The Predictors of Low Back Pain in Helicopter Pilots

Helikopter Pilotlarında Bel Ağrısının Belirleyicileri

Özge Çınar-Medeni[1], Nevin Atalay Güzel[1], Murat Erdoğan[2]

[1]Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara, Turkey
[2]Turkish Military Academy Leadership. Research & Development Centre. Ankara, Turkey

ABSTRACT

Objective: Helicopter pilots frequently complain about low back pain (LBP). The aim of this study is to investigate the effect of age, body mass index, total flying hours, smoking habit, regular sports participation and core endurance on LBP, and to determine the predictors of LBP in helicopter pilots.
Methods: Twenty-one military helicopter pilots (29.09±6.52 years) were assessed. Demographic information and total flying hours were recorded. Low back disability was evaluated with the Oswestry low back disability questionnaire. The prone bridge test, side bridge test, supine isometric chest raise test and Sorenson test were conducted to assess the core endurance. The parameters affecting the Oswestry disability score were analyzed with the Spearman's correlation coefficient. A multiple linear regression model was used to identify the independent predictors of the Oswestry score. Dependent variable was the Oswestry score, and the independent variable were age, body mass index, total flying hours, smoking habit, regular sports participation, the prone-bridge, side-bridge, Sorenson and supine isometric chest raise test scores.
Results: The low back disability was correlated with age and total flying hours (r=0.55, p=0.015; r=0.53, p=0.01). Results of the linear regression showed that age, total flying hours, smoking status, regular sports participation, the side bridge test score, the prone bridge test score were all the predictors of low back disability (R^2=0.54, p<0.05).
Conclusion: Increased **t**otal flying hours, smoking habit, sedentary lifestyle, the impaired back muscle endurance and age negatively affected the low back disability status. Modification of the lifestyle and improving the endurance of the back muscles might positively affect the disability level due to the LBP in helicopter pilots.

Key Words: Core stability, military, oswestry, physical endurance, vibration, low back pain.

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ÖZET

Amaç: Helikopter pilotları sıklıkla bel ağrısından şikâyet etmektedirler. Bu çalışmanın amacı, helikopter pilotlarında yaş, vücut kitle indeksi, toplam uçuş saati, sigara alışkanlığı, düzenli spora katılım ve gövde dayanıklılığının bel ağrısı üzerine etkisini araştırmak ve bel ağrısını tahmin edebilecek faktörleri belirlemektir.
Yöntemler: Yirmi bir askeri helikopter pilotunun (yaş: 29.09±6.52) demografik bilgileri ve toplam uçuş süreleri kaydedildi. Bel özür düzeyi Oswestry bel özür ölçeği ile değerlendirildi. Yüzüstü köprü, yan köprü, supin izometrik gövde kaldırma ve Sorenson testleri gövde dayanıklılığını değerlendirmek amacıyla uygulandı. Oswestry dizabilite puanını etkileyen faktörler Spearman korelasyon katsayısı ile değerlendirildi. Bağımsız prediktörlerin Oswestry skoru üzerindeki etkileri çok değişkenli regresyon modeli ile incelendi. Oswestry skoru bağımlı değişken; yaş, vücut kitle indeksi, toplam uçuş saati, sigara alışkanlığı, düzenli spora katılım, yüzüstü köprü, yan köprü, Sorenson ve supin izometrik gövde kaldırma test skorları bağımsız değişken olarak belirlendi.
Bulgular: Bel özür düzeyi yaş ve toplam uçuş süresi ile ilişkili bulundu (sırasıyla: r=0.55, p=0.015; r=0.53, p=0.01). Doğrusal regresyon analizi sonucunda yaş, toplam uçus saati, sigara kullanımı, düzenli spor alışkanlığı, yan köprü ve yüzüstü köprü test skorlarının bel özür düzeyinin belirleyicileri olduğu tespit edildi (R^2=0.54, p<0.05).
Sonuç: Artmış toplam uçuş süresi, sigara kullanımı, sedanter yaşam, gövde kaslarının enduransının etkilenmesi ve değiştirilemeyen bir parametre olarak ilerleyen yaşın, bel özür düzeyini olumsuz etkilediği görüldü. Yaşam biçiminin değiştirilmesi ve gövde kaslarının dayanıklılığının artırılmasının helikopter pilotlarında bel ağrısına bağlı özür düzeyini olumlu yönde etkileyeceği düşünülmektedir.

Anahtar Sözcükler: Gövde stabilizasyonu, askeri, oswestry, fiziksel dayanıklılık, titreşim, bel ağrısı

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Address for Correspondence / Yazışma Adresi: Özge Çınar Medeni, Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation. Emniyet Mah. Muammer Yaşar Bostancı Cad. No:16 Beşevler, Fax:+90(312)2162636 Ankara, Turkey, E-mail:ozgecinar@gmail.com

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INTRODUCTION

Helicopter pilots are exposed to the whole body vibration (WBV) in their working environment. The WBV has been associated with a low back pain (LBP) and helicopter pilots show a high prevalence of LBP when compared with other professions (1). Vibration-created forces, an inadequate seat shock-absorption system and improper sitting postures seem to be the occupational factors lying at the origin of the LBP in helicopter pilots (2, 3). Cyclic compressive forces might increase the load on the spine of the pilots, leading to the LBP (3). Vibration affects the diffusion between intervertebral discs and consequently leads to a disc degeneration; and, the vascular structure might lead to a vascular damage within the spine (4, 5). Also some mechanical disadvantages accompany the vibration-created forces. The improper sitting posture, forward flexion of the lumbar and thoracic spine and unsupported upper extremities create a physical demand on the lumbar spine. This increases compressive forces on L3, L4 and L5 (2). To cope with these spinal extensors become highly needed in a mechanically disadvantaged posture (2), and fatigue of the involved muscles is related to the low back pain (6). Because of these occupational factors increased total flying hours result in the increased LBP in this population (1).

The core stability is a popular method to prevent and treat LBP. It depends on muscle endurance, strength and neuromuscular control. Muscle endurance parameters were found to be predicting LBP in general population (7). The occurrence of low back pain leads to the alteration in the function of transverses abdominus and multifidus muscles which are responsible for the stability of the core region. In a healthy state, transverses abdominus is activated before the major mover muscles, decreasing the segmental movements in spine as a protective mechanism (8). In the occurrence of pain, it induces muscle activation and this sequentially causes pain. Due to pain, muscle firing mechanisms were seen to be changed in both static and dynamic postures (9). These changed muscular activities might have a potential to affect the low back muscle's endurance and low back stability. It was stated that static back muscle endurance is a strong predictor of LBP, and that decreased endurance is related to pain (7). Other researchers showed prone and supine isometric chest raise tests, Sorenson test, prone and supine isometric double leg raise tests all to be a predictor of LBP (10). In addition to occupational factors, aging, increased body mass index (BMI), smoking habit and regular physical exercise practice were found to be correlated with the low back pain (11-13). However these studies were done in general population, which is generally not exposed to vibration-created forces unlike helicopter pilots.

The aim of this study is to investigate the effect of age, BMI, total flying hours, smoking habit, regular physical activity and the core endurance on the LBP, and to determine the predictors of LBP in helicopter pilots.

METHODS

Setting and participants: In a military research center, volunteers were determined, and those who were eligible for the study were selected. Twenty-one volunteering military helicopter pilots from the Turkish Armed Forces were included. Inclusion criteria were being 18-45 years old and not having any musculoskeletal injury. Pilots with any neurologic rheumatologic disease and musculoskeletal injury were excluded from the study. Each subject provided a written informed consent before participating and the study was approved by the military service. Demographic information, body mass index (BMI) and total flying hours were recorded. Smoking habit was coded as "yes" or "no". Regular sports participation (at least 3 times per week) was also coded as "yes" or "no". The low back disability was evaluated with the Oswestry low back disability questionnaire (14). The core muscle endurance of pilots was also assessed.

Interventions

To assess the posterior core muscle's endurance, the prone-bridge test was used (15). In the prone position, subjects propped on elbows, placed shoulder-width apart, and arms were set perpendicular to the body. The feet were set with a narrow base, and then the subject raised the pelvis from floor. The shoulders, hips and ankles were required to be in a straight line and the time over which the patient could maintain this position was recorded (10).

The lateral core endurance was evaluated with the side-bridge test. In a side-lying position, subjects propped on their dominant extremity's elbow. The top foot was placed in front of the subjacent foot for support. Subjects were instructed to raise the hips and the body and to maintain a straight line over their body length. The uninvolved arm was crossed on the chest. The time during which the patient could maintain this position was recorded (16).

The back extensor endurance was assessed with the Sorenson test. Subjects were placed on the treatment table in the prone position. The upper edge of the iliac crests was aligned with the edge of the table. The lower body was fixed to the table by straps. With the arms crossed on the chest, the subjects were required to maintain the upper body in a horizontal position. The time during which the patient could maintain this position was recorded (10).

The flexor endurance was evaluated with the supine isometric chest raise test. In the supine position, the knees and hips were flexed 90 degrees with the hands crossed on the chest. The subjects were asked to lift the neck and the upper body and to stay in this position. The time over which the patient could maintain this position was recorded (10).

Statistical analysis

Statistical analysis were done using SPSS software version 15. The relationship between the Oswestry low back disability questionnaire score one on hand, and age, BMI, total flying hours, smoking status, regular sports participation and core endurance tests, on the other, was analyzed with the Spearman's Correlation coefficient. A multiple linear regression model was used to identify the independent predictors of the Oswestry score. Dependent variable was the Oswestry score, and the independent variables were age, body mass index, smoking status, regular sports participation, total flying hours, the prone-bridge, the side-bridge, the Sorenson and the supine isometric chest raise test scores. The model fit was assessed using appropriate residual and goodness-of-fit statistics. A backward analysis method was preferred. A 5 % type-1 error level was used to infer the statistical significance.

RESULTS

Demographic information is given in Table 1. Ten pilots (47.60 %) reported having a smoking habit. Nine pilots (42.85 %) reported that they did regular physical exercises at least three times a week. All participants completed the whole tests, and there was no missing data. Absolute values of the Oswestry low back disability questionnaire score, total flying hours and the core endurance test scores are given in Table 2. The low back disability was correlated with age and total flying hours (r=0.55, p=0.015; r=0.53, p=0.01) (Table 3). Based on the results of the regression analysis, age, total flying hours, smoking status, regular sports participation, the side bridge test score and the prone bridge test score were identified as the predictors of the Oswestry score (R^2=0.54, p<0.05) (Table 4).

Table 1: Demographic information of pilots.

	Mean±SD	Minimum	Maximum
Age (years)	29.09±6.52	22	43
Height (cm)	177.88±5.40	170.00	184.00
Body weight (kg)	78.11±7.18	67	92
Body mass index (kg/m^2)	24.52±1.69	22.69	27.68

Table 2: Descriptive statistics of subjects.

	Mean±SD
Oswestry score	4.62±6.10
Total flying-hour (hours)	1499.62±1698.01
Prone bridge (sec.)	109.63±41.13
Side bridge (sec.)	67.64±27.65
Extensor endurance (sec.)	110.73±27.52
Flexor endurance (sec.)	79.84±44.47

Table 3: The correlation of Oswestry disability index with other parameters.

	Spearman's rho	p
Age	0.55	**0.015***
BMI	0.11	0.62
Total flying-hour	0.53	**0.016***
Smoking status	0.27	0.26
Regular sports participation	-0.009	0.97
Prone bridge	-0.40	0.08
Side bridge	-0.24	0.30
Extensor endurance	-0.23	0.32
Flexor endurance	-0.23	0.34

*Correlation is significant at the 0.05 level (p<0.05).

DISCUSSION

This study aimed to establish a relationship between the LBP on one hand, and age, BMI, total flying hours, smoking status, regular sports participation and the core muscle endurance, on the other, and to determine the predictors of the LBP in helicopter pilots. The results of this study supported the findings of the previous literature (1, 6, 12) about the relationship between the LBP on one hand, and age and total flying hours, on the <other. The results also showed that smoking, regular sports participation and back muscle endurance were the predictors of LBP in military helicopter pilots.

It is known that vibration-created forces on muscle and tendon tissues result in altered proprioception, and lead to kinesthetic illusions (17).

Table 4. The results of the regression analysis of Oswestry score.

	B	SE	β	T	p	
Constant	-59.99	29.96		-1.96	0.08	
Age	2.99	1.39	2.72	2.14	0.06	
Total-flying hours	-0.01	0.007	-2.63	-1.85	0.10	**R^2=0.54 F=3.73 p=0.04**
Regular sports participation	6.39	2.60	0.533	2.45	0.03	
Smoking status	4.67	3.51	0.39	1.33	0.21	
Prone bridge test	-0.12	0.04	-0.93	-2.91	0.01	
Side bridge test	-0.11	0.08	-0.39	-1.32	0.22	

B=Regression coefficient
SE=Standard error
β =Corrected correlation coefficient

Additionally, an increased reflex response was seen after the exposure to vibration. The whole-body vibration alters the kinesthetic sense of the trunk and increases position-sense error ratio, as well as affecting the dynamic trunk stability. These alterations remain for a while after the exposure to vibration and are thought to be correlated with LBP in helicopter pilots (18). Total flying hours represent the duration of exposure to vibration-created forces in the helicopter and the duration of the improper sitting posture. As a result, the increased total flying hours increase the LBP, and the relationship of the LBP with the total flying hours was consistent with the results of the previous literature (1, 6).

BMI has a strong relationship with the LBP in the general population, because the increased physical load on spinal anatomic structures causes degenerative changes (11). However, in helicopter pilots no relationship was found between these two parameters (19), a finding that was in line with the results of our study. In studies which were done with the general population, subjects' BMI distribution had a wide range, and mostly obese individuals were included (11). However, in the current study, helicopter pilots' BMI was (mean±SD) 24.52±1.69, a measure that had a narrow range, and pilots were not obese. Therefore, the obtained results were not unexpected.

The effect of smoking habit and regular sports participation on LBP was not investigated to date in helicopter pilots. Some studies in general population showed that these parameters are correlated with LBP (12, 13). Our results supported the findings of these studies, and pointed out that LBP in helicopter pilots was not only work-related. An alteration of lifestyle can be recommended to helicopter pilots to relieve their LBP.

An awkward posture is responsible for the development of musculoskeletal disorders (20). Sitting posture in helicopter includes not only trunk flexion but also, asymmetric postures such as bending and twisting (21). The combination of flexion, bending and twisting is more deleterious than only flexion (22). Because of the effect of vibration on dynamic stability and awkward sitting posture, core endurance might be important in this population. Our results showed that the prone bridge score, representing the activity of anterior core muscles (15), and the side bridge score representing the activity of quadratus lumborum muscle (23), were predictors of LBP in helicopter pilots. In general population back extensor muscle endurance, prone and supine bridge scores were found to be correlated with LBP (7, 10, 24). Due to flexed and asymmetrical posture of the trunk in helicopter (21), the endurance of the anterior and lateral core muscles might be affected and this might explain why the side bridge and prone bridge scores are the predictors of LBP in helicopter pilots.

In another study the fatigue of erector spinae muscles were correlated with the duration of flight and total flying hours. That study also concluded that LBP could result from the back extensor muscle fatigue (6). However anterior and lateral core muscles were not analyzed in that study. Thus, our results do not necessarily contradict its findings.

The present study contributes to the literature by establishing a relationship between the LBP on one hand, and lifestyle and the core endurance, on the other, in helicopter pilots. Future studies should focus on the effect of different exercise programs on the LBP in helicopter pilots.

In this study only the core endurance was evaluated in relation to LBP as a physical assessment. A detailed evaluation of low back region was not carried out. It should be another research area for further studies. Other limitations were that pilots who were assessed in this study were young and the number of pilots was low. So, the generalizability of these results to the whole pilot population is uncertain. However, important findings emerging from this study might provide guidance for future studies that may use a greater number of subjects.

CONCLUSION

Based on this study's results, it can be concluded that to cope with the detrimental effects of flight, an alteration of lifestyle and the endurance training of core muscles should be recommended to helicopter pilots. Although it would be very useful, it may not be possible to decrease flying hours. Additionally, an assessment of core endurance might be used as a screening test for the LBP in helicopter pilots.

Conflict of Interest
No conflict of interest was declared by the authors.

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