age groups participate in an interview in their homes and approximately 5,000 of them also participate in the health examination component, which is typically conducted in mobile examination centers (National Center for Health Statistics, 2007). From the data collected in NHANES, the following parameters were utilized: Age, gender, ethnicity, estimated physical activity level, blood pressure measurements, history of HTN, and use of anti-hypertensive drugs. The operational definition of having HTN is that an individual was told at least twice by a physician that she/ he has high blood pressure (National Center for Health Statistics, 2002b). The MAP was calculated using the formula: $[MAP = DBP + 1/3(SDP - DBP)]$ (Mohrman & Heller, 2006).

The data were analyzed using the SPSS 18 (Statistical Package for Social Sciences) statistical package (Chicago, IL). The following non-parametric statistical tests were employed to analyze the data: Frequencies, crosstabs, and chi-square tests.

Results

The sample size included 10,020 individuals (20- 89 years old) from NHANES cycles 2003-2004 and 2005-2006. The gender consistency of the sample was 48.0% male and 52.0% female. Table 1 summarizes the socio-demographic characteristics of the sample utilized in this study, while figure 1 highlights the number of individuals with HTN in the sample.

There were 1339 individuals who reported to have HTN (Figure 1), of those only 993 individuals had blood pressure measurements as part of the NHANES. All these 1339 individuals with HTN also reported that they were taking anti-hypertensive drugs. At every level, light physical activity was most prevalent. Of the individuals with HTN, 79.5% (789 of 993) had normal MAP levels of $d \leq 93$ mmHg (optimum rate). Additionally, 70.2% (554 of 789) of those individuals with normal MAP levels also reported light participation in

Table 1: Socio-demographic Characteristics of Sample

	Sample Frequencies	Sample Percentages
Gender		
Male	4805	48.0
Female	5215	52.0
Total	10020	100.0
Age		
20-29	1977	19.7
30-39	1688	16.8
40-49	1631	16.3
50-59	1253	12.5
60-69	1461	14.6
70-79	1099	11.0
80-89	911	9.1
Total	10020	100.0
Ethnicity/Race		
Non- Hispanic White	5184	51.7
Non- Hispanic Black	2117	21.1
Mexican American	1988	19.8
Other Hispanics	306	3.1
Other Race- Including Multi Racial	425	4.2
Total	10020	100.0

FIGURE 1
Individuals who answered whether they were told by a physician at least twice that they had hypertension.

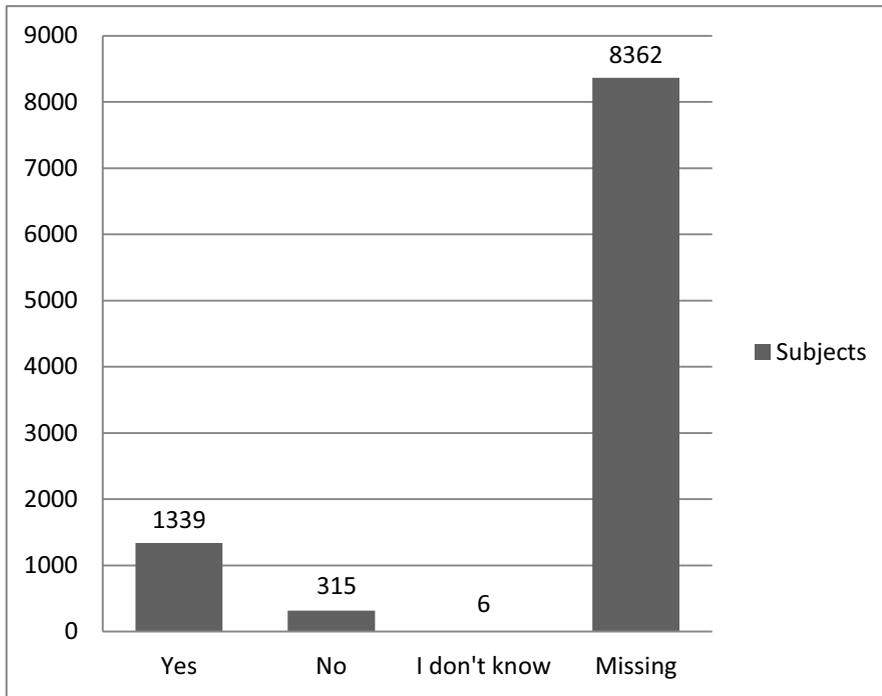


FIGURE 2
Mean Arterial Pressures and Estimated Physical Activity Levels in Hypertensive individuals

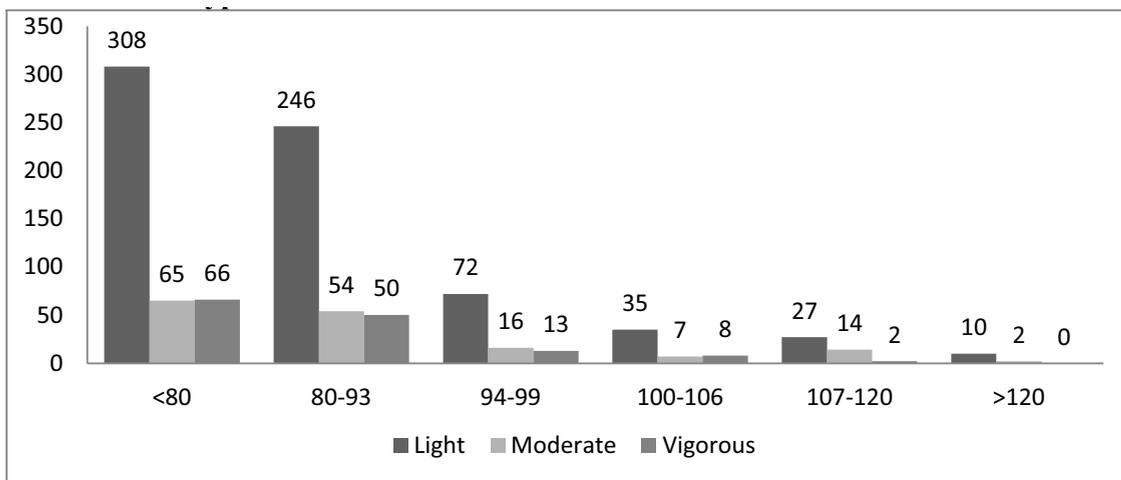
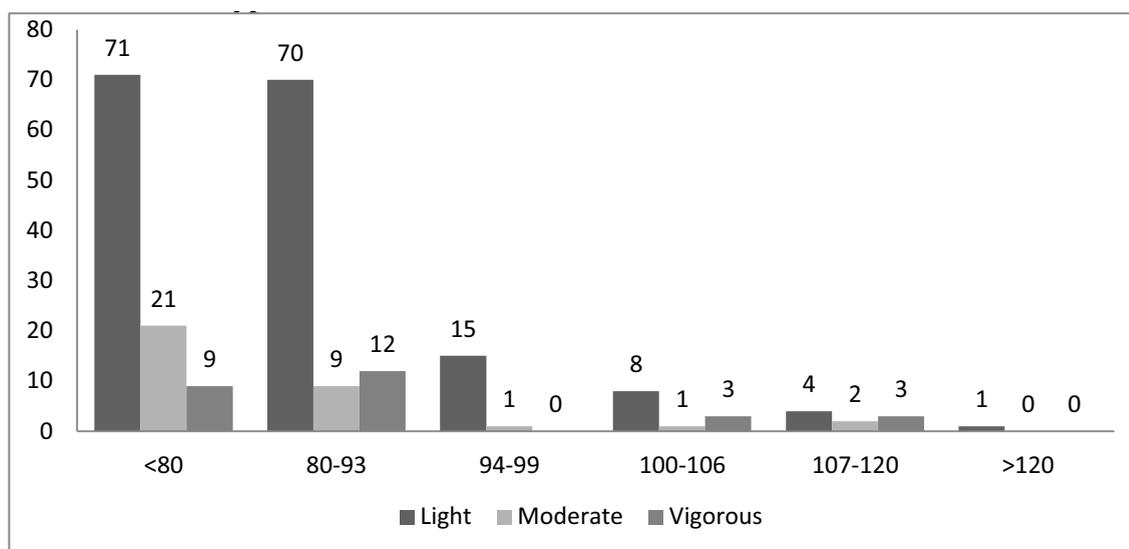


FIGURE 3
Mean Arterial Pressures and Estimated Physical Activity Levels
in Non-Hypertensive individuals



physical activity. On the other hand, 20.7% (206 of 993) of individuals with HTN reported undesirable MAP levels of 94mmHg. Among those individuals with undesirable MAP levels 30.0% (62 of 206) also reported light participation in physical activity. Therefore, 40% less individuals in the latter group reported participating in light physical activity on a weekly basis. Figure 2 shows the relationship between mean arterial pressure levels and estimated level of physical activity in individuals with HTN ($P>0.05$).

There were 315 individuals in the sample that answered the survey question regarding having HTN, but reported not being diagnosed with hypertension. Of those individuals, only 230 had blood pressure measurements. 83.5% (192 of 230) of the individuals without HTN had desirable MAP levels of <93mmHg. 73.4% (141 of 192) of those individuals with desirable MAP levels also reported light participation in physical activity. On the other hand, 16.5% (38 of 230) of the individuals without HTN had undesirable MAP levels of \geq 94mmHg. 34.2% (13 of 38) of those individuals with undesirable MAP levels also reported light participation in physical activity. Therefore, 39% less individuals in the latter group

reported participating in light physical activity on a weekly basis. Figure 3 shows the relationship between mean arterial pressure levels and estimated level of physical activity in individuals without HTN ($P>0.05$).

Discussion

The results of the study indicate that the majority of individuals regardless of age, ethnicity, gender or diagnosis of HTN participated in light physical activity. It also appears that, regardless of hypertensive status, individuals participating in light physical activity had MAP levels within normal limits. In the contrary, individuals with undesirable MAP levels in both groups reported considerably lower levels of participation in physical activity.

The authors of this study questioned whether there is a link between MAP and physical activity in individuals with and without HTN. Regular physical activity has been linked to an overall decrease in systolic blood pressure and thus decreasing the risk of stroke and cardiovascular disease (Cutler et al., 2008). Additionally, a few authors (Aubuchon, 2009; Jones et al., 2007) have claimed that MAP is a better indicator of HTN. When comparing the MAP of

individuals with HTN to those without HTN, it is clear that in both groups those who displayed well controlled MAP levels (<93mmHg) also reported performing light physical activity. The majority of those individuals who reported being diagnosed with HTN also reported normal mean arterial pressure levels. Among individuals with HTN, those who reported at least light physical activity maintained normal MAP levels. The results also indicated that individuals with high MAP levels (>120) did not report participating in any physical activity, suggesting a direct link between worsening of symptoms and decreasing physical activity, or they were instructed by their physician not to exercise due to medical complications.

Although the results of this study fell under the threshold set for tests of significance, the strong response patterns lead the authors to speculate that there is an inverse link between light physical activity and MAP levels in individuals without HTN. Despite similar results, the authors refrain from claiming a similar link for individuals with HTN. Since, as mentioned earlier in the results, all individuals with HTN in this study were taking anti-hypertensive drugs, it would be unwise to claim that light physical activity

could be linked to normal MAP levels regardless of the use of these drugs. However, the authors speculate that light physical activity in addition to medication can lead to decreased MAP levels in individuals with HTN.

Based on the type of data required, only two NHANES cycles were available for the study and many of the selected cases were excluded due to missing values in key variables, such as diagnosis and BP measurements. Additionally, due to the large number of missing values, the authors were unable to produce population estimates, and therefore the results cannot be generalized. Lastly, since the results are limited to the sample, the authors opted to use SPSS 18 for statistical analysis, instead of survey-analysis specific software.

Conclusion

The results of this study indicate that light levels of regular physical activity were linked to lower mean arterial pressure levels in most subjects in the sample, both with and without hypertension. Further research is warranted to examine cause and effect relationships between physical activity and mean arterial pressure.

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Muscle Timing and Activation Patterns during Two Movement Screening Tests in Subjects With and Without Low Back Pain

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Abstract

Study Design: Controlled laboratory study. **Purpose:** The aim of this study was to determine if there are any differences in hip and trunk muscle activation and firing patterns during 2 movement screening tests in individuals with low back pain (LBP) and control participants.

Methods: Muscle activation for specific trunk and lower extremity muscles was examined by surface Electromyography (EMG). Twenty-two healthy active controls (mean age \pm SD, 27.2 \pm 4.6 years) and twelve subjects with LBP (mean age \pm SD, 44.4 \pm 14.6 years) participated in the study. The movement tests under investigation were the prone straight leg raise (PSLR) and sidelying hip abduction (SHA). Mean onset muscle timing and activation patterns were identified for each movement test. Separate one-way analyses of variance (ANOVAs) were used to determine differences in muscle onset times between groups. The influence of age was considered as a covariate in the analysis.

Results: Significant between group differences were identified in muscle onset times. During the PSLR, subjects with LBP recruited muscles of the lower extremity before the trunk. This pattern was reversed for the controls. The onset time of the gluteus maximus was significantly greater for subjects with LBP ($P=0.001$). During SHA, the firing sequence was similar for both groups. Compared to healthy controls, subjects with LBP displayed a significant delay in onset times for all back muscles ($P<0.002$).

Conclusions: Subjects with LBP were unable to effectively recruit/control their trunk musculature during these movement screening tests. A better understanding of this movement impairment and the restoration of trunk control may lead to a faster recovery.

Keywords: electromyography, muscle timing, firing patterns, low back pain

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Introduction

Low back pain (LBP) is one of the most common conditions experienced by the majority of society. In the United States, LBP is one of the top five reasons for physician office visits with approximately 19 million visits reported in 2001 (Deyo, Mirza, & Martin, 2006; Panel on Musculoskeletal Disorders and the Workplace, 2001). Lifetime prevalence has been reported to be between 60% and 90% (Anderson, 1991; Waddell, 1987) and at any given time 6.8% of the world's population is affected by LBP (Cox, 2011). According to Patel and Ogle (2000), 50% of the active work force will experience symptoms related to LBP annually. It is one of the principal causes of absenteeism from work and daily activity impairment (van Dieen, Selen, &

Cholewicki, 2003). One in five individuals with LBP report substantial limitations in activity (Von Korff & Saunders, 1996). After an acute episode, approximately 33% will report persistent back pain of at least moderate intensity during the following year (Von Korff & Saunders, 1996). Further, 10% of all patients suffering from LBP will experience disability lasting greater than three months (Woby, Watson, Roach, & Urmston, 2004).

Individuals with back pain were found to have trunk extensor weakness, excessive fatigability and poor lumbar muscle endurance (Pitcher, Behm, & MacKinnon, 2008; Taimela, Kankaanpaa, & Airaksinen, 1998). Low back pain has also been shown to negatively affect maximum voluntary muscle activation, through neuromuscular inhibition and/or altered motor control patterns of the trunk (O'Sullivan, Phytty, Twomey, & Allison, 1997; Richardson & Jull, 1995; Zedka, Prochazka, Knight, Gillard, & Gauthier, 1999).

In order to identify appropriate strengthening exercises, many studies have focused on muscle activity levels as opposed to understanding the muscle firing sequence and how it may differ in individuals with back pain. Electromyography (EMG) studies of the trunk musculature found that individuals with LBP displayed differences in muscle group amplitudes/activation levels that could not be explained by postural asymmetries (Dolce & Raczynski, 1985; Lariviere, Gagnon, & Loisel, 2000). Bullock-Saxton, Janda, and Bullock (1994) found that subjects with LBP experienced a delay in gluteus maximus firing while prone and gluteus medius firing while sidelying. Irregular firing patterns may lead to compensatory substitutions which reduce the effectiveness of stabilizing muscles (Danneels et al., 2002). Subjects with LBP also produced significantly lower force values (during isometric contraction) in the lumbar iliocostalis and the longissimus than those without pain (Candotti et al., 2008).

The prone straight leg raise (PSLR) and sidelying hip abduction (SHA) movement tests are frequently used to screen patients with low back and/or pelvic dysfunction

(Davis, Bridge, Miller, & Nelson-Wong, 2011). Individuals with these dysfunctions seem to display altered movement patterns, making this type of screen appropriate. SHA may be useful in predicting low back pain (LBP) development during prolonged standing tasks (Nelson-Wong, Flynn, & Callaghan, 2009). It is important to understand normal firing patterns in order to correctly identify muscle dysfunction and choose effective treatment interventions (Vogt & Banzer, 1997). Therefore, the purpose of this study was to examine if differences exist in hip and trunk muscle activation and firing patterns during 2 movement screening tests in individuals with low LBP and healthy controls. Based on previous literature, we hypothesized that back muscle onset times and muscles firing patterns would differ between those with and without LBP.

Methods

Subjects

Twenty-two healthy active subjects serving as a control group (11 males, 11 females; mean \pm SD age, 27.2 ± 4.6 years; body mass index, 24.7 ± 4.9 kg/m²) and 12 subjects with LBP (5 males, 7 females; mean \pm SD age, 44.4 ± 14.6 years; body mass index, 29.7 ± 10.3 kg/m²) volunteered to participate in this study. All subjects were 18 years of age or older and completed an informed consent form that described the testing protocol, which was approved by the University of Maryland Eastern Shore Institutional Review Board for protection of human subjects. Female subjects were excluded if they were currently pregnant or gave birth within the last 2 years.

The control group was recreationally active and participated in physical activity for an average of 3.5 hours per week. Subjects were in good general health and reported no symptoms of injury at the time of testing, no back or lower extremity pain for the past 6 months, and no history of back or lower extremity surgery. Subjects with low back pain were recruited from local physical therapy clinics and accepted for the study if they (1) reported that the back pain began

within the last two months; (2) described a current level of pain 3 on a (0 to 10) visual analog scale; and (3) were referred to physical therapy by a physician or self-referred. Subjects with LBP were excluded if any of the following were present: (1) a history of back or lower extremity surgery; (2) signs of nerve root compression (2 or more of the following: positive straight leg raise test at an angle less than 45° or diminished lower extremity strength, sensory function, or deep tendon reflexes); and (3) evidence of serious pathology (e.g., acute spinal fracture, tumor, infection, etc).

General Practice Physical Activity Questionnaire (GPPAQ)

The GPPAQ provides a simple, four-level Physical Activity Index (PAI) reflecting an individual's current physical activity level. The instrument is intended for adults (16-74 years of age) and is a simple tool, requiring 30 seconds to complete. The GPPAQ has been shown to have good face and construct validity (Khaw et al., 2006). Subjects in the control group were asked to complete the GPPAQ in order to better understand their physical activity level in terms of their job and the type and amount of aerobic exercise regularly performed.

Pain Intensity

The visual analog scale (VAS) has been shown to be a valid and reliable instrument used to measure intensity of pain (McCormack, Horne, & Sheather, 1988; Price, McGrath, Rafii, & Buckingham, 1983). A 10-cm visual scale, with written descriptors at 0 ("no pain") and 10 ("maximum pain"), was used to understand pain intensity and determine participation eligibility. Subjects with LBP were asked to rate their current pain intensity and describe the current pain location.

Protocol

Subjects attended one test session. During this time demographic data was collected, questionnaires completed, and subjects were assessed for the movement tests under investigation. Testing was performed on the dominant lower extremity

or, in subjects with LBP, the pain dominant or movement impaired lower extremity. The EMG procedure consisted of electrode placement, practice and familiarization, and muscle onset timing assessment.

Electrode Placement

Subjects were prepared for electrode placement. Alcohol was used to cleanse the skin and reduce tissue impedance. Bipolar surface electrodes (Noraxon USA, Inc; Scottsdale, AZ) were placed on the selected muscles for each test, according to a basic understanding of surface anatomy (Greenman, 2003; Kendall, 2005). All of the posterior trunk and hip/thigh muscles (primarily responsible for the movement under consideration) accessible for assessment with surface EMG (Konrad, 2006) were investigated. Electrodes were silver-silver chloride pre-gelled with a diameter of 1 cm and inter-electrode distance of 2 cm. The same examiner, a physical therapist with approximately 14 years of clinical experience and a board certified orthopedic clinical specialist, positioned the electrodes on all subjects. Each electrode was connected to a Noraxon Telemyo 2400T G2 transmitter (Noraxon USA, Inc; Scottsdale, AZ). The sampling rate was 1500 Hz. All raw myoelectric signals were pre-amplified (overall gain, 500). The common mode rejection ratio was >100 dB, the signal-to-noise ratio was <1 μ V RMS baseline noise, and filtered to produce a bandwidth of 10-500 Hz.

For both movement tests, the same trunk muscles (lumbar multifidus and lumbar erector spinae) were recorded on both sides of the torso. The lumbar multifidus electrodes were placed 2 cm lateral to the L5 spinous process. Lumbar erector spinae electrodes were placed 4 cm lateral to the L3 spinous process. The lower extremity muscles differed for each movement test. During the PSLR, the Gluteus Maximus electrodes were placed 4 cm inferior to the posterior superior iliac spine. The medial and lateral hamstring electrodes were placed at the mid-thigh level, between the gluteal fold and the respective femoral condyle. During SHA, the tensor fascia latae electrodes were

placed at the mid-point of an imaginary line between the greater trochanter and the anterior superior iliac spine (ASIS). The Gluteus Medius electrodes were applied 2.5 cm posterior to the midpoint of the line bisecting the ASIS and greater trochanter.

All electrodes were aligned parallel to the fiber direction of the target muscle. Correct electrode placement was verified by EMG signal analysis (visual inspection) during the motion test under consideration. This information was also used to ensure that a true baseline was maintained at rest. A reference electrode was placed along the shaft of the most palpable rib posteriorly, on the right mid-axillary line.

Movement Tests

All subjects were screened to ensure they were able to perform each movement test. The test leg was identified and each subject was familiarized with the desired movement (verbally and visually) and practiced the motion twice. Corrective feedback was provided, if needed. With EMG equipment, each subject performed 2 trials for reliability and 2 trials for timing analysis, for each movement test. A standardized set of computer generated voice commands were used to synchronize the data collection process. Upon command, subjects moved into the desired position and held that position for 3 seconds. Subjects rested for 1 minute between trials.

The prone straight leg raise was the first movement test analyzed. Subjects were positioned their stomachs with their knees extended and ankles off the edge of the table. From this position, maximal hip extension was performed (Figure 1A).

The next movement test analyzed was sidelying hip abduction. For this movement test, subjects were positioned on his or her non-test side with the test leg in neutral, resting on a pillow, with the knee extended. From this position, maximal hip abduction was performed (Figure 1B).

Data Processing

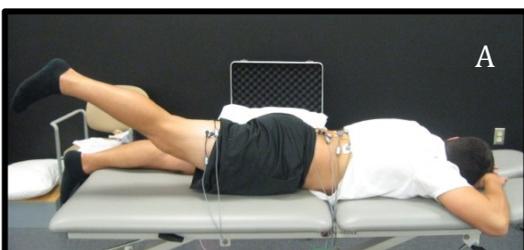
Raw EMG data were converted from analog to digital at 1500 Hz. The raw signals were rectified, smoothed, and reduced for cardiac artifact. Activation of the different muscles was determined for each movement test. We analyzed a 5 second window starting from the point where the subject was given the verbal command to contract. A muscle was considered to be activated when the signal surpassed the trigger level of 3 standard deviations beyond the baseline activity level at the beginning of the concentric phase of the motion. This method sets activation at a higher threshold and is considered to be a reliable technique (Bolgia, Malone, Umberger, & Uhl, 2010; Di Fabio, 1987). The point in time when each muscle reached this activity level was determined. If a muscle did not reach this level, the onset time was coded as 5 seconds. These measures of time were averaged for each muscle during both movement tests.

Statistical Analysis

The statistical analysis was performed using Statistical Package for the Social Sciences, version 19.0 (SPSS Inc, Chicago, IL). An intraclass correlation coefficient (ICC) was used to determine same day test-retest reliability of the EMG recordings. The individual mean muscle onset times were averaged, across the group, to determine

FIGURE 1

Movement Tests: (A) prone straight leg raise and (B) sidelying hip abduction



overall mean onset time for each muscle. From this data, the firing patterns for the 2 movement tests (PSLR and SHA) were established. A 1-way analysis of variance (ANOVA), with age as a covariate, was applied for each muscle to identify differences between groups. This was performed for each movement test.

Results

Prone Hip Extension

During prone hip extension, Vogt and Banzer (1997) showed that in asymptomatic individuals, the ipsilateral erector spinae was recruited prior to the hamstrings. During the same motion, the gluteus maximus was the last muscle, within the muscles assessed, to be activated (Lehman, Lennon, Tresidder, Rayfield, & Poschar, 2004; Sakamoto et al., 2009; Vogt & Banzer, 1997). Results from our study revealed a similar activation pattern for subjects without LBP. The gross recruitment pattern began with the contralateral trunk extensors, followed by the ipsilateral trunk extensors, and finally the gluteus maximus. The immediate activation of the contralateral trunk muscles may initiate a stabilization process and balance the force required to move the limb on the opposite side of the body.

We found that this pattern was generally reversed in subjects with LBP as the recruitment process moved from a distal to proximal direction, with the exception of the gluteus maximus. In both groups, the gluteus maximus was the last muscle to fire. However, when comparing gluteus maximus activation times between groups, the onset time was significantly longer in subjects with LBP. This delay in activation of the gluteus maximus may have occurred secondary to inhibition of the stabilizing trunk musculature. Danneels et al. (2002) discussed how pain, pain avoidance and deconditioning may contribute to a reduction in back muscle EMG activity levels in subjects with LBP.

Sidelying Hip Abduction

When asymptomatic individuals performed SHA, the gluteus medius and tensor fascia latae were clinically observed

to become active prior to the ipsilateral erector spinae, with the GM firing first (Greenman, 2003). Our results for sidelying hip abduction showed that subjects with and without low back pain displayed a similar muscle firing pattern, recruiting the lower extremity prior to the low back musculature. However, subjects with low back pain displayed a significant delay in the onset times for all of the back musculature examined. Although not found to be statistically different, subjects with low back pain displayed a mean delay of gluteus medius activation by more than one second. This delay in gluteus medius activation, possibly due to inhibition of the back musculature, may be clinically significant and could lead to abnormal movement patterns. Previous research has identified gluteus medius weakness as a factor that contributes to lower extremity injury via altered joint loading patterns and reduced motor control (Fulkerson, 2002; Powers, 2003).

The sidelying hip abduction screening tool performed moderately well in predicting those who are at risk for developing low back pain during prolonged standing (Nelson-Wong et al., 2009). This motion has also been shown to be effective in activating the gluteus medius (Bolgia & Uhl, 2005; Distefano, Blackburn, Marshall, & Padua, 2009; Ekstrom, Donatelli, & Carp, 2007).

The same day test-retest ICCs for the EMG recordings from each muscle during each movement test are provided in Tables 1 and 2. These data suggest moderate to high reliability across trials for all muscles during each movement test. The only exception identified was the ipsilateral erector spinae during the PSLR, which was less reliable.

During the PSLR movement test, subjects with LBP activated the extremity muscles earlier than the back musculature. In healthy subjects, this pattern was reversed. In both groups, the gluteus maximus was the last muscle to be recruited. During SHA, the recruitment patterns were similar for both groups (extremity muscles fired before trunk musculature).

Significant differences in muscle onset timing were identified during both the PSLR and SHA tests. Compared to controls,

subjects with LBP displayed a significantly greater gluteus maximus ($P=.001$) and ipsilateral erector spinae ($P=.037$) activation times during the PSLR (Table 3). Subjects with LBP also demonstrated significantly greater trunk muscle activation times ($P<.002$), for all trunk muscles, during SHA (Table 4).

Muscle onset timing data and recruitment sequence for the PSLR and

SHA are summarized in Tables 3 and 4, respectively. Subjects with LBP described their current pain intensity (mean \pm SD) as 4.1 ± 1 cm on the VAS. Forty-one percent of the subjects with LBP reported having current pain in the central low back, 25% described pain in the right low back and right posterior thigh, 17% had pain in the left low back, and 17% had pain in the left low back and left posterior thigh.

TABLE 1
Within Subject Reliability For Each Muscle During The Prone Straight Leg Raise

Muscle	ICC	SEM (ms)
Contralateral Erector Spinae	0.90	293
Contralateral Multifidus	0.76	439
Ipsilateral Biceps Femoris	0.65	132
Ipsilateral Semitendinosus	0.65	180
Ipsilateral Multifidus	0.97	137
Ipsilateral Erector Spinae	0.39	899
Gluteus Maximus	0.96	295

Abbreviations: ICC, intraclass correlation coefficient; SEM, standard error of measurement; ms, milliseconds.

TABLE 2
Within Subject Reliability For Each Muscle During Side Lying Hip Abduction

Muscle	ICC	SEM (ms)
Tensor Fascia Latae	0.77	439
Gluteus Medius	0.90	365
Ipsilateral Multifidus	0.93	501
Ipsilateral Erector Spinae	0.98	276
Contralateral Erector Spinae	0.94	493
Contralateral Multifidus	0.96	401

Abbreviations: ICC, intraclass correlation coefficient; SEM, standard error of measurement; ms, milliseconds.

TABLE 3
Timing of Selected Muscles During The Prone Straight Leg Raise*

Muscle Under Investigation	Control (n=22)		LBP (n=12)		P
	Sequence & Mean Onset Time				
Contralateral Erector Spinae	1	720 ± 235	5	1516 ± 1353	.229
Contralateral Multifidus	2	738 ± 171	4	1504 ± 1236	.670
Ipsilateral Biceps Femoris	3	744 ± 173	1	756 ± 243	.716
Ipsilateral Semitendinosus	4	747 ± 262	2	824 ± 272	.082
Ipsilateral Multifidus	5	736 ± 227	3	1363 ± 1207	.279
Ipsilateral Erector Spinae	6	823 ± 264	6	2064 ± 1121	.037
Gluteus Maximus	7	882 ± 180	7	2810 ± 1885	.001

* Values are expressed as mean ± SD milliseconds.

TABLE 4
Timing of Selected Muscles During Side Lying Hip Abduction*

Muscle Under Investigation	Control (n=22)		LBP (n=12)		P
	Sequence & Mean Onset Time				
Tensor Fascia Latae	1	648 ± 126	1	1282 ± 1333	.102
Gluteus Medius	2	648 ± 150	2	1629 ± 1715	.115
Ipsilateral Multifidus	3	1086 ± 919	3	4176 ± 1283	< .001
Ipsilateral Erector Spinae	4	977 ± 404	6	4887 ± 393	< .001
Contralateral Erector Spinae	5	2734 ± 1914	5	4814 ± 490	.002
Contralateral Multifidus	6	1546 ± 1463	4	4431 ± 1295	< .001

* Values are expressed as mean ± SD milliseconds.

Discussion

The main objective in this study was to examine the differences in muscle onset timing and firing patterns during two frequently used screening tests in individuals with and without LBP. Significant differences in muscle onset times were identified between the two groups. During both movement tests, activation of the spine musculature was delayed in subjects with LBP. In addition, during the PSLR, subjects with LBP experienced a significant delay in gluteus maximus and ipsilateral erector spinae firing with a general reversal of muscle group recruitment patterns.

The movement tests examined in this study were chosen because they are

commonly used by physical therapists to screen patients with low back and/or pelvic dysfunction. The quantity and quality of motion is assessed as well as any movement substitutions, secondary to abnormal muscle recruitment and/or symptom changes. Differences in muscle firing patterns have been linked to low back pain (LBP) and it has been suggested that clinicians should measure not only the strength, but also consider the sequence of trunk muscle activation (D'Orazio, 1993; Greenman, 2003).

When using the PSLR as a screening tool for individuals with low back pain, it is important to recognize that the gluteus maximus is expected to fire last and that palpation should be used to assess for

muscular inhibition. Therapists should consider palpation of the lumbar musculature and gluteus maximus in order to identify gross side-to-side inhibition asymmetries while observing for any movement substitutions. When using SHA as a screening tool for individuals with low back pain, it is important to recognize that the low back musculature (paraspinals and multifidii), on both sides of the trunk, may be dysfunctional. During this test, therapists should consider palpating both sides of the trunk musculature while simultaneously observing for any abnormal movement patterns. In patients with LBP, abnormal firing patterns may lead to compensatory substitutions which reduce the ability of the stabilizing muscles to perform optimally (Danneels et al., 2002). Several authors agree that the most common pathologic substitution, during the SHA, seems to be a delay in activation of the gluteus medius (Bruno & J., 2007; Bullock-Saxton et al., 1994; Greenman, 2003). Hodges and Richardson (1998) concur and demonstrated that in patients with LBP, the normal proximal to distal muscle activation pattern was reversed.

Conclusion

The prone straight leg raise and sidelying hip abduction screening tools are frequently

used by physical therapists to assess for abnormal movement patterns and/or muscle inhibition. Compared to controls, subjects with low back pain showed a general recruitment pattern of extremity prior to trunk musculature during the PSLR. In addition, subjects with low back pain showed a significant delay in activation of the gluteus maximus and the ipsilateral paraspinal muscles. During the second test, SHA recruitment patterns were nearly identical for both groups as the lower extremity muscles were activated before the trunk. However, compared to controls, subjects with low back pain showed a significant delay in activation of all trunk musculature. Therefore, back muscle inhibition should be an immediate treatment consideration for individuals who are experiencing low back pain and test positive on either of the movement screening tests. Additional research is warranted in identifying treatment interventions that are most effective in restoring normal firing patterns and muscle activation in individuals with low back pain.

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The Implementation of Conductive Education in the Treatment of a Five Year Old Girl with Cerebral Palsy: A Case Report

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Abstract

Background and Purpose: *Conductive Education is an intervention utilizing group settings focused on enhancing function and preventing secondary complications in individuals with neurological disorders, particularly children with cerebral palsy. The purpose of this case report is to determine if a child diagnosed with cerebral palsy improves her independence and functional skills following an intervention that includes elements of conductive education.*

Case Description: *The patient was a five year old female with a diagnosis of spastic diplegia cerebral palsy who presented with impairments in strength, gait, and coordination.*

Outcomes: *Improved average TUG score and mastery in seven out of 31 goals with progression documented in other goals.*

Discussion and Conclusion: *Following a three week application of conductive education, the patient was able to improve upon her functional limitations.*

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Introduction

Conductive Education (CE) is an education-based rehabilitation approach for the treatment of adults and children with neurological disorders. It was developed in Hungary in the 1940s and, in the US, has been commonly used in treating children with Cerebral Palsy (CP), a condition affecting one out of every 1,000 children ((Bourke-Taylor, OShea, & Gaebler-Spira, 2007; Effgen & Chan, 2010). Conductive Education primarily addresses issues of participation and activity limitation. However, CE assists the children in meeting their developmental milestones by addressing impairments such as spasticity, muscle weakness, decreased postural control, lack of balance and coordination, difficulty with gait, and patterns of extension and/or flexion. Conductive Education is considered to be rehabilitation through learning (<http://www.conductiveed.com/about.asp>).

The foundation of CE is the neuroplasticity of the human brain, capitalizing on the brain's ability to form new pathways after damage has occurred (http://www.center-for-independence.org/conductive_ed.html). CE also works on the theory that children with CP can learn what normal children learn, only in different ways. Children without CP learn everyday activities through assimilation, whereas children with CP must be taught tasks as skills (<http://www.conductived.com/about.asp>). The learning environment in a CE program is important for the progress of every child. The staff is responsible for creating a stimulating and supportive atmosphere that promotes enjoyment, participation and learning. The motivating environment is created by the group through the use of specific techniques termed "facilitations," and the routine that structures the CE program (Bourke-Taylor, OShea, & Gaebler, 2007). Following the CE model, learning takes place in a group setting facilitated by a conductor, physical therapist, or occupational therapist. Conductors are the leaders of the group sessions and receive specialized training in the treatment of motor dysfunctions. Typically, a conductor is certified in CE after completing three to four years of training at the Peto Institute in Hungary (Ratliffe & Sanekane, 2009). Implementation of CE in Hungary entails the children living on-site and the intervention taking place from the time the child awakens until bedtime. However, in the United States, the model of service delivery varies. Children receive CE for a few hours per day, five days per week, and CE can be provided by conductors, physical therapists, and/or occupational therapists.

Within the United States, there is at least one college, Aquinas College in Grand Rapids, MI, that offers a bachelor program for conductors. The bachelor program focuses less on the theory and pathology of CP and more on how to treat individuals with CP using the principles of CE. Children work on ADLs, gait training, and functional mobility. Teaching is done through repetition, rhythmic intention, and facilitation of

movement. Whenever possible, the ratio of conductors or therapists to children is one to one or one to three. Therapy sessions include programs focusing on stretching, lying, sitting, standing, and walking; transitioning between positions.

A study by Effgen & Chan (2010), observed the gross motor objectives attainment in nine children with CP participating in a CE program in a preschool. The nine children were observed over an 11 month period. Gross motor objectives involved stability, transfer, gait and mobility skills. This study ranks low in reliability and validity due to the low number of participants as well as the fact that the research used was not an experimental design. However, the study showed the children attained 94% of their objectives. Effgen & Chan (2010) referenced a study conducted by Stuber and DeJong (2007) where children participating in an early intervention program not related to CE attained 53% of their objectives as compared to the children in the study conducted by Effgen & Chan (2010) who attained 94% of their objectives.

A systematic review of CE done by Darrah, Watkins, Chen, & Bowen (2004) examined a total of 15 articles published between 1966 and 2001. Table 1 describes the levels of evidence relating to research. Of the 15 articles examined, only one met the standards for the highest level of evidence. There were three studies each that met the criteria for level II and level III classification. Five studies met the criteria for a level IV classification and three studies for a level V classification. The majority of these studies had no control groups. Of the four studies that did have a control group, the majority showed no difference between CE and the control group. The systematic review by Darrah, Watkins, Chen, & Bowen (2004) concluded "...the present literature base does not provide conclusive evidence either in support of or against CE as an intervention strategy." The limited number of studies and their weak quality makes it impossible for the literature alone to guide decision-making regarding CE. The fact that there were only 15 articles published in

English that analyzed on CE between 1966 and 2001 speaks volumes about the lack of research.

The purpose of this case study is to determine if a child with a diagnosis of CP improves her independence and functional skills following an intervention that includes elements of conductive education. The aim of this study is to add to the current body of literature, further assisting therapists in the decision-making process supporting the use of CE.

Methodology

Case Description

The patient is a 5 year old female with a diagnosis of CP, specifically spastic diplegia. Spastic CP is the most common type of CP and is described as muscles of the body being tight, stiff, and weak, making control of movement difficult (Pountney, 2010). Spastic diplegia refers to a situation in which all four extremities are affected, but the legs are affected more than the arms. CP in this case was caused by periventricular leukomalacia with damage primarily to the right frontal lobe. The patient was born at 29 weeks gestation at 2 lbs 14 oz. The patient's delayed developmental milestones as compared to normal were: rolling, met at 12 months vs. typically at 4-6 months; supported sitting, met at 12 months vs. typically developing at 7-9 months; unsupported sitting, met at 15 months vs. typical development at 7-9 months; supported walking, met at 18 months vs. typically developing at 10-12 months; and finger-feeding, met at 12 months vs. typical 10-12 months (Scherzer, 2009). To control spasticity, the patient was prescribed Baclofen. The patient ambulated with a reversed wheeled walker and did not require splinting. At the start of treatment, she was able to take only 3-4 small steps with contact guard assistance. The patient's family sought CE physical therapy treatments to increase the patient's independence in all activities of daily living.

Tests and Measures

Functional Activities: At evaluation,

measurements using the Timed Up and Go (TUG) and Peabody Developmental Motor Scale 2 (PDMS-2) were obtained. The TUG was originally developed to test the basic mobility skills of the elderly and assess their fall risk, but has been adapted as a measure for children with CP as well (Williams, Carroll, Reddihough, Phillips & Gala, 2005). The authors conducted a study testing the reliability and validity of the TUG in children with CP and spina bifida. In this study, the TUG was used to test functional mobility, defined as "an individual's ability to maneuver his or her body capably and independently to accomplish everyday tasks." The TUG requires patients to start by sitting in a chair, stand, walk three meters, turn around, walk back and sit down. Three trials are done each testing session and an average of the three times is recorded. No normative data was found on what time children should achieve on the TUG if they have no impairments or limitations, but a decrease in the amount of time it takes to complete the TUG correlates to an increase in functional mobility. TUG has a test-retest reliability of 0.85-0.96, minimal detectable change of 2.9 seconds or 23%, and standard error measurement (SEM) of 1.14 seconds (Williams et al, 2005). At evaluation, the patient had an average TUG score of 33.4 seconds.

Motor Skills: The Peabody Developmental Motor Scales (PDMS-2) was designed to assess the motor skills of children from birth through 5 years of age. The PDMS-2 is used as an evaluation tool to determine if there is a developmental delay. The PDMS-2 evaluates motor abilities in the following categories: Reflexes, Stationary, Locomotion, Object Manipulation, Grasping, and Visual-Motor Integration. The Reflex section of this tool is only used for children aged 0-12 months. The Stationary section is composed of tasks that can be completed with the subject in a standing or sitting stationary position. The Locomotion section involves tasks using locomotion or components of locomotion. The Object Manipulation section tests the subject's ability to interact with his/her environment in a coordinated manner. The Grasping and

Visual-Motor Integration sections are typically performed by an occupational therapist and consist of eye tracking and grasping tasks. Each item of the PDMS-2 is scored with a 0, 1, or 2. A score of 2 represents an ability to fully and correctly complete the tasks; therefore the PDMS-2 is a test in which the goal of the patient is to achieve the highest score possible. The PDMS-2 has a test-retest reliability of 0.88-1.00, effect size of 0.2, standardized response mean of 1.3, and an SEM of 1.96 (Hsiang-Hu, Hua-Fang, & Ching-Lin, 2006). At evaluation, the patient scored a raw score of 37 for Stationary, 69 for Locomotion, and 4 for Object Manipulation. Although these scores are indicative of a delay in all categories, the purpose of this study does not focus on the level of delay, rather the patient's ability to increase her PDMS-2 scores.

Strength, Balance, and Coordination: Strength was assessed by analyzing the patient's ability to pull herself forward on a plinth. The patient's ability to transition from four-point to tall kneeling was assessed for a measure of strength, balance, and coordination. Ability to maintain tall kneeling without support for 30 seconds was also assessed as a measure of balance and strength. There are no reliability measures for these assessments. Measures in this category are based on the amount of assistance needed. A decrease in level of assistance represents improvements in strength, balance, and coordination. Level of assistance was determined using the following terms and operational definitions identified in Table 2.

Evaluation

At initial examination, the patient presented with deficits in functional mobility, strength, balance, and coordination. The average TUG score was 33.4 seconds. At examination, the patient's raw scores were 37 for Stationary, 69 for Locomotion, and 4 for Object Manipulation on the PDMS-2. The patient required MinA to pull herself forward on a plinth, transition from four-point (on hands and knees) to tall kneeling, and maintain tall kneeling without upper extremity

support for 30 seconds.

Diagnosis and Prognosis

The physical therapy evaluation was consistent with a physical therapy diagnosis of Neuromuscular Practice Pattern 5 C: Impaired Motor Function and Sensory Integrity Associated with Non-progressive Disorders of the Central Nervous System - Congenital Origin or Acquired in Infancy or Childhood (American Physical Therapy Association, 2003). The patient was diagnosed at Level III on the Gross Motor Function Classification System. Individuals with a Level III diagnosis typically require an assistive device for ambulation and have limitations walking within the community (Wu, Day, Strauss, & Shavelle, 2004). Wu, Day, Strauss, & Shavelle (2004) emphasize that determination of motor abilities at age two is the best predictor of future motor abilities/ambulation. Due to the parents' active involvement in the patient's care and the lack of co-morbidities, the rehabilitation prognosis for this patient is good. Table 3 shows the breakdown of which programs were given each week and how many times they were given during that week.

Interventions

CE requires children to actively participate in five basic programs consisting of stretching, lying, sitting, standing, and walking. Throughout each program, the facilitation known as Rhythmic Intention is included. Rhythmic Intention is the verbal self-direction that a child will say when attempting a task. Rhythmic Intention capitalizes on the child's ability to learn through repetition, language, and rhythm (Bourke-Taylor et al., 2007). It involves language and verbal cadence to prepare and provide the child with a basis for normal movement (Ratliffe, & Sanekane, 2009). Rhythmic Intention can include counting, singing, and rhyming. It is thought that the use of external language from an adult will help direct the child's movement and as the child becomes more independent in movement, the language will become internalized (Ratliffe, & Sanekane, 2009). All instructions are recited in the first person,

“I raise my hands up”, to help the children understand they are the ones responsible for completing the task, as opposed to someone else doing it for them.

Stretching Program: Most sessions begin with a stretching program to help loosen and relax the children before the more active programs begin. The stretching program aims to prevent further muscle tightness/contractures as a result of spasticity, which is a problem many children with CP demonstrate.

Lying Program: The lying program takes place on a mat or a plinth. If it is a “plinth day,” children work on sit to stand transfers and pulling themselves forward on the plinth with their hands as presented in Figure 1. Working on the plinth helps children learn and apply functional tasks related to their home environment such as getting in and out of bed. The slats on the plinth provide a structure for the children to grab and pull themselves forward. During the lying program children are expected to lie in an outstretched, extended position. Many children with CP have spasticity and tend to hold their extremities in a flexed position. Having the children lie in an extended position gives a stretch to the muscles and helps maintain their range of motion. Children also practice functional tasks while in the lying position, such as hand eye coordination. They also practice tasks with rings and sticks that replicate the motions required for dressing themselves while lying supine.

Sitting Program: The sitting program is aimed at improving the child’s static and dynamic sitting balance. The sitting program can be performed on the floor in a criss-cross leg position or on a stool. While on the stool, children are asked to perform different tasks which challenge their dynamic balance. Children with tight adductor muscles are given an abductor wedge to place between their legs, maintain the legs in a neutral position, ultimately preventing a loss in hip range of motion.

Standing Program: The standing program incorporates ladderback standers to aid children in transitioning from lying prone to standing. Children start in a lying position

and are asked to transition to four-point, then to tall kneeling with hands walking up ladder as needed. Children then transfer from tall kneeling to half kneeling with a focus on weight shifting to contralateral sides as presented in Figure 2. Children are then asked to move from half kneeling to standing. This is all done with both hands on the ladder as needed. While in the standing position, focus is on equal weight-bearing bilaterally through the legs as well as maintaining upright posture as presented in Figure 3. All movements are facilitated by the conductor, physical therapist, or occupational therapist. For more advanced tasks, children are asked to bring one foot up onto the first step, thus working on unilateral standing.

Walking Program: The walking program is aimed at improving the child’s gait pattern as well as their independence in walking. During the walking program, children are able to use their assistive devices and are required to walk a certain distance while therapists facilitate their movement as necessary. CE gives them the opportunity to practice ambulating with a lower level of assistance than they would normally require.

Outcomes

TUG: The patient was assessed at the beginning of summer program and at the end using the TUG. Table 4 outlines the results for the TUG. The TUG was administered by three people. One physical therapist was responsible for timing the patient with a stopwatch, the other two people, another PT and a student physical therapist, watched to ensure the patient was walking the correct distances. The patient decreased her TUG time by 9.3 seconds at end of study, with the MDC being 2.9 seconds.

PDMS-2: The PDMS-2 was also administered at beginning and end of the summer program. The results of the PDMS-2 can be found in Table 5. The patient improved her score on the stationary component by 1 point. Locomotion score was improved by 3 points and object manipulation score was improved by 4 points.

Strength, Balance and Coordination: The patient's strength, balance, and coordination were assessed by observing her ability to pull herself forward on a plinth, transition from four-point to tall kneeling, and maintaining tall kneeling for 30 seconds without support of her arms. The results of these observations are located in Table 6. The patient progressed from MinA in pulling herself forward on a plinth, to CGA. The patient was able to achieve a level of SBA, starting from MinA in this area and transitioning from four-point to tall kneeling and maintaining tall kneeling for 30 seconds without support of her arms.

Discussion

In this study, the patient was able to improve her average TUG score by 9.3 seconds, which is greater than the minimal detectable change of 2.9 seconds with a greater difference than the SEM of 1.14 seconds. Results in this area indicate the patient did have gains in balance during ambulation as well as a faster gait pattern, keeping in mind the patient utilized her reverse rolling walker during this test. However, during treatment sessions, the patient was able to practice ambulating without an assistive device. It is hoped that with further CE, she will be able to ambulate independently.

The patient was able to improve her PDMS-2 raw scores by at least two points in each category, which shows she is making improvements in the areas of static and dynamic balance, motor control, coordination, and functional mobility. The PDMS-2, however, is not intended to be a test to assess progress made, it is strictly used to assess whether there are deficits present. For future studies, it is recommended that a different outcome measure be used in place of the PDMS-2.

The patient in this study had a total of 31 goals, mastering 7 and making minimal to moderate progress in the remaining 24 goals. She was able to achieve 23% of her goals in three weeks. These results relate back to the study conducted by Effgen & Chan (2010) in which nine patients were able to

reach 94% of their goals in 11 months. In theory, if this patient achieved 23% of her goals in three weeks, she would be able to achieve 100% in approximately 13 weeks, in a perfect world. For example, the patient had a goal relating to transferring on and off the toilet. This activity was rarely practiced at the center or during therapy due to the patient not needing to use the restroom during treatment sessions. These results support Effgen, & Chan (2010) in that CE shows a correlation with improved objective attainment as well as a correlation between amount of time practiced and objective attainment. In the goals that were specifically assessed as a measure of strength, balance, and coordination, the patient was able to achieve one of those goals, but made significant progress in all three goals. The patient progressed from needing MinA to pull herself forward on a plinth, to only requiring CGA. Assistance needed by the patient in this study solely focused on assisting with proper hand placement rather than making up for a deficit in strength in which the patient made gains.

Overall, the 5 year old girl with a diagnosis of CP appeared to have benefited from an intervention which incorporated elements of CE. Due to the inability to generalize based on findings from this case study and until more randomized controlled trials are done, the true effects of CE remain in question.

Numerous limitations are evidenced in the case report. Utilization of one subject in this case study does not allow for generalization to the general population. In addition, this case study does not add strong evidence to the body of literature showing cause and effect as seen in RCTs. Therefore, further studies utilizing RCT designs are strongly recommended. The patient was only observed for three weeks, which is a very short time frame with this patient population considering that progression is expected to be very slow. There was a lack of more appropriate assessment tools which could have better shown changes over time for a patient with CP. The School Functional Assessment would be appropriate to use, but due to lack

of access, it was not used in this study (Schenker, Coster, & Parush, 2005). The Gross Motor Function Measure also would have been an acceptable assessment, but was not chosen due to the significant length of time it takes to administer this assessment tool (Vos-Vromans, Ketelaar, & Gorter, 2005).

Conclusion

This case report illustrated that a child with CP can benefit and improve her acquisition of ADL skills and functional mobility. Improvement was most notable in the decrease in TUG time. Also, the patient was able to walk for 10 feet or more with SBA without an assistive device as compared to requiring a reverse rolling

walker for ambulation at initial examination. The patient was able to achieve 7 of her 31 goals in three weeks which is remarkable due to the fact that most children with CP have goals that are set at yearlong increments.

CP can require long term or lifelong therapy and CE is not a treatment that was designed for short term implementation. CE has the ability to be very effective for children with CP. It is recommended that future research be conducted utilizing RCTs and comparing CE to more conventional and accepted types of therapies. Also, further research is needed focusing on outcome measures best suited for detecting changes in children with CP in order to increase reliability, validity and replication abilities of the studies.

TABLE 1
Levels of Evidence

Level	Non-empirical	Group Research	Outcomes Research	Single Subject Research
I		Randomized controlled trial All or none case series		N-of-1 randomized controlled trial
II		Non-randomized controlled trial Prospective cohort study with concurrent control group	Analytic survey	ABABA design Alternating treatments Multiple baselines across participants
III		Case-control study Cohort study with historical control group		ABA design
IV		Before and after case series without control group		AB design
V	Descriptive case series/case reports Anecdotes Expert Opinion Theories based on physiology, bench, or animal research Common sense/first principles			

Adapted from Effgen, S., & McEwen, I.R. (2008). Review of selected physical therapy interventions for school age children with disabilities, *Physical Therapy Review*, 13,297-312.

TABLE 2
Terminology for Level of Assistance

Level of Assistance	Definition
Independent (I)	Patient does not require any physical supervision or assistance from another person or from an assistive device.
Modified Independence (MI)	Patient uses adaptive or assistive equipment
Standby Assistance (SBA)	Patient requires verbal or tactile cues from another person, the person is very close to the patient, but is not touching them
Contact Guard Assistance (CGA)	Patient requires support of another person touching them or their gait belt
Supervision (S)	Patient requires only S with therapist standing 15ft away
Minimal Assistance (MinA)	Patient able to perform 75% or more of the activity requiring assistance to complete activity
Moderate Assistance (ModA)	Patient performs 50-75% of the activity
Maximal Assistance (MaxA)	Patent performs 25-50% of activity

Adapted from Pierson, F.M., & Fairchild, S.L. (2008). Principles and Techniques of Patient Care (4th ed.), St. Louis, MO: Saunders Elsevier.

TABLE 3
Interventions (An X equals the number of interventions provided each week.)

Week	Stretching Program	Lying Program	Sitting Program	Standing Program	Walking Program
1	XX	XXXX	XXXXX	XXX	XXXX
2	XX	XXXXX	XXXXX	XXXX	XXXXX
3	X	XXX	XXXX	XXX	XXXX

TABLE 4
TUG Initial and Final

TUG	First Visit	Final Visit
1 st Trial	39.0s	26.5
2 nd Trial	31.0s	21.5
3 rd Trial	30.3s	24.3
Average	33.4s	24.1

TABLE 5
PDMS-2 Raw Scores

Peabody (PDMS-2)	First Visit Raw Score	Final Visit Raw Score
Stationary	37	38
Locomotion	69	72
Object Manipulation	4	8

TABLE 6
Goal Acquisition to Measure Strength, Balance, and Coordination

Pt. Goals to measure increased strength, balance, or control.	Level of Assistance Required			
	Visit 1	Visit 6	Visit 11	Visit 15
Pull forward on plinth given S.	MinA	MinA	CGA	CGA
Transition four-point to tall kneeling given S.	MinA	CGA	SBA	SBA
Maintain tall kneeling without UE support for 30s with SBA.	MinA	CGA	CGA	SBA

FIGURE 1
Pulling Self Forward



FIGURE 2
Half Kneeling to Full Kneeling



FIGURE 3
Standing Upright



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Reality versus Perception of Cultural Competency In Speech-Language Pathology Students

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Abstract

Fifty-four students in undergraduate and graduate speech pathology programs in the State of South Carolina participated in this study. The participants completed surveys which assessed their self-perception of cultural competence and their knowledge of multicultural issues, based on a Multicultural IQ test, developed by Andrea Moxley. The graduate students demonstrated a greater degree of cultural competence than the undergraduate students. The preliminary results suggest that direct instruction may be beneficial in improving the cultural competence of speech-language pathology students.
Keywords: *cultural competence, multicultural competence, multicultural education, speech-language pathology*

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Introduction

The landscape of the United States is rapidly changing. America is becoming a more culturally diverse population (Dickson & Jepsen, 2007). A recent census profile indicated that by the year 2050, the minority population in the United States will expand by at least 44% (U.S. Census Bureau, 2008). As the minority population escalates, there will be an increase in the number of individuals from culturally and linguistically diverse backgrounds. This will require speech-language pathologists as well as other health professionals to increase their cultural competency. Suarez-Balcazar and Rodakowski (2007) concluded that “becoming culturally competent is an on-going contextual, developmental, and experiential process of personal growth that results in professional understanding and improved ability to adequately serve individuals who look, think, and behave differently from us.” Cultural competence goes beyond the ideology of tolerance to an acceptance of individuals who are different from the mainstream society (Rose, 2013). Speech-language pathologists must exhibit cultural understanding to establish trust, and open communication to effectively diagnose and treat individuals from diverse backgrounds, in a manner that promotes understanding as well as healthcare/ rehabilitation compliance. This will increase the efficacy of speech-language intervention and ultimately improve patient rehabilitation outcome measures.

Cultural competence is necessary to train speech-language pathologists who are effective humanistic practitioners for individuals of differing ethnicity, culture, gender, age, economic status, religion, physical appearance, educational level, marital status and sexual orientation. Though an increase in patient diversity may pose challenges for practicing speech-language pathologists, it is important to adequately provide speech-language diagnostic and therapeutic

services without compromising cultural integrity. Training healthcare professionals to acquire cultural competency is necessary for them to have, “knowledge of the values and norms of different cultural groups; [to] be aware of their own culturally based assumptions and biases; and [to] be able to demonstrate skills that are acceptable to clients from diverse backgrounds.” (Sue, Arredondo, & McDavis, 1992).

While there are few peer reviewed articles pertaining to cultural competence in the field of speech-language pathology, several articles exist regarding cultural competence and counselor education. Dickson & Jepson (2007) surveyed master’s level counseling students about their multicultural training experiences and multicultural counseling competencies. Program directors at 232 out of 366 counselor education programs from all geographic regions of the United States participated in the study. A total of 516 students from 152 out of the 232 programs completed the survey. This study examined how multicultural aspects of counselor education program experiences in program ambience, multicultural instructional strategies, and multicultural clinical experiences contributed to students’ multicultural counseling competencies. The multicultural training experiences assessed: a) traditional strategies (e.g. class lectures), b) exposure strategies (e.g. speakers from diverse backgrounds, and c) participatory strategies (e.g. role-plays simulations and candid class discussion). The results revealed that multicultural coursework alone is not adequate to efficiently promote multicultural competence (Dickson & Jepson, 2007).

The field of counselor education has made advances in its ability to train professionals using multicultural competencies adopted by the Association for Multicultural Counseling Development (Sue et al., 1992). This field further evolved by developing cultural inventories and assessments to measure counselors’ multicultural competency (Cartwright, B, Daniels, J., & Zhang, S., 2008). Self-assessment of multicultural competence has

enabled researchers to study this field, educators to train counselors, and professionals to identify areas to pursue for in depth professional development (Cartwright et al., 2008). In one study, Cartwright and others (2008) sought to compare counselor education students’ self-reported scores on three domains (awareness, knowledge, and skills) in comparison with “the score that independent observers provided by reviewing videotaped role-plays of the participants working with culturally different persons in individual counseling situations.” A total of 31 counselor education students, the majority of which were female (55%, N=17) and Asian/Pacific Islanders (71%, N=22), with a mean income of \$40,000-\$60,000 participated in the study. The Multicultural Awareness Knowledge and Skills Survey- Counselor Education—Revised (MAKSS-CE-R) was used to assess counselor education students’ self-assessment of multicultural competency; and the Multicultural Counseling Assessment Survey Form I (MCAS) was used by observers to rate the students’ performance during the role-play (D’Andrea, 2004). The results revealed that the counselor students’ self-report of cultural competence was much higher than the observer rating of their cultural competence (Cartwright et al., 2008).

While multicultural competence in counselor education has evolved over the past four decades, the field of speech-language pathology has only recently emphasized the importance of speech-language pathologists possessing multicultural knowledge, skills and awareness. The American Speech-Language Hearing Association (ASHA) has included cultural competence in the Code of Ethics, which holds licensed and practicing therapists accountable for multicultural competence, as well as other skills for best practice in this area (ASHA, 2010). In order to obtain a Certificate of Clinical Competency in speech-language pathology, practitioners must master multicultural competencies, which were incorporated in each of the nine content areas of the knowledge and skills acquisition. ASHA’s Code of Ethics states:

Standard I-C: Individuals shall not discriminate in the delivery of professional services or the conduct of research and scholarly activities on the basis of race or ethnicity, gender, gender identity/gender expression, age, religion, national origin, sexual orientation, or disability (ASHA, 2010).

Prior to the inclusion of this specific standard, cultural competence was implied though not explicitly required (Rose, 2013, p. 185). ASHA's Code of Ethics stated:

Standard III-C: The applicant must demonstrate knowledge of the nature of speech, language, hearing, and communication disorders and differences and swallowing disorders, including the etiologies, characteristic, anatomical/physiological, acoustic, psychological, developmental, linguistic, and cultural correlates. (ASHA, 2005b)

ASHA has had position statements since the late 1990s regarding English as a second language, and has since instituted a Multicultural Issues Board to develop strategies to increase the diversity of the organization as well as the number of peer reviewed articles that include individuals from culturally and linguistically diverse backgrounds (Reeves, Rodriguez & Masiongale, 2010).

ASHA currently recommends an infusion model to disseminate multicultural content in the curriculum of graduate academic programs. This model recognizes that communication is culturally embedded; therefore, academic and clinical learning should be inherently multicultural (Stockman, Boulton, & Robinson, 2004). The implementation of multicultural training within the field of speech-language pathology is a more recent occurrence than similar training in other behavioral sciences and clinical training programs (i.e., psychology, counselor education). Limited literature is available regarding the teaching of multicultural content in the field of speech-language pathology and the effectiveness with which it prepares culturally competent practitioners.

It is suggested that integrating the three dimensions of competency acknowledged by ASHA as critical for developing cultural competence (awareness, knowledge, and skills) is vital (ASHA, 1983, 1985, 2004, 2005a, 2010). Awareness is the clinician's ability to be cognizant of personal biases and communicate in a way that is positive for the clinician as well as the client, for best treatment practices. Knowledge is the importance of the clinician's ability to understand relevant issues for clients from various cultural backgrounds and use that information to influence communication across cultures. The skills dimension defines the speech-language pathologist's ability in the clinical setting to appropriately incorporate culturally relevant materials and services to diverse populations.

Lubinski and Matteliano (2008) developed a resource manual for undergraduate and graduate speech-language programs to integrate cultural competency into their curriculum. The International Classification of Functioning, Disability and Health (ICF) was created by the World Health Organization (WHO) as a guide to organize and identify specific domains of assessment, treatment and evaluation of outcomes (Reed, Lux, Bufka, Peterson, Threat, Trask, 2005). Resources such as suggested courses to infuse cultural competency, learner outcomes, sample activities, rubrics, case studies and scenarios are provided in the guide. The guide draws upon best practices and research from various social science fields to infuse cultural competence into the speech-language pathology curriculum.

Taylor and Campbell (1992) conducted a national survey of master's level ASHA-certified speech-language pathologists from 30 states and ten federal regions of the United States. A total of 1,140 subjects (38 individuals per state) were randomly selected and mailed the survey. Of those mailed surveys, 713 subjects were selected for the study. Taylor and Campbell (1992) used a four-point Likert scale to survey respondents on their competency levels of various areas of speech-language pathology including: evaluation of service population, treatment of

service populations, general skills and administrative skills. The Likert scale's responses were based upon four levels of perceived competency: not competent, somewhat competent, competent, and very competent. The respondents perceived themselves as competent on 14 out of the 32 skills. The top ten skills with the highest competency level corresponded with skills deemed "general" as opposed to the skills of "treatment, evaluation and administrative" (Campbell and Taylor, 1992). None of the ten highest ratings for perceived competency by speech-language pathologists included skills related to cultural competence. Four out of 10 skills that were perceived as non-competent related to cultural competence. They included: evaluation of bilingual speakers; treatment of bilingual speakers; evaluation of speakers of variations of the linguistic standard; and treatment of variations of the linguistic standard. The majority of speech-language pathologists who were surveyed did not perceive themselves as culturally competent.

Using a questionnaire which included a multicultural IQ test (Moxley, 2003), this study sought to determine if the perception of undergraduate and graduate speech-language pathology students, regarding their level of cultural competence, was accurate.

Methods

A total of 54 graduate and undergraduate speech-language pathology students in two South Carolina higher education institutions participated in this study. The department head of each program was asked to send the link of the online survey to senior-level speech-language pathology undergraduate students and second-year graduate students. The participants were then directed to read a short introduction explaining the meaning of the survey. By agreeing to take the survey, students provided implicit consent to this research study. The respondents included one male and 53 female students. Fifty-four survey questionnaires were completed in entirety.

Fifty-eight percent of the participants were African American, and 42% were

Caucasian. Fifty-one percent (N=28) were undergraduate students; and 49% (N=26) were graduate students. One undergraduate institution was a single-gender private, liberal arts college (N= 10) while the other undergraduate institution was a historically black college/university (HBCU) (N=18). All of the undergraduate respondents were female (N=28). Ninety-six percent of the graduate respondents were female (N=25). All graduate level participants (N=26) attended the HBCU. The study design was a cross-sectional survey, using an on-line questionnaire (see Table 1). The online questionnaire was based on a multicultural IQ test, which was developed by Andrea Moxley, and published in an issue of the *ASHA Leader* (Moxley, 2003). The revised questionnaire also elicited demographic information and perceptions regarding cultural competence. Data for the 54 students were collected using Survey Builder, and analyzed using Microsoft Excel.

Results

Although graduate students were less likely to have completed a course in cultural competence prior to beginning their speech-language pathology program, they scored significantly higher than undergraduate students on the multicultural assessment (see Figure 2). All respondents were more confident in their level of cultural competence prior to the completion of Moxley's test (Figure 1). Twenty-two percent of the participants changed their opinion of their level of cultural competence after completing the questionnaire. Initially, 61% of undergraduate students reported that they were culturally competent. However, 43% reported being culturally competent after completing the questionnaire. Similarly, 65% of graduate students initially reported that they were culturally competent. However, 46% reported being culturally competent after completing the multicultural IQ test. Ninety-six percent of the graduate students received a score less than 60% on the IQ test portion of the questionnaire. The undergraduate mean score was 41% (Figure 2). Results from the survey also indicate

that there were differences between undergraduate and graduate level minority students (see Figure 4). The mean score for minority graduate students was 59%, compared to a mean score of 56% for non-minority graduate students. The mean score for minority undergraduate students was 38%, compared to a mean score of 46% for non-minority undergraduate students (see Figure 4). Figure 5 illustrates the mean scores for students with and without an undergraduate degree in Speech –Language Pathology.

Discussion and Conclusion

The higher scores of graduate students may be attributed to more life experiences and self-awareness compared to undergraduate students. It must also be considered that the sample included students who were enrolled in either a historically black university or a single-gender (female) college. Based on the questions posed in the survey, it can be speculated that students used knowledge acquired through general educational courses and personal experiences to demonstrate cultural competence. Only 9-15% of the respondents identified sexual orientation, religious beliefs, socioeconomic levels, regionalisms, age-based peer groups, educational background, ability/disability, and race/ethnicity as dimensions of cultural diversity. Students who had previously taken a course in the area of multicultural competence had higher scores on the IQ test than those who had not previously taken such a course.

The survey yielded valuable insight about speech-language pathology students and cultural competency. Students' initial scores of the perception of their own cultural competence were lowered following exposure to Moxley's assessment tool. These results are congruent with the results from research by Marra (2010) on cultural competency in the field of athletic training (Marra, Covassin, Shingles, Canady, & Mackowiak, 2010; Cartwright, Daniels, & Shuqiang, 2008) as well as psychology

students in the field of counseling. The current research also suggests that taking a multicultural variations or multicultural competence course is highly important in order to attain cultural competence. One must also consider that many aspects of multicultural competence are based on knowledge that is both taught in the classroom and experienced in life.

Research conducted in the field of medicine has shown that a "hidden [cultural] curriculum" may be the best way for students to become culturally competent (Brown, A., Casanova, R., Crandall, S., Haidet, P., Gomez, A., Richter, R., Thompson, B. & Vivo, R., 2010). This research also suggests that questionnaires and other assessment instruments could be used to determine a student's ability to provide appropriate therapy models and communication to multicultural clients. Research conducted in many other fields has suggested that by simply having awareness of one's own cultural competence, a person may improve his or her overall cultural competence (Marra et. al, 2010; Cartwright et. al, 2008).

According to Clark (2002), "few graduate programs provide pedagogical training within their discipline, and fewer still provide guidance in how to incorporate a multicultural perspective." Han & Thomas (2010) provide many effective activities that professors may use in instruction to help students become more culturally competent. Future research should be conducted on perceptions of multicultural competence after participants have had formal education in multicultural variations. Although research pertaining to the cultural competence of undergraduate and graduate students is currently limited in the field of speech-language pathology, this study shows the need for more multicultural instruction. Student clinicians in both undergraduate and graduate programs should maintain openness and understanding towards their culturally and linguistically diverse clients, in order to provide them with appropriate treatment.

TABLE 1
The Multicultural Assessment Questionnaire*

1. What is your Gender:
Male
Female
2. What is your race?
African-American
Caucasian
Hispanic
Latino
Asian
Bi-racial
Other
3. Are you bilingual?
Yes
No
4. What is your academic status?
Undergraduate-Senior
Graduate
5. Which University/College are you attending to pursue your current Speech Language Pathology degree?
Winthrop University
Columbia College
University of South Carolina-full time program
University of South Carolina-distance education program
South Carolina State University-Undergraduate program
South Carolina State University –Graduate Program
6. If you are a graduate student, is your previous degree in Speech Language Pathology and Audiology?
Yes
No
Not a graduate student
7. Have you completed a class dealing with multiculturalism/cultural variations in your program of study?
Yes
No
8. Do you consider yourself to be culturally competent at this point in your field of study in speech language pathology?
Yes
No

9. Cultural diversity is shaped by many different factors including:
(circle all that apply)
1. sexual orientation
 2. religious beliefs
 3. socioeconomic levels
 4. regionalisms
 5. age-based peer groups
 6. educational background
 7. ability/disability
 8. race/ethnicity
10. Culturally and linguistically diverse clients should be seen only by those professionals who are of similar cultural/linguistic background.
1. True
 2. False
11. Bilingual speech-language pathologists and audiologists earn a different certificate of clinical competence from ASHA than monolingual audiologists and speech-language pathologists.
1. True
 2. False
12. A bilingual clinician needs to be fluent in the language spoken by the client, but does not need to understand normal language acquisition in the language spoken.
1. True
 2. False
13. If you are working with same-sex parents, it is only important to get the medical information about the biological parents.
1. True
 2. False
14. There are universal gestures to indicate agreement, such as nodding the head to indicate “yes.”
1. True
 2. False
15. In Hispanic communities, it would be appropriate to initiate an assessment sharing meeting with a personal conversation rather than to immediately provide the results.
1. True
 2. False
16. Monolingual language learners and bilingual language learners should have the same emerging language milestones.
1. True
 2. False

17. The use of African American English is influenced by many different variables including (circle all that apply)
1. age
 2. race
 3. geographic location
 4. occupation
 5. intelligence
 6. income
 7. education
 8. religion
18. Speech-language and hearing difficulties are more prevalent among Native Americans.
1. True
 2. False
19. It is possible that 1%–2% of your clients will be gay, lesbian, bisexual, or transgendered.
1. True
 2. False
20. If a family member or friend speaks English as well as the client's native language, and is willing to act as an interpreter, this is the best possible solution.
1. True
 2. False
21. When conducting a language assessment on a client with limited ability to speak English, which one of the following is LEAST useful?
1. Research on the client's culture(s), speech community, or communication environment
 2. An interview on how the client's language development compares to peers in his/her speech community or communication environment
 3. An interview with a family member, or other person who knew the client previously, to describe and compare the client's language skills before the insult or injury that may have led to an acquired language disorder
 4. Information on the family history of speech/language problems or academic difficulties
 5. Competent use of a linguistic/sociolinguistic cultural informant/broker to gain insight into the impact of culture on the client's communication skills
 6. Use of language data received from the interpreter/translator
 7. Standard scores from a translated battery of assessments
22. Cultural and linguistic biases may occur in testing tools and have an impact on an appropriate differential diagnosis between a language disorder and a language difference. Cultural biases do NOT include the following:
1. question types
 2. differences in features of language
 3. specific response tasks
 4. test format
23. An audiologist must be aware of the influences of different races and ethnicities when completing an audiologic evaluation.
1. True
 2. False

24. Fitting considerations for personal assistive devices may vary across races and ethnicities.

1. True
2. False

25. When working with an interpreter, the interpreter makes diagnoses.

1. True
2. False

26. Variations in dialects of the Spanish language are reflected in (circle all that apply)

1. pronunciation
2. vocabulary
3. grammar
4. structure of language

27. In many Native American communities, the best way to learn is:

1. through rote memorization
2. practice
3. by listening and observing
4. using nature

28. After completing this survey, do you consider yourself to be culturally competent in the field of speech-language pathology?

- Yes
No

*Modified by to incorporate demographic data for additional research purposes.

FIGURE 1

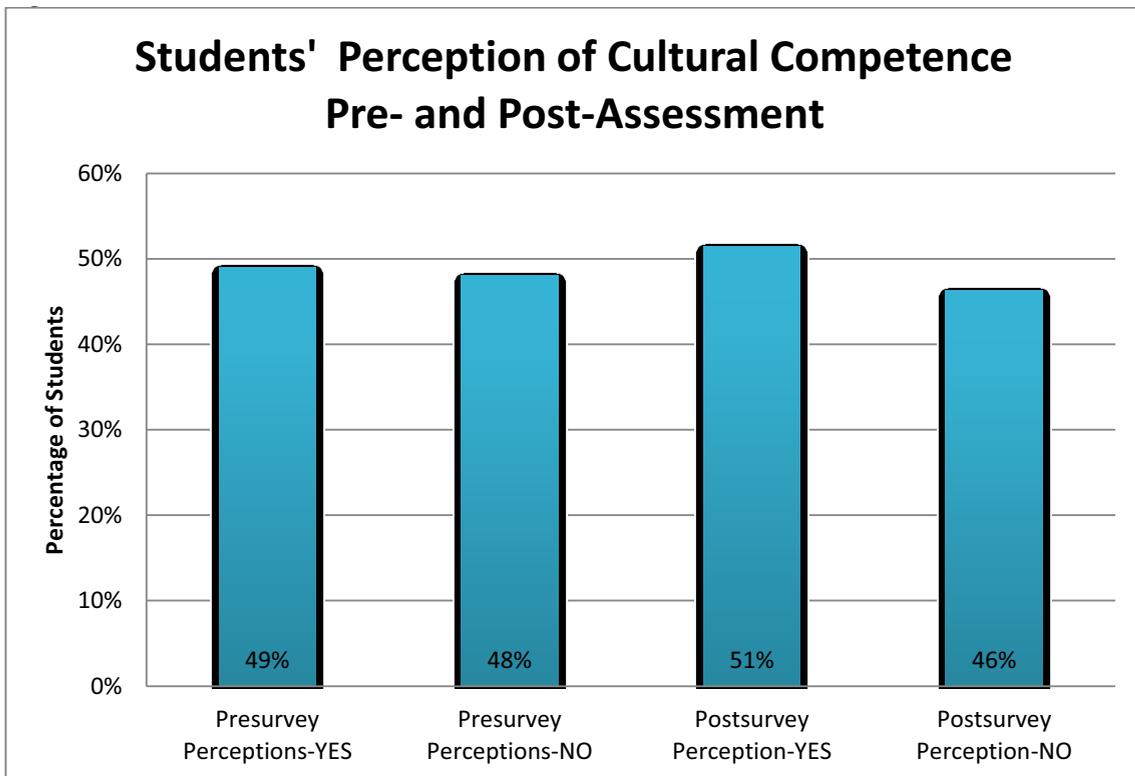


FIGURE 2

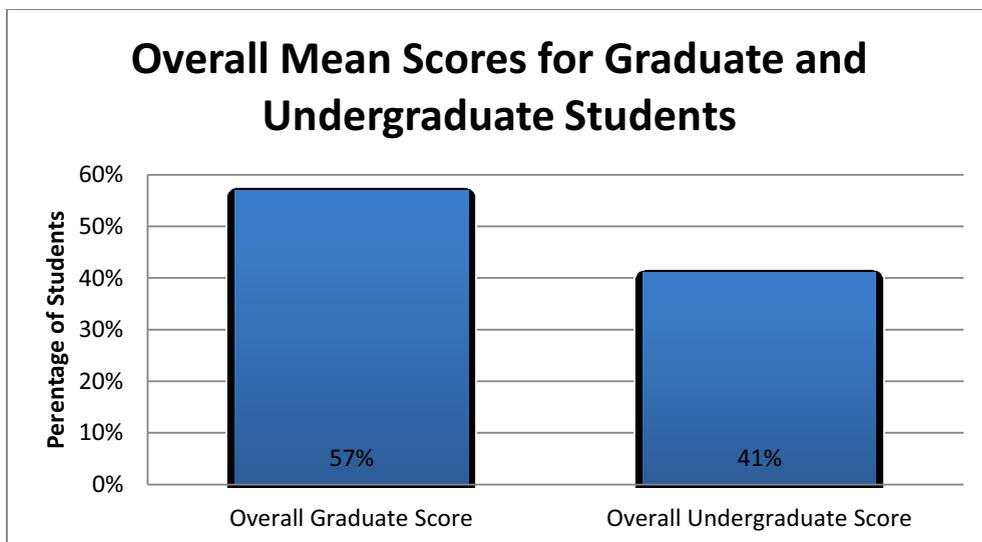


FIGURE 3

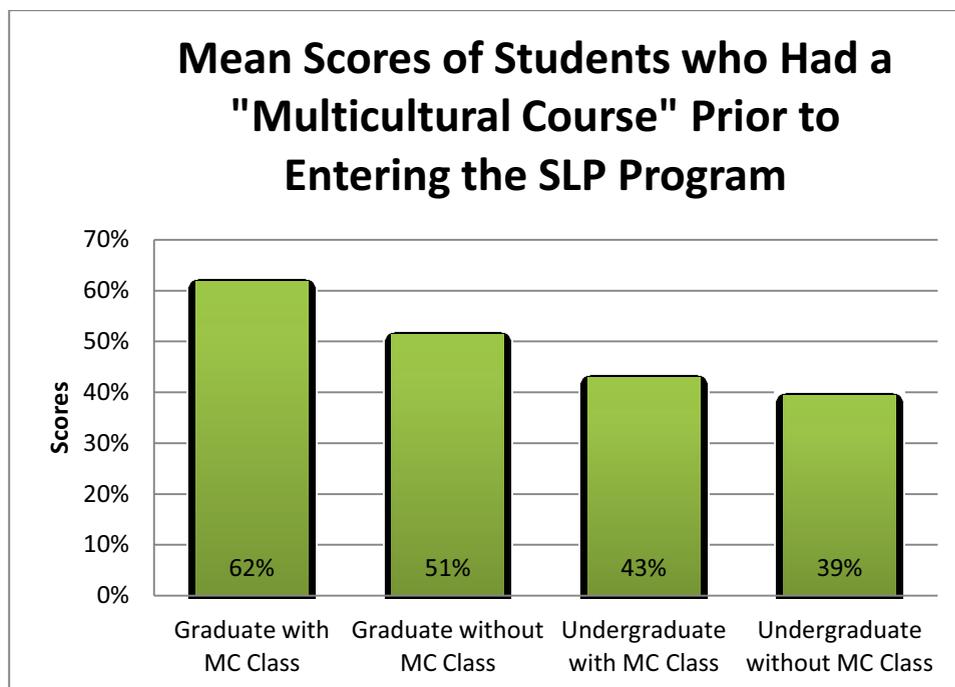


FIGURE 4

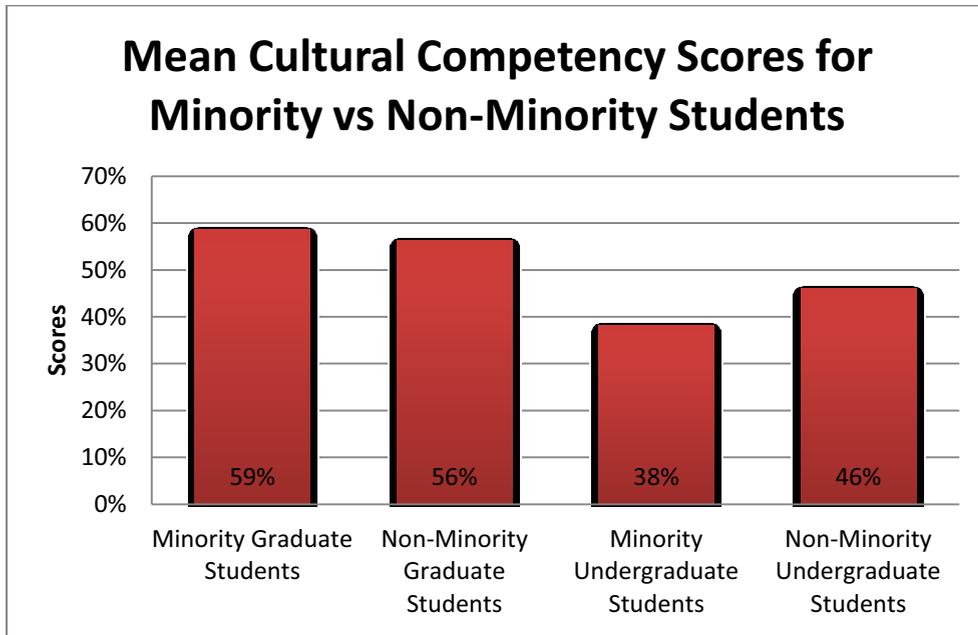


FIGURE 5

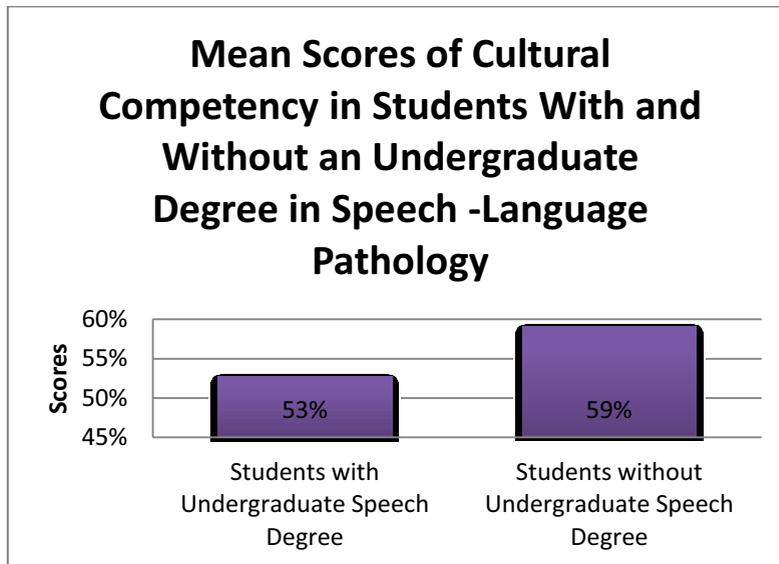


TABLE 2
Average Scores for All Students on the Multicultural IQ Test of the Questionnaire

Multicultural Questions	Type of Question	Percentage Correct
1. Cultural diversity is shaped by many different factors including:	CAA	48%
2. Culturally and linguistically diverse clients should be seen only by those professionals who are of similar cultural/linguistic background.	TF	81%
3. Bilingual speech-language pathologists and audiologists earn a different certificate of clinical competence from ASHA than monolingual audiologists and speech-language pathologists.	TF	83%
4. A bilingual clinician needs to be fluent in the language spoken by the client, but does not need to understand normal language acquisition in the language.	TF	93%
5. If you are working with same-sex parents, it is only important to get the medical information about the biological parents	TF	61%
6. There are universal gestures to indicate agreement, such as nodding the head to indicate "yes."	TF	30%
7. In Hispanic communities, it would be appropriate to initiate an assessment sharing meeting with a personal conversation rather than immediately providing the results	TF	67%
8. Monolingual language learners and bilingual language learners should have the same emerging language milestones	TF	59%
9. The use of African American English is influenced by many different variables including:	CAA	2%
10. Speech-language and hearing difficulties are more prevalent among Native Americans	TF	37%
11. It is possible that 1%-2% of your clients will be gay, lesbian, bisexual, or transgendered	TF	9%
12. If a family member or friend speaks English as well as the client's native language, and is willing to act as an interpreter, this is the best possible solution.	TF	52%
13. When conducting a language assessment on a client with limited ability to speak English, which one of the follow is LEAST useful?	MC	37%
14. Cultural and Linguistic biases may occur in testing tools and have an impact on appropriate differential diagnosis between a language disorder and a language difference. Cultural biases do NOT include the following:	MC	26%
15. An audiologist must be aware of the influences of different races and ethnicities when completing an audiological evaluation.	TF	74%
16. Fitting considerations for personal assistive devices may vary across races and ethnicities.	TF	57%
17. When working with an interpreter, the interpreter makes diagnoses.	TF	94%
18. Variations in dialects of the Spanish language are reflected in:	CAA	6%
19. In many Native American communities, the best way to learn is:	MC	6%

CAA = Check all that apply, TF = True False, MC = Multiple Choice

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Perceptions of Spanish Speaking Individuals Regarding the Impact of Language Barriers on Physical Therapy Interventions: A Pilot Study

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Abstract

Purpose: *The purpose of this study is to examine whether the quality of care that patients with limited English proficiency (LEP) receive, is being adversely affected by the language barriers.*

Methodology: *A convenience sample of 30 patients whose primary language is Spanish was used. The subjects were recruited from three different Physical Therapy facilities in the Washington, DC metropolitan area. The design of this study was a cross sectional survey. The instrument of this survey was a questionnaire. The Statistical Package for the Social Sciences (SPSS) 15 software was employed for data analysis. Statistical techniques included descriptive statistics and cross-tabulations.*

Results: *The overall survey results indicated that Spanish speaking individuals often use family members as interpreters, but that the language barriers do not affect the effectiveness of care.*

Conclusion: *The patients in this study were not negatively affected by language barriers, possibly because a number of the practitioners were Spanish speaking. The findings of this study cannot be generalized, because of the small sample size, and the lack of random sample selection. Additional research is needed required in order to assess whether the results from this study can be replicated.*

Key Words: *Spanish speaking patients, patient satisfaction, rehabilitation, language interpreters*

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Introduction

Health care providers in the United States are dealing with an ever growing population of patients whose primary language is not English. The providers in major cities and along the United States borders, in particular, encounter a diversity of languages and cultures. The 2010 Census reported that of the 308.7 million residents in the continental United States, 50.5 million (16 percent) were Hispanic or Latinos. Today, they are the largest ethnic minority in the United States. The Hispanic population has increased by 43 percent, from 35.3 million in 2000 to 50.5 million in 2010, and is expected to continue to rise (Ennis et. al, 2011). Many of the Latinos in this country have limited English proficiency (Fernandez et. al, 2006). This language barrier

suggests the need for translation and interpretation services in all areas of American life. Translations, which refer to written documents, and interpretation, which refers to oral communication, are especially vital in the field of health care, where, crucial decisions are made every day. Latinos, like the majority of other ethnic minorities, are often diagnosed with chronic medical conditions. They are less likely than whites to visit a physician or mental health provider, or to receive preventative care (Mead et al., 2008).

Studies have shown that Spanish-speaking Latinos are less satisfied with the healthcare they receive than their English-speaking counterparts, and are less likely to rate their providers as respectful and concerned about them (O'Brien and Shea, 2009). A lack of English skills is a primary barrier to receiving adequate health care. Language and communication problems may also lead to patient dissatisfaction, poor comprehension and adherence to treatments, and lower quality of care, because of possible misunderstanding or poor relay information through inappropriate interpretation (O'Brien and Shea, 2009). Patients who do not speak English as a first language need qualified interpreters to describe potentially complex medical problems and treatment plans. Federal laws mandate that language services must be made available to each individual with limited English proficiency (LEP), who cannot speak, read, or understand the English language at a level that permits him or her to interact effectively with clinical or non-clinical staff at a health care organization (Youdelman, 2008).

Title VI of the Civil Rights Act of 1964 ("Title VI") is the Federal Law that protects individuals and groups from discrimination on the basis of their race, color, and national origin in programs and activities that receive Federal financial assistance. Title VI states that no person shall "on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." The Department of

Health and Human Services (HHS) has concluded that LEP individuals are denied meaningful access to health service on the basis of national origin if they cannot receive important health information in their native tongue, free of cost to them (Chen, Youdelman, and Brooks, 2007). The language services (interpreter or translation) may not be provided by a friend or family member. This regulation is an unfunded mandate (Youdelman, 2008).

Bilingual clinicians and other staff who communicate directly with patients and consumers in their preferred language must demonstrate a command of both English and the target language, including knowledge and facility with the terms and concepts relevant to the type of encounter (Anderson et al., 2003). The purpose of this pilot study was to determine if LEP patients were being adversely affected by the language barriers, and to identify the perceptions of Spanish-speaking individuals regarding their encounters with the health care system, specifically rehabilitation services.

Methodology

A convenience sample of 30 patients in the Washington, DC metropolitan area, whose primary language is Spanish, was used (Figure 1). The subjects were recruited from three different Physical Therapy clinics in the Washington, DC metropolitan area. All of the clinics were classified as ambulatory care facilities. Subjects were included in this study if they were 18 years and older, if they identified themselves as Latino (or Hispanic), and if their first language was Spanish. Individuals who did not meet all of the established criteria were excluded.

A cross sectional survey design was used. The instrument of this survey was a questionnaire, which was developed by the researchers. The investigators developed a questionnaire consisting of seven demographic questions and 12 closed- end Likert questions, (Table 1) in order to assess the Spanish speaking patients' perceptions about the quality of their Physical Therapy services. The surveys were written in

English and Spanish. Prior to completing the questionnaire, the participants received a preamble explaining what research is being done, by whom and for what reason. This research project was approved by the Howard University Institutional Review Board.

The Statistical Package for the Social Sciences (SPSS) 15 software (Chicago, SPSS Inc) was employed for data analysis. Statistical techniques included descriptive statistics and cross-tabulations.

Results

Thirty (30) Spanish speaking patients completed the survey. The sample participants included 17 males and 13

females, and were 18 to 65 years of age. Ten subjects were bilingual, and 20 subjects spoke Spanish only. The survey results indicated that while Spanish speaking individuals often use family members as interpreters, the language barriers did not negatively affect the perceptions of quality of care. A small percentage of the physical therapists spoke Spanish. Home exercise programs in each of the facilities were written in Spanish. The patients only occasionally received interpreter services. It was also noted that U.S. federal laws were not always followed. Specifically, professional interpreter services were not consistently provided.

The following tables summarize the responses of the participants:

Table 1
Questionnaire

1. What is your age?
 - A. 18- 24
 - B. 25-44
 - C. 45-64
 - D. > 65

2. What is your gender?
 - A. Male
 - B. Female

3. What is your level of education?
 - A. Elementary School (Eight Grade or Less)
 - B. Some High School (Ninth to 12th Grade)
 - C. High School Graduate

4. What is your yearly income?
 - A. \$10,000 or less
 - B. Between \$10,000 and \$20,000
 - C. Between \$20,000 and \$30,000
 - D. Greater than \$40,000

5. Do you have health insurance?
 - A. Yes
 - B. No

6. How long have you been in the U.S.?
A. <1 to < 5 Years
B. 5 to < 10 Years
C. 10 Years or Greater
7. What is your **PRIMARY** language?
A. Spanish Only
B. Spanish and English

Choose the response which best describes your feelings regarding Questions 8 – 19.

A. Rarely B. Sometimes C. Often D. Always E. Not Applicable

8. ____ Do you see a medical doctor on a regular basis?
9. ____ If yes, does your doctor speak Spanish?
10. ____ Have you ever had a problem understanding a medical professional (doctor, nurse, therapist, etc.) because you did not speak English?
11. ____ If yes, Were you offered the services of an interpreter?
A. Yes
B. No
12. ____ How often does a family member go with you on medical appointments, in order to translate for you?
13. ____ Does your physical therapist speak Spanish fluently?
14. ____ At your physical therapy appointments, have you ever had a problem because you could not understand your therapist?
15. ____ Have you ever been provided interpreter services by your physical therapist?
16. ____ How often does a family member go with you on your PT appointments, in order to translate for you?
17. ____ Have you ever had a bad reaction to any PT treatments or exercises?
18. ____ Are you ever confused about how to perform exercises at home?
19. ____ Were written exercises provided to you in Spanish?

TABLE 2
Descriptive Statistics of the Sample

<i>Age</i>		
	N	%
18-24 Years	5	16.7
25-44 Years	15	50.0
45-64 Years	7	23.3
≥ 65 Years	3	10.0
Total	30	100
<i>Gender</i>		
Male	17	56.7
Female	13	43.3
Total	30	100
<i>Language Skills</i>		
Spanish Only	20	66.7
Spanish and English	10	33.3
Total	30	100
<i>Education</i>		
8 th Grade or Less	7	23.3
Some High School	11	36.7
High School Grad/GED	8	26.7
No Answer	4	13.3
Total	30	100
<i>Years in US</i>		
>1 to < 5 Years	7	23.3
≥5 to < 10 Years	6	20
≥10 Years	17	56.7
Total	30	100
<i>Income</i>		
<\$10000	5	16.7
\$10,000-\$20,000	5	16.7
>\$20,000 - \$30,000	8	26.7
>\$30,000 - \$40,000	3	10
>\$40,000	2	6.6
No Answer	7	23.3
Total	30	100

TABLE 3
Number of Participants by Clinic

Clinic	N	Percent
Clinic # 1	10	33.3
Clinic # 2	9	30.0
Clinic # 3	11	36.7
Total	30	100

TABLE 4
Physical Therapist's Ability to Speak English by Clinic

Clinic	PT's Ability to Speak Spanish	Interpreter Provided
Clinic # 1	1 PT – English Only	No
Clinic # 2	1 PT – Fluent in Spanish	N/A
	1 PT – Some Spanish	Yes
Clinic # 3	1 PT – Fluent in Spanish	N/A
	1 PT – Some Spanish	Yes

TABLE 5
Patient Perceptions Regarding Therapy Services

Survey Question	Always	Sometimes	Never
Did you have a problem understanding your physical therapist?	10% (n=3)	13.3% (n=4)	73.3% (n=4)
Were you offered the services of an interpreter by your therapist?	40% (n=12)	16.7% (n=5)	43.3% (n=13)
Did a family member interpret for you during your physical therapy session?	10% (n=3)	20% (n=6)	66.7% (n=15)
Did you have a problem understanding your therapist?	40% (n=12)	23.3% (n=7)	33.3% (n=10)
Did you ever experience a negative reaction following your physical therapy services, because you did not understand your therapist?	0% (n=0)	13.3% (n=4)	83.3% (n=25)
Were you confused about how to perform your physical therapy services at home?	3.3% (n=1)	13.3% (n=4)	80% (n=24)
Were the written home exercises provided to you in Spanish?	46.7% (n=14)	30% (n=9)	23.3% (n=7)
My PT spoke fluent Spanish (Clinic 1 (n=8))	0% (n=0)	25% (n=2)	75% (n=6)
My PT spoke fluent Spanish (Clinic 2 (n=9))	33.3% (n=3)	33.3% (n=3)	33.3% (n=3)
My PT spoke fluent Spanish (Clinic 3 (n=11))	63.6% (n=7)	9.1% (n=1)	27.3% (n=3)

Discussion/Conclusions

Many of the clinics did not consistently follow the federal mandates regarding the provision of services to PT patients. Two of the three providers were making a consistent effort to provide legally appropriate care. The majority of patients reported that the PT services they received were appropriate and effective. Spanish speaking individuals often used family members as interpreters during P.T. services. Language barriers may have affected the quality of health care provided; however, most patients surveyed appeared to receive effective care. When facilities provided interpreter services or fluent Spanish speakers, the perceptions of quality care were increased.

A number of the findings of this pilot study are consistent with research literature describing the use of family members as interpreters for patients with limited English proficiency. Approximately 25% of the patients had difficulty understanding their physical therapist. The patients in this study were, in general, not negatively affected by language barriers, possibly because a number of the practitioners were Spanish speaking. Language barriers may have affected the quality of health care provided; however, most patients surveyed appeared to receive effective care. When facilities provided interpreter services or fluent Spanish speakers, the perceptions of quality care

were increased. The urban and cosmopolitan nature of the Washington, DC area may have influenced the findings, as the health practitioners in less diverse areas of the country may not be as conversant in Spanish. Additional research is needed in order to assess whether the results from this study can be reproduced.

It may be important for academic programs to teach potential healthcare providers medical Spanish in order to ensure that health services are provided legally and effectively. Miscommunication between healthcare workers and patients can cause a wide range of medical mistakes and liabilities. Due to the expenses involved in providing interpreter services, many employers, especially in border states or communities with a large Latino population, may be more likely to hire health care providers who are fluent in Spanish.

Limitations

The survey findings cannot be generalized for the following reasons: the sample was not random; the number of participants was small; and there were no comparisons made between those who were not LEP versus those who were. These comparisons may have demonstrated that any difficulties experienced by LEP patients were anomalies.

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Developing a Research Agenda to Address Health Disparities in Rehabilitation: Findings from a National HBCU Conference

Steven B. Chesbro

Abstract

A national conference to address health disparities in rehabilitation was convened on the campus of Alabama State University in Montgomery, AL on March 1-3, 2012. The specific aims of this conference were to: 1) guide faculty of historically Black colleges and universities (HBCUs) with rehabilitation programs in the development of a national research agenda that addresses health disparities in rehabilitation; 2) create a network of faculty members and others who collectively work to improve health equity for African Americans in rehabilitation settings; and 3) facilitate faculty development through collaborative efforts. Seventy-five individuals participated in the conference designed to create a research agenda. Participants included faculty from 23 universities, including 16 HBCUs, and six professional associations representing African American educators, providers, and researchers. Participants engaged in a modified Delphi Technique process to identify priority health disparity issues. Interdisciplinary teams considered topical themes that emerged through the multistep process. Six topical themes emerged as research agenda priorities: access to care, cultural competency, health literacy, interprofessional collaboration/education, metabolic syndrome, and minority representation in rehabilitation fields.

Key Words: *African American, health disparity, health equity, rehabilitation*

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Background

Significant research on the health disparities affecting African Americans and other minority communities is presented in the literature (Institute of Medicine, 2003; American College of Physicians, 2010; Commission to End Health Disparities, 2007; Drum, McClain, Horner-Johnson, & Taitano, 2011; Agency for Healthcare Research and Quality, 2010). However, little investigation has addressed the role of rehabilitation providers in the health disparity of African American rehabilitative health. Much of the available research on the topic has focused on physician directed intervention, health policy, on differences among groups of individuals. Information regarding the effect of biases, education, and professional roles and responsibilities of rehabilitation providers on service provision is insufficient. Faculty members at HBCUs often have a small voice compared to those at predominantly White institutions, which often have a different focus or mission, and are uniquely positioned to address and to seek avenues to promote health equity for African Americans.

The idea for this conference strategy came from a concern about the dearth of information related to health disparities and rehabilitation. It was believed that the discussion initiated at this conference would serve to empower participants to contribute to the research process, and to create systems needed to engage and follow up. For the purposes of this conference, the term

rehabilitation includes the fields of occupational therapy, physical therapy, prosthetics and orthotics, rehabilitation counseling, and speech language-pathology. Unfortunately, only 19 of the 105 HBCUs have programs leading to degrees in these fields.

Faculty members at HBCUs are often interested in research pertaining to the needs of African American and minority communities. Therefore, the creation of a research agenda that focuses on the role of rehabilitation services and rehabilitation service providers in the outcomes of African Americans is significant. Rehabilitation professionals provide primary, secondary and tertiary prevention, as well as examination and intervention within their scope of practice. Seeking to identify those components of service provision that inhibit positive rehabilitation outcomes for African Americans will guide the work at this conference (U.S. Department of Health and Human Services, 2010).

The significance of this conference was that it addressed the dearth of information on the relationships among health disparities and rehabilitation services and rehabilitation service providers. Much of the literature pertaining to health disparities and rehabilitation lacks a focus on true rehabilitation services and service providers. Often the research focus is on rehabilitation as a phase or period of medical intervention, which is usually initiated, guided by, and ended by a physician's actions. This gap in knowledge is important to understanding why rehabilitation outcomes, especially for African Americans, often present with large disparities (e.g., stroke).

The work initiated by such a conference may have a significant impact on the way rehabilitation programs at HBCUs view health disparities, challenge the role of rehabilitation services and service providers in the creation or mitigation of health disparities, and lead to the answering of research questions that evolve from this experience. The findings from the research projects initiated as a result of this conference could impact general knowledge, health care policy, quality of care/service

provision, and professional education in rehabilitation.

Few rehabilitation conferences have programming that attracts faculty from HBCUs who are interested in health disparities research. This conference would be the first of its kind, in that it would include the five rehabilitation professions that have a direct impact on the rehabilitative health of those in need of rehabilitation services, especially for African Americans. Another innovative component of this conference would be the creation of a research network that served to engage faculty in ongoing discussion and action regarding the pursuit of health equity in rehabilitation, especially for African Americans.

In preparation for this conference plan, and support for a grant application, an electronic survey was sent to each of the 36 rehabilitation programs and 6 related professional organizations. The survey identified institution, program or association type, number of core faculty represented, and likelihood of sending a faculty representative (or association representative) if no funding was received, if partial funding was received or if full funding was received. A comment section was also included in the survey.

Professional associations sampled in the survey include those groups who exist to address the needs of African American or minority interests, including the: American Academy of Physical Therapy (AAPT), Department of Minority Affairs of the American Physical Therapy Association (APTA), National Black Occupational Therapy Caucus (NBOC), National Association of Multicultural Rehabilitation Concerns (NAMRC), National Black Association for Speech-Language and Hearing (NBASLH), and National Society for Allied Health (NSAH).

Of the 36 programs directors and 6 professional organizations executives surveyed, 19 programs and 2 professional organizations responded (49%). The 19 programs responding represented 14 universities, 5 program types, and 108 faculty members (range=1 to 10 faculty members per program). Respondents were asked to

rate the likelihood of sending a faculty member or association representative based on three levels of available funding. With no funding, only 15% responded there was a 100% chance they would send a representative (these were likely ASU responses). With partial funding, 25% believed there was a 100% chance they would send a representative. However, with full funding 81% believed there was a 100% chance of sending a representative to participate in the conference.

The purpose of this grant proposal was to seek funding to assist in the implementation of a conference which would facilitate the development of a research agenda to address rehabilitation specific health disparity issues in African American communities. Specifically, this conference sought to engage rehabilitation faculty from the nineteen (19) historically black colleges and universities (HBCU) with rehabilitation programs. The conference was designed to allow faculty participants to address issues, both known and unknown, which would seek equity in rehabilitative health. These issues would include primary, secondary, or tertiary health problems encountered by consumers, communities, and providers.

The specific aims of this conference were to: 1) guide faculty at HBCUs with rehabilitation programs in the development of a national research agenda that addresses health disparities in rehabilitation; 2) create a network of faculty members and others who collectively work to improve health equity for African Americans in rehabilitation settings; and 3) facilitate faculty development through collaborative efforts.

This conference proposal was submitted to the Agency for Healthcare Research and Quality (AHRQ) through their Small Grant Program for Conference Support (R13). The conference was funded, in part, by AHRQ and hosted by the *Center to Advance Rehabilitative Health and Education* (CARE) in the College of Health Sciences at Alabama State University in Montgomery, Alabama.

Methods

Participants

Seventy-five (75) individuals participated in the conference designed to create a research agenda that addressed health disparities in rehabilitation. Participants included faculty and graduate students from 23 universities, including 16 HBCUs, and six professional associations representing minority providers. Participants from institutions other than the host institution completed an application to attend the conference; described their interest in health disparities in rehabilitation; requested funding support (if appropriate); submitted a copy of their curriculum vitae; and submitted a letter of support from their program director or supervisor (faculty applicants).

Conference Environment

Alabama State University (ASU), the host institution for this conference, is a regional, comprehensive, historically Black, state supported university. In carrying out its mission, the university serves the city of Montgomery, the state of Alabama, the nation, and the global community.

The College of Health Sciences at ASU prepares its students to meet the needs of society with a special focus on professional skills associated with a given discipline. One unique component of the college's mission is a commitment to serving "underserved and underrepresented communities". The faculty and staff believe this speaks to not only the students we serve, but also the individuals our graduates serve. Established in 2000, the College of Health Sciences is home to three (3) Centers and six (6) healthcare related degree programs, and three (3) certificate programs.

The Center to Advance Rehabilitative Health and Education (CARE) at Alabama State University (ASU) addresses the rehabilitative health needs of all individuals, with a special focus on African Americans and other minority populations in five key domains: clinical services, community-based services, educational services, policy reform, and research. The Center serves as an

umbrella program, under which many of the works in the College of Health Sciences are attributed or housed; however, collaborative works with other colleges and institutions may be affiliated with CARE. The Center is unique in that no other established programs identifying rehabilitative health as their primary function are known to exist. These varied efforts make Alabama State University and the Center to Advance Rehabilitative Health and Education an ideal host of this conference.

Conference Approach

The purpose of this conference was to facilitate the creation of a research agenda to address rehabilitation specific health disparity issues in African American communities (Agency for Healthcare Research and Quality, 2004). Imbedded in the conference experience was support for developing and carrying out identified research plans and dissemination of research findings.

Purposeful application of adult education theories was used to facilitate participant development in the area of health disparities research. One theory applied was *situated cognition*. Driscoll (2004) described situated cognition as a “shift in focus from the individual to the sociocultural setting and the activities of the people within that setting. Knowledge accrues through the live practice of the people in a society.” Learning concepts are “both situated and progressively developed through activity” (Brown, Collins, & Duguid, 1989). Legitimate peripheral participation is a key principle of situated cognition and suggests “newcomers” become part of a community through “situated activity” (Brill, 2001). The concept of anchored instruction was used as it allowed the participants to focus on a specific topic to overcome any knowledge or skill deficits in research. Consideration of learning strategy was also included. Each developmental activity was “anchored” in the central problem of rehabilitative health and health disparities.

The two-day agenda was created to developmentally guide the participants

through a process that leads to the creation of a research agenda to be addressed by rehabilitation faculty at HBCUs.

Implementation and dissemination strategies were also be presented. Featured speakers at the conference included Steven Chesbro, DPT, EdD, Lynda Woodruff, PT, PhD, FAAPT, and Louis Sullivan, MD. Dr. Chesbro provided a conference overview and delivered a presentation titled *Health Disparities, the Pursuit of Health Equity and Rehabilitation Professionals: The Basics of a Research Agenda*. Dr. Woodruff delivered a presentation titled *The Current State of Research on Health Disparities and Rehabilitative Health*. Dr. Sullivan, former Secretary of the U.S. Department of Health & Human Services, presented unprepared remarks about health disparities and entertained questions. He then delivered a presentation titled *The American Journey to Health Equity*. The remainder of the conference engaged participants in a modified Delphi Technique process to identify key areas of research need, to discuss post-conference work, and discuss a communication plan.

Modified Delphi Technique

Participants engaged in a modified Delphi Technique process to identify health disparity issues. Interdisciplinary teams considered topical themes that emerged through the multistep process [Specific Aim 1]. Contact information for each of the conference participants was provided. A Blackboard site was created for conference participants to use as a research network forum. All participants were provided with an individual specific log in and password for the Blackboard site [Specific Aim 2].

Conference Planning and Evaluation

A conference committee was appointed to plan, implement and evaluate the project. Participants had the opportunity to evaluate the conference using a Likert scale survey, and open comment sections. A running video camera was available for participants who wanted to make narrative comments about their conference experience, in addition to

completing the paper-based survey.

Findings

Seventy-five (75) participants attended the conference and represented 23 universities, including 16 HBCUs, and 6 professional organizations (Table 3). Travel awards using AHRQ grant funds were provided to 47 of the participants to subsidize travel and housing costs associated with conference attendance.

Ten (10) major themes and 48 sub-themes were identified during early stages of the process. At the final stage of the process, six (6) topical themes emerged as research agenda priorities: access to care, cultural competency, health literacy, interprofessional collaboration and education, metabolic syndrome, and minority representation in the identified rehabilitation fields.

Participants agreed that research addressing health disparities in rehabilitation should be pursued. Six specific themes have been deemed to be of greater urgency in the pursuit of health equity in rehabilitation [Specific Aim 1]. Conference participants have reported working collaboratively and independently to address health disparities in their program's curriculum or research [Specific Aims 2 and 3]. Collaborative dissemination products have included publications and peer-reviewed presentations (Table 4) [Specific Aims 3].

A total of 56 participants completed the conference evaluation form. Formal evaluative feedback received by conference participants was positive (Table 2).

Narrative Comment Results to Open Ended Questions

Many participants reported that assistance with travel was key to their ability to attend the conference and is likely to be a factor for future attendance (50 total responses). Networking and group thought were reported by many as what they liked most about the conference (54 total responses). A lack of sufficient time and full agenda were reported as issues participants liked least (48 responses). Suggestions for future conferences included fewer agenda

items, speakers on research methods in health disparities, and having consultants present to assist in research design.

Discussion and Conclusion

The need to identify priorities for research related to health disparities in rehabilitation determined to be a significant need by the conference participants. Many participants commented on the overdue need to bring rehabilitation providers together to discuss this topic, as no other forums that would facilitate such a function were identified.

The six (6) priority themes that emerged related to much of the recent literature related to health disparities. Access to rehabilitative care, especially for those in underrepresented and underserved areas is of specific concern. Cultural competency has been perceived as “a strategy to improve quality and eliminate racial/ethnic disparities in health care” (Betancourt, Green, Carrillo, & Park, 2012). Low health literacy is known to create “gaps that can prevent patients from adhering to prevention and treatment protocols” (HRSA, 2012). Interprofessional collaborative models have been well received in medicine, dentistry, nursing, pharmacy and public health, but are still emerging in rehabilitation fields (Klocko, Krumwiede, Olivares-Urueta, & Williamson, 2012; Giordano, Umland, & Lyons, 2012; Wellmon, Gilin, Knauss, & Linn, 2012). Metabolic syndrome is associated with many of the morbid conditions that impact the need for rehabilitation services, especially diabetes, heart disease, and stroke (National Diabetes Information Clearinghouse, 2011). The need to increase the representation of minorities in the health professions has been highlighted for years, and racial/ethnic diversity in rehabilitation fields is known to be deficient (The Sullivan Commission, 2004).

Beyond the findings highlighted above, this conference led to the submission of a proposal to create a follow-up conference that would highlight four (4) key concepts in health disparities research and would provide support for the creation of research designs for the six (6) themes identified at this

conference. Key concepts to be highlighted at a follow-up conference are: biostatistics and epidemiology in health disparities research, cultural competence research, health disparities research methods, and health professions and health disparities

research. This conference would ideally result in interprofessional teams who are ready to engage in theme specific research related to health disparities in rehabilitation. The grant was submitted to the Agency for Healthcare Research and Quality.

TABLE 1
Historically Black Institutions with Rehabilitation Programs as of February 2011

Institution:	OT	PT	P&O	RC	SLP
Alabama A&M University				X	X
Alabama State University	X	X	X	X	
Coppin State University				X	
Florida A&M University	X	X			
Fort Valley State University				X	
Hampton University		X			X
Howard University	X	X			X
Jackson State University				X	X
Langston University		X		X	
North Carolina A&T				X	
North Carolina Central University				X	X
South Carolina State University				X	X
Southern University				X	
Tennessee State University	X	X			X
Tuskegee University	X				
University of Maryland—Eastern Shore		X		X	
University of the District of Columbia					X
Wilberforce				X	
Winston Salem State University	X	X		X	
Sub-total	6	8	1	13	8
Total Graduate Rehabilitation Programs	36				

TABLE 2
Participants evaluation feedback on key factors (1=lowest/5=highest).

	1	2	3	4	5
Overall satisfaction with the conference	0	0	2	10	43
Overall satisfaction with the conference format	0	0	3	17	35
Overall satisfaction with accommodations and facilities	0	0	0	4	50
Likely to attend or recommend this conference in the future	0	0	0	5	50

TABLE 3
Participant List

Name:	Profession:	Organization:
Joan Fobbs-Wilson, PhD., CRC	RC	Alabama A & M University
Steven Chesbro, PT, DPT, EdD, GCS	PT	Alabama State University
Charlotte Daniel-Carr, BA	HS Librarian	Alabama State University
Angela Davis, EdD, MPA, OTR/L	OT	Alabama State University
Susan Denham, EdD, OTR/L, CHT	OT	Alabama State University
Jewell Dickson, MPH, OTR/L, ATP	OT	Alabama State University
Damien Gent Dotson, PhD	RS	Alabama State University
Mary Beth Downs, PhD	OT/PT	Alabama State University
John Chad Duncan, PhD, CRC, CPO	RC/PO	Alabama State University
Dothel W. Edwards, RhD, CRC, CLCP	RC	Alabama State University
John L. Garland, PhD, BCC, GCDF	RC	Alabama State University
DeAnna L. Henderson, PhD, LPC, CRC	RC	Alabama State University
Jill Heitzman, PT, DPT, GCS, CWS, FACCWS	PT	Alabama State University
Jason Hutchinson, SPT	PT	Alabama State University
Veronica Jackson, PT, DPT	PT	Alabama State University
Daie Johnson, SPT	PT	Alabama State University
Kiersten Koen, MS, SPT	PT	Alabama State University
Cindy LaPorte', PT, PhD	PT	Alabama State University
Jerry Lee, DC, PT, MA	PT	Alabama State University
Barney LeVeau, PT, PhD	PT	Alabama State University
Julian McGhee, PT, DPT, ATC	PT	Alabama State University
Valda Montgomery, LAT, PhD	PT	Alabama State University
Inga Moten, MLS	HS Librarian	Alabama State University
Greshundria Raines, OTD, MPS, OTR/L	OT	Alabama State University
Tracy Thomas, PT, PhD	OT	Alabama State University
Bernadette Williams, PT, DSc, GCS	PT	Alabama State University
Catrina Waters, MS	MCH	Alabama State University
Janet D. Spry, EdD, CRC, LCPC, CVE, MCRSP	RC	Coppin State University
Adrienne Jackson, PT, PhD, MPA	PT	Florida A & M University
Ellenor Brown, MSPO	P&O	Georgia Institute of Technology
Geza F. Kogler, PhD, CO	P&O	Georgia Institute of Technology
Yolanda Rainey, PT, DPT, MS	PT	Hampton University
Marya Shegog, PhD, MPH, CHES	Public Health	Hampton University
Ukonnaya Bigelow, PT, DPT	PT	Howard University
Pamela Brown-White, PT, MBA	PT	Howard University
Abigail Gordon, PT, DPT	PT	Howard University
Revenda Greene, PT, PhD	PT	Howard University
Shirley J. Jackson, PhD, OTR/L, FAOTA	OT	Howard University
Silvia Martinez, EdD, CCC-SLP	CSD/SLP	Howard University
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Senora D. Simpson, PT, Dr.PH, MPH	PT	Howard University
Wilhelmina Wright-Harp, PhD, ASHA Fellow	CSD/SLP	Howard University
Mario J. Azevedo, PhD, MPH	Epidemiology	Jackson State University
Carol L. Cannon, MS, CCC-SLP	CSD/SLP	Jackson State University
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TABLE 3 continued
Participant List

Eddie Taylor, PT, MEd, DPT	PT	Langston University
Andre L. Washington, MS, CRC	RC	Langston University
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Tina T. Smith, PhD, CCC-SLP	CSD/SLP	Tennessee State University
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Amanda Johnson-Burress, MRC	RC	University of Texas-Pan America
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Jennifaye V. Greene, PT, MS, NCS, PhD (c)	AAPT	Non University Affiliated Participant
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Gene Gary-Williams, PT, PhD	NSAH	Non University Affiliated Participant
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Courtland Wyatt, PT, DPT	SHIRE	Non University Affiliated Participant

TABLE 4
Presentations and Publications as of November 1, 2012

- Mayo, R. (2012) NBASLH Members Attend Health Disparities Conference at Alabama State University. *ReSound*, Summer:2-3. Retrieved November 8, 2012 from <http://www.nbaslh.org/pdf/2012-Summer-Resound.pdf>.
- Lemmon, R. (2012). Health Disparities Conference at Alabama State University. *In Touch*, Summer:3. Retrieved November 8, 2012 from <http://scsha.com/intouch/InTouch-summer2012.pdf>.
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- Chesbro, S.B. (2012, December). Developing a Research Agenda to Address Health Disparities in Rehabilitation: Findings from a National HBCU Conference. A presentation accepted at the *2012 Science of Eliminating Health Disparities Summit* (NIH/NIMHD). National Harbor, MD.
- Wright-Harp, W., Mayo, R., Martinez, S., Payne, J., & Lemmon, R. (2012, November). Addressing Health Disparities in Minority Populations with Communication Disorders. A paper presentation at the *2012 Annual Convention of the American Speech-Language-Hearing Association*.

FIGURE 1
Conference participants gather for a group photo.
(Photo by David Campbell, ASU Photographer)



FIGURE 2
Louis Sullivan, MD, former Secretary of the U.S. Department of Health and Human Services speaks about health disparities in the United States.
(Photo by David Campbell, ASU Photographer)



FIGURE 3
Lynda Woodruff, PT, PhD, FAAPT, speaks to participants about what is known in the area of health disparities and rehabilitation. (Photo by David Campbell, ASU Photographer)



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Fluctuations in Reproductive Hormonal Levels and its Predisposition on Anterior Cruciate Ligament Tears

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Abstract

Background: Estrogen receptors have been located in the fibroblasts of human Anterior Cruciate Ligament (ACL) leading to a relaxation of soft tissue, alteration of function, diminished knee stability, and a predisposition to an ACL tear.

Purpose: The purpose of this study is to determine if there is a significant difference in the predisposition of ACL tears during the menstrual cycle between premenopausal females with body fat composition percentages greater than 30 as compared to premenopausal women with body fat composition percentages less than or equal to 30.

Methodology: Ten female students (age = 23.9) who were premenopausal participated in this study. Percent body fat composition, independent variable, was measured using the Tanita 300 BFA (= 34.08). The dependent measures were the predisposition to ACL tears: 1) anterior tibial displacement (mm), 2) Q-angle and 3) muscle strength (lbs).

Conclusion: Participants with < 30% body fat composition exhibited an increase in ACL laxity.

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Introduction

Establishing a clear association of the influence of female sex steroid hormones on soft tissue function as it relates to injury is a common intent amongst researchers. Recently assessed in collegiate athletes, due to the increased likelihood of soft tissue injuries (Hicks-Little, Thatcher, Hauth, Goldfuss, & Cordova, 2007), female athletes were ten times more likely than their male counterparts to sustain general sports related injuries (Constantini, Dubnov, & Lebrun, 2005). Hicks-Little et al. (2007) noted a disparate proportion of non-contact knee injuries in female athletes, specifically of the anterior cruciate ligament (ACL). In addition to the many anatomical and neuromuscular dissimilarities existing between genders, hormonal changes are often noted as the mechanism affecting ligament laxity, muscle strength, and biomechanical factors leading to a predisposition of ligament tears in female athletes (Constantini et al., 2005 ; Martineau, AL-Jassir, Lenczner, & Burman, 2004). A common basis of hormone fluctuation during the female life span is the female reproductive life cycle (Constantini et al., 2005). With a continuous flow from prepuberty and menarche into pregnancy and menopause, the female reproductive life cycle encompasses a continuous fluctuation of endogenous female sex steroid hormones (Constantini et al., 2005).

A large component of the female reproductive cycle is the menstrual cycle. Touted as a critically important biological rhythm in females, the menstrual cycle is coordinated by the communications of the hypothalamus, pituitary gland, and the ovaries (Constantini et al., 2005 ; Martineau et al., 2004). Commonly, the phases comprising the menstrual cycle are noted as the follicular, ovulatory, and luteal phases (Karageanes, Blackburn, & Vangelos, 2000). These phases are distinguished by the constant fluctuation of the following endogenous hormones: estrogen, progesterone, follicle stimulating hormone (FSH), and luteinizing hormone (LH) (Janes de Jong, Boot, Thom, Ruell, & Thompson, 2001). Normally, encompassing 28 to 30 days, the menstrual cycle begins with the follicular phase. Generally averaging 9 days in length, the follicular phase includes a slow increase of estrogen which triggers the release of LH. A continued increase in estrogen and LH leads into the ovulatory phase by the 14th day. During this phase, averaging 5 days in length, progesterone levels are low. Following the release of the ovum, progesterone levels rise indicating the start of the luteal phase. After this 14 day phase, progesterone secretions cease and menstrual bleeding (menses) begins followed by a slowing of estrogen secretion. An increase of FSH marks the beginning of another menstrual cycle (Constantini et al., 2005; Hicks-Little et al., 2007; Karageanes et al., 2000).

Hormonal Fluctuations and ACL Injuries

Investigations proposing to target a link between fluctuating endogenous female sex steroid hormones and ACL injuries located estrogen and progesterone receptors in the fibroblasts of the human ACL (Martineau et al., 2004). Estrogen has been noted to relax soft tissue and reduce the synthesis of collagen and proliferation of fibroblasts on the human ACL (Hicks-Little et al., 2007). These changes in the structure of the ligament lead to an alteration of function, diminished knee stability, and a predisposition to an ACL tear.

Past studies have indicated an increase in ACL injuries during various phases of the female reproductive life cycle (Constantini, et al., 2005). The surge of estrogen noted prior to and during the ovulatory phase assisted Wojtys, Huston, Lindenfield, Hewett, & Greenfield (1998) in establishing an association between the hormone and the increase of ACL injuries in female athletes with previous non-contact ACL injuries. Conversely, by using saliva samples to determine specific menstrual cycle phases and a sample size that included female athletes with previous ACL injuries ranging from middle school level through college, Slauterbeck et al. (2002) obtained different results. Their results revealed a higher incidence of ACL injuries within the first two days of the menstrual cycle (follicular phase) when estrogen and progesterone levels are at their lowest.

Hormonal Fluctuations and Body Fat Composition

A known role of estrogen is its responsibility in the pattern of fat deposition in the breasts, buttocks, and thighs of the female (Constantini et al., 2005). The adipose tissue throughout the female body is responsible for metabolizing the female sex steroid hormones especially estrogen (Szymczak, Milewicz, Thijssen, Blankenstein, & Daroszewski, 1998; Washington, 2008). This metabolism is increased in obese individuals due to their excess adipose tissue leading to an increase of circulating estrogen hormone (Sitter, 1987; Washington, 2008). The amount of adipose tissue is most accurately quantified by the percent of body fat. The recommended percentage of body fat in females is equal to or less than 25 (Lebrun et al., 1995). Values greater than that are considered above average (25-29%), over fat (29-35%) and obese (35+%) (Lebrun et al., 1995). Lebrun et al. noted no significant differences in weight, percent body fat, and sum of skin folds during the follicular and luteal phases of the same subject.

Hormonal Fluctuations and Ligament Laxity

The predictable surges of female sex steroid hormones have also been discovered to alter the consistency of the ligament and increase its predisposition of laxity and damage (Hicks-Little et al., 2007). When detecting the extent of ACL laxity in adolescent female athletes, Karageanes et al. observed no statistical significance in ACL laxity during the phases of the menstrual cycle (Karageanes et al., 2000). Alternatively, Hicks-Little et al. noted increased laxity in the ACL of postpubescent female collegiate athletes during their ovulatory and luteal phases. Unlike the counting method, Karageanes et al. and Hicks-Little et al. used to distinguish the phases of the menstrual cycle, Heitz, Eisenman, Beck, & Walker (1999) noted an increase in laxity during the luteal phase versus the follicular or ovulatory phases in his physically active female participants as indicated by blood serum analysis.

Hormonal Fluctuations and Biomechanical Factors

The impact of the hormonal fluctuations on existing anatomical differences between genders is another aspect in need of investigation. On average, females have a larger quadriceps angle (Q-angle) than males (Charlton, Charlton, & Ciccotti, 2001). In combination with their wider pelvis, a greater Q-angle places the female knee in a greater position of instability or excessive genu valgum (Boden, Griffin, & Garret, 2000). This has been proposed as a factor leading to an increase of ACL injuries in females although past research has indicated no direct connection (Charlton et al., 2001).

Hormonal Fluctuations and Muscle Strength

How the menstrual cycle influences changes in soft tissue, specifically large muscle groups, is not well associated. Recent discussions list the female sex steroid hormones, estrogen and progesterone, as being influential on muscle strength, endurance, and performance (Friden, Hirschberg, & Saartok, 2003). Most

researchers attempt to link athletic performance level and hormonal fluctuations thereby considering the influence of variables other than muscle strength (Sarwar, Niclos, & Rutherford, 1996). Taking a cue from previous studies which indicate a decrease of estrogen in postmenopausal women as a link to the decrease of the adductor pollicis, Sarwar et al. (1996) investigated the ability of estrogen to affect the amount of force produced by skeletal muscle. The purpose of their study was to determine any effects of menstrual cycle phases on muscle strength using simple muscle testing. They assessed the ability of relatively sedentary women to maximally activate their quadriceps, using maximal voluntary isometric contraction (MVIC) and weekly contractility measurements during the phases of the menstrual cycle. Sarwar et al. noted significant differences of the MVIC in the ovulatory (mid cycle) phase of non-oral contraceptive users when compared to the other phases. Their results were indicative of gains in strength during the ovulatory (mid cycle) phase when compared to those taking oral contraceptives. Sarwar et al. concluded that the increase in muscular strength and fatigability during ovulation may be a cause for the increased injury rate noted during this phase. Unlike Sarwar et al. who used a counting method to distinguish the menstrual phases, Friden et al. used hormonal assays to confirm and define the specific phases of the menstrual cycle. Using moderately active female participants, Friden et al. revealed no significant differences in muscle strength between the specific phases of the menstrual cycle.

These studies and many others have indicated a link between the menstrual cycle and the increased incidence of ACL tears in the female athletic population. However, fewer studies have ventured to link specific factors with the predisposition of ACL tears in the non-athletic population. This study aims to illustrate the predisposing factors of ACL tears in an effort to inform health care providers about impending risks for knee injury in a more inclusive population of female clients. Therefore, the purpose of this study is to determine if a significant

difference exists in the predisposing factors of ACL tears between premenopausal females with body fat composition percentages greater than 25 as compared to premenopausal women with body fat composition percentages less than or equal to 25 across the menstrual cycle. The predisposing factors include ligament laxity, muscle strength and Q-angle. The clinical applications of these findings are proposed to have an overall effect on physical therapy treatment programs and protocols. These findings will also act as a tool for advocating for the use of menstrual cycle information with information gathered during the patient examination portion of the Patient/Client Management Model.

Methods

Subjects

In an effort to secure participants for this study, researchers posted flyers on the campus of a Historically Black College/University (HBCU), petitioned instructors for class visitation via e-mail, and personally contacted students. To enhance these efforts, 200 participant brochures were constructed and distributed to premenopausal female students and faculty. Thirty female students volunteered to become participants in this study after completing the demographic questionnaire and providing informed consent. Volunteers were eliminated if they: 1) had a prior history of pregnancy; 2) had a prior surgical history of a hysterectomy; 3) had an abnormal menstrual cycle (< 24 days or >33 days); 4) were using hormonal therapy; 5) were using contraceptive shots or patches; 6) consistently participated in exercise > 2 days/week; or 7) obtained an 84 or below on the Lysholm Knee Rating Scale. Other requirements included having a muscle strength of 3⁺/5 in their quadriceps complex, and being faculty, staff, or student. Based on the research criteria, 10 students (20 knees), 9 African American and 1 European American, qualified for the study, reflecting a sample of convenience. The participants were premenopausal, ranging from 21 to 27 years of age (= 23.9 years), reportedly

healthy, free of knee pathologies, and experiencing a normal menstrual cycle (between 24-33 days).

Instrumentation

An objective measure of anterior knee joint laxity was obtained using the KT 1000 Arthrometer (MEDmetric Corp., San Diego, CA). Numerous studies have used the KT 1000 to assess the anterior displacement of the tibia on the femur (Charlton et al., 2001; Hanten, 1987; Hick-Little et al., 2007; Karageanes et al., 2000; Martineau et al., 2004; Tegner & Lysholm, 1985). The displacement is measured in millimeters (mm). According to Hanten et al. the test-retest reliability coefficient of the KT 1000 has a range from .84 - .92 (Tegner & Lysholm, 1985). The Lysholm Knee Score was used to assess knee pathology and pain. This instrument has a test-retest intraclass correlation (ICC) efficient of .97 (Schaubert & Bohannon, 2005). A goniometer was used to measure the angle of knee flexion during the KT 1000 testing procedure. A microfet 2 hand held dynamometer (HHD) (Hoggan Health Industries, Draper, UT) was used to measure the MVIC of the quadriceps complex in the optimal manual muscle testing (MMT) position provided by Daniels and Worthingham's Muscle Testing: Techniques of Manual Examination 8th Edition (Hislop & Montgomery, 2007). According to the study conducted by Schaubert et al. (2005), the microfet 2 HHD has an ICC of .92. The Tanita 300A Body Fat Analyzer (Tanita Corporation of America, Inc., Arlington Heights, Illinois) was used to assess the participants percent body fat (%BF). Test-retest reliability for the Tanita 300A BFA yields an ICC of .99 (Huston, Greenfield, & Wojtys, 2000).

Procedures

All procedures were approved by the HBCU's Institutional Review Board (IRB) prior to the initiation of this research study. All assessments were conducted in the Exercise Physiology/Cardiopulmonary Laboratory on the campus.

Prior to participation in the first assessment session, participants were verbally oriented and provided with verbal

clarification of equipment, procedures, and any possible risk factors. Participants were also given the opportunity to have their concerns addressed by the researchers via a question and answer session. The self-reporting of prior menstruation and counting methods were used to determine the occurrence of the three phases of the menstrual cycle in each participant. Participants were scheduled to be assessed on the 1st, 13th, and 23rd day of one menstrual cycle as indicated by the information provided on the demographic questionnaire. The assessment sessions included measurements for percent body fat composition, MVIC, and anterior tibial displacement on the femur. All data collected during the assessment sessions were documented on a data collection sheet.

The same researcher performed the anterior displacement of the tibia on the femur for each of the three assessment sessions. The test-retest reliability with use of the KT-1000 was established for this researcher during our pilot study yielding an intrarater reliability of .93. A second researcher was assigned to perform percent body fat composition and conducted MVIC measurements for each of the three assessment sessions.

Percent body fat composition was determined by the utilization of the Tanita 300 BFA. Participants were tested according to the Tanita 300 BFA instruction manual. The participant's height was measured using a standard tape measure and entered into the Tanita along with the age, gender, and standard clothing weight. Results were printed from the Tanita and the information was transferred on the data collection sheet. This measurement was only collected during the first assessment session (day 1 of menstrual cycle).

The MVIC of bilateral quadriceps complex was measured using a HHD. Participants were placed on a plinth in the appropriate testing position according to Hislop. The researchers eliminated upper extremity compensation and screw home mechanism by ensuring the participants were measured with their hands in their laps and knees in slight flexion. Three trials of the

MVIC were conducted on each leg with the participant holding the position for 3 seconds and relaxing before assuming the position for the next trial.

In preparation for use of the KT 1000 participants remained on the plinth in supine position with full extension of all four extremities. A gait belt was fastened mid-femur to prevent external hip rotation during the measurement. The remainder of the testing position was carried out according to the KT 1000 instruction manual. Three trials of 15 lbs, 20 lbs, and 30 lbs of force were applied in order to measure knee joint laxity by focusing on anterior tibial displacement.

In an effort to control internal validity of this study, the researchers monitored multiple factors. The participants were asked to maintain their daily routines throughout the length of the study. Participants were measured for 3 sessions in a 1 month time period. During the study the same instruments were used by the same researchers in the same testing site. All instruments used were calibrated and participants were oriented to their use.

Statistical Analysis

The independent variable (IV) is the percent body fat composition with 2 levels: ≤ 25 and >25 percent body fat composition. The dependent variable was the anterior displacement of the tibia on the femur as measured using the KT1000 as an indicator of potential predisposition to ACL injury. The compliance index was used in an effort to detect maximal anterior displacement of the tibia on the femur irrespective of soft tissue approximation. The difference of 30 and 15lbs of force were analyzed for the left and right knee in accordance to the compliance index.

Data were statistically analyzed utilizing nonparametric tests in lieu of parametric tests due to the small sample size. The Mann-Whitney U Test was used to compare the changes on the dependent measures across the phases of the menstrual cycle as related to the percent body fat composition greater than 25 versus body fat composition percentages less than or equal to 25. Statistically significant differences were

considered at an α -level of 0.05 or less. All statistical analyses were completed using SPSS for Windows Software Version 16.

Results

Percent Body Fat Composition

Participants were grouped based on their percent body fat. Due to the small sample size ($n=10$) only 1 of the 10 participants measured less than 25% body fat. The remaining participants measured significantly greater than 30% body fat ($= 34.08\%$). The percent body fat was increased to $\leq 30\%$

and $>30\%$ to evenly distribute participants into each group (Table 1a).

Anterior Tibial Displacement

Statistical significance was noted in multiple factors when comparing percent body fat composition. The Mann-Whitney U Test analysis of anterior tibial displacement yielded a significance level less than .024 for the right lower extremity. This significance is noted in the $\leq 30\%$ group when compared to the $>30\%$ group with a mean rank of 19.13 and 11.87 respectively (Table 1b and Figure 1a).

TABLE 1a
Mann-Whitney U Test Analysis: Anterior Tibial Displacement (mm) 30 lbs-15 lbs on Left Lower Extremity

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	17.77	266.50
> 30	15	13.23	198.50

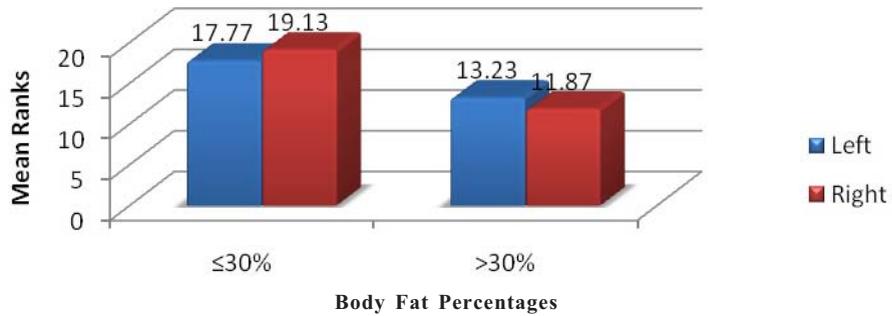
Mean = 2.6217 ($\pm .991$), Range = 1.15-5.10, U = 78.50, p value $< .158$

TABLE 1b
Mann-Whitney U Test Analysis: Anterior Tibial Displacement (mm) 30 lbs-15 lbs on Right Lower Extremity

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	17.77	266.50
> 30	15	13.23	198.50

Mean = 2.34 ($\pm .915$), Range = 1.05-5.25, U = 58, p value $< .024$

FIGURE 1a
Anterior Tibial Displacement (mm) 30 lbs - 15 lbs on Right Lower Extremity



Q-angle

The left lower extremity exhibited a statistical significance in the Q-angle with a significance level less than .020. The Q-angle of > 30% revealed the greatest

difference with a mean rank of 19.23 versus 11.77 in the ≤ 30% group (Table 2a and Figure 2b). Conversely, the right lower extremity exhibited no statistical difference with a p value of .078 (Table 2b and Figure 2b).

TABLE 2a
Mann-Whitney U Test Analysis: Q-angle (°) of Left Lower Extremity
in ≤ 30% BF vs. >30% BF

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	11.77	176.50
> 30	15	19.23	288.50

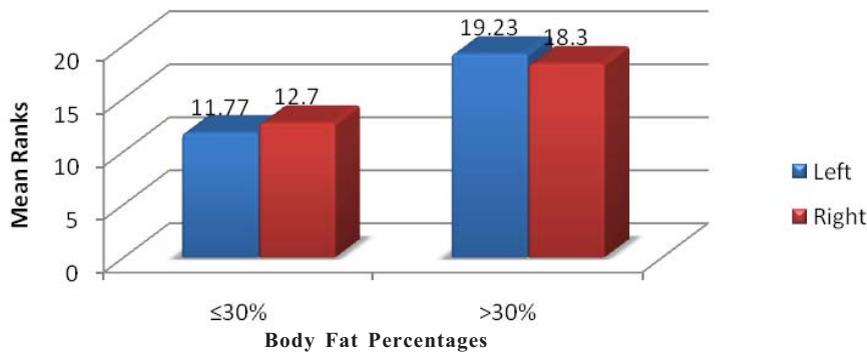
Mean = 13.133 (± 3.549), Range = 6-20, U = 56.5, p value < .02

TABLE 2b
Mann-Whitney U Test Analysis: Q-angle (°) of Right Lower Extremity
in ≤ 30% BF vs. >30% BF

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	12.70	190.50
> 30	15	18.30	274.50

Mean = 13.833 (± .3.495), Range = 8-20, U = 70.50, p value < .078

FIGURE 2b
Mann-Whitney U Test Analysis: *Q*-angle (°) of Right Lower Extremity
in ≤ 30% BF vs. >30% BF



MVIC

The left lower extremity exhibited a statistical significance in MVIC with a significance p-value less than .004. Conversely the MVIC of the ≤ 30%

revealed the greatest difference with a mean rank of 20.13 versus 10.87 in the > 30% group (Table 3a). No significant difference was noted for the right extremity as evidence by the p-value of .115 (Table 3b)

TABLE 3a
Mann-Whitney U Test Analysis: *MVIC* (lbs) of Left Lower Extremity
in ≤ 30% BF vs. >30% BF

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	20.13	302
> 30	15	10.87	163

Mean = 51.517 (±4.780), Range = 42-60, U = 43, p value < .004

TABLE 3b
Mann-Whitney U Test Analysis: *MVIC* (lbs) of Right Lower Extremity
in ≤ 30% BF vs. >30% BF

Percent Body Fat	N	Mean Rank	Sum Of Ranks
≤ 30	15	18.03	270.50
> 30	15	12.97	194.50

Mean = 58.5 (± .6.799), Range = 43-72, U = 74.5, p value < .115

Discussion and Limitations

The purpose of this study was to illustrate the predisposing factors leading to an ACL tear. These factors included ligament laxity, muscle strength (MVIC), and biomechanical factors (i.e Q-angle). Percent body fat was determined for each participant and data used as the independent variable, within the study focusing on increased body fat as a strong indicator of excess estrogen production. Ten premenopausal women were assessed during the follicular (day 1), ovulatory (day 13), and luteal phases (day 23) of one menstrual cycle. The dependent measures included anterior tibial displacement, Q-angle and muscle strength. Based on prior published research efforts noting the higher incidence of ACL injuries in women, the researchers proposed the following question to expose the significance of such factors.

Is there a significant difference in the predisposition of ACL tears between premenopausal women with body fat composition percentages greater than 30 as compared to premenopausal women with body fat composition percentages less than or equal to 30 across the menstrual cycle?

These findings were consistent with other studies that noted the correlation between increased amounts of adipose tissue and increased amounts of estrogen. The percent body fat composition accurately depicts the amount of adipose tissue; therefore, differences were noted in each factor. Due to the right lower extremity having a significance value less than .05 for anterior tibial displacement and the left lower extremity having a level of significance less than .05 for the Q-angle and MVIC, the null hypothesis is rejected. Due to a significance level greater than .05 for the anterior tibial displacement of the left lower extremity the null hypothesis is accepted. The null hypothesis is also accepted for the Q-angle and MVIC of the right lower extremity.

The results of our study reflected the limitations encountered by the researchers. The sample size is a direct result of the restrictive exclusion criteria that we outlined

based on previous published studies. The importance of excluding factors that influence hormone fluctuation was our primary goal, but it proved to be difficult to find many participants that had not engaged in these factors in the age range outlined. Another limitation to the study is the use of the counting method to distinguish the phase of the menstrual cycle. By using this method we were unable to note sensitive changes in the fluctuation of the hormone and depended on the information provided by the participant and literature to determine the proper hormonal fluctuations. The topic of menstruation also proved to be a limitation. When soliciting participants in several classrooms, women were often reluctant to engage in our proposal. We attribute this reluctance to the taboo of speaking about personal biological functions, specifically to a stranger. Lastly, the dial increments of the KT 1000 Arthrometer provided no reference for the slight changes of ligament laxity. Measurements falling between the outlined increments were subjectively documented by the researcher.

Our recommendations for improvement would be a more reliable method of detecting hormone fluctuations. Devices such as ovulation kits and fertility kits were considered for this study but were projected to aid in compliance issues with our sample population. Also the methods of distribution proved to have poor follow through so more interactive and homogenous events are recommended to recruit participants. Lastly, the use of the manual maximal displacement method, as outlined in the KT 1000 manual, would benefit the researchers in noting the maximal measurement of displacement prior to the standard measurement forces.

Conclusion

Based on the small sample size and sampling from one HBCU campus located in one southern state within the United States, results of the study are not generalizable to the larger population. The conclusions from this study revealed: 1) participants with $\leq 30\%$ body fat composition exhibited an increased ligament laxity and muscle

strength; and 2) participants with > 30% body fat composition exhibited increased biomechanical changes. The preliminary findings support the clinical applications of menstrual cycle information in the physical

therapy treatment program. Based on the information provided, clinicians will be able to adjust the selection of specific interventions and reduce the application of force during specific treatments.



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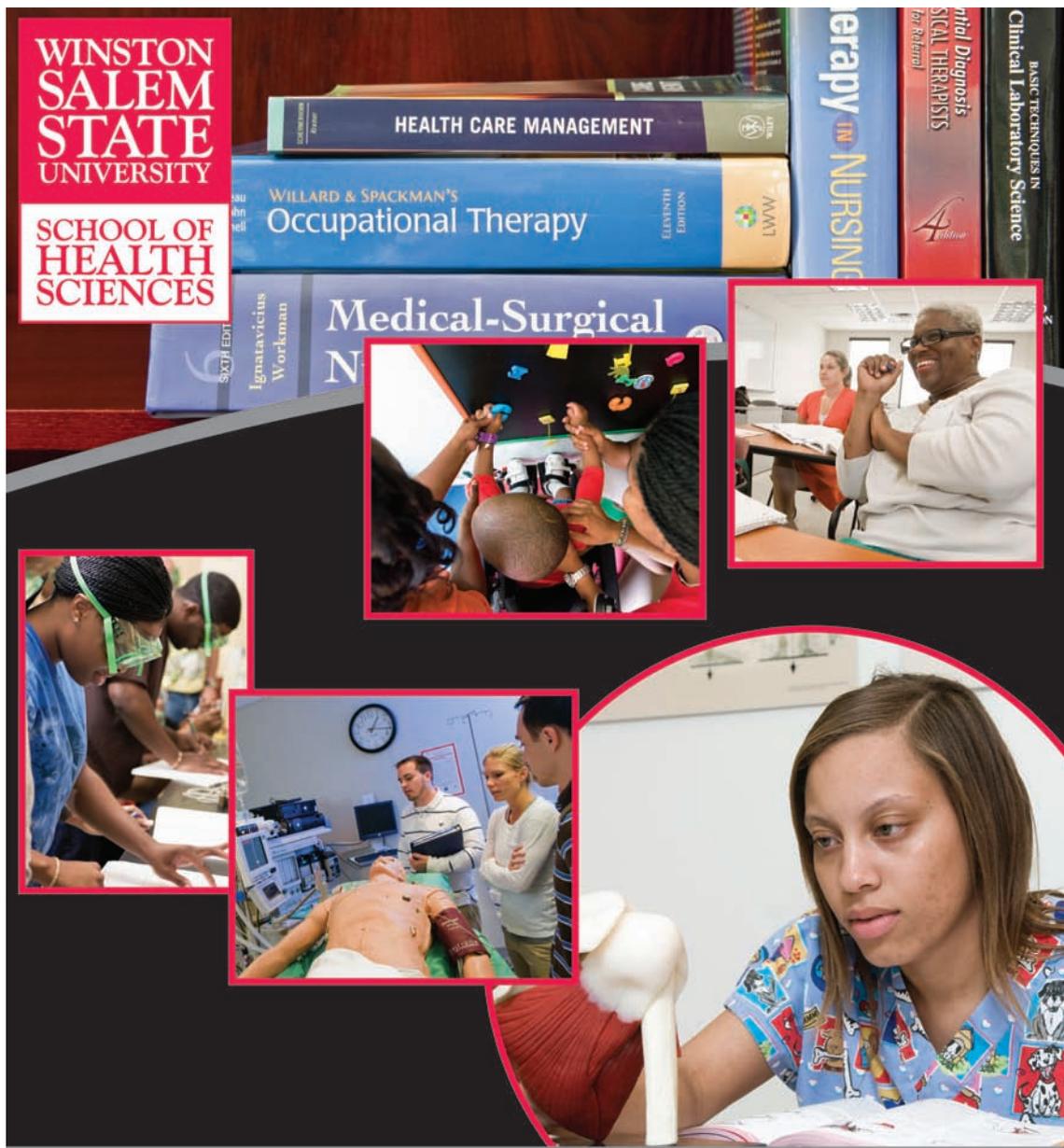
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The College of Health Sciences is housed in the 80,000-square-foot John L. Buskey Health Sciences Center and is home

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