





PREVALENCE OF THORACIC OUTLET SYNDROME IN WORKERS AND PLAYERS OF FAISALABAD

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ABSTRACT

Background of the Study: A neurovascular compression that causes pain and tingling sensation in arms either unilateral or bilateral and aggravates with overhead activities is termed as thoracic outlet syndrome. Symptoms includes discomfort, pain, heaviness and thoracic nerve impingement. It is a form of group of disorders that affects bony, muscular and even fibrous structures. If left untreated TOS can result in devastating functional and structural abnormalities.

Methodology: It was a cross sectional observational study. A sample of 195 players and workers was taken from public sector organizations of Faisalabad. Inclusion criteria consisted of participants with 20 years of age or older. Gender was specified to be male only. Players who were actively participating in any sports were included. Laboring staff that were involved in overhead activities were included.

Convenience sampling technique was used. Subjects with previously diagnosed traumatic injury and surgery were excluded. Adson maneuver and DASH questionnaire was utilized as data collection procedure.

Results: Data was analyzed using SPSS version 21. Independent t test was applied to record prevalence of thoracic outlet syndrome. P-value 0.0001 demonstrates statistically significant prevalence in players and workers. An overall of 59% prevalence was recorded in both workers and players.

Conclusions: It is concluded that thoracic outlet syndrome is highly prevalent in both workers and players. Comparison between both populations demonstrates slightly high prevalence in players by 51.8%, as those for workers to be 48.2. It is frequent within age groups of 20-30 in players and 30-50 years in workers.

Keywords: *DASH, thoracic, adson, impingement, prevalence, syndrome.*

Introduction

Peet at el first coined the term thoracic outlet syndrome in 1956, according to him compression of neurovascular structures at the thoracic outlet makes up for this syndrome. Structures susceptible to compression are brachial plexus, subclavian vein and subclavian artery¹ and Subclavian and axillary vein compression leads to venous thoracic outlet. Compression of subclavian artery results in dilation of arteries causing aneurysms and induction of non-radicular

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pain, numbness, coolness and pallor that worse in cold environment². This is a rare pathology is called arteria thoracic outlet syndrome. Neurogenic is the most common category of thoracic outlet, the word neurogenic itself suggests involvement of nerves. Brachial plexus compression at the level of thoracic outlet makes up for it³. Ninety five percent of individuals suffer from neurogenic thoracic outlet surgery, scar tissue and adhesion formation can lead to trauma and chronic repetitive injury and furthermore can cause direct impingement of nerves and vessels. Venous thoracic outlet comprises of 3-5 percent of patients. These patients suffer from thrombosis due to excessive compression of subclavian vein. Thrombosis may be obstructive or occlusive. Vein becomes inflamed, swollen and scarred. Arterial TOS is the rarest of all syndromes accounting for only 1-2 percent of individuals. Pulsation and continuous friction of subclavian artery can cause fibrosis and stenosis. There is purple red discoloration of effected extremity². There is a large variety of symptoms that thoracic outlet syndrome comprises; tingling down the arm, numbness, temperature and color changes, tourniquet like feeling in the arm, few days of soreness, prominent veins that doubts for deep venous thrombosis⁴. In thoracic outlet syndrome, laxity of ligaments has a great impact on the stability of shoulder. The laxity characteristic of ligaments provides with hypermobility that allows movement outside the end range of shoulder⁵. Protraction of scapula, anterior shifting of shoulder with 90 degree of abduction and flexion and head in a flexed position are characteristics of individuals with thoracic outlet syndrome⁶. The most frequent risk factors of TOS are functional acquired causes consisting of muscle imbalance of shoulder and neck, and dysfunction of upper limb musculature⁷. Associated factors responsible for functionally acquired causes are due to overuse of limb, altered physical and mental health and psychosocial factors in unfavorable conditions. Other causes may include DVT, osteomyelitis, hyperostosis, certain anatomical defects, poor posture, pressure on joints and age. Females are more likely to be effected by thoracic outlet than males⁸. Workplace factors and stressors have a great impact on thoracic outlet of person especially the dynamic factors. There are varieties of jobs in which there are postural constraints and repetitive movements involving elevation of arm overhead by carrying heavy loads on shoulder and overstretching of arms that contribute to the factors responsible for thoracic outlet syndrome⁹. Industrial workers, cashiers, forestry workers, switchboard operators, porters, farmers and laborers suffers from prolonged cervical flexion, retropulsion of shoulders, heavy load bearing and excessive use of upper limb musculature, due to which there can be imbalance of peripheral nervous system and muscles¹⁰. Therefore thoracic outlet is associated with work related musculoskeletal disorders (WRMSD). Thus also known as occupational syndrome. Symptoms relevant to workplace TOS comprises of paresthesia, pain of the upper limb and postural abnormalities⁸. Surgical management involves proper diagnosis and evaluation of symptoms of individual's condition. Preoperative management should include exclusion of peripheral and cervical neuropathies. Scalene injection, decompression and first rib resection with scalenectomy are major surgical options¹¹. Peet suggested some interventions that consisted of specific exercise program to correct the disturbances leading to disability of upper limb musculature. Stretching of pectoralis, strengthening of levator scapulae muscle, moist heat, massage and correction of posture were few of the intervention therapies¹². In order to understand the mechanism of correct diaphragmatic breathing, respiratory education was suggested. More emphasis is on relaxation of shortened muscles because they are involved in generating force. Re positioning of joints, coordination exercises, muscular balance and ergonomics instruction in ADL's are also considered in treating this syndrome¹³. Manual therapy and osteopathic techniques, a specific exercise program and application of electrical modalities, chiropractic manipulations and modifications in work environment and work stressors has a positive impact in improvement of TOS symptoms¹⁴. CJ Demaree and K Wang in 2017 conducted a study which suggests that Thoracic outlet syndrome effecting high performance musicians playing string instruments. Upper extremities involved in strenuous and excessive repetitions of same activities lead towards compression of neurovascular structure in shoulder region causing compression of thoracic nerve. A case series was reported which consisted of five elite musicians, three violinists and two violist¹⁵. Due to years of intense

practice, chronic repetitive activity of upper limb musculature and lack of rest during work spells, upper shoulder region suffered a neurovascular compression and development of neurogenic thoracic outlet syndrome. Patients were able to resume their respective careers after diagnosis and awareness of thoracic outlet syndrome¹⁶. M Nagoshi, T Ishihama in 2017 Investigated of degree of thoracic outlet syndrome in throwing injuries. The study aimed in evaluating the existence degree of thoracic outlet in players with throwing injuries. Four hundred and twenty patients were enrolled in data collection which comprised of twenty three women with average age of 17 years and three hundred and eight seven men. Previously subjects were suffering from elbow or shoulder injuries. Data collection comprised if sixty three university students, 21 adults and players from one hundred and two elementary schools. Power of anterior elevation and sulcus sign between TOS and non-thoracic outlet syndrome groups were calculated were calculated. Prevalence of 48.1 percent was seen in throwing injury. Half of all cases presented with thoracic outlet symptoms. 83 percent subjects witnessed muscle weakness in thoracic outlet pathology¹⁷.

Methodology

A comparative cross sectional survey was done in public sector organizations and laboring staff of Faisalabad: Government college university Faisalabad, Agricultural university Faisalabad, Government community college Faisalabad, Clock Tower Faisalabad, Nawab Carpets Susan Road Faisalabad, Smarts Gym, Canal road Kashmir bridge Faisalabad and Arham enterprises after approval by College of physical therapy, GC University Faisalabad. A Sample of 195 players and labors was taken by convenience sampling from population of 20,000 from different setups mentioned above. Sample size was calculated using RAOSOFT calculator and following formula; $E = \text{Sqrt} [(N - n) \times n / (N-1)]$. The inclusion criteria for study was set as it was obligatory for participants to be 20 years of age or older and Gender was specified to be male only. Customary for players to be engaged in regular athletic happenings like cricket, hockey, badminton, weightlifting, guitarists and baseball in which there is a recurring consumption of shoulder girdle movement and rotation. Labors involved were loaders, sweepers, transporters and construction staff as well as work which required similar actions and activities with elevation of arms over head. People with age less than 20 years were excluded. Females were disqualified because of their less participation in sports and scarce share in laboring staff. Subjects with previously diagnosed traumatic injury and surgery were also left out for the sake of expanding the opportunity for participants who were unaware and undiagnosed. The participation of players in mostly indoor games was also omitted.

Data collection procedure

The study was comparative cross-sectional study, comparing two groups in more than one geographical location. Sample size was 195 calculated through RAOSOFT calculator by adding response rate as 85 percent and confidence interval 95 percent. 5 percent error was taken into consideration. Inclusion criteria met with only males above age of 20 years. Two age groups were defined 20 to 30 and 30 to 50. Females were omitted from inclusion criteria. Convenient sampling technique was used for data collection. A standardized 30 item DASH (disabilities of arm, shoulder and hand) questionnaire was used as a main tool for the assessment and evaluation. The tool comprised of close ended questions for 101 players and 94 workers who were residents of Faisalabad after their approval for participation in research. This questionnaire contains all the considerations and factors associated with thoracic outlet syndrome. Reliability and validity of this questionnaire is 0.94 and 0.73 respectively. At first participants were introduced to consent form. Consent form was attested by participants through their signature and thumb prints. Data comprised of qualitative variables.

Data collection tool

In order to find out the association of players and workers with thoracic outlet pathology, 30-item DASH questionnaire was used. For neurological assessment, Adson test was implemented.

Result

The study was conducted to evaluate the prevalence of thoracic outlet syndrome in weight bearing workers and players of Faisalabad.

Variables	Frequency	Percent%
Age (years)		
20-30	102	52.3%
30-50	93	47.7%
Occupation		
Players	101	51.8%
Workers	94	48.2%
Hand Dominancy		
Right Hand	150	76.9%
Left Hand	50	23.1%
Affected Arm		
Right	143	73.3%
Left	52	26.7%

Table 01: Demographics of Participants

Total 195 subjects took part in the research study. All subjects filled out DASH questionnaire and Adson maneuver was performed in all subjects. SPSS version 22 was used for the analysis of data. P value 0.000 states statistically significant result supporting alternative hypothesis. Table 1 shows demographics of participants that is, age, occupation, hand dominancy, adson maneuver and affected arm.

Adson test	Frequency	Percent
Positive	115	59%
Negative	80	41%

Table 02: Adson test

Table 2 showed selected variables from DASH questionnaire and their frequency in selected populations.

Variables	Frequency	Percentage %
Write		
No Difficulty	103	52.8%
Mild Difficulty	39	20%
Moderate Difficulty	28	14.4%
Severe Difficulty	16	8.2%
Unable	9	4.6%
Place an object on a shelf above head		
No Difficulty	26	17.4%
Mild Difficulty	24	13.8%
Moderate Difficulty	47	23.1%
Severe Difficulty	79	33.3%
Unable	19	12.3%
Put on a Pullover Sweater		
No Difficulty	24	12.3%
Mild Difficulty	27	13.8%
Moderate Difficulty	35	17.9%
Severe Difficulty	57	29.2%
Unable	52	26.7%
Recreational Activities which Require Some Force		
No Difficulty	38	19.5%
Mild Difficulty	51	26.2%
Moderate Difficulty	43	22.1%
Severe Difficulty	54	27.7%
Unable	9	4.6%
Recreational Activities which you Move Your Arm Freely		
No Difficulty	41	21%
Mild Difficulty	36	18.5%
Moderate Difficulty	54	27.7%
Severe Difficulty	56	28.7%
Unable	8	4.1%
In the Last week, rate the severity of arm, shoulder or Hand Pain		
No Difficulty	16	8.2%
Mild Difficulty	53	27.2%
Moderate Difficulty	55	28.2%
Severe Difficulty	53	27.2%
Unable	18	9.2%
In the Last week, rate the severity of weakness arm, shoulder or Hand		
No Difficulty	6	3.1%
Mild Difficulty	36	18.5%
Moderate Difficulty	32	16.4%
Severe Difficulty	66	33.8%
Unable	55	28.2%

Table 02: DASH Questionnaire

Discussion

Thoracic outlet syndrome is very miscellaneous set of disorders attributed by compression of any of the neurovascular structures passing through the chest. In this study, there is a notified information regarding TOS being prevalent in players and workers with high significance that is a notion to be taken seriously. Comparison of prevalence of thoracic outlet syndrome between players and workers concludes that athletes with overhead abduction activities and repetitive throwing injuries are more susceptible to the pathology than workers with excessive weight

bearing. Current study demonstrates that prevalence of thoracic outlet syndrome in players within age of 20-30 years is more than those within age of 30-50 years whereas this is opposite in case of workers. Workers presented with illness more frequently within age group of 30-50. The phases of throwing and constant carrying of loads encompasses extreme pressure causing severe retraction of scapula and abducted position of upper extremity, this enhanced posture causes compaction of neurovascular structures resulting in dysfunction of neuronal components. The study of Otoshi highlighted the prevalence by 32.8 percent among 422 subjects which was thrice more than in workers. 31.3 percent subjects presented with symptoms of heaviness and 30 percent presented with symptoms of paresthesia⁹. Our study showed 51.8 and 48.2 percent prevalence in players and workers respectively with 56 subjects reporting 28.7 percent symptoms of tingling and 33.8 percent weakness in shoulder, arm and hand. Otoshi study consisted of EAST neurological test for confirmation of thoracic outlet syndrome and 78.3 percent subjects reported with positive test. Whereas in this study ADSON maneuver was conducted that includes diminishing radial pulse in desired position. Out of 195 total participants, 115 subjects presented with positive test with frequency of 59 percent. According to study conducted in South Korean company 9 percent incidence was recorded in workers engaged in heavy chores. Force of work, time and age were taken as independent variable and arm was dependent variable. Visual analogue scale showed multiple regression for these variables to be statistically significant with p value < 0.001¹⁸. In current study, Dominant hand, age was taken to be independent variable whereas affected arm was dependent variable. P value was 0.000 stating high significance. The most common complaints among laboring staff were stiffness of upper extremity, inability to wash one's back, tingling sensations, and difficulty lifting heavy objects with frequency of 77.9, 59, 28.7 and 82 respectively. These symptoms are highly responsible for high risk of thoracic outlet syndrome than in those who are not exposed to them. Investigation led us to conclusion that occupation with excessive use of arm overhead, repeated action of shoulders, outstretched arms, vibratory tools usage and lifting elbow above torso are vulnerable to the risk of thoracic outlet pathology. All 195 subjects showed at least one of the listed activities. The types of sports presented in our study like cricket, hockey, badminton, weightlifting and laboring staff like loaders, sweepers and transporters had a common occurrence of repetitive arm motion, shoulder pulling and micro trauma along with inflammation. These were reliable with those elaborated in literature. Thoracic outlet disease is more prevalent in women than in males with ratio of 4:1. Usually age between 20 to 40 years are more prone to it than mid age. Rarity is found in children because of less responsibility and no tension for daily living expenses. In accordance with literature 90-95 percent occurrence is of neurogenic thoracic outlet pathology. Inclusion criteria consisted of males only because in literature maximally researches were conducted on females. Also due to less exposure of females to athletic and laboring activities, they were ruled out from study¹⁹. In the previous studies 13.5 percent vascular response and 2 percent neurological response of adson maneuver was present among participants. Current study generates 59 percent adson maneuver among subjects²⁰. Level of severity in performing recreational activities and common household chores were also determined to assess and examine the subjects thoroughly. Epidemiological reconnaissance of upper extremity from year 2002-2003 concluded that work related musculoskeletal disorders were frequent in working population with frequency of 13 percent facing one of musculoskeletal disorders every year 50 percent of 2685 subjects reported various MSDs within surveillance. Results clarified that age is very important factor for these disorders as they increases with increase in the age. 95 percent men were prone to these MSD. Women reported 89 percent frequency less than the age of 50 years²¹. In our current study workers showed more prone to thoracic outlet syndrome with increasing age. 68 subjects out of 195 were listed with age group 30-50 and exhibited 34.9 percent frequency. This cross sectional study aims to illuminate that whether the hypothesis under study will have excess of significance or group under study will have superfluous predominance. Mostly the occupation exposure and relation with disease needs large sample size to detect prevalence. Previously, shoulder neck diseases were investigated in various occupational

groups like assembly workers, banking employees, coalminers and iron production labors. For thoracic outlet syndrome 4.0 odd ratio was determined. As compared to our findings, our study consisted of workers that were involved in transportation of loads, bricks and cement sacks carrying and porters. The prevalence was found to be 48 percent among these workers²² Reviewing literature we got to know various case reports about thoracic outlet syndrome in various athletic activities e.g. elite archer, swimmers, musicians, baseball player, marathon etc. Fragility, cloudy ache, numbness were basic attributes of athletes progressing into thoracic outlet. This is due to constant ABER (abduction and external rotation) posture. This results in compression of brachial plexus ramis²³. Disabilities of arm, shoulder and hand questionnaire (DASH) was taken under consideration for evaluation process of thoracic outlet disease. Mean scores were calculated to find out the severity level of disease. 11 item version of DASH was mostly used. Study of Chandra conducted mean of 40.4 in water polo players, football, volley ball and other athletes²⁴. DASH was founded by American academy and other associations for the measure of disability of upper extremity. It is in high demand specifically in cross sectional and prospective studies. The DASH consists of modules; to measure symptoms in athletes, performing artists and workers who's to require high degree of stress and load. In our study most of the DASH scoring ranges from 40-60 mean. In a study conducted in 2001 by Hsu, four hundred and eighty five population was taken to for findings of WRMSD. In-service discomfort and other primary illnesses were seen in 485 incorporated subjects. A wide-ranging upper body assessment was carried out among all subjects. Average age was seen to be 38.5 years. Almost 2 percent of subjects were those who were affianced in repetitive labor and twenty eight percent were artists of musical group. An overall subjective and objective evaluation was done that covered the degree of sensitivity, laxity, power, ache and disproportions. Tests for neurological assessment like Tinel's test were implemented for the validation of thoracic outlet syndrome. Noteworthy conclusions showed 70 percent prevalence of neurogenic thoracic outlet disease. Conclusions stated that neurogenic thoracic outlet pathology is highly dependable on working posture²⁵.

Limitations & Recommendations

Study has been followed by some limitations. Research was based only on male gender due to less participation of females in sports and infrequent share in weight bearing happenings despite of the fact, literature reviews concluded that females were more prevalent for TOS than males. The main objective of study was to compare the prevalence of thoracic outlet syndrome in players and workers, however there is a need of assessing the risk factors responsible for this disease for proper understanding of the nature of problem. Unawareness of the pathology was also problematic in accumulating the statistics. Self-doubting, insecurity and distrustfulness in players and worker made the research more back-breaking. It is of great importance to know and observe the way one holds one's body and the position of spine, head and joints. Achievement of base of support in sports is necessarily vital factor that comes from correct posture.

Conclusion

It is concluded that thoracic outlet syndrome is highly prevalent in both workers and players. Comparison between both populations demonstrates slightly high prevalence in players by 51.8%, as those for workers to be 48.2%. In association with age groups, chi square findings tell us that TOS is frequent within age groups of 20-30 in players and 30-50 years in workers. The less than 0.05 p value states statistically significant result confirming the alternative hypothesis. To conclude, the pathology is frequently prevalent in both populations with difference in the frequency of age groups.

AUTHORS' CONTRIBUTION:

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Ghazal Hussain, Hafiz Hamid Rashid

Acquisition, Analysis or Interpretation of Data: Hafsa Khan

Manuscript Writing & Approval: Sara Hussain, Ghazal Hussain

All authors acknowledge their accountability for all facets of the research, ensuring that any concerns regarding the accuracy or integrity of the work are duly investigated and resolved.

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References

1. Jones MR, Prabhakar A, Viswanath O, Urits I, Green JB, Kendrick JB, et al. Thoracic outlet syndrome: a comprehensive review of pathophysiology, diagnosis, and treatment. *Pain and therapy*. 2019;8:5-18.
2. Illig KA, Rodriguez-Zoppi E, Bland T, Muftah M, Jospitre E. The incidence of thoracic outlet syndrome. *Annals of Vascular Surgery*. 2021;70:263-72.
3. Dengler NF, Pedro MT, Kretschmer T, Heinen C, Rosahl SK, Antoniadis G. Neurogenic Thoracic Outlet Syndrome: Presentation, Diagnosis, and Treatment. *Deutsches Ärzteblatt International*. 2022;119(43):735
4. Grunebach H, Arnold MW, Lum YW. Thoracic outlet syndrome. *Vascular Medicine*. 2015;20(5):493-5.
5. Henry BM, Vikse J, Sanna B, Tattera D, Gomulska M, Pękala PA, et al. Cervical rib prevalence and its association with thoracic outlet syndrome: a meta-analysis of 141 studies with surgical considerations. *World neurosurgery*. 2018;110:e965-e78.
6. Levine N, Rigby B, editors. *Thoracic Outlet Syndrome: Biomechanical and Exercise Considerations*. Healthcare; 2018: Multidisciplinary Digital Publishing Institute.
7. Al-Redouan A, Benes M, Abbaspour E, Kunc V, Kachlik D. Prevalence and anatomy of the anomalous subclavius posticus muscle and its clinical implications with emphasis in neurogenic thoracic outlet syndrome: Scoping review and meta-analysis. *Annals of Anatomy-Anatomischer Anzeiger*. 2023:152046.
8. Laulan J, Fouquet B, Rodaix C, Jauffret P, Roquelaure Y, Descatha A. Thoracic outlet syndrome: definition, aetiological factors, diagnosis, management and occupational impact. *Journal of occupational rehabilitation*. 2011;21(3):366-73.
9. Otoshi K, Kikuchi S, Kato K, Sato R, Igari T, Kaga T, et al. The prevalence and characteristics of thoracic outlet syndrome in high school baseball players. *Health*. 2017;9(08):1223.
10. DiLosa KL, Humphries MD, editors. *Epidemiology of thoracic outlet syndrome*. *Seminars in Vascular Surgery*; 2021: Elsevier.

11. Weaver M, Lum Y. New diagnostic and treatment modalities for neurogenic thoracic outlet syndrome. *Diagnostics*. 2017;7(2):28.
12. Masocatto NO, Da-Matta T, Prozzo TG, Couto WJ, Porfirio G. Thoracic outlet syndrome: a narrative review. *Revista do Colégio Brasileiro de Cirurgiões*. 2019;46
13. Vanti C, Natalini L, Romeo A, Tosarelli D, Pillastrini P. Conservative treatment of thoracic outlet syndrome. *Eura Medicophys*. 2007;43:55-70.
14. Lo C-nC, Bukry SA, Alsuleman S, Simon JV. Systematic review: The effectiveness of physical treatments on thoracic outlet syndrome in reducing clinical symptoms. *Hong Kong Physiotherapy Journal*. 2011;29(2):53-63
15. Ferrante MA, Ferrante ND. The thoracic outlet syndromes: Part 1. Overview of the thoracic outlet syndromes and review of true neurogenic thoracic outlet syndrome. *Muscle & nerve*. 2017;55(6):782-93
16. Demaree CJ, Wang K, Lin PH. Thoracic outlet syndrome affecting high-performance musicians playing bowed string instruments. *Vascular*. 2017;25(3):329-32.
17. Nagoshi M, Ishihama T, Hirooka T, Hashizume H. Investigation of the degree of thoracic outlet syndrome in throwing injuries. *Journal of Shoulder and Elbow Surgery*. 2017;26(4):e111.
18. Kim S-H, Baek S, Kwon Y-H. Prevalence and Clinical Characteristics of Neurogenic Thoracic Outlet Syndrome in Specific Industrial Field. *Journal of the Korean Society for Surgery of the Hand*. 2016;21(3):113-21.
19. Ramzan A, Ghauri SS, Nguyen T, Athar P, Sheikh K, Evans RW. Thoracic outlet syndrome.
20. Rayan G, Jensen C. Thoracic outlet syndrome: provocative examination maneuvers in a typical population. *Journal of shoulder and elbow surgery*. 1995;4(2):113-7.
21. Roquelaure Y, Ha C, Leclerc A, Touranchet A, Sauteron M, Melchior M, et al. Epidemiologic surveillance of upper-extremity musculoskeletal disorders in the working population. *Arthritis Care & Research: Official Journal of the American College of Rheumatology*. 2006;55(5):765-78.
22. Hagberg M, Wegman D. Prevalence rates and odds ratios of shoulder-neck diseases in different occupational groups. *Occupational and Environmental Medicine*. 1987;44(9):602-10.
23. Park JY, Oh KS, Yoo HY, Lee JG. Case report: thoracic outlet syndrome in an elite archer in full-draw position. *Clinical Orthopaedics and Related Research®*. 2013;471(9):3056-60.
24. Chandra V, Little C, Lee JT. Thoracic outlet syndrome in high-performance athletes. *Journal of vascular surgery*. 2014;60(4):1012-8.

25. Pascarelli EF, Hsu Y-P. Understanding work-related upper extremity disorders: clinical findings in 485 computer users, musicians, and others. *Journal of Occupational Rehabilitation*. 2001;11(1):1-21.

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