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Research Article / Araştırma

The effects of physical activity on the sense of joint position and light touch*

Fiziksel aktivite düzeyinin eklem pozisyon hissi ve hafif dokunma duyusu üzerine olan etkileri

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Key Words: Physical Activity Level, Joint Position Sensation, Light Touch Sense, Proprioception, Knee joint.

Anahtar Kelimeler: Fiziksel Aktivite Düzeyi, Eklem Pozisyon Hissi, Hafif Dokunma Duyusu, Propriosepsiyon, Diz Eklemi

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ABSTRACT

Aim: The aim of this study was to investigate the associations between joint position sensation and light touch sensibility and levels of physical activity among university students. **Method**: Fifty university students, 24 females and 26 males, participated in the study. Students were divided into 3 groups according to their physical activity levels. Physical activity level was assessed using the International Physical Activity Questionnaire and joint position sense was assessed using Baseline® digital goniometer at 15°, 30°, 45° and 60° angles of the knee joint. Light touch sensation was evaluated with the Semmes-Weinstein Monofilament test. **Results**: The mean age of the participants was 19.60 ± 0.80 years. Physically active participants had higher joint position sense at 30° and 45° flexion of the knee and light touch sensation medial to the patella than inactive participants ($p<0.05$). There was a positive correlation between physical activity level and knee joint position sense at 30°, 45°, 60° ($p<0.05$). **Conclusion**: As the level of physical activity increased, the joint position sense of the knee joint and light touch sensation at the medial and midpoint of the patella increased.

ÖZ

Amaç: Bu çalışmanın amacı üniversite öğrencilerinin fiziksel aktivite düzeyleri ile eklem pozisyon hissi ve hafif dokunma duyusu arasında ilişkiyi incelemekti. **Yöntem**: Çalışmaya 24'ü kadın, 26'sı erkek olmak üzere 50 üniversite öğrencisi katıldı. Öğrenciler fiziksel aktivite düzeylerine göre 3 gruba ayrıldı. Fiziksel aktivite düzeyi Uluslararası Fiziksel Aktivite Anketi ile eklem pozisyon hissi Baseline® marka dijital gonyometre ile diz ekleminin 15°, 30°, 45° ve 60° açılarında değerlendirildi. Hafif dokunma duyusu Semmes-Weinstein Monofilament testi ile değerlendirildi. **Bulgular**: Katılımcıların yaş ortalaması 19.60 ± 0.80 idi. Fiziksel olarak aktif olan katılımcıların, dizin 30° ve 45° fleksiyonundaki eklem pozisyon hissi ve patella medialindeki hafif dokunma duyusu inaktif katılımcılara göre daha yüksekti ($p<0.05$). Fiziksel aktivite düzeyi ile 30°,45°,60°'deki diz eklem pozisyon hissi arasında pozitif yönlü ilişki vardı ($p<0.05$). **Sonuç**: Fiziksel aktivite düzeyi arttıkça diz ekleminin eklem pozisyon hissi ve patella mediali ile orta noktasında hafif dokunma duyusu artmıştır.

INTRODUCTION

Proprioception is the individual's awareness of his own body position, posture, movement and change in balance. This occurs by the correct transmission of afferent information from mechanoreceptors to the central nervous system (CNS). Proprioceptive sensory receptors are located in muscles, tendons, joints, ligaments and skin (Baltaci & Kohl, 2003). Proprioceptive sense allows activities such as running and jumping to be performed properly. Balance and coordination are achieved by maintaining stability in different positions and controlling the changing center of gravity. When the proprioceptive sense is damaged, deterioration occurs in terms of duration, shape and rhythm in walking (Domínguez-Navarro et al., 2018).

All of the activities that increase the energy expenditure above the basal level and occur with the contraction of any muscle are physical activity (Blasco Redondo, 2015). Several characteristics, including exercise intensity, duration, and frequency, make up physical activity (PA) (Lubans et al., 2016). Multiples of resting metabolic rates are called Metabolic Equivalent Task (MET). This value is equal to resting oxygen consumption. Indicates the oxygen consumption required per unit of body

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weight (mL/kg/min). The American College of Sports Medicine (ACSM) divides the intensity of PA into 4 classes according to the MET value spent. These; light-intensity PA (<3 MET), moderate-intensity PA (3-6 MET), vigorous PA (6-8 MET), and very vigorous PA (>8 MET) (Mendes et al., 2018). The impact of PA level on balance and quality of life has been studied in the literatüre (de Labra et al., 2015; Roberts et al., 2017). The number of studies examining the relationship between proprioceptive sense and physical activity level is quite insufficient (Clemson et al., 2012; Lam et al., 2018) Yang et al. showed that there is a positive correlation between ankle proprioceptive sense and PA level (Yang et al., 2022) However, there is no study in the literature examining the relationship between the level of PA and the proprioceptive sense of the knee joint and the light touch sense. The purpose of this study was to determine whether there is any relationship between university students' PA levels and their feeling of knee joint position and sense of knee joint light touch.

MATERIALS AND METHODS

Students from Sakarya University of Applied Sciences took part in this cross-sectional study in person from April to May 2022. The study was conducted at the Akyazı Health Services Vocational School of Sakarya University of Applied Sciences. Fifty volunteers without any orthopedic, neurological, sensory, and cognitive disease and without a history of lower extremity trauma or surgery were included. Participants were divided into three groups according to physical activity level: inactive, minimally active and active.

Evaluation Methods and Procedures

Sociodemographic Assessment

Participants' age, gender, body mass index (BMI), dominant side, alcohol and cigarette use were evaluated.

Joint Position Sense (JPS) Assessment

The JPS test measures the repeatability of a given position. In both open and closed kinetic chain positions, this test can be carried out actively or passively (E et al., 2016). The relevant joint of the participant is passively brought to certain angles and asked to feel this angle. Then, the participant is asked to bring the same related joint to the same angle again with his eyes closed. The deviation angle between the two measurements is recorded (Smith et al., 2013). In the study, the participants' JPS was evaluated at 15°, 30°, 45° and 60° of the knee joint with Baseline® brand digital goniometer. The assessment was performed with the participants lying supine and eyes closed. In the application, the goniometer was zeroed with the participants' hips in the neutral position and both knees in the full extension position. The value seen on the goniometer was monitored while the patient slowly brought the knee towards flexion in the direction of the specified target angle. When the measured target angle was reached, the participant was asked to stop. The participant was allowed to fully perceive that target angle by holding the knee in this position for 5 seconds. Afterwards, the participant was asked to bring the knee to full extension and bring it to the same angle again. Measurements were repeated 3 times for each target angle and angular failure were averaged.

Light Touch Sense (LTS) Assessment

LTS of the participants was evaluated with the Semmes-Weinstein Monofilament test. The Semmes-Weinstein Monofilament test is performed with 6 filaments of different diameters with approximately the same length. The thicknesses of the filaments are 2.83, 3.61, 4.31, 4.56, 5.07, 6.65 mm. As the filament diameter becomes thicker, the pressure and sensory input also increase (Suda et al., 2020). In the study, the participants' LTS was evaluated at the midpoint of the patella, midpoint of the patellar tendon and medial to the patella. Filaments were applied from thin to thick and the number of the first monofilament felt by the participant was recorded. In the assessment, pressure was applied until the filaments were curled and the participant was asked if he/she felt this pressure. If not, the same application was repeated by increasing the filament thickness in order.

Physical Activity Level (PAL) Assessment

The International Physical Activity Questionnaire (IPAQ), whose Turkish validity and reliability research was carried out by Öztürk et al., was used to assess the PAL of the participants. In the questionnaire, the PA of the participants in the last 7 days are questioned. The total activity level is computed by averaging the intensity and duration of all the days the person has been active (Savcı et al., 2006).

Walking: Multiplied by 3.3 MET

Moderate-intensity physical activity: Multiplied by 4.0 MET

Vigorous physical activity: Multiplied by 8.0 MET

For example; The score of the individual who walks for 40 minutes 4 days a week is calculated as 4×3.3×40= 528 METs. Participants with a total score of less than 600 MET are classified as inactive, between 600 MET and 3000 MET are classified as minimally active, and more than 3000 MET are classified as active (Craig, 2011). This formula was utilized in this study to determine each

participant's PAL. PAL of the participants were evaluated by IPAQ. Total METs were calculated and participants were divided into three groups as inactive, minimally active and active.

Ethics

Before starting the study, ethics approval was obtained from Sakarya University of Applied Sciences Ethics Committee. The Declaration of Helsinki was followed when conducting the study, and participants' written agreement was obtained after being informed of its methodology and goal.

Statistical Analysis

Continuous variables for descriptive statistics in the study; mean (X) and standard deviation (Sd); number (n) and percentage (%) from categorical variables value is used. The normality distribution test of continuous variables was performed with the Shao test. The test findings revealed that the study's continuous variables were distributed normally (parametrically). Therefore, ANOVA analysis of variance was used in pairwise comparisons. The significance of the difference between groups was evaluated with the Tukey test. The significance of the Pearson correlation coefficient test was performed to establish the association between the variables. In the calculations, the Type-1 error value was taken as 0.05 and determined as 5%, and the SPSS (IBM SPSS statistics 23) statistical package program was used to calculate the study.

RESULTS

24 of the participants were female and 26 were male. 46 had right dominant side and 4 had left dominant side. 14 were smokers and 36 were non-smokers. 6 of the participants use alcohol and 44 did not use alcohol. The mean age, BMI, IPAQ, Angular Deviation of Joint Position Sense (ADJPS) and LTS around the patella of the participants are given in Table 1.

When participants are grouped according to their PAL; It was found that there were 9 participants in the inactive, 21 participants in the minimally active and 20 participants in the active group. There is a statistically significant difference between the groups in ADJPS at 30°, 45°, 60° of the knee and in the mean of all angles. There is also a statistically significant difference in LTS between the middle and medial of the patella. ($p<0.05$) (Table 2).

Active individuals had lower ADJPS at 30° and 45° flexion of the knee and higher LTS in the medial patella than inactive individuals. ADJPS at 45° and 60° flexion of the knee was lower in active individuals than minimally active individuals, and the LTS in the medial patella was higher. In addition, avarage of ADJPS at 15°, 30°, 45° and 60° flexion of the knee were lower in active individuals than minimally active and inactive individuals. (Table3.).

There is a negative correlation between the PAL of the participants and the knee ADJPS 30°, 45°, 60° and the average ADJPS of the knee joint at all angles. There is a negative correlation between the mean LTS in the medial and patella and the ADJPS 45° of the knee. There is a negative correlation between the mean of the knee ADJPS at different angles and the LTS of the medial patella (Table 4).

DISCUSSION

In this study, we investigated the relationship between PAL and knee JPS and LTS in young university students. 9 of the participants were inactive, 21 were minimally active and 20 were active. As the PAL of the participants increased, JPS and LTS increased at all angles of the knee joint. In addition, the LTS of the medial patella increased as the participants' knee JPS increased.

Erden et al. stated that the JPS is different at different angles of the knee joint (Erden, 2009). According to studies in the literature, passive JPS rises as the knee joint approaches extension (Erden, 2009; Pincivero et al., 2001). In our study, in parallel with the literature, ADJPS increased as the knee joint position sense increased from 15° flexion to 60° flexion. This means that the JPS decreased.

Although the number of studies examining the relationship between PAL and JPS in the literature is quite insufficient, studies show that regular PA increases knee JPS (Jeong et al., 2019; Kaya et al., 2019).

In our study, parallel to the literature (Relph & Herrington, 2016), as the PAL of the participants increased, the knee JPS at 30°, 45°, 60° and the average JPS at all angles of the knee increased.

In a study examining ankle complex proprioception and plantar cutaneous sensation in elderly women with different PAL, 68 participants were divided into three groups as inactive, minimally active and active according to physical activity level. In this study, the physical activity levels of the participants were assessed with IPAQ as in our study. According to the results of the study it was shown that as the PAL increased, LTS increased (Yang et al., 2022). There are very few studies that look at the PAL and the plantar LTS in the literature. Also, no research has been done to determine how patellar LTS and PAL are related. In our study, as the PAL of the participants increased, the LTS increased in the middle and medial of the patella. In addition, as the JPS

Table1. Demographic Information of Participants (n=50)

	M*± SD**
Age	19.60 ± 0.80
BMI	23.14 ± 2.44
IPAQ	2954.56 ± 2298.82
ADJPS 15°	2.05 ± 1.19
ADJPS 30°	3.64 ± 1.02
ADJPS 45°	3.65 ± 0.84
ADJPS 60°	4.11 ± 0.95
Avarage of JPS	3.86 ± 0.60
Patella midpoint	3.32 ± 0.37
Patellar tendon middle	3.61 ± 1.51
Patella medial	3.45 ± 0.53
Avarage of Patella	3.46 ± 0.61

*M= Mean; **SD= Standart Deviation

Table 2. Comparison of Groups by PAL

	Inactive n=9	Minimally Active n=21	Active n=20	p
BMI	22.82 ± 1.74	23.60 ± 2.49	22.81 ± 2.67	0.54
ADJPS 15°	4.54 ± 1.32	4.06 ± 0.99	3.83 ± 1.32	0.33
ADJPS 30°	4.25 ± 1.26	3.84 ± 0.72	3.14 ± 0.99	**0.01***
ADJPS 45°	4.02 ± 0.54	4.06 ± 0.52	3.05 ± 0.90	**0.00***
ADJPS 60°	4.46 ± 0.36	4,38 ± 0.74	3.68 ± 1.18	**0.02***
Avarage of JPS	4.32 ± 0.49	4.09 ± 0.41	3.43 ± 0.54	**0.00***
Patella midpoint	3.43 ± 0.34	3.42 ± 0.34	3.15 ± 0.38	**0.04***
Patellar tendon middle	3.59 ± 0.52	3.49 ± 0.43	3.75 ± 2.36	0.86
Patella medial	3.75 ± 0.48	3.69 ± 0.47	3.06 ± 0.36	**0.00***
Avarage of Patella	3.59 ± 0.39	3.53 ± 0.29	3.32 ± 0.88	0.43

*p<0.05

Table 3. Significance Between Groups by PAL

		Mean Difference	p	Tukey
ADJPS 30°	Active (1)	-1.11	**0.01***	1>3
	Minimally Active (2)	-0.70	0.05	
	Inactive (3)	0.40	0.53	
ADJPS 45°	Active (1)	-0.96	**0.00***	1>3 1>2
	Minimally Active (2)	-1.01	**0.00***	
	Inactive (3)	-0.04	0.98	
ADJPS 60°	Active (1)	-0.78	0.09	1>2
	Minimally Active (2)	-0.69	**0.04***	
	Inactive (3)	0.08	0.97	
Avarage of ADJPS	Active (1)	-0.89	**0.00***	1>3 1>2
	Minimally Active (2)	-0.66	**0.00***	
	Inactive (3)	0.23	0.46	
Patella midpoint	Active (1)	-0.27	0.14	1>2
	Minimally Active (2)	-0.21	**0.04***	
	Inactive (3)	0.05	0.96	

*p<0.05

Table 4. The Relationship Between PAL, ADJPS, and LTS

		IPAQ	ADJPS 15°	ADJPS 30°	ADJPS 45°	ADJPS 60°	Avarage of ADJPS	Patella midpoint	Patellar tendon middle	Patella medial	Avarage of Patella
IPAQ	p r	1									
ADJPS 15°	p r	0,25 -0.16	1								
ADJPS 30°	p r	**0.01*** -0.36	0.39 0.12	1							
ADJPS 45°	p r	**0.00*** -0.57	0.06 0.26	0.97 0.01	1						
ADJPS 60°	p r	**0.02*** -0.33	0.33 -0.14	**0.01*** 0.36	0.06 0.27	1					
Avarage of ADJPS	p r	**0.00*** -0.57	**0.00*** 0.59	**0.00*** 0.63	**0.00*** 0.59	**0.00*** 0.58	1				
Patella midpoint	p r	**0.01*** -0.38	0.91 0.02	0.82 -0.03	0.07 0.26	0.09 0.24	0.20 0.18	1			
Patellar tendon middle	p r	0.08 -0.03	0.99 0.01	0.19 -0.18	0.02* 0.33	0.59 -0.08	0.96 0.01	0.19 0.19	1		
Patella medial	p r	**0.00*** -0.55	0.98 0.01	0.33 0.14	**0.01*** 0.45	0.64 0.26	**0.01*** 0.33	**0.01*** 0.34	0.14 0.21	1	
Avarage of Patella	p r	0.06 -0.27	0.97 0.01	0.42 -0.12	**0.01*** 0.46	0.68 0.06	0.34 0.14	**0.01*** 0.45	**0.00*** 0.92	**0.00*** 0.52	1

in 45° knee flexion increased, the LTS in the middle of the patellar tendon and medial of the patella also increased. As the results of our study revealed the relationship between PAL, JPS and LTS, the importance of PAL in terms of sensory and propreoception was indicated.

Limitations of The Study

It is important to use bigger and more representative sample groups for examining the association between PAL and the knee JPS and joint LTS. In this study, the sitting time is not calculated in IPAQ score calculation. In future studies, the relationship between sitting time, JPS and LTS should be examined.

CONCLUSION

As the PAL increased, JPS and LTS of the middle and medial patella increased at 30°, 45° and 60° of the knee joint. As the LTS of the medial patella increased, the JPS of the knee joint increased. In order to increase the proprioception of the knee joint, it could be recommended to increase the PAL and sensory training can be given to the knee area.

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