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A Comparison of the Lower Extremity Proprioceptive Senses of the University Students that Exercise Regularly and Those Who Do Not

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ABSTRACT

This study has been conducted with a view to identifying and comparing the lower extremity proprioceptive senses of the university students who exercise regularly and those who do not. The study group included voluntary participants studying at various departments of Ağrı İbrahim Çeçen University (Faculty of Education and Physical Education and Sports High School), of whom 65 exercised regularly and 59 did not engage in any sports activity. The propriceptive senses of the subjects participating in the study were measured using standardized methods and materials. Their height and weight were measured. They were asked to do a warm up run for 5 minutes and the study was ended once their proprioceptive senses were measured after they were found to have complied with the proprioceptive sense platform. The data obtained from the study was analyzed by using the SPSS 22 software package. Normality distribution was tested by applying the Shapiro-Wilks test. Parametric tests were preferred as the data was found to have distributed normally. A paired-samples t-test was applied to test the level of significance of difference between the students' proprioceptive sense scores. As a result of the study, it was established that the proprioceptive sense values of the male and female students who exercised regularly were better than those who did not engage in sports ($p<0.05$).

KEYWORDS
Sports, Students, Proprioceptive senses

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1. Introduction

The term 'proprioception' was coined for the first time by Sherrington in 1906 (Sherrington, 1906). The term is the combination of the Latin words 'proprio' and 'ception'. The word proprio means 'one's own' while the word ception means perception. This way, proprioception can be defined as personalized perception. However, the studies and assessments conducted thus far since the term proprioception was first coined in 1906 suggest that the term

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proprioception is not capable of accounting for the entire process on its own. This is because it is not merely a perception process, but it also requires an analysis of the perceived situation and presentation of the risk identified as a result of such analysis and creation of a peripheral response by the central nervous system (CNS) in order to eliminate the risks thus presented (Johansson, 2000). Proprioception is the position sense of the joints and extremities, the neural data input for which maintained through the receptors located on the joints and the surrounding tissues. It plays a major role in muscular movement as well as the sensitivity of movements and joint stability. Impairment in propriception results in the increase of postural release, diminishment of balance, increased risk of falling down and impairment of the ability to walk (Stillman, 2002).

The amount of contraction of proprioceptive muscles provides information as to the amount of stress applied to the joints and as to the position of the body in general including the joints. Therefore its contributes to the improvement of the joint control and kinesthetic sense and helps maintain one's balance (Guyton, 1993). When a person experiences initially voluntary and then involuntary changes in their posture, the person in question may develop quick joint protection and postural control reactions. Improvement of proprioception leads to development of quick joint protection and postural control reactions in the face of involuntary postural changes (Fitzgerald et al., 2000).

Visual, vestibular and sensory stimuli are quite important in measuring the proprioceptive senses. While the proprioceptive sense can be measured in two ways -namely active and passive position sense measurements- the passive position sense measurement is the most commonly applied method (Ulkar et al., 2004). In this study, the position sense is measured in a passive way. Due to the fact that the proprioceptive sense has a complicated nature and is affected by a number of factors, it is hard to be assessed objectively. Despite the fact there is a complete consensus on the importance of proprioceptive sense training, there is still no clear cut agreement as to which method is the most reliable and valid in terms of assessing the proprioceptive sense (Friden et al., 2001; Hurkmans et al., 2007).

Being the complementary and integral part of the general education curriculum and driven based on the integrity of organism principle, physical education and sports is critically important in terms of physical development, development of movement skills and nerve and muscle coordination, maintaining personal and social congruence (education of personality) (Bucher and Koenig, 1983; Harmandar, 2004). Physical Education is a system of activities that aim to develop the physical structure of the body, joints and muscles in a controlled and balanced manner and teach how to use the physical strength –which is spent at work and social activities after school- in the most efficient manner and thereby utilizing the organ functions in a controlled and methodical manner (Haywood, 1989).

Universities are the institutions where scientific production and vocational training is provided. However, universities can not be solely perceived from

this particular point of view. Universities should also be regarded as places where healthy citizens are integrated into society in addition to being equipped with professional training and skills. For this reason, social and sportive activities have a significant place in universities (Hazar, 1996). In this respect, maintaining life long sport activities in universities -which hold a significant place in transition to professional life - is highly important in turning students into healthier individuals in their future life. Sports activities will help individuals become healthier, more energetic and productive during their university years when they step into maturity. Such productivity gained through sports will contribute greatly to both the society and individual (Günay and Cicioğlu, 2001). We are of the opinion that the increase in studies that emphasize and prove the importance of sports for university students will make a significant contribution to the literature in general. In the light of the above facts, the present study aims to establish and compare the lower extremity proprioceptive senses of the university students that engage in sports regularly and those who do not.

2. Materials and Methods

While the population of the present study consists of Turkish university students that engage in sports and those who do not, the study sample includes the students that study at various departments of Ağrı İbrahim Çeçen University (Faculty of Education and Physical Education and Sports High School), of whom 65 exercise regularly and 59 do not engage in any sports activity. Prior to the performance of tests, all the test subjects were asked to fill out a medical survey determining their health condition and sign an informed consent form stating that they participate in the study on a voluntary basis. Each individual agreeing to participate in the study has been informed as to the contents of the study in detail. Prior to the performance of measurements, all the participants have been warned not to get involved in heavy physical exercise and consume alcohol a day before the measurement. Our study was conducted in two days, on the first day the students that exercised regularly were measured, while on the second day those who did not engage in sports were measured. A height and weight measurement was conducted respectively for each subject participating in the study. They were, then, asked to do a warm up run for 5 minutes, and the study was ended once their proprioceptive senses were measured after they were found to have complied with the proprioceptive sense platform. This study was conducted at AĞRI İbrahim Çeçen University, BESYO, Physiology Laboratory.

Height and body weight measurements:

The height of the subjects was measured using a height measuring scale with 0.01 m sensitivity degree (SECA, Germany) and their body weight was measured using an electronic scale with 0.1 kg sensitivity degree (SECA, Germany) (Göktepe et al., 2015; Özkan et al., 2013; Yıldız et al., 2016).

Body Mass Index (BMI):

BMI is calculated by dividing weight in kg by height squared in meters (kg/m2) (Eklioğlu et al., 2016; Göktepe et al., 2015; Moran and Mcglynn, 1997; Norris et al., 2005; Taylor et al., 1998).

Proprioceptive Sense Measurements:

Proprioceptive sense measurements were conducted by using a (Pro-Kin, Tecnobody, Dalmine, Italy; 20 Hz sampling rate, sensitivity 0.1°, product type:PK252) make isokinetic dynamometer. The proprioceptive sense test was performed by choosing a valid and reliable Multiaxial Proprioceptive Assessment module (Tessalina et al., 2016; Wang et al., 2011) and the pressure level of the stabilometer was adjusted to the difficulty level 5 (through 50) for this particular test (Göktepe et al., 2015; Güngör, 2010). The subjects were asked to hold the arms of the device throughout the test. By following the circular trajectory displayed on the screen, the platform was rotated 5 times clockwise for 60 seconds, after which the test was completed (Göktepe et al., 2015; Song et al., 2013; Url 1, 2016; Göktepe et al., 2015; Karakaş, 2012).

Data Analysis:

The statistical evaluation of the data was performed by using the SPSS 22.0 (SPSS Inc., Chicago, IL, USA) software package. The data obtained in the study was presented in the form of mean and standard deviation. The Shapiro-Wilks test was run for normality distribution. Parametric tests were preferred as the data distributed normally. A paired-samples t-test was applied to test the level of significance between the students' proprioceptive sense scores. While the results were evaluated at the 95% confidence interval, the statistical significance value established as $p<0.05$.

3. Results

Table 1: Physical Characteristics of the Students Participating in the Study

Gender		N	Age (year)	Height (cm)	Body weight (kg)	BMI (kg/m2)	Sports Age (year)
Male	Engaging in sports	39	22,21±2,41	173,42±7,46	66,33±6,54	22,07±1,99	6,51±3,18
	Not engaging in sports	34	22,21±1,93	174,21±6,06	67,74±8,05	22,31±2,31	-
Female	Engaging in sports	26	18,69±2,94	162,56±5,25	52,84±5,69	19,99±1,86	4,73±2,24
	Not engaging in sports	25	21,40±2,57	163,73±7,56	54,83±7,03	20,47±2,46	-

The physical characteristics of the participants are presented in the Table 1. According to the results, the average age of the male students that engage in sports on a regular basis is 22,21±2,41 years, their height is 173,42±7,46 cm, their body weight is 66,33±6,54 kg, their BMI is 22,07±1,99 (kg/m2) and their sports age is 6,51±3,18 years. The average age of the female students that engage in sports on a regular basis is 18,69±2,94 years, their height is 162,56±5,25 cm, their body weight is 52,84±5,69 kg, their BMI is 19,99±1,86 (kg/m2) and their sports age is 4,73±2,24 years. The average age of the male students that did not engage in sports on a regular basis is 22,21±1,93 years, their height is 174,21±6,06 cm, their body weight is 67,74±8,05 kg and their BMI is 22,31±2,31 (kg/m2). The average age of the female students that did not engage in sports on a regular basis is 21,40±2,57 years, their height is 163,73±7,56 cm, their body weight is 54,83±7,03 kg and their BMI is 20,47±2,46 (kg/m2).

Table 2. The results of the Paired-Samples t-test conducted for testing the level of significance of difference between the proprioceptive sense scores of the students that engage in sports on a regular basis and those who do not.

			N	X	SD	SD	t	p
Sİ	**Male**	**Engaging in sports**	39	0,59	0,44	61	2,57	**0,01***
		Not engaging in sports	34	0,89	0,45			
	Female	**Engaging in sports**	26	1,08	1,00	49	2,14	**0,04***
		Not engaging in sports	25	1,27	0,65			
AFV	**Male**	**Engaging in sports**	39	1,15	0,76	61	0,31	0,75
		Not engaging in sports	34	1,09	0,49			
	Female	**Engaging in**	26	1,30	0,54	49	0,60	0,55

		sports						
		Not engaging in sports	25	1,10	0,60			
ATE	**Male**	**Engaging in sports**	39	25,36	4,08	61	5,42	**0,00***
		Not engaging in sports	34	35,00	9,86			
	Female	**Engaging in sports**	26	26,88	9,03	49	7,11	**0,00***
		Not engaging in sports	25	42,44	6,29			

***(p < 0.05) Sİ: Stability index, AFV: Average force variance, ATE: Average tracking error.**

When the dependent t test results of the students are observed in the Table 2 above, there is no statistically significant difference in the proprioceptive sense (AFV) values of the students that engage in sports on a regular basis and those who do not in terms of gender variable (p>0,05). However, there is a statistically significant difference in favor of the students that engage in sports regularly in terms of proprioceptive sense (SI) and (ATE) values (p<0.05). In this respect, it can be argued that the proprioceptive sense values of the male and female students that engage in sports on a regular basis are better than those who do not engage in sports at all.

4. Discussion

Proprioceptive process is initially triggered with the mechanoreceptors' perception of changing positions, conditions or strengths. The presence of mechanoreceptors is known to the scientists ever since the publication of the Raober's works in 1874 (Aydoğ et al., 2003). Since then, a good number of studies have been conducted into mechanoreceptors, as a result of such anatomical, histological and physiological studies, mechanoreceptors were understood to have constituted the first pillar of the proprioception process. It is possible to come across mechanoreceptors in the skin, subcutaneous tissues, tendons, all the tissues within joints as well as the organs and organelles. A vast majority of the histological studies conducted in this field focused on the knee joint, and the presence of mechanoreceptors were identified in the meniscus, capsula, cruciate ligaments, meniscofemoral ligaments, fibular

collateral ligaments and even in pylicas (Mine et al., 2000; Assimakopoulos et al., 1992; Boyd, 1954; Halata and Haus, 1989; Halata & Groth, 1976; Schultz et al., 1984; Zimny et al., 1986; Zimny, 1988; Zimny, Albright & Dabezies, 1988; Grigg & Hoffman, 1982). Proprioceptive mechanism is essential for maintaining appropriate joint function in sports as well as the activities of daily living and some other professional activities (Yıldız et al., 2009).

The studies that examined lower extremity and position sense have used various different measurement methods and arrangements in various different positions. For this purpose, the literature has made use of electrogoniometers, video analysis systems, passive movement systems (biodex), isokinetic devices (Larsen et al., 2005; Alp and Pepe, 2008; Ün et al., 2002; Coşkun 2008; Brumagneemail et al., 1999; Erden, 2002; Chan, 2009; Erdem, 2007). The advantages of such measurement methods over each other have not yet been identified. In contradistinction to such methods, this study has employed a system that measured the active joint position sense. This system that has been arranged based on active joint position sense method and validated accordingly is based on the principle of measuring a person's ability to follow a trace displayed on a computer screen in closed kinetic position (Gattie et al., 2013; M.R.S., 2006; Yosmaoglu et al., 2013). In a similar fashion with most studies conducted in the literature, the proprioception sense was measured with active joint position method (Gajdosik ve Lusin, 1983).

Since it is well known fact that the diminishment in muscle mass and strength through aging affects the propriocetion sense in a negative way (Hurley et al., 1998), care has been taken to keep the average age of the study group close to each other and thus the negative effects of the proprioceptive measurements brought about by aging has been avoided. In their study on the relationship between sportive performance and proprioception, Lin et al. pointed out that the skills of the persons were directly proportional with proprioception. According to the measurements conducted on three groups that engaged in playing tennis, the athletes in the elite group had the lowest error ratio compared to the other groups (Lin et al., 2006). In their study where 15 female gymnasts, with the average age of 19, were compared with 30 sedentary individuals, with the average age of 20, through a proprioception device in a 45 degree flexion, Lephart et al. (1996) has presented significant differences in terms of knee joint proprioception. Such findings lead one to think that this may be to do with the development of proprioception as a result of a long term training routine.

Another study conducted by Muaidi et al. (2009) saw the measurement of knee joint proprioception of Olympic level footballers through a dynamometer. The experimental group consisted of 18 footballers, and the control group consisted of 18 healthy individuals who did not engage in sports. It was found that the knee joint proprioception values of the elite level footballers –measured for determining passive movement- were fairly higher than those who did not engage in sports. In his study, Akdoğan (2011) studied the joint position sense (propriception) in the knee joint among the folk dancers who rehearsed regularly

and sedentary individuals who did not exercise by employing a digital goniometer (DG) method. The study group consisted of a total of 30 voluntary males, 15 of whom were folk dancers (with the average age of 21.33 ± 0.89, average training age 3 ± 0.76 years) and 15 of whom were sedentary individuals (with the average age of 21,2 ± 0.75 years). When the joint position sense measurements were observed in the dominant leg at 150, 300, 450 and 600 degree and in three different measurement positions using a digital goniometer, it was established that there was a statistically significant difference in favor of folk dancers at 450 and 600 degrees in non weight bearing (NWB) position. In his study, Akman (2007) studied the propriception of the black sea folk dancers in the knee joint area. When the values obtained through electogoniometer were examined, it was found that the 200 measurements of the dancers' right knee joint were significantly different than that of the sedentary individuals. Another study conducted on the effect of regular folk dance rehearsals and ballet exercises on the joint position sense found that the increase in the ability to dance led to an improvement in the joint position sense and therefore the proprioception sense in the body and overall postural control (Esen et al., 2013; Akdoğan and Ertan, 2013). Xu et al. studied the effect of tai chi exercises on the proprioception in the ankles and knees in the elderly. They compared the elderly that do tai chi for a long time with those who swam and ran for a long time and that of the sedentary individuals. As a result of the comparison, the joint position sense in those who did tai chi were found to be highly significant than that of the sedentary individuals and significant than that of the runners and swimmers (Xu et al., 2004). In their study, Higgins et al. (1997) studied the propriocetion in the knee joint in athletes in both weight bearing (WB) and non weight bearing (NWB) positions and compared it with anterior tibial translation. According to their study, proprioception was found to have increase with the WB exercises. This is because they believed that the number of mechanoreceptors led to an increase in proprioceptive input. A statistically significant difference was found in non weight bearing (NWB) exercises when conducted on one's back at 450 degrees with the groups of swimmers and sedentary individuals (irrespective of gender) (Okçu, 2012). Lephart et al. (1997) found that regular exercise increases the neuro-sensory and motor development and positively affects the sense of balance and proprioception and thereby reduces the risk of injury. The evidence suggests that the proprioception values of the young individuals engaging in sports are higher than those who do not engage in sports and that their knee joint position sense at different joint angles are found to be different than the latter group (Riberio et al., 2010). The results of the aforementioned studies appear to be in parallel with the findings of this study. In this respect, the reason why the individuals engaging in sports have better proprioceptive skills than others is believed to lie in the fact that the individuals in question have been training for a long time (Arslan, 2009).

Some other studies, however, have failed to establish any difference between the joint position senses of athletes and sedentary individuals (Bartlett et al., 2002; Akman, 2007). Another study investigating the relationship between the dominant isokinetic strength and joint position sense in the girls

and boys engaging in sports and the girls not engaging in sports established that there was not a strong relationship between the parameters (Yurdagül, 2012). The findings of the studies conducted by Bartlett et al., (2002), Akman, (2007) and Yurdagül (2012) do not appear to support the findings of the present study.

5. Discussion

As a result of this study, it has been established that the proprioceptive sense values of the male and female students who exercise regularly are better than those who do not engage in sports ($p<0.05$). On the strength of the findings of this study, it can be suggested that the proprioceptive sense in the students not engaging in sports can be improved by encouraging them to take part in physical exercises on a regular basis and this in turn can contribute to the further improvement in muscle control, movement sensitivity and joint stability as well as to the maintenance of most daily living activities that involve nervous and physical elements in a healthier manner.

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