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The Effects of Wearing Headscarves on Cervical Spine Proprioception and Range of Motion

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The Effects of Wearing Headscarves on Cervical Spine Proprioception and Range of Motion

by

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Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Science.

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ABBREVIATIONS

ROM	Range of Motion
JPE	Joint Position Sense
CROM	Cervical Ragne of Motion
WAD	Whiplash-Associated Disorder
ICF	International Classification of Function
SPSS	Statistical Product and Service Solutions
BMI	Body Mass Index
FHP	Forward Head Posture

ABSTRACT OF THE DISSERTATION

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by

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Doctor of Science, Graduate Program in Physical Therapy
Loma Linda University, September 2017
Dr. Gurinder Bains, Chairperson

Background: Wearing the headscarf is a part of an essential religious practice by females in Islamic cultures. Regular wear of the headscarf might have an influence on cervical proprioception and range of motion (ROM). The cervical spine is unique in providing multidirectional movement as well as providing the sense of awareness of movement of the head and neck in space. Impairments in cervical mobility and proprioception have been reported in subjects with whiplash-associated disorder as well as subjects having neck pain.

Objectives: 1) To determine the effects of wearing the headscarf on cervical spine ROM and joint position error (JPE), 2) To analyze the influence of age at onset of wearing the headscarf and duration of hours per day wearing the headscarf on cervical ROM and JPE.

Methods: Fifty-two females with mean age of 28.1±3.1 years were divided into two groups: Headscarf group (n=26) and control group (n=26). Cervical range of motion (CROM) device was used to measure cervical mobility in a seated position for flexion, extension, right lateral flexion, left lateral flexion, right rotation and left rotation. JPE was measured using the head-mounted laser method.

Results: The headscarf group reported a significant limitation in cervical ROM in all six directions. JPE test revealed no significant difference between groups. Moreover, females in the headscarf group who wore the headscarf for more than 6 hours per day had significantly less left rotation compared to those who wear it for less than or equal to 6 hours (71.3±2.1 vs. 64.5±2.1, η^2=2.2; p=0.045). Additionally, there was significantly more JPE when relocating from flexion (5.1±0.6 vs. 8.0±1.0, η^2=1.5; p=0.048) compared to those who wear the headscarf for less than or equal to 6 hours.

Conclusion: Wearing of the headscarf may result in cervical ROM limitation. The duration of wearing the headscarf daily is a key factor to limited cervical ROM an increase in cervical JPE.

Key words: Cervical spine, range of motion, neck pain, mobility, proprioception, movement, joint position error test, headdress, headscarf, and Hijab.

CHAPTER ONE

INTRODUCTION

Wearing the headscarf is a part of an essential religious practice by females in Islamic cultures. The headscarf is referred to the scarf that wraps up over the head and around the neck[1]. Females in Islamic cultures wear the headscarf when they are in public and usually begin wearing it at the onset of puberty[2]. Muslims represent the second largest religious group in the world and are estimated to become the second largest religious group in the United States by the year 2040[3].

According to the Pew Research Center (2014), there are approximately 1.7 billion Muslims in the world. Estimating the total number of females worldwide who wear headscarves is difficult. Several Islamic countries mandate females to wear headscarves when out in public, while other countries have banned the use of headscarves in public. However, in the majority of the world's countries, wearing headscarves is optional. For example, in the United States, where wearing of the headscarves are optional, 43% of Muslim females reported that they wear the headscarf, which makes for a total of 433,000 females[4]. In contrast, in Saudi Arabia, a country that mandates the wearing of headscarves, all females over the age of 15 are expected to wear headscarves, which makes for 9,210,133 females[5]. In such cultures, females start wearing headscarves at an early age and for extended periods of time daily. Consequently, routine wearing of headscarves may have an influence on cervical range of motion (ROM) and cervical proprioception.

The cervical spine is unique in providing three-dimensional movement of the head while keeping the horizontality of the visual gaze. A majority of the movements occur at the craniocervical junction, which is uniquely adapted to stability and motion[6]. Hence, cervical ROM is commonly used in clinical settings as a standard practice to classify neck pain with mobility deficits[7].

Limitation in cervical spine ROM is a common symptom associated with disorders in the cervical spine[8]. Impairments of cervical ROM may develop at an early stage of neck pain and can differentiate between people with subclinical neck pain and no neck pain[9,10]. Lee et al.[9] investigated the ability to use active cervical ROM to distinguish between treated and untreated neck pain. Fifty-five subjects were divided into three groups: treated neck pain, untreated neck pain, and no neck pain. Subjects in the treated pain group reported more pain than those in the untreated pain group. The results indicated a reduction in head protraction range in the treated pain group compared to the untreated pain group. Additionally, there was a decrease in rotation and extension ROM for the pain groups but not for the no-pain group. Lee et al.[10] further investigated a population with high incidence of neck pain. They compared active cervical ROM among computer workers with frequent and infrequent neck pain. The findings revealed that cervical ROM is affected by the frequency of neck pain with limitations in cervical ROM with more frequent neck pain.

Cervical ROM can be a predictive outcome measure for neck-pain related conditions. Kasch et al.[11] prospectively investigated the ability of active cervical mobility, cervical pain, and non-pain complaints as predictors of handicap following whiplash injury. Subjects who had initial limitation in cervical ROM were 4.6 times at higher risk for disability following whiplash injury. Therefore, it was suggested that reduced cervical ROM is one of the prognostic factors for increased disability after acute whiplash. Additionally, Dall'Alba et al.[12] examined the ability of cervical ROM to discriminate between asymptomatic subjects and those with persistence whiplash associated disorders. The finding indicated that cervical ROM successfully discriminates between subjects with whiplash-associated disorder (WAD) and an asymptomatic control group. Therefore, it was proposed that cervical ROM could be used as an indicator of physical impairments.

Proprioception plays an important role in sensorimotor control of posture and movement. Han et al.[13] defined proprioception as "the individuals ability to integrate the sensory signals from mechanoreceptors to thereby determine body segment position and movement in space." Cervical joint position sense (JPS) is a major component of proprioception and is defined as the sense of movement of the head and neck in space. Cervical spine muscles contain a high density of muscle spindles that provide substantial proprioceptive information[14]. Additionally, higher densities of muscle spindles are located in the deeper, upper cervical spine muscles[15]. These receptors have central connections with the visual and vestibular systems. Therefore, upper cervical spine plays an important role in postural control.

The joint position error (JPE) test was first introduced by Revel et al.[16]. It is widely used test to measure head repositioning accuracy. It reflects the individual's ability to reproduce a previously predetermined head position with elimination of visual and verbal feedback. The error individuals produce while relocating the head to the predetermined position is defined as joint position error. The JPE test has good test-retest and inter-tester reliability [17]. A specificity of 93% and a sensitivity of 86% were provided with the cut off point of 4.5° (equivalent to 7 cm) that differentiate people with impairments of cervical spine proprioception[16,18].

Impairments in cervical proprioception have been reported in subjects with WAD[16,18,24]. Stanton et al.[25] conducted a systematic review with meta-analysis on impaired proprioception in chronic idiopathic neck pain. The meta-analysis on 10 studies demonstrated that people with chronic neck pain performed significantly worse in head repositioning accuracy to neutral. Additionally, a systematic review by De Vries et al.[26] reported higher joint position sense error in people with neck pain compared to healthy control.

Kit Siu et al.[27] investigated the relationship among cervical range of motion, postural stability, and head-repositioning accuracy in healthy adults. The results demonstrated that head-repositioning accuracy was correlated with both postural stability and cervical ROM in healthy subjects. Quek et al.[28] reported that older adults with cervical pain who demonstrated cervical ROM asymmetry had more postural sway compared with subjects without ROM asymmetry. Thus, Grip et al.[23] reported the significance of utilizing both ROM and proprioception to describe cervical dysfunction.

Wearing protective headgear has been shown to decrease active cervical ROM. McCarthy et al.[29] studied the effects of wearing an American football helmet on active cervical ROM and proprioception. Fifteen American football player with their age-matched control participated. Cervical ROM and head repositioning accuracy were measured during cervical flexion and extension. The results indicated that wearing the helmet significantly decreased cervical extension in both groups. Head-repositioning accuracy was similar between the groups without the helmet. However, when wearing the helmet American football players appeared to be more accurate in head repositioning accuracy than controls Additionally, soft neck collars significantly reduced cervical spine rotation[30]. Therefore, it is reasonable to assume that other headdresses, including headscarves, may also influence cervical ROM.

The wearing of headscarves may influence cervical proprioception especially when worn for an extended time period. To the best of our knowledge, there is only one study that investigated the effect of wearing headscarves on cervical proprioception. Alqabbani et al.[31] reported greater joint position error in females wearing headscarves compared to females with no headscarves (details in chapter 2). The findings of this pilot study indicated the need to further explore the influence of wearing the headscarves on cervical proprioception and cervical mobility and to investigate other factors related to the wearing of headscarves.

The primary objectives of this dissertation were to determine the effects of wearing the headscarf on cervical spine range of motion and to determine the effects of wearing the headscarf on cervical joint position error. Among females who wear the headscarf, a secondary aim was to analyze the influence of age at onset of wearing the headscarf and duration of hours per day wearing the headscarf on cervical ROM and JPE.

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CHAPTER TWO

THE EFFECTS OF WEARING HEADSCARVES ON CERVICAL SPINE PROPRIOCEPTION

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Abstract

Background: Proprioception plays an important role in sensorimotor control of posture and movement. Impairments in cervical proprioception have been demonstrated in subjects with whiplash-associated disorder, patients with age-related degeneration, and patients with articular diseases or spondylosis. The joint position error test is widely used to measure head repositioning accuracy.

Objective: The purpose of this pilot study was to compare cervical spine joint position error in females who routinely wear headscarves to females that do not wear headscarves.

Methods: Twelve females with mean age 27.5±4.0 years were divided into two groups: females who routinely wear headscarves (n=6), and females who never wear headscarves (n=6). Joint position error was measured using a head-mounted laser while subjects were seated. The tasks involved relocating the head to neutral after flexion, extension, right rotation, and left rotation. A total of six trials were done for each direction.

Results: The joint position error was higher in females wearing headscarves compared to females who do not wear them in the cumulative joint position error score (8.2±1.0 vs. 4.4±1.0, p=0.06) as well as during moving to right rotation (9.3±1.6 vs. 3.1±1.6, p=0.06).

Conclusion: Wearing headscarves may influence cervical joint position error and can negatively impact postural control. However, further studies are needed to confirm this finding.

Key Words: Cervical spine, proprioception, joint position error, headscarves

Introduction

Proprioception plays an important role in sensorimotor control of posture and movement. There is a high density of muscle spindles in the cervical spine muscles serving as primary receptors of proprioception.[14] Moreover, there are higher densities of muscle spindles in the deeper neck muscles and upper cervical spine compared to the lower cervical spine.[15] Injuries to cervical spine soft tissue structures can compromise proprioception and contribute to deficits in head and neck position sense[8]. Impairments in cervical proprioception have been documented in subjects with whiplash-associated disorder (WAD), patients with age-related degeneration, and patients with articular diseases or spondylosis.[1]

The joint position error (JPE) test was first introduced by Revel et al 1991.[17] It is widely used test to measure head repositioning accuracy.[1,3-9] The error is calculated by measuring the distance between the reference position and reproduced position and converting it to degrees.[1] The JPE has good test-retest and inter-tester reliability.[2,3] Several studies have reported that there is a greater JPE in patients with WAD compared to healthy controls.[2,4,5]

Owens et al.[6] measured JPE in healthy volunteers after recent muscle history contraction. Their results showed a significant undershooting after maximum voluntary contraction suggesting a possible mechanism of joint position error. Consequently, this may introduce a clinical measure for paraspinal muscle contribution to cervical pain and dysfunction.[6]

A headscarf is operationally defined as a scarf that wraps up over the head and around the neck. Females in Islamic cultures are required to wear this scarf when out in public. Several Islamic countries mandate a dress code for women that involve wearing headscarves while other countries have banned the wearing of headscarves. However, the majority of the countries around the world make the wearing of headscarves optional for women. According to Pew Research Center from the one-million Muslim women in the United States, 43% wear headscarves. The influence of headscarves on cervical proprioception has not been determined. Therefore, the purpose of this pilot study was to investigate the impact of wearing headscarves on neck proprioception; and to compare cervical spine JPE in females who routinely wear scarves to females that do not wear scarves.

Methods

Subjects

Twelve females with mean age 27.5± 4.0 years participated in the study. Subjects were divided into two groups. Group 1: six females who routinely wore headscarves; Group 2: six females who never wore headscarves. Subjects were excluded if they have had a recent episode of cervical pain or trauma, had tenderness or muscle spasm, or limited cervical range of motion. Subjects were recruited from Loma Linda University and signed a Loma Linda University Institution Review Board approved informed consent prior to participation.

Procedure

Joint position error was assessed using a head mounted laser. The starting position for cervical JPE test was in upright sitting 90 centimeters (cm) away from the front of a wall with their feet resting on the floor and back against the back of a chair. Subjects assumed a neutral head position and were required to memorize this position as their perceived neutral position. Subjects were then asked to close their eyes and maximally rotate their head to the left, right, flexion, and extension. Immediately after each direction they were asked to return to their perceived neutral head position while keeping their eyes closed. When subjects indicated that they had returned to their perceived neutral position, the investigator marked the position with a marker. Each task was repeated 6 times. The difference between the beginning and ending position was calculated.

Statistical Analysis

The general characteristics of the subjects were summarized using means and standard deviations. The normality of the variables was examined using Kolmogorov-Smirnov test. The characteristics of subjects in the two groups were compared using an independent t-test or Mann-Whitney U test. The mean joint position error (JPE) was computed using the readings in the six trials in four directions. To control for the effects of age, analysis of covariance (ANCOVA) was used to assess differences in mean JPE between the two groups. The inter-rater reliability of all the measures taken was examined using Pearson's Correlation. The mean JPE among females while wearing a scarf and when they took it off was compared using Wilcoxon signed rank test. The level of significance was set at $p \leq 0.05$.

Results

Results of the ANCOVA showed that there was a borderline significant difference in mean± standard error (SE) joint position error in cumulative and when moving to the right side between the two groups (8.2± 1.0 vs. 4.4± 1.0, $F_{1,9,0.05}$=4.6;p=0.06), (9.3±1.6 vs. 3.1±1.6, $F_{1,9,0.05}$ =4.9; p=0.06) respectively. However, there was no significant difference in mean JPE when moving towards left, extension and flexion (p>0.05, refer to Table 1). Moreover, there was no significant difference in the mean JPE within females when they wore the scarf and when they took it off (p>0.05).

Table 1. Mean (SE) of Joint Position Error (JPE) in the four directions (n=12)

	Scarf (n_1=6)	No Scarf (n_2=6)	p – value[a]
Cumulative JPE	8.22(1.01)	4.42(1.01)	0.06
JPE Right	9.27(1.60)	3.12(1.60)	0.06
JPE Left	9.74(2.13)	4.84(2.13)	0.22
JPE Extension	7.22(0.74)	5.36(0.74)	0.19
JPE Flexion	6.64(1.29)	4.35(1.29)	0.34

Abbreviation: SE, Standard error of the mean; JPE, Joint Position Error.
[a] Analysis of covariance

Discussion

Joint position error in females who wear headscarves was compared to those who do not wear headscarves. The results indicated that the joint position error was higher in females wearing headscarves compared to females who do not wear them. A borderline significance was found in the cumulative JPE score as well as when moving to right rotation. However, there was no significant difference in mean JPE within females when they wore the headscarf and when they took the headscarf off.

Neck proprioception plays an important role in postural control. Increased JPE has been reported in subjects with WAD.[1,3,4] Joint position error has also been reported in subjects with neck pain[10,12]. Deficits in cervical proprioception as indicated by higher JPE might be a predisposing factor for development of cervical pain and dysfunction. In our study, subjects who wore headscarves showed to have higher JPE compared to those who did not wear them when moving their head in all directions (Table 2). Although this increase in JPE had a borderline significance, this difference may contribute to maintenance of joint stability and thus may increase the risk of injury.

Similar to this study, Sterling et al.[11] reported a significant difference in JPE between subjects with traumatic neck pain compared with healthy control in right rotation only.[11] They concluded that the side of pain might contribute to this discrepancy because the majority of the subjects had bilateral involvement. Although, hand dominance was not considered in their study, they speculated that it might explain their finding.

Moreover, Treleaven et al.[8] demonstrated a significantly higher joint position error in subjects with WAD compared with healthy control in rotation and extension. Their analysis revealed that WAD subjects with dizziness had significantly higher JPE in right rotation compared to WAD subjects without dizziness.[8] Additionally, Kristjansson et al.[12] demonstrated a significantly higher joint position error in subjects with neck pain compared to healthy control in rotation.[12]

In this study, subjects who wore headscarves were older than those who did not wear them, and it is well documented that neck proprioception tends to decline with age.

Although we statistically controlled for age in our sample, age difference might have an effect on JPE in subjects who wear headscarves. Hence, further studies are warranted to compare JPE in females who wear headscarves compared to age-matched controls.

There is a relationship between range of motion (ROM) and JPE[13]; however, in this study we did not measure ROM, which may contribute to the relocation accuracy. Wearing the headscarves over the neck might hinder full cervical ROM and might be the reason for impaired JPE. Further studies need to include ROM measurements and correlate them with JPE. Additionally, age is considered to be a factor causing a decline in repositioning accuracy; therefore, further studies need to correlate both variables. Also, although subjects performed the JPE test in alternating directions, some biofeedback may have occurred as subjects opened their eyes after relocating their head for each repetition. Future studies should blindfold subjects throughout the entire procedure to minimize potential biofeedback and learning effect as described in a previous study[10]. Finally, the JPE testing should also be performed in standing to determine the effect of cervical proprioception postural control between women who wear headscarves and those that don't.

In conclusion, the findings of this pilot study suggest that wearing headscarves can potentially influence head repositioning accuracy. Future research is needed to confirm these findings and should include larger sample size, age-matched control, blindfolding to minimize biofeedback, inclusion of JPE with range of motion measurements as well in standing for postural control measurements.

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CHAPTER THREE

EFFECTS OF WEARING HEADSCARVES ON CERVICAL SPINE MOBILITY

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Abstract

Background: Cervical spine provides three-dimensional movements of the head on the body while keeping the horizontality of visual gaze. Thus, cervical range of motion (ROM) is an important assessment that is commonly used in clinical practice. Headscarf is commonly used attire by females in Islamic cultures.

Objectives: The aim of the study was to investigate the effect of wearing headscarves on cervical ROM in females who wear headscarves compared with females who don't wear headscarves

Methods: Fifty-two females with mean age 28.1±3.1 years were divided into two groups: Headscarf group (n=26) and no-scarf group (n=26). Cervical range of motion was measured in a seated position for flexion, extension, right lateral flexion, left lateral flexion, right rotation and left rotation.

Results: The headscarf group reported a significant limitation in cervical ROM in all six directions. Moreover, females in the headscarf group who wore the headscarf for more or equal to 6 hours had significantly less left rotation compared to those who wear it for less than 6 hours (71.3±2.1 vs. 64.5±2.1, $\eta^2=2.2$; $p=0.045$).

Conclusion: Wearing the headscarf may influence cervical ROM. In addition, six hours or more of daily wear may result in further decline of cervical ROM.

Key Words: Cervical spine, range of motion, neck pain, mobility, movement, cervical limitation, Cervical Range of Motion Device, headdress, headscarf, and Hijab.

Introduction

Cervical spine mobility is maintained by the unique bony and soft tissue structures of the cervical spine that allow for multidirectional movements of the head. A majority of the movements occur in the upper cervical spine at the craniocervical junction, which allows for three-dimensional movements while maintaining the horizontality of visual gaze[1]. Hence, cervical range of motion (ROM) is an important assessment that is commonly used to classify patients with neck pain with mobility deficits and neck pain with headaches, according to the International Classification of Function (ICF)[2].

Wearing protective headgear has been shown to decrease active cervical ROM. McCarthy et al.[3] studied the impact of wearing an American football helmet on active cervical ROM and found that wearing helmets significantly decreased cervical extension. Additionally, soft neck collars significantly reduce cervical spine rotation[4]. Therefore, it is reasonable to assume that other headdresses, including headscarves, may also influence cervical ROM.

The headscarf is operationally defined as a scarf that wraps up over the head and around the neck[5]. Females in Islamic cultures often wear the headscarf when they are in public and usually begin wearing it at the onset of puberty[6]. According to the Pew Research Center (2014), there are approximately 1.7 billion Muslims, and they constitute the second largest religious group in the world. Moreover, Muslims are estimated to become the second largest religious group in the United States of America by the year 2040[7].

It is difficult to estimate the total number of females worldwide who wear headscarves, as several Islamic countries mandate females to wear them when out in public, while other countries have banned the use of headscarves in public. However, wearing headscarves is optional in the majority of the world's countries. For example, in the USA, where headscarves are optional, 43% of Muslim females reported that they wear the headscarf, which makes for a total of 433,000 females[8]. In contrast, in Saudi Arabia, a country that mandates the wearing of headscarves, all females over the age of 15 are expected to wear them, which makes for a total of 9,210,133 females[9]. In such cultures, females start wearing headscarves at an early age and for extended periods of time daily. Consequently, routine wearing of headscarves might have an influence on cervical ROM.

It has been reported that people with cervical spine pain report limited cervical ROM compared to people without cervical spine pain[10,11]. Lee et al.[10] investigated the ability to use active cervical ROM to distinguish between treated and untreated neck pain. Fifty-five subjects were divided into three groups: treated neck pain, untreated neck pain, and no neck pain. Subjects in the treated pain group reported more pain than subjects in the untreated pain group. The results indicated a reduction in head protraction range in the treated pain group compared to the untreated pain group. Additionally, there was a decrease in rotation and extension ROM for the pain groups but not for the no-pain group. Lee et al.[11] further investigated a population with high incidence of neck pain. They compared active cervical ROM among computer workers with frequent and infrequent neck pain. The findings revealed that cervical ROM is affected by the frequency of neck pain with limitations in cervical ROM with more frequent neck pain.

Therefore, Lee et al.[10,11] suggested that impairments of cervical ROM may develop at an early stage of neck pain and can differentiate between people with subclinical neck pain and no neck pain. Kasch et al.[12] predicted that reduced cervical ROM is one of the prognostic factors for disability after acute whiplash. Moreover, Dall'Alba et al.[13] indicated that cervical ROM successfully discriminates between subjects with whiplash-associated disorder (WAD) and an asymptomatic control group.

To the best of our knowledge, no previous investigations into the effects of wearing headscarves on cervical spine mobility have been conducted. Therefore, the primary aim of the present study was to investigate the effects of wearing headscarves on cervical ROM in females who wear headscarves compared with females who do not wear headscarves. Among females who wore the headscarf, a secondary aim was to compare cervical ROM measures by time spent per day wearing the headscarf (≤6 hours versus >6 hours) and age at onset of wearing the headscarf (≤12 years versus >12 years). We also examined the relationship between outcome variables and age at onset of wearing the headscarf, number of years worn, and time spent per day wearing the headscarf.

Methods

Subjects

Fifty-two females with mean age 28.1±3.1 years participated in the study. Subjects were divided into two groups (headscarf group: twenty-six females who routinely wore headscarves; control group: twenty-six females who never wore headscarves). Individuals who met the inclusion criteria ranged from 20-40 years of age, had been wearing the headscarf for a minimum of five years, and began wearing the headscarf before or at 15 years of age. Subjects were excluded if they had cervical pain for less than six months, or if they had tenderness or muscle spasm in the cervical area.

Subjects were recruited from Loma Linda University and the surrounding communities by flyers and word of mouth. All subjects signed an informed consent form approved by Loma Linda University Institution Review Board prior to participation.

Cervical Range of Motion Device (CROM)

The Cervical Range of Motion device (CROM) (Performance Attainment Associates, Roseville, MN, USA) was used. CROM includes three inclinometers for the three planes of motion. Two of the inclinometers are nonadjustable for measuring sagittal and frontal movements. The third inclinometer has adjustable compass-like magnets for measuring rotation. It works with the magnets located and secured at the subject's upper trunk. The inclinometers are attached to a light-weight plastic frame. The frame is secured on the head by a hook-and-loop fastening straps. It has good validity[14] r=0.93-0.98 and intra-rater reliability[15] ICC=0.87-0.94.

Procedures

The CROM device was used to measure flexion/extension, lateral flexion, and rotation for each subject. The subjects were seated on a comfortable chair with their feet resting on the floor and their backs against the chair and their arms resting on their laps. Any jewelry, hats, and glasses were removed before securing the CROM device on the subject's head. Subjects who wore the headscarves were asked to remove them before CROM device measurements. First, the investigator explained the cervical movements to the subjects and indicated that all movements should be performed to the end range. Second, subjects performed a practice trial in each direction to ensure familiarization when moving their heads with the CROM device. Then, subjects performed the neck movements in the following order: right rotation, left rotation, flexion, extension, right lateral bending, and left lateral bending. Each movement was repeated for three trials.

For the flexion/extension and lateral flexion movements, the investigator recorded the value of the relevant inclinometer indicating the starting position. At the end of each movement, the investigator recorded the value of the inclinometer again, indicating the end position. The amount of movement was calculated by subtracting the ending position from the starting position. For rotation movement, the dial of the magnetic inclinometer was manually set to zero before the movement. The value after the movement directly indicated the amount of rotation.

Statistical Analysis

The Statistical Product and Service Solutions (SPSS) for Windows version 24.0 (IBM Corp., Armonk, New York) was used to analyze the data. A sample size of 52 subjects was needed to obtain a medium effect size of 0.7 and power of 0.8. Data was summarized using frequencies and relative frequencies for categorical variables and means ± standard deviation (SD) for quantitative variables. The normality of the quantitative variables was examined using Kolmogorov-Smirnov and Shapiro-Wilk tests. Mean age and body mass index (Kg/m^2) of females in the headscarf group and those in the control group were compared using independent t-test. Mean outcome variables (cervical ROM right rotation, left rotation, flexion, extension, right lateral flexion, left lateral flexion) by time spent per day wearing the headscarf (≤6 hours versus > 6 hours) and age at onset of wearing the headscarf (≤12 years versus >12 years) were compared using independent t-test. The relationship between cervical ROM measures and age at onset of wearing the headscarf, number of years worn, and hours per day spent wearing the headscarf were examined using Pearson's correlation. Mean outcome variables by time spent per day wearing the headscarf (≤6 hours versus > 6 hours) and age at onset of wearing the headscarf (≤12 years versus >12 years) were assessed using independent t-test. The level of significance was set at a p-value of ≤0.05. Fisher's Chi-square test of independence was used to compare hand dominance between the two groups. The significance level was set at a p-value of less or equal than 0.05.

Results

A total of 52 females with mean age 28.1± 3.1 years participated in the study. The distribution of age, body mass index (BMI) in Kg/m^2, and range of motion (degrees) was approximately normal. There was no significant difference in mean BMI between the headscarf and control groups (26.9±5.3 vs. 27.4± 5.0, p= 0.73) and hand dominance (right-handed (92.3%, n=24) in the headscarf group vs. (84.6%, n=22) in the control group; p=0.33). In the headscarf group, the mean age at onset of wearing the headscarf was 12.6±1.6 years, the mean time spent per day wearing the headscarf was 7.0±2.3 hours, and the mean number of years worn was 15.5±3.6 years.

There was a significant difference in mean± standard error (SE) in range of motion in all directions between the two groups (Table 1). Females in the headscarf group had a significant reduction in CROM for right rotation (60.9±1.6 vs. 71.1±1.7, η2=1.2; p<0.001), left rotation (67.2±1.7 vs. 73.6±2.2, η2=0.7; p=0.024), flexion (55.0±1.3 vs. 61.4±1.6, η2=0.9; p=0.004), extension (63.5±2.0 vs. 72.0±1.8, η2=0.9; p=0.003), right flexion (40.6±1.3 vs. 46.5±1.8, η2=0.7; p=0.01), and left flexion (43.8±1.3 vs. 49.4±1.6, η2=0.7; p=0.011).

Table 1. Mean (SE) of cervical ROM between headscarf group and control group (N=52)

	Headscarf Group (n_1=26)	Control Group (n_2=26)	Effect size	p –value[a]
Rt. Rotation	60.9 (1.6)	71.1(1.7)	1.2	<0.001
Lt. Rotation	67.2(1.7)	73.6(2.2)	0.7	0.024
Flexion	55.0(1.3)	61.4(1.6)	0.9	0.004
Extension	63.5(2.0)	72.0(1.8)	0.9	0.003
Rt. Lateral Flexion	40.6(1.3)	46.5(1.8)	0.7	0.010
Lt. Lateral Flexion	43.8(1.3)	49.4(1.6)	0.7	0.011

Abbreviation: SE, Standard error of the mean; ROM, range of motion; Rt, Right; Lt, Left
[a] Independent t-test

In addition, there was a significant difference in mean cervical ROM in left rotation by the hours per day spent wearing the headscarf (71.3±2.1 vs. 64.5±2.1, η^2=2.2; p=0.045), and a trend towards statistical significance in mean ROM in flexion (57.8±2.4 vs. 53.2±1.4, η^2=1.6; p=0.093; Table 2).

Table 2. Mean (SE) of cervical ROM by number of hours wearing the headscarf (N=26)

	≤ 6 Hours (n_1=10)	> 6 Hours (n_2=16)	Effect size	p –value[a]
Right Rotation	63.8(2.4)	59.0(2.1)	1.5	0.158
Left Rotation	71.3(2.1)	64.5(2.1)	2.2	0.045
Flexion	57.8(2.4)	53.2(1.4)	1.6	0.093
Extension	65.9(3.3)	62.0(2.5)	0.9	0.359
Rt. Lateral Flexion	42.5(2.6)	39.5(1.3	1.0	0.271
Lt. Lateral Flexion	44.0(2.4)	43.7(1.6)	0.1	0.927

Abbreviation: SE, Standard error of the mean; Rt, Right; Lt, Left.
[a] Independent t-test

There was also a correlation between the age subjects started wearing the headscarf and left flexion ROM (r=0.36, p=0.04). However, no significant differences in mean ROM by age at onset of wearing headscarf (≤12 years vs. > 12 years) were detected (p>0.05, Table 3).

Table 3. Mean (SE) of cervical ROM by onset of wearing the headscarf (N= 26)

	≤ 12 years (n_1=12)	> 12 years (n_2=14)	Effect size	p –value[a]
Rt. Rotation	61.9(2.2)	59.9(2.4)	0.2	0.371
Lt. Rotation	68.2(2.1)	66.3(2.6)	0.2	0.523
Flexion	54.4(2.1)	55.5(1.7)	0.2	0.857
Extension	63.1(3.6)	63.9(2.3)	0.1	0.461
Rt. Lateral Flexion	39.4(2.2)	41.6(1.5)	0.3	0.714
Lt. Lateral Flexion	42.9(2.6)	44.6(1.2)	0.2	0.476

Abbreviation: SE, Standard error of the mean.
[a] Independent t-test

Discussion

In this study, the differences in active cervical ROM between females who routinely wore the headscarf and females who never wore the headscarf were investigated. The findings indicated that the headscarf group reported a significant limitation in cervical ROM in all six directions. Additionally, females in the headscarf group who wore the headscarf for six hours or more a day had significantly less left rotation compared to those who wore it for less than six hours a day. There was no significant difference in cervical ROM by age at onset of wearing the headscarf or number of years worn.

Podolsky et al.[4] revealed a significant cervical rotation limitation when using a soft-collar. Also, McCarthy et al.[3] reported limitation in cervical extension associated with helmet-wearing seen in American football players. However, no limitations were detected when measuring cervical ROM without the helmet. In contrast to our study, all measurements of cervical ROM were performed without the headscarf. This revealed a significant decrease in cervical ROM in all directions. Our subjects wore the headscarf for an extended period. The mean time spent per day wearing the headscarf was 7.0±2.3 hours and the mean number of years worn was 15.5±3.6 years. Consequently, the headscarf can act as a physical restriction to maximum cervical mobility during everyday activities. This physical restriction over time may result in muscle adaptive shortening and postural changes, leading to restrictions in cervical ROM. Dunleavy and Goldberg[16] reported that erect posture is more likely to increase the amount of cervical ROM as compared to habitual posture. Since, in the current study, neither EMG nor postural analysis was assessed, this explanation needs to be explored in future studies.

The standard error of measurement (SEM) for CROM device in all directions ranged from 1.6° (right-lateral flexion) to 2.8° (flexion)[14]. Audette et al.[14] calculated the minimal detectable change (MDC), which provides the minimal amount of change that is unlikely to be due to chance. The MDC ranged from 3.6° (right lateral flexion) to 6.5° (flexion). In our study, the decrease in cervical ROM was clinically important since the difference in CROM device measurements between the groups ranged from 5.6° (left lateral flexion) to 10.2° (right rotation).

Wearing the headscarf for six hours or more resulted in a significant decrease in left cervical rotation. Sjolander et al.[17] investigated chronic neck pain with insidious onset and reported similar findings in left rotation limitation. In their study, they assessed cervical ROM in the transverse plane motion only. In addition, Lee et al.[11] reported a significant limitation in left rotation cervical ROM only in a group of young subjects with subclinical neck pain. Those studies were conducted to detect any limitation in cervical ROM regardless of the direction. Additionally, the studies calculated cervical ROM in one plane of motion. Therefore, no explanations or speculations on why the limitation was only recorded in left rotation were provided.

Hand dominance may be considered a factor, as 92.3% of the headscarf group participants were right-handed. Usually, right-handed females wrap the headscarf first over the left side then insert it near the right ear side. In this headscarf style, the female may avoid moving the head to the left side in order to keep the headscarf on. This headscarf style may explain the significant reduction in left rotation. However, no detailed information was obtained from the subjects regarding headscarf style. In the current study, when the time spent per day wearing the headscarf was considered, it revealed a trend toward further implications in cervical ROM. This suggests that the amount of time females spend wearing the headscarf is a factor in cervical ROM limitation.

There is a general agreement in the literature that age generates a significant decrease in range of motion in asymptomatic subjects[18-20], as well as with subjects with neck pain[13]. In our sample, the mean age for the subjects was 28.1± 3.1 years, which represents a relatively young population. Nevertheless, within this age range, a significant reduction in cervical ROM was detected. It is reasonable to predict that, within the population of females who wear headscarves, the limitation in cervical ROM may tend to be greater as they grow older. Therefore, future studies should investigate older adult females who wear headscarves.

There is also a link between headscarf use and cervical proprioception. Alqabbani et al.[21] found a trend towards greater cervical joint position error in females who wore headscarves compared to females who did not wear headscarves. This suggests that wearing the headscarf may implicate other sensory-motor dysfunctions of the cervical spine. Further investigations are needed to determine the effect of wearing headscarves on other cervical spine outcomes.

Furthermore, there is a relationship between cervical ROM and forward head posture (FHP)[22]. However, in this study, no FHP measurements were obtained. Thus, future studies are warranted to include postural or movement analysis to further explain the limitations of cervical ROM. In this study, we considered three factors related to headscarves: onset of the practice, hours worn per day, and the number of years worn. Future research should include factors such as styles and textures of headscarves.

In conclusion, wearing the headscarf is an essential religious practice by females in Islamic cultures. Regular wear of the headscarf may influence cervical mobility. Additionally, wearing it for six hours or more may result in further decline of cervical

ROM. Therefore, it is suggested that females minimize the amount of time spent wearing the headscarf, if appropriate. Moreover, to maintain cervical mobility, performance of regular range of motion exercises is recommended, especially for females whose daily routines require them to wear the headscarf for more than six hours.

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CHAPTER FOUR

DOES WEARING HEADSCARVES IMPACT CERVICAL SPINE PROPRIOCEPTION?

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Abstract

Background: The cervical spine provides proprioceptive input to maintain proper body alignment. Cervical proprioception is the sense of position and movement of the head and neck in space. Headscarves are common attire worn by females in Islamic cultures.

Objectives: The aim of the study was to investigate the effect of wearing headscarves on cervical joint position error (JPE) in females who wear headscarves compared with females who don't wear headscarves.

Methods: Fifty-two females with mean age 28.1±3.1 years were divided into two groups: Headscarf group (n=26) and control group (n=26). JPE was measured using the head-mounted laser method.

Results: There was no significant difference in mean cervical JPE between groups. However, females in the headscarf group who wore the headscarf for more than six hours daily had significantly more JPE when relocating from flexion (5.1±0.6 vs. 8.0±1.0, η^2=2.4; p=0.048) and a more cumulative JPE (5.3±0.3 vs. 7.0±0.5, η^2=2.2; p=0.084).

Conclusion: Wearing headscarves for more than 6 hours daily may influence cervical proprioception.

Key Words: Cervical spine, proprioception, joint position error test, and headscarves.

Introduction

Cervical proprioception is defined as the sense of position and movement of the head and neck in space[1]. Cervical spine muscles contain a high density of muscle spindles that provide substantial proprioceptive information[2]. Additionally, higher densities of muscle spindles are located in the deeper, upper cervical spine muscles[3]. These receptors have central connections with visual and vestibular systems. Therefore, proper head and neck alignment in space influences individual's ability to maintain postural control. Consequently, balance is ensured by the complex interaction of visual, vestibular, and proprioception[4,5].

The primary measure of cervical proprioception is the joint position error (JPE) test. Revel et al.[6] described the JPE test that measures head repositioning accuracy (HRA). It reflects the individual's ability to reproduce a previously predetermined head position. The error individuals produce while relocating the head to the predetermined position is defined as joint position error.

Increased JPE has been reported in subjects with whiplash-associated disorder (WAD)[7-11], and those with neck pain[6,12,13]. Moreover, increased fatigue in cervical spine muscle may alter head repositioning accuracy[14-16]. Consequently, deficits in cervical proprioception may be a predisposing factor for development of cervical pain and dysfunction[17,18].

Muslims represent the second largest religious group in the world and are estimated to become the second largest religious group in the United States by the year 2040[19]. Wearing headscarves is an essential practice by most Muslim women around the world when out in public. Females typically begin wearing a headscarf around the onset of puberty[20]. The headscarf is defined as the scarf that is worn to cover the head and the neck[21]. Several Islamic countries mandate dress codes for women that include wearing headscarves while other countries have banned the wearing of headscarves. However, the majority of the countries around the world make the wearing of headscarves optional for women. In the USA, where headscarves are optional, 43% of Muslim females reported that they wore the headscarf making a total number of 433,000 females[22].

The wearing of headscarves may influence cervical proprioception especially when worn for an extended time period. To the best of our knowledge, there is only one study that investigated the effect of wearing headscarves on cervical proprioception. Alqabbani et al.[23], reported greater joint position error in females wearing headscarves compared to females with no headscarves. The findings of this pilot study indicated the need to further explore the influence of wearing the headscarves on cervical proprioception and to investigate other factors related to the wearing of headscarves.

Therefore, the primary aim of the present study was to investigate the effect of wearing headscarves on cervical spine joint position error test in females wearing headscarves compared with females who never wore a headscarf. Among females who wore headscarves, a secondary aim was to compare cervical JPE test measures by duration per day the headscarf was worn ($\leq$ 6 hours versus $>$ 6 hours) and age at onset of wearing headscarves ($\leq$12 years versus $>$ 12 years). We also examined the relationship between outcome variables and age at onset of wearing headscarves, number of years wearing them and duration per day wearing the headscarf.

Methods

Subjects

Fifty-two females with mean age 28.1±3.1 years participated in the study. Subjects were divided into two groups (headscarf group: twenty-six females who routinely wore headscarves; control group: twenty-six females who never wore headscarves). Inclusion criteria consisted of age ranged from 20-40 years of age, had been wearing headscarves for a minimum of five years, and began wearing headscarves before or at 15 years of age. Subjects were excluded if they had cervical pain for less than six months or had tenderness or muscle spasm in the cervical area.

Subjects were recruited from Loma Linda University and the surrounding communities by flyers and word of mouth. All subjects signed an informed consent form that was approved by Loma Linda University Institutional Review Board prior to participation.

Cervical joint Position Error (JPE)

Cervical joint position error test was measured using the head mounted laser method described by Revel et al.[6]. The test requires a laser pointer attached to the top of the head, a blindfold to occlude vision, and a target paper with markers. The JPE has good test-retest and inter-tester reliability[24].

Procedures

The starting position for the subjects was to have them sit 90 centimeters from a wall with their feet resting on the floor and back against the back of a chair. While the subjects were blindfolded, the head mounted laser was secured over the subject's head. Subjects assumed a neutral head position, and were asked to memorize this position as their perceived neutral position. Once they indicated their neutral head position, the chart on the wall was moved so that the laser light was on the center of the chart. Subjects were then asked to maximally turn their head to the left, right, flexion, and extension. Immediately after each direction, they were asked to return to their perceived neutral head position while keeping their eyes closed. When subjects indicated that they have returned to their perceived neutral position, the investigator marked the position with a marker. Then the investigator passively returned the subjects' head to the starting position. Each task was repeated 6 times for a total of 24 repetitions. The distance between the beginning and ending position was measured. Females wearing headscarves performed JPE testing while having their headscarves on.

Statistical Analysis

The Statistical Product and Service Solutions (SPSS) for Windows version 24.0 (IBM Corp., Armonk, New York) was used to analyze the data. A sample size of 52 subjects was needed to obtain a medium effect size of 0.7 and power of 0.8. Data were summarized using frequencies and relative frequencies for categorical variables and means ± standard deviation (SD) for quantitative variables. The normality of the quantitative variables was examined using Kolmogorov-Smirnov and Shapiro-Wilk tests. Based on the distribution of the outcome variables, they were compared between the two study groups using independent t-test. Mean age and body mass index (kg/m^2) of females in headscarves group and those in the control group were compared using independent t-test. Mean outcome variables (JPE right rotation, left rotation, extension, flexion) by time spent per day wearing headscarves (≤6 hours versus > 6 hours) and age at onset of wearing headscarves (≤12 years versus >12 years) were compared using independent t-test. The relationship between cervical JPE measures and age at onset of wearing headscarves, number of years worn, and hours per day spent wearing them were examined using Pearson's correlation. Mean outcome variables by time spent per day wearing headscarves (≤6 hours versus > 6 hours) and age at onset of wearing headscarves (≤12 years versus >12 years) were assessed using independent t-test. The level of significance was set at a p-value of ≤0.05. Fisher's Chi-square test of independence was used to compare hand dominance between the two groups.

Results

A total of 52 females with mean age 28.1± 3.1 years participated in the study. The distribution of age, body mass index (BMI) in kg/m^2, and JPE measurements in cm were approximately normal. There was no significant difference in mean BMI (26.9±5.3 vs. 27.4± 5.0, p=0 .73) and hand dominance (right-handed (92.3%, n=24) in the headscarf group vs. 84.6%, n=22) in the control group; p=0.33). There was no significant difference between groups in cervical JPE measurements (p>.05, Table 1).

Table 1. Mean (SE) of JPE test between headscarf group and control group (N=52)

	Headscarf Group (n_1=26)	Control Group (n_2=26)	Effect size	p –value[a]
JPE Rt. Rotation	6.1(0.4)	5.6(.4)	0.2	0.451
JPE Lt. Rotation	6.2(0.6)	5.7(0.5)	0.2	0.474
JPE Extension	6.2(0.5)	6.3(0.4)	0.0	0.879
JPE Flexion	6.9(0.7)	5.9(0.5)	0.3	0.284
Cumulative JPE	6.3(0.5)	5.9(0.3)	0.2	0.419

Abbreviation: SE, Standard error of the mean; JPE, joint position error (cm); Rt, Right; Lt, Left.
[a] Independent t test

Results showed that there was a significant positive correlation between number of hours wearing headscarves and cumulative JPE (r=0.41, p=0.02); JPE relocating from right rotation (r=0.46, p=0.01); and JPE relocating from flexion (r=0.47, p=0.01). Additionally, females in the headscarf group who wore headscarves for more than six hours daily had significantly higher mean JPE when relocating from flexion (5.1±0.6 vs. 8.0±1.0, η^2=1.5; p=0.048) and higher mean cumulative JPE (5.3±0.3 vs. 7.0±0.5, η^2=1.5; p=0.084) Table 2. There was no significant difference in mean JPE by age that subjects started wearing headscarves (≤12 years vs. > 12 years) (p>0.05, Table 3).

Table 2. Mean (SE) of JPE test by number of hours wearing the headscarf (N= 26)

	≤ 6 Hours (n_1=10)	> 6 Hours (n_2=16)	Effect size	p –value[a]
JPE Rt Rotation	5.3(0.6)	6.5(0.6)	0.6	0.178
JPE Lt Rotation.	5.1(0.3)	6.9(0.8)	1.6	0.112
JPE Extension	5.9(0.5)	6.4(0.7)	0.2	0.557
JPE Flexion	5.1(0.6)	8.0(1.0)	1.5	0.048
Cumulative JPE	5.3(0.3)	7.0(0.5)	1.5	0.084

Abbreviation: SE, Standard error of the mean; JPE, joint position error (cm); Rt, Right; Lt, Left.
[a] Independent t test

Table 3. Mean (SE) of JPE test by onset of wearing the headscarf (N=26)

	≤ 12 years (n_1=12)	> 12 years (n_2=14)	Effect size	p –value[a]
JPE Right Rotation	5.8(0.6)	6.3(0.6)	0.2	0.573
JPE Left Rotation.	6.9(1.1)	5.6(0.4)	0.5	0.507
JPE Extension	6.5(0.8)	6.0(0.5)	0.2	0.205
JPE Flexion	5.9(0.9)	7.7(1.1)	0.5	0.513
Cumulative JPE	6.3(0.8)	6.4(0.5)	0.0	0.362

Abbreviation: SE, Standard error of the mean; JPE, joint position error (cm)
[a] Independent t test

Discussion

Joint position error in females who wear headscarves was compared to those who do not wear headscarves. The findings indicate that there is no significant difference in mean joint position error between the groups. These findings are similar to those reported by Armstrong et al.[25] which indicated no significant difference in repositioning accuracy in whiplash and healthy groups. However, these results contrast the pilot study by Alqabbani et al.[23] that reveled higher JPE in females who wear headscarves compared to those who do not. In that study subjects who wore headscarves were older than those who did not wear them while in the current study the subjects were age matched. This may indicate that the main effect of higher JPE in that study was age as it is well documented that proprioception declines with age[26.27].

However, females in the headscarf group who wore headscarves for more than six hours daily had significantly higher JPE when relocating from flexion and higher cumulative JPE when compared to subjects who wore headscarves for six hours or less daily. There was no significant difference in mean cervical JPE by age at onset of wearing the headscarf or number of years worn. The findings of the present study suggest that time spent per day wearing headscarves may result in increased cervical JPE. Females wearing headscarves may exert more loads on the surrounding muscles to maintain the headscarf in place. Over time, this may result in cervical spine muscular fatigue. Pinault and Vuillerme[16] investigated the effect of muscular fatigue in cervical joint position sense. They reported less accurate head repositioning in healthy subjects following fatigue condition compared to no fatigue condition.

Our sample represents a relatively young population (mean age 28.1± 3.1 years). Nevertheless, within this age range, a higher error was detected when wearing headscarves for more than six hours. It is reasonable to predict that within the population of females who wear headscarves, the influence of cervical JPE may tend to be greater as they grow older. Therefore, future studies should investigate older adult females who wear headscarves.

The study had some potential limitations. First, only subjects with age range from 20-40 years were included. Further research is warranted to include a wider age range to investigate the influence of age on cervical proprioception. Second, measurements of craniovertebral angle were not obtained. Future studies should investigate the impact of wearing headscarves on forward head posture to further explain the effect on JPE. Other studies may investigate the effect of interventions to improve repositioning accuracy in this population.

In conclusion, Females in Islamic cultures often wear headscarves as part of an essential religious practice. Regular wearing of headscarves may influence cervical proprioception. Our findings suggest that the daily duration females spend wearing the headscarf may result in higher cervical JPE. Thus, it is suggested to minimize the duration of time spent wearing the headscarf, if and when appropriate. Additionally, it is advised to perform cervical proprioceptive training to improve relocation accuracy.

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CHAPTER FIVE

DISCUSSION

Cervical ROM and cervical JPE were compared between females who routinely wore headscarves and females who never wore headscarves. Cervical ROM was significantly limited in the headscarf group in all six directions (right rotation, left rotation, flexion, extension, right lateral flexion, and left lateral flexion). Furthermore, females in the headscarf group who wore the headscarf for more than six hours daily had significantly less cervical left rotation compared to those who wore it for six hours or less daily. There were no significant differences in JPE between subjects in the headscarf group compared to the control group. However, females in the headscarf group who wore the headscarf for more than six hours daily had a significantly higher JPE when relocating from flexion and a higher cumulative JPE when compared to subjects who wore the headscarf for six hours or less daily.

Cervical ROM results in the current study were similar to Podolsky et al.[1] who reported a significant cervical rotation limitation in subjects while wearing a soft-collar. McCarthy et al.[2] also reported limitations in cervical extension associated with helmet wearing seen in American football players. However, no limitations were detected in these same subjects when measuring cervical ROM without the helmet. In contrast, all measurements of cervical ROM in the present study were performed without wearing the headscarf and we observed a significant decrease in cervical ROM in all directions.

Audette et al.[3] calculated the standard error of measurement (SEM) and the minimal detectable change (MDC), which provides the minimal amount of change that is unlikely to be due to chance for CROM device. The MDC ranged from 3.6° (right lateral flexion) to 6.5° (flexion) and the SEM ranged from 1.6° (right-lateral flexion) to 2.8° (flexion)[3]. In this study, the reduction in cervical ROM exceeded the SEM and met or exceeded the MDC; therefore, the limitation in cervical ROM may be considered to be clinically important.

JPE in women who wear headscarves was compared to JPE in women who do not wear headscarves. The findings indicated no significant difference in mean JPE between groups. These findings are similar to those reported by Armstrong et al.[4], who indicated no significant difference in repositioning accuracy in whiplash versus healthy groups. However, these results contrast Alqabbani et al.[5] who reported higher JPE in women who wore headscarves compared to those who do not. In that study, subjects who wore headscarves were older than those who did not, while in the current study, the subjects were age matched. We suggest that the main contributor to higher JPE in the Alqabbani et al.[5] study was age, as it is well documented that proprioception declines with age[6,7].

In the current study, when the time spent per day wearing the headscarf was considered, it revealed a trend toward further limitation in cervical ROM as well as higher JPE. This suggests that the amount of time females spend wearing the headscarf is a factor that affect cervical mobility and proprioception. Subjects in the headscarf group wore the headscarf for an extended period. The mean time spent per day wearing the headscarf was 7.0±2.3 hours. Wearing the headscarf for an extended time may exert a greater stress on the surrounding muscles to keep the headscarf in place. Over time, this may result in cervical spine muscular fatigue. Pinault and Vuillerme[8] investigated the effect of muscular fatigue on cervical joint position sense. They reported less accurate head repositioning in healthy subjects following a fatigue condition compared to a no-fatigue condition. Additionally, it is suggested that the headscarf can act as a physical restriction to maximum cervical mobility during everyday activities. This physical restriction over time may result in muscle adaptive shortening and postural changes, leading to restrictions in cervical ROM. Dunleavy and Goldberg[9] reported that an erect posture is more likely to increase the amount of cervical ROM as compared to a habitual posture.

In our study, only left cervical rotation was limited. Hand dominance may be considered a factor, as 92.3% of the headscarf group participants were right-handed. Usually, right-handed females wrap the headscarf first over the left side then insert it near the right ear side. In this headscarf style, females may avoid moving their head to the left side in order to keep the headscarf in place. This headscarf style may explain the significant reduction in left rotation. However, no detailed information was obtained from the subjects regarding headscarf style.

This study had some limitations. First, our sample represents a relatively young population (mean age 28.1 ± 3.1 years). Nevertheless, within this age range, a significant reduction in cervical ROM as well as a higher error was detected in subjects wearing the headscarf for more than six hours. It is reasonable that within this population of women who wear headscarves, the influence of cervical ROM and JPE may tend to be greater as they age. Therefore, future studies should investigate older adult women who wear headscarves.

Furthermore, there is a relationship between cervical ROM and forward head posture (FHP)[10]. However, in this study, no FHP measurements were obtained. Thus, future studies are warranted to include postural or movement analysis to further explain the limitations of cervical ROM. In this study, we considered three factors related to headscarves: Onset of the practice, hours worn per day, and the number of years worn. Future research should include factors such as styles and textures of headscarves.

In addition, other studies may investigate the effect of interventions to improve cervical muscle flexibility and repositioning accuracy in this population.

Conclusion

Women in Islamic cultures often wear headscarves as part of an essential religious practice. Regular wearing of the headscarf may influence cervical mobility. The findings suggest a longer duration of wearing the headscarf may lead to a further decline of cervical ROM as well as higher cervical JPE. Therefore, it is suggested that females minimize the amount of time spent wearing the headscarf, if appropriate. Moreover, to maintain cervical mobility, performance of regular range of motion exercises is recommended, especially for females whose daily routines require them to wear the headscarf for more than six hours.

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APPENDIX A

CERVICAL ROM AND JPE EVALUATION FORM

Subject ID: ……………………….**Age:**………..**Height:** ……….**Weight:**………

Subject group: Wearing Scarf Not Wearing Scarf

Hand Dominance: Right left

Onset of wearing headscarf: **Daily duration of wearing the headscarf:**

Examiner Name:

Cervical Rang of Motion

	1	2	3	Average
Right Rotation				
Left Rotation				
Flexion				
Extension				
Right Lateral flexion				
Left Lateral Flexion				

Joint Position Error Measurements/ Sitting

	1	2	3	4	5	6	Average
JPE_Rt.							
JPE_Lt.							
JPE_Up							
JPE_Down							

APPENDIX B

INFORMED CONSENT

TITLE: **EFFECT OF WEARING HEADSCARVES ON CERVICAL JOINT POSITION ERROR, STANDING BALANCE AND CERVICAL RANGE OF MOTION**

SPONSOR: **Department of Physical Therapy, Loma Linda University**

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1. WHY IS THIS STUDY BEING DONE?

The purpose of the study is to determine the impact of wearing Islamic scarf on neck proprioception; and to compare neck-repositioning accuracy in sitting and standing between females who routinely wear scarves to those who do not wear scarves.

You are invited to participate in this study if you are a female between the ages of 21-40 who either routinely wears headscarf or never wore it.

2. HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

60 subjects will participate in this study.

3. HOW LONG WILL THE STUDY GO ON?

Your participation in this study will require one session of 60 minutes.

4. HOW WILL I BE INVOLVED?

Participation in this study involves the following:

Your date of birth, height and weight will be recorded then you will answer a few questions to determine your eligibility to participate.

Sitting Joint Position Error(SIT-JPE:
Head repositioning accuracy will be assessed using a head mounted laser. You will be asked to sit upright 90 cm away from the front of a wall with your feet resting on the floor and your back resting on a back of chair. Then you will be asked to assume a neutral head position and be required to memorize this position as your perceived neutral position. Then you will be asked to maximally rotate your head to the left, right, flexion, and extension. Immediately after each direction you will be asked to return to your perceived neutral head position. When you indicate that you have returned to your perceived neutral position, the investigator will mark the position with a marker. You will be blindfolded throughout the procedure. Each task will be repeated 6 times. The difference between the beginning and ending position will be calculated to determine any difference.

Standing Joint Position Error (ST-JPE):
The same procedure on sitting will be repeated while standing on a BASIC Balance Master platform. The amount of sway of your body's center of gravity over the base of support will be measures while performing Joint position error test.

Cervical Range of Motion (CROM):
Your cervical range of motion will be measured using Cervical Range of Motion device. The CROM device includes three inclinometers for the three planes of motion. The inclinometers are attached to a light-weighted plastic frame. The frame will be secured on your head by a hook-and-loop fastening straps. You will be sitting on a comfortable chair with the feet resting on the floor and back against the back of a chair and your arm resting on your lab. Any jewelry, hat, and glasses will be removed before securing the CROM device. You will perform a trial in each direction to ensure familiarization when moving your head with the CROM device. Then you will perform the neck movements and return to neutral. Three trials of the following movement will be performed: flexion, extension, left rotation, right rotation, left lateral flexion, and right lateral flexion.

5. WHAT ARE THE REASONABLY FORESEEABLE RISKS OR DISCOMFORTS I MIGHT HAVE?

Participating in this study exposes you to minimal risk because you may be disappointed if your lose your balance during the testing procedures. To prevent falling, you will be wearing a safety harness and two researchers will be standing beside you at all times. There is also a minimal risk of breach of confidentiality.

6. WILL THERE BE ANY BENEFIT TO ME OR OTHERS?

There is no benefit to you directly but scientific information we learn from the study may benefit humanity by determining if wearing headscarves can have an effect of neck proprioception and it might lead to intervention exercise trials in future research.

7. WHAT ARE MY RIGHTS AS A SUBJECT?

Participation in this study is voluntary. Your decision whether or not to participate or terminate at any time will not affect your present or future relationship with the Loma Linda University Department of Physical Therapy. You do not give up any legal rights by participating in this study.

8. WHAT HAPPENS IF I WANT TO STOP TAKING PART IN THIS STUDY?

You are free to withdraw from this study at any time. If you decide to withdraw from this study you should notify the research team immediately. The research team may also end your participation in this study if you do not follow instructions, or if your safety and welfare are at risk.

9. HOW WILL INFORMATION ABOUT ME BE KEPT CONFIDENTIAL?

Your identity will not be recorded with the research data. We cannot guarantee absolute confidentiality. You will not be identified by name in any publications describing the results of this study. All electronic data will be maintained on an encrypted computer and paper data kept in a locked file cabinet in a locked office.

10. WHAT COSTS ARE INVOLVED?

There is no cost to you for your participation in this study beyond the time involved to participate.

11. WILL I BE PAID TO PARTICIPATE IN THIS STUDY?

You will receive a $10 gift card at the conclusion of the session of data collection.

12. WHO DO I CALL IF I HAVE QUESTIONS?

If you feel you have been injured by taking part in this study, consult with a physician or call 911 if the situation is a medical emergency. No funds have been set aside nor any plans made to compensate you for time lost for work, disability, pain or other discomforts resulting from your participation in this research.

13. SUBJECT'S STATEMENT OF CONSENT

If you wish to contact an impartial third party not associated with this study regarding any question or complaint you may have about the study, you may contact the Office of Patient Relations, Loma Linda University Medical Center, Loma Linda, CA 92354, phone (909) 558-4674, e-mail patientrelations@llu.edu for information and assistance.

14. SUBJECT'S STATEMENT OF CONSENT

I have read the contents of the consent form and have listened to the verbal explanation given by the investigators. My questions concerning this study have been answered to my satisfaction. I hereby give voluntary consent to participate in this study. I have been given a copy of this consent form. Signing this consent document does not waive my rights nor does it release the investigators, institution, or sponsors from their responsibilities. I may call and leave a voice message for Eric Johnson, DSc during routine office hours at this number (909) 558-4632 ext. 47471 or e-mail him at ejohnson@llu.edu, if I have additional questions and concerns.

I understand I will be given a copy of this consent form after signing it.

______________________________ ______________________________

Signature of Investigator | Printed Name of Investigator

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Date

15. INVESTIGATOR'S STATEMENT

I have reviewed the contents of this consent form with the person signing above. I have explained potential risks and benefits of the study.

______________________________ ______________________________

Signature of Investigator | Printed Name of Investigator

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Date