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ARAŞTIRMA / RESEARCH

Correlation between ventral neck muscle endurance and cervical progressive isoinertial lifting capacity

Ön boyun kas enduransı ve servikal ağırlık kaldırma testi arasındaki ilişki

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Abstract

Purpose: The purposes of this study were to document the characteristics of ventral neck flexor muscle endurance (NMFE) and compare the endurance time to some anthropometric measurements due to genders in healthy young adult population.

Materials and Methods: Measurements were taken from 185 medical students (104 males - 81 females) aged between 18-22yrs. Neck flexor (NF) endurance was measured with clinic endurance test, CROM (cervical range of motion) and head posture measurements were taken with CROM device and cervical physical performance was determined with progressive isoinertial lifting evaluation test (PILE). Neck pain and disability level were evaluated with the neck disability index (NDI).

Results: Cervical range of motion and the NDI score were found significantly higher in females than in males. When the activity level increased, endurance time and PILE test components increased, however there was a weak correlation between endurance time and ROMs. Finally, it was observed that there was a relationship between NF muscle endurance and the NDI, range of motion (ROM), physical performance - activity level and lifestyle.

Conclusion: It could provide important information to performance and endurance exercise studies program. Also, they may be helpful to assign patients to appropriate and most beneficial treatment programs, as well as to develop specific programs.

Keywords: Progressive isonertial lifting evaluation (PILE), functional capacity, neck pain.

Öz

Amaç: Bu çalışmanın amacı sağlıklı genç yetişkin populasyonda ön boyun fleksor kas endurans özelliklerini betimlemek ve cinsiyete göre bazı antropometrik ölçümleri endurans süresi ile karşılaştırmaktı.

Gereç ve Yöntem: Ölçümler yaşları 18-22 arasında değişen 185 (104 Erkek, 81 Kadın) Tıp Fakültesi öğrencilerinden alındı. Boyun fleksor enduransı klinik endurans testi ile, boyun eklem hareket açıklığı ve baş postürü aleti ile ve servikal fiziksel performansı servikal fiziksel performans testi, [(servikal ağırlık kaldırma testi (PILE)] ile belirlendi.

Bulgular: Servikal normal eklem hareket açıklığı ve boyun ağrı ve disabilite skoru kadınlarda erkeklerden daha yüksek bulundu. Aktivite düzeyi arttıkça endurans süresi ve PILE test skoru ve eklem hareket açıklığı arttı. Sonuç olarak, boyun fleksor kas enduransı ile boyun ağrı ve disabilite indeksi, eklem hareket açıklığı, fiziksel performans-aktivite düzeyi ve yaşam şekli arasında ilişki olduğu gözlendi.

Sonuç: Bu çalışma sonuçları performans ve endurans egzersiz çalışmalarına önemli bilgi sağlayabilir. Ayrıca, hastalara özgü tedavi programlarının geliştirilmesinin yanısıra, hastalara uygun ve daha faydalı tedavi programı belirlemeye yardımcı olabilir

Anahtar kelimeler: Servikal ağırlık kaldırma testi, fonksiyonel kapasite, boyun ağrısı

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INTRODUCTION

Occupational neck pain is a major burden to society 50 % - 70 % of the population[1-3]. It has been seen more often in females than in males[3]. In addition to human suffering, it causes a substantial economic burden due to absence from work and the wide use of medical services[4-6]. The largest expenses due to neck pain have been identified within individuals having recurrent disabling episodes of it, and developing long term pain and disability, which results in activity restrictions[3,7,8]. Therefore, there is a need for effective preventive interventions to avoid the development of chronic problems, reduced function and high costs[7,9,10]. However, males showed more tolerance for pain and higher pain threshold than females for several pain modalities and lower prevelance of disability[6].

Some studies have demonstrated an association between neck pain, cervical impairments and lower deep neck flexion (DNF) muscle performance such as activation, strength and endurance[1,2,7]. Furthermore, endurance plays an important role in resisting to fatigue[7]. Additionally, neck pain alters muscle activity pattern and leads to decrease activation of DNF muscles movement[1]. Conversely, the activation of superficial cervical flexor muscles increase[1]. Moreover, neck muscles (especially deep neck muscles) play a significant role in mechanical stabilizing of the cervical spine[2,8]. DNF muscles including m. longus colli, m.longus capitis, m.rectus capitis anterior and m.rectus capitis lateralis settle deep to m. sternocleidomastoid, anterior and anterolateral of cervical spine[1,2]. Especially m.longus colli and m.longus capitis have an major stabilizing factors and DNF muscles are responsible for supporting cervical lordosis, neck flexion motion. The poor performance of these muscles causes cervical impairment and postural deformity[1,7,9]. Moreover, cervical impairment leads to decrease in parameters including neck range of motion, endurance and strength[2,10]. Furthermore, muscle pain or disability affects muscle function negatively. This leads to decrease in physical activity level[11]. In a result of this, the muscle mass and endurance will decrease.

According to Mayer et al. the most appropriate way to test lifting-capacity, in order to measure patient progress in functional restoration programs for spinal disorders, is by use of dynamic isoinertial tests[12]. In order to enhance lifting-capacity, it is important to consider variables with influence on this parameter. There are some physical, demographic and anthropometric variables known as being associated with lifting-capacity: Prior cross-sectional studies in populations with mostly chronic back pain reported that perceived effort, body height and body weight were positively related to lifting-capacity[13] .

The purposes of this study were to (1) document the characteristics of ventral neck flexor muscle endurance and (2) compare the endurance time to neck disability index (NDI), physical activity level - physical performance (PILE test), time spent on computer, range of motion (ROM), head-neck anthropometric measurements and posture due to genders in healthy young adult population.

MATERIAL AND METHODS

The study group consisted of 185 healthy subjects aged between 18-22 years (81 females, 43.8 % and 104 males, 56.2 %) from University Faculty of Medicine. Inclusion criteria for this study was absence of any history of trauma, serious pathology and infection, absence of previous surgery of neck, and absence of any congenital anomalies or systemic diseases (Figure 1).

Procedure

This study was approved by the Institutional Review Ethics Committee at Cukurova University. The research study was explained to each participant prior to data collection and he or she gave informed consent. The evaluation design consisted of demographic data, anthropometric measurements, physical activity level, neck flexor muscle endurance test, time spent on computer, the neck disability index (NDI), cervical range of motion (CROM) and progressive isonertial lifting evaluation (PILE) test. These parameters were as follows;

The demographic variables (age, height, weight) were taken from all of the students and body mass index (BMI) was calculated in standart formula (kg/m^2)

Disability and pain regarding cervical vertebra disorders were evaluated with neck disability index for people who report neck pain The NDI is the most commonly used outcome measure for neck disability and has acceptable reliability, although intraclass correlation coefficients (ICCs) range from 0.50 to 0.98. This index which is found to be a valid and reliable method consists of 10 parameters and 5 or 6 questions in every section. This questionnaire is designed to help researchers well understand how their neck pain affects their ability to manage everyday-life activities. Subjects marked the box that most closely describes theirs' day situation[14]. The parameters were pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping and recreation. Item scores ranged from 0 (no disability) to 5 (total disability)[15,16]. This index was filled in during 5 minutes by participants

Cervical ROMs were evaluated with CROM deluxe instrument (CROM instrument-performance attainment associates, St. Paul, MN, 55117, United States). CROM was reliable and accurate measurement device[17-19]. The measurements consisted of cervical flexion and extension, right and left rotation, right and left lateral flexion[18-20]. During the measurement, participants sat erect in a straight-back chair, arms hanging at sides and feet flat on the floor. The CROM instrument was fastened to the head by a velcro strap. Neck flexion-extension and lateral flexion movements were measured by gravity goniometers and cervical rotation movement were recorded an compass goniometer with a magnetic yoke[19,20]. It was asked to the participant to flex head further until full cervical flexion and then the score was read and noted from magnetic inclinometer which was settled on the instrument. Second measurement was cervical extension. Participants extended head back further until full extension. The participant should flex the head laterally to the left and right respectively. It was noted and recorded score from the lateral flexion meter. The CROM instrument with magnetic yoke measured cervical rotation movement. Participant turned the head further to the left and then right as possible.

The NF muscles endurance test was performed in a supine position with legs positioned straight and arms positioned side the body and lying position[2,21]. The test was made with a goniometer ad modum Myrin fixed just above the ear and a weight of 0,5 kg on the forehead[22,23]. The participants were instructed to flex the upper cervical spine (chin against chest)[24]. The person lifted the head and neck until the head was 10° flexion adding 0.5 kg weight placed on forehead until exhaustion. The endurance time was recorded using stopwatch in seconds.

Additionally, the cervical physical performance was measured with PILE test that is known as progressive isoinertial lifting evaluation for lumbar or cervical. It was determined that the cervical PILE tests are known as a functional lifting test can be accepted as appropriate methods for measuring different aspects of neck muscle function and it also has an agreeable degree of reproducibility. Furthermore, PILE test that is sensitive to change is functional, well-described and reliable method[25]. The subject lifts a box (height 22 cm, width 50 cm, depth 40 cm) from approximately 76 cm (waist-lower shelf height) to 137 cm (shoulder-upper shelf height) above the floor and returns the box to the floor. The lifting motion takes in the transfer from level one to the next level and once again four times[22,26]. The weight of the box is increased after every fourt sequence. Different weights are added to men and women (2.25 kg and 4.5 kg) and the result is adjusted for the body weight[25]. Kilogram lifted at the last period is used as outcome measurement and this used as the test result value. The female starts with 3.6 kg load and men start with 5.9 kg load[22,26].

The activity level was measured with asking daily physical activities in the last 12 months[22,25]. Then it was asked to participants whether they perform regular sport and exercise or not and suitable choice was marked. The results of these two questions were evaluated with four score (1- inactivity, 4-high activity level). Lifestyle was asked with a question including time spent on computer. The lifestyle result scores were evaluated in three ways as 0-5.99 hours, 6-7.99 hours and 8 hours and over during one day[24,27].

Statistical analysis

The SPSS 16.0 program was used for statistical analysis of the measurement results. From these measurements, means, standard deviations (SD), percentage and minimum and maximum values were calculated. Moreover, Mann Whitney U test, Kruskal Wallis Test and Chi Square tests were used in statistical analysis of data. Pearson's or Spearman Correlation Coefficient were performed. Additionally, the level of significance was considered to be $p < 0.05$ level.

RESULTS

Table 1 shows the mean values of the age, height, weight, body mass index (BMI), head circumference and neck circumference of the 81 females and 104 males.

Females had lower activity level than males ($p=0.0001$). In addition, when activity level was increased, endurance time was also increased. When

NF muscles endurance time was compared to genders, endurance time was found statistically higher in males than females (p=0.0001). When the time spent on computer increased, the endurance time decreased significantly in only females (p=0.007) (Table 1).

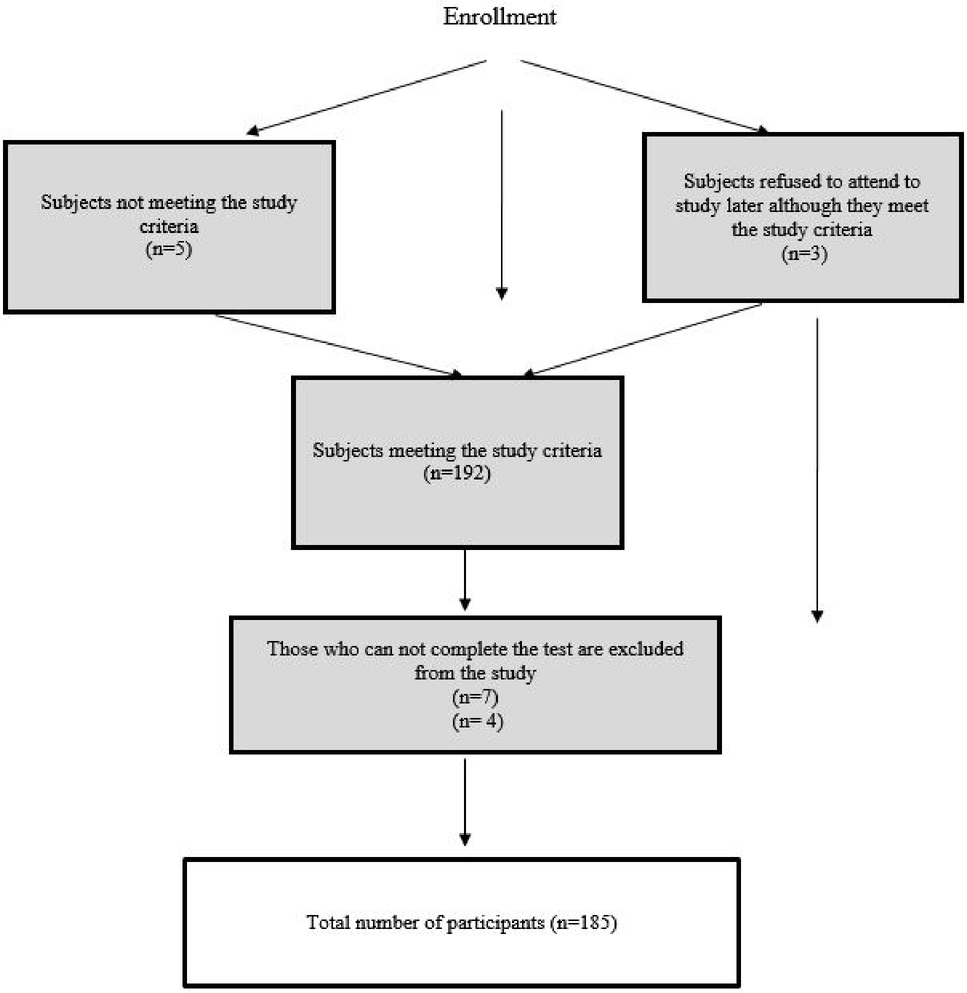

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) inclusion flow diagram

Table 1. Baseline characteristics of the study group according to genders

(Mean±Standard deviation)	Female (81)	Male (104)	p
Age (years)	19.6±1.1	19.6±1.8	p>0.05
Height (m)	1.64±0.06	1.77±0.07	p<0.05
Weight (kg)	61.5±10.7	74.8±14.1	p<0.05
Body mass index (kg/m²)	22.9±4.2 kg/m²	23.7±3.7	p<0.05
Head circumference (cm)	54.3±1.5	56.4±1.8	p<0.0001
Neck circumference (cm)	31.2±1.7	37.0±2.3	p<0.0001

p<0.05

NDI scores were found higher in females than males (p=0.016). The endurance time was found lower in There was significantly difference in cervical extension (p=0.006), right rotation (p=0.001), left rotation (p=0.026) ROMs according to genders. There was low correlation between right rotation (r=0.22), left lateral flexion (r=0.28) and cervical extension (r=0.30) in ROMs measurement and the endurance time in females, whereas there was low correlation between right rotation (r=0.24) and left rotation (r=0.33) ROMs (r=0.21) and endurance time in males. There was a difference between endurance time and genders (p=0.0001). There was a weak correlation between PILE test components and endurance time in females (r=0.31) wheras there was moderate correlation in males (r=0.50) (Table 3) disabled males (p=0.027), whereas there was no significant difference in disabled females (p=0.208) (Table 2).

Table 2. The distribution of the activity level and comparison of endurance time and the relationship between the time spent on computer and endurance time according to genders

The Activity Level Score	Endurance Time				Endurance time and genders P
	Female (N:81) 42.9±29.1 second		Male (N:104) 68.5±32.4 second		
	N	Mean±SD	N	Mean±SD	
1 (Inactivity)	6 (7.4 %)	33.7±32.7	3 (2.9 %)	51.7±13.3	.0001
2 (low)	52 (64.2 %)	40.6±24.8	36 (34.6 %)	64.3±31.4	
3 (moderate)	19 (23.5 %)	42.89±25.9	46 (44.2 %)	71±33.5	
4 (high)	4 (4.9 %)	88.5±58	19 (18.3 %)	70.3±33.9	

Time spent on computer	Endurance Time					
	Female (N:81)			Male (N:104)		
	N	Mean±SD	P	N	Mean±SD	P
<6 hours	13 (16.1%)	66.1±37.3	.007	30 (28.8%)	70.5±31.2	.646
6-8 hours	29 (35.8%)	42.3±24.1		42 (40.4%)	71.2±36.8	
>8 hours	39 (48.1%)	35.8±26.2		32 (30.8%)	63.1±27.4	

There was significantly difference in cervical extension (p=0.006), right rotation (p=0.001), left rotation (p=0.026) ROMs according to genders. There was low correlation between right rotation (r=0.22), left lateral flexion (r=0.28) and cervical extension (r=0.30) in ROMs measurement and the endurance time in females, whereas there was low correlation between right rotation (r=0.24) and left rotation (r=0.33) ROMs (r=0.21) and endurance time in males.

There was a difference between endurance time and genders (p=0.0001). There was a weak correlation between PILE test components and endurance time in females (r=0.31) wheras there was moderate correlation in males (r=0.50) (Table 3)

Table 3. Correlation between NDI scores and endurance time

Variables	Values	Female (N:81)		Male (N:104)	
NDI Score	Mean ± SD	5.05 ± 3.46		3.96 ± 2.65	
	Median (Min.- Max.)	4 (0 - 16)		4 (0 - 12)	
	P	.016			
Endurance Time		N:43 No disability	N:38 Low disabilty	N:68 No disability	N:36 Low disabilty
	Mean ± SD	47.3 ± 32.4	38.1 ± 24.4	73.7 ± 32.6	58.6 ± 29.9
	P	.208		.027	

NDI= The neck disability index
0-4: no disability, 5-14: low disability, 15-24:moderate disability.

There was a weak correlation between neck circumference and endurance time only in males and there was a weak correlation between PILE test components and antropometric measurements in females, whereas there was moderate correlation between neck circumference and PILE test in males. Also, there was low correlation BMI and PILE test (Table 4). The activity level was increased, PILE test components were correlated to genders (Table 5).

Table 4. The correlation between PILE test and genders; and endurance time.

Servical PILE Test		N	Mean±SD	Median (Min-Max.)	Endurance Time (r)
Max.Weight Lifted (kg)	Male	104	21.04 ± 5.02	19.40 (10.40 - 41.90)	
	Female	81	9.65 ± 2.12	10.35 (5.85 - 17.10)	
Endurance Time (s)	Male	104	87.30 ± 22.30	80 (40 - 180)	0.50
	Female	81	73.83 ± 18.88	80 (40 - 140)	0.31
Total Work (TW) (kg.m)	Male	104	150.26 ± 71.97	123.46 (39.77 - 524.84)	
	Female	81	62.11 ± 27.32	68.08(23.06 - 176.78)	
Total Power Consumption (TP)	Male	104	1.64 ± 0.30	1.54(0.99 - 2.92)	
	Female	81	0.81 ± 0.13	0.85(0.58 - 1.26)	

PILE= Progressive isonertial lifting evaluation, S=Seconds; TW=Total Work; TP= Total Power

Table 5. The correlation between anthropometric measurements, endurance time, activity level and PILE test

Anthropometric Measurements	Gender	Endurance Time - Anthropometric Measurements (r)	PILE Test -Anthropometric Measurements (r)
Head Circumference	Female (N:81)	0.01	0.26
	Male (N:104)	0.01	0.12
Neck Circumference	Female(N:81)	0.06	0.33
	Male (N:104)	0.24	0.43
Body Mass Index (BMI)	Female(N:81)	0.08	0.23
	Male (N:104)	0.19	0.34

PILE Test

Activity Level Score	Gender-N	Max. Weight Lifted (kg)	Endurance Time (second)	Total Work (Kg.m)	Total Power Consumption (kg.m/second)
		Mean±SD	Mean±SD	Mean±SD	Mean±SD
1	Female-6	7.72±1.69	56.67±15.65	40.44±16.64	0.70±0.10
	Male -3	13.40±2.60	53.33±11.55	64.01±20.10	1.18±0.16
2	Female-52	9.27±1.51	70.38±13.42	56.46±17.25	0.78±0.09
	Male-36	19.27±4.37	79.44±19.41	127.03±56.56	1.53±0.26
3	Female-19	10.70±2.73	83.16±24.28	76.40±38.57	0.87±0.17
	Male-46	21.16±3.48	87.83±15.48	148.20±44.66	1.65±0.21
4	Female-4	12.60±1.84	100.00±16.33	100.20±27.37	1.00±0.11
	Male-19	25.32±6.37	106.31±28.32	212.90±109.15	1.90±1.40

DISCUSSION

This study compared the relationship between ventral neck flexor muscles endurance and gender, disability and pain, physical activity level-physical performance (PILE test), ROM, head and neck antropometric measurement and posture. It was observed that ventral NF muscles'endurance was related to functional level, ROM, cervical physical performance and the lifestyle. Especially, while the lifestyle and disability affect endurance time negatively in females, only disability affects endurance time negatively in males. In addition, there was an association between cervical physical performance and physical activity level.

Ventral neck flexor muscles endurance time was higher in males 68.5 seconds and this value was found as 43 seconds in females in this study, whereas the endurance time was evaluated as 68 seconds in 20-25 years old Australian females[28]. The mean values of ventral neck flexor muscle endurance time were 153 seconds and 37 seconds in males and females respectively in Sweden population[24]. In the other study from Sweden population it was reported as 55 seconds on average value in both sexes[22]. Furthermore, same dimension was found on average 44.9 seconds in both genders in Italians[21]. When we analyzed the literature findings, it was obtained that there are different methods for estimating the endurance time[21-24, 28]. We preferred the method using load (0.5 kg) during the test[22,23]. There were differences between our results and the literature data. We think that these diversities may due to the characteristics of the groups, age, methods and physiological differences between populations.

The NDI is the most commonly used outcome measure for neck pain and has acceptable reliability, although intraclass correlation coefficients (ICCs) range from 0.50 to 0.98. This questionnaire is designed to help researchers well understand how your neck pain affects your ability to manage everyday-life activities. Subjects mark the box that most closely describes theirs' day situation. Test include some parameters including pain intensity, personal care, lifting, work, reading, recreation[14]. Assessment of Turkish version of neck pain and disability scale were performed by Biçer et al[15]. The NDI was used to determine whether neck pain affects the daily living activities or not. According to endurance time and neck disability index score comparison in genders, endurance time was found significant lower in disabled males. Although there were no significant difference in females, the endurance time was lower in disabled females (Disable level was determined according to NDI score). When we analysed values, disability value was greater in females. The poor performance of neck muscles causes impairment, and disability[1,7,9]. This leads to decrease in physical activity level[11]. In the light of these literature data, we think that the reason of increased disability could be correlated with lower physical activity level, physical performance and endurance capacity.

The prevelance of chronic health diseases was related with decreased physical activity and it was suggested that physical inactivity in young adulthood or children was associated with chronic musculoskeletal problems in later life[29,30]. It was determined that physical activity had positive effects on musculoskeletal and cardiovascular health, self concept, anxiety and depression symptoms. Moreover, it was demonstrated that there was positive effects in muscle strength and endurance with physical activity for 30-45 minutes duration 3 to 5 days per week[29]. In this study, subjects were asked two questions about daily physical activities, exercise and sport that were performed during the last 12 month. There was no significantly difference between activity level and endurance time in genders. Moreover, when analysing an association between genders and activity level, females had lower activity level than males. Additionally, we found that 47.6% of subjects performed physical activity in low level and aproximately 75% of subjects spent time on computer 6 hours or over during a day. One study showed that there was no relationship between sedantary activities (like watching TV, using a computer) and neck-shoulder pain[30]. Conversely, some studies showed that there was relationship between sedentary activities including computer related activities and musculoskeletal disorders or neck pain[31,32]. It was demonstrated that when computer use was 2-3 h/day or more, neck pain risk increased[32]. Furthermore, it was reported that females suffered from neck shoulder pain more often than males[30]. In similar to this study, when participants spent more time on computer, the endurance time decreased significantly in only female.

It was determined that the cervical PILE tests are known as a functional lifting test can be accepted as appropriate methods for measuring different aspects of neck muscle function and it also has an agreeable degree of reproducibility. Furthermore, reliability and agreement were defined for the cervical PILE test and so it's intra class correlation coefficient (ICC) intraobserver reliability ranged from 0.88 to 0.96 and an almost perfect inter-observer reliability coefficient was reported[3]. In this study, there was a weak correlation between PILE test components and endurance time in females, whereas in males there was moderate correlation. In addition to this, when physical activity level increased, PILE test components were increased.

Fiebert el al examined the relationship between neck circumference and cervical ROM and cervical strength during resting and neutral head postures in healthy young adults[17]. It was reported that head posture affected cervical range of motion and females had greater extension ROM in neutral and resting head posture[17]. When we observed our study group values, there was no significant correlation in females between endurance time and neck-head circumference, whereas in males, there was a weak correlation between neck circumference and endurance time. Moreover, there was a weak correlation between PILE test components and antropometric measurements in females, while in males there was moderate correlation between neck circumference and PILE test. Additionally, there was a weak correlation between head circumference and body mass index and PILE test in males.

Natural head position (NHP) is the usual, balanced position of the head which is adopted for viewing the horizon or an object at eye level[33]. According to the literature findings, studies about relationship of endurance and posture are limited. But it was reported that head and neck movements showed some differences between neck pain and asymptomatic subjects[34]. And it also showed that there was a significant relation between lower endurance capacity and head posture[35].

The study has a number of limitations. Because of the study's design, no causal relationships between the independent variables could be drawn. The socio-economic homogeneity of this sample of predominantly females with mild neck pain might affect the generalization of the results. Some applied outcome measures have been validated only in chronic neck pain populations. Therefore, it is possible that some relevant factors were not uncovered by these measurements and other might be detected by more sensitive measures in a less affected population.

Further research and especially longitudinal studies are needed to confirm and broaden the knowledge about causal relationships between the variables and to identify further factors influencing the improvement of lifting-capacity. Additional data about treatment-related processes during follow-up intervals could be helpful.

In conclusion, the findings of this study also highlight the objective measurement results regarding relationship between ventral neck flexors muscles' endurance test, ROMs, physical activity level and NDI scores in healthy young adults. Therefore, the observations presented in this study have defined anatomic parameters that need to be taken into consideration for determine neck problems. As a result, we believe that the data obtained in this study should provide crucial information and could be used as a reference data for studies about physical performance and endurance exercise programme.

Yazar Katkıları: Çalışma konsepti/Tasarımı: GA, SÖP, GB, PG, EK, AHY, MGB, Veri toplama: GA, SÖP, GB, PG, EK, AHY, MGB, Veri analizi ve yorumlama: GA, SÖP, GB, PG, EK, AHY, MGB, Yazı taslağı: GA, SÖP, GB, PG, EK, AHY, MGB, İçeriğin eleştirel incelenmesi: GA, SÖP, GB, PG, EK, AHY, MGB, Son onay ve sorumluluk: GA, SÖP, GB, PG, EK, AHY, MGB, Teknik ve malzeme desteği: GA, SÖP, GB, PG, EK, AHY, MGB, Süpervizyon: GA, SÖP, GB, PG, EK, AHY, MGB, Fon sağlama (mevcut ise): yok.
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