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Research

The Interplay Between Shoulder Pain, Upper Limb Function, and Respiratory Capacity in Wheelchair Athletes

Tekerlekli Sandalye Sporcularında Omuz Ağrısı, Üst Ekstremite Fonksiyonu ve Solunum Kapasitesi Arasındaki İlişki

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ABSTRACT

Objective: To examine the relationship between shoulder pain, upper extremity functionality, and respiratory parameters in wheelchair athletes due to repetitive mechanical loading.

Methods: This cross-sectional study included 30 active wheelchair athletes. Shoulder pain was assessed using a pressure algometer. Upper extremity functionality was evaluated with the Quick Disabilities of the Arm, Shoulder and Hand (Quick-DASH) questionnaire, JAMAR hand dynamometer, and Blazepod reaction system. Respiratory function was measured using maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP), and chest expansion.

Results: Significant positive correlations were found between algometry values and grip strength ($p<0.01$), as well as between grip strength and both MIP and MEP ($p<0.001$). A negative correlation was observed between Quick-DASH scores and grip strength ($p<0.01$), indicating that decreased upper extremity function is associated with reduced muscle strength. These findings suggest a close interaction between musculoskeletal pain, upper limb performance, and respiratory muscle strength.

Conclusion: The interplay between shoulder pain, upper limb function, and respiratory parameters highlights the importance of a multidimensional evaluation approach in wheelchair athletes. Addressing these interrelated factors may contribute to more effective training and rehabilitation strategies.

Keywords: Wheelchair sports, musculoskeletal pain, hand grip strength, respiratory function, disability evaluation, athletic performance

ÖZ

Amaç: Tekerlekli sandalye kullanan sporcularda tekrarlayan mekanik yüklenmeye bağlı olarak gelişebilen omuz ağrısı, üst ekstremite fonksiyonu ve solunum parametreleri arasındaki ilişkiyi incelemektir.

Gereç ve Yöntem: Kesitsel tasarımla yürütülen bu çalışmaya 30 aktif tekerlekli sandalye sporcusu dahil edildi. Omuz ağrısı basınç algometresiyle değerlendirildi. Üst ekstremite fonksiyonelliği Kol, Omuz ve El Engellilik Anketi-Kısa Form (QuickDASH), JAMAR el dinamometresi ve Blazepod reaksiyon sistemi ile ölçüldü. Solunum fonksiyonları; maksimum inspiratuvar basınç (MIP), maksimum ekspiratuvar basınç (MEP) ve göğüs çevresi ölçümleriyle değerlendirildi.

Bulgular: Algometre ve kavrama kuvveti arasında anlamlı pozitif korelasyon ($p<0,01$); kavrama kuvveti ile MIP ve MEP arasında ise daha güçlü pozitif korelasyonlar ($p<0,001$) bulundu. Quick-DASH skorları ile kavrama kuvveti arasında anlamlı negatif korelasyon ($p<0,01$) saptandı. Bu durum, üst ekstremite fonksiyonundaki azalmanın kas kuvvetinde düşüşle ilişkili olduğunu göstermektedir.

Sonuç: Tekerlekli sandalye sporcularında ağrı, üst ekstremite fonksiyonu ve solunum parametreleri arasındaki çok boyutlu etkileşim, değerlendirme ve rehabilitasyon süreçlerinde bütüncül bir yaklaşımın gerekliliğini ortaya koymaktadır. Bu alanlardaki ilişkilerin göz önünde bulundurulması, daha etkili sporcu sağlığı ve performans yönetimi açısından önemlidir.

Anahtar Kelimeler: Tekerlekli sandalye sporları, kas-iskelet sistemi ağrısı, el kavrama kuvveti, solunum fonksiyonu, özürlülük değerlendirmesi, atletik performans

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INTRODUCTION

Regular participation in physical activity by individuals who use wheelchairs has positive effects on various multidimensional health parameters, such as maintaining musculoskeletal health, enhancing cardiovascular endurance, supporting psychological well-being, and promoting social integration. Physical activity serves as a key tool in reducing secondary complications and increasing functional independence. Moreover, sport and exercise are not merely recreational pursuits but are considered fundamental components of the multidisciplinary rehabilitation process (1,2).

In this population, the upper extremities play a crucial role in ensuring mobility and facilitating activities of daily living. However, their intensive and repetitive use-especially during activities such as wheelchair propulsion, transfers, reaching, and maintaining balance-leads to mechanical overloading, particularly in the shoulder girdle. This can result in overuse syndromes, tendinopathies, musculoskeletal pain, and ultimately, functional loss and reduced quality of life (3,4). Upper extremity pain has been reported in 30% to 73% of individuals who use wheelchairs, with the shoulder, wrist, and elbow being the most affected regions. Among athletes, such pain disrupts training continuity, decreases performance capacity, and significantly impairs independent living skills (5,6).

Beyond pain, upper extremity functionality comprises not only muscle strength and joint range of motion, but also proprioception, reaction time, grip strength, and effective use in daily activities. Self-report questionnaires such as the Quick Disabilities of the Arm, Shoulder and Hand (Quick-DASH) are widely used to assess disability and functional capacity related to the upper limbs, offering valuable insights for guiding rehabilitation efforts (7,8).

In addition to their role in movement, upper extremity muscles contribute to trunk stabilization and function as accessory respiratory muscles. Key muscle groups—such as the pectoralis major, latissimus dorsi, and serratus anterior—are actively involved in both inspiratory and expiratory phases of respiration. Therefore, reduced upper extremity function may lead to weakened respiratory muscle strength and limited chest expansion. While pain, upper extremity functionality, and respiratory function have often been studied independently in the literature, a combined evaluation of these systems may form the basis of a more comprehensive clinical approach. Simultaneous assessment of these parameters allows for more individualized and balanced rehabilitation goals, while also improving understanding of inter-system interactions. In particular, the dual role of upper extremity muscles in both motor function and ventilation- in whom postural stabilization is compromised-highlights the significance of this relationship (9-12).

Recent studies emphasize that integrating pain, functionality, and respiratory parameters into the assessment process offers considerable advantages in clinical decision-making. Such a multidisciplinary evaluation approach supports more effective and personalized rehabilitation planning by elucidating the complex interactions among physiological systems (13,14).

In this context, a multidisciplinary evaluation approach is suggested, to enhance the clinical decision-making process in wheelchair users. The aim of this study is to identify the relationships between shoulder pain, upper extremity functionality, and respiratory parameters in wheelchair athletes, and to evaluate how these systems interact.

METHODS

Study Design and Participants

This study was conducted between August and October 2024 at the Bağcılar Municipality Disability Center in İstanbul. It was designed as a cross-sectional descriptive study and approval was received from the Bezmialem Vakıf University Non-Interventional Clinical Research Ethics Committee (approval no: 2024/260, date: 10.06.2024). The study was carried out in accordance with the principles of the Declaration of Helsinki and included 30 volunteer wheelchair athletes.

Inclusion criteria were: being between 18 and 50 years of age, using a wheelchair for at least one year, and actively participating in sports activities. Individuals who had undergone upper extremity surgery within the past year or had cognitive or communicative impairments were excluded from the study. Informed consent was obtained from all participants.

Pain Assessment

To evaluate musculoskeletal pain, a Baseline® digital algometer (dolorimeter) (Fabrication Enterprises Inc., New York, USA) was used. Measurements were performed bilaterally at the most sensitive points of the deltoid, biceps, and triceps muscles. The device applied mechanical pressure perpendicularly using a 1 cm^2 metal tip. When the participant first perceived pain, the application was stopped and the value displayed on the screen was recorded in Newtons (N). Three measurements were taken for each region, and the average value was used for analysis (15).

Functionality Assessment

Hand grip strength was measured using a Camry® digital hand dynamometer (Camry Electronic Co. Ltd., Guangdong, China) as an objective performance indicator. Three trials were performed for each hand, and the highest value was used for analysis (Figure 1) (16).

Reaction time was assessed using the Blazepod® system (Blazepod Ltd., Tel Aviv, Israel), a validated and reliable tool that measures motor response time to visual stimuli (Figure 2) (17). Participants completed a 30-second light sensor test, during which their response time to the light stimuli and the number of missed light emitting diode (LED) signals were recorded.

Functionality was also subjectively assessed using the Quick-DASH questionnaire. The Quick-DASH is a valid and reliable short-form tool consisting of 11 items that evaluate functional limitations and symptoms related to the upper extremity (18,19).

Measurement of Respiratory Parameters

Respiratory muscle strength was assessed through maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) measurements. The evaluation was conducted using a portable digital SONMOL respiratory muscle trainer device, in accordance with the guidelines of the American Thoracic Society and the European Respiratory Society (20). A nose clip was applied to each participant, and the test was performed using mouth breathing maneuvers. Among the three best attempts, the highest value was used for analysis.

Chest expansion was measured using a tape measure at the axillary, epigastric, and subcostal levels. The difference between maximum inspiration and expiration was recorded in centimeters. Each measurement was repeated three times, and the average was calculated for analysis (21).

Figure 1. Measurement of hand grip strength

Statistical Analysis

All data were analyzed using IBM SPSS Statistics version 21.0 (Armonk, New York, USA). The normality of continuous variables was assessed using the Shapiro-Wilk test. For variables with a parametric distribution, Pearson correlation analysis was used, while Spearman correlation analysis was applied for non-parametric variables. A significance level of $p<0.05$ was considered statistically significant. A priori power analysis was conducted based on Cohen's classification for a large effect size ($r=0.50$), an alpha level of 0.05, and a statistical power of 80%. The analysis indicated that a minimum of 30 participants would be sufficient for detecting significant correlations (22).

RESULTS

Demographic and Descriptive Data

Among the 30 athletes who participated in the study, 80% (n=24) were male and 20% (n=6) were female, indicating that the majority of participants were men. Regarding educational background, 46.67% (n=14) had completed high school, 20% (n=6) had completed elementary school, 16.67% (n=5) had completed an associate degree, 13.33% (n=4) had completed a bachelor's degree, and only 3.33% (n=1) held a doctoral degree. None of the participants held a master's degree. This distribution shows that the majority of participants had received education at the secondary level.

When categorized by sports disciplines, 33.33% (n=10), of the athletes participated in basketball and arm wrestling, with both groups represented equally. Archery and boccia

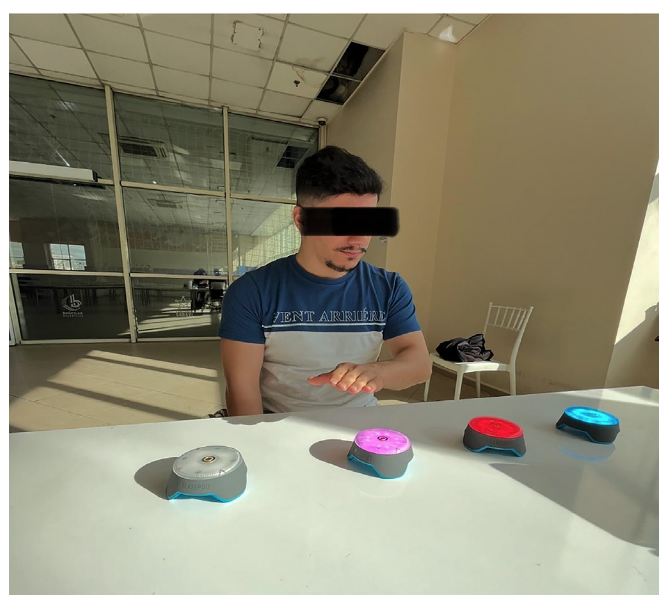

Figure 2. Measurement of reaction time

were each represented by 16.66% (n=5) of the participants. Regarding types of disabilities, 30% (n=9) had paraplegia, 26.67% (n=8) had cerebral palsy (CP), 26.67% (n=8) had spina bifida, 10% (n=3) had post-polio syndrome, and 3.33% (n=1) were an amputee. These results indicate that the majority of athletes in the study had congenital or early-onset neurologically based disabilities. Additional demographic information such as body mass index and duration of disability is presented in Table 1.

Algometer Values

Pain threshold values determined by algometric measurements of the deltoid, biceps, and triceps muscle groups were evaluated separately for the right and left sides among the participating athletes. In the deltoid muscle group, the mean pain threshold was found to be 7.9±2.42 kg/cm² on the right side and 7.8±2.26 kg/cm² on the left. The minimum values were 3.6 and 4.0 kg/cm², and the maximum values were 12.3 and 11.7 kg/cm², respectively. The similarity between the sides suggests no lateralized sensitivity difference in the deltoid muscle.

In the biceps muscle group, the mean pain threshold was 6.8±1.65 kg/cm² on the right and 6.5±1.78 kg/cm² on the left. While the pain threshold values of the right and left biceps were relatively close, the slightly lower average on the left side may indicate greater pain sensitivity in the non-dominant limb for some individuals.

For the triceps muscle group, the mean pain threshold was equal on both sides at 8.5 kg/cm². The standard deviations were ±2.59 on the right and ±2.5 on the left. This symmetrical distribution in the triceps suggests no significant difference in muscle strength or usage intensity between sides.

Upper Extremity Functionality Values

An evaluation of upper extremity functionality measurements among the participating athletes revealed that the mean hand grip strength was 35.1±15.14 kg for the right hand and 33.1±16.54 kg for the left hand. Minimum and maximum values ranged from 10 to 62.9 kg for the right hand and from 9 to 59.3 kg for the left hand.

Regarding reaction time data, participants extinguished an average of 32.8±10.75 LEDs with the right extremity (with a mean response time of 639.5±168.62 ms) and missed an average of 2.1±3.41 LEDs. With the left extremity, they extinguished an average of 33.7±9.77 LEDs, had an average response time of 635.3±136.61 ms, and missed 1.6±3.44 LEDs.

The average score obtained from the Quick-DASH questionnaire, which was used to assess functional status of the upper extremity, was 23.5±16.38. This average score indicates a low-to-moderate level of functional impairment. The high standard deviation suggests a wide variation in upper extremity functionality among participants, which may be influenced by differences in disability type and the nature of the sports disciplines practiced.

Respiratory Parameters

An analysis of the respiratory parameters of the participating athletes revealed that the mean MIP was 73.15±32.38 cmH_2O. This value falls within the reference range of 60-100 cmH_2O reported in the literature, suggesting that inspiratory muscle strength was generally within physiological limits. However, the minimum value was as low as 23.6 cmH_2O, indicating possible inspiratory muscle weakness in some individuals.

In contrast, the mean MEP was calculated as 58.4±26.42 cmH_2O. Since this average falls below the clinical threshold of 80 cmH_2O, it suggests insufficient expiratory muscle strength. The wide distribution range (17.3-141 cmH_2O) reveals notable inter-individual differences among participants. This finding is particularly important

Table 1. Descriptive statistics of athletes' demographic characteristics

	n		Min.	Max.	Mean±SD
Age (years)	30		18	49	31.2±9.69
Body weight (kg)	30		48	110	71.2±16.26
Height (cm)	30		132	189	168±12.44
BMI (kg/m²)	30		16.9	41.6	25.3±5.58
Years of athletic participation	30		1	23	7.3±6.22
Duration of disability (years)	30		6	47	22.3±10.21
Biceps circumference (cm)	30	Right Left	22 22	48 44	32.2±5.42 31.8±5.26
Forearm circumference (cm)	30	Right Left	21 20	35 36	27.5±3.41 26.9±3.67
Weekly training duration (hours)	30		10	20	15.3±4.79

Max.: Maximum, Min.: Minimum, n: Number of participants, SD: Standard deviation, BMI: Body mass index in the context of weakened muscles responsible for trunk stabilization and effective coughing.

Thoracic mobility was assessed at the axillary, epigastric, and subcostal levels. The mean axillary expansion was 4.95±1.99 cm, slightly below the reference value (≥5 cm), but still close to the normal range. The mean epigastric expansion was measured at 4.33±1.87 cm, indicating abnormal thoracic mobility based on the <5 cm criterion. The mean subcostal expansion was 3.88±2.09 cm. This measurement not only falls within the abnormal range but also approaches the pathological threshold of 2.5 cm in some individuals.

Relationship Between Algometer, Upper Extremity Functional Parameters, and Respiratory Parameters

When examining the correlation between pain threshold values measured with the algometer and grip strength, significant positive correlations were observed across all muscle groups (p<0.01). Notably, a strong correlation was found between right deltoid (r=0.655, p<0.001) and right-hand grip strength, and between right biceps (r=0.647, p<0.001) and right-hand grip strength. Similarly, strong correlations were observed between left deltoid (r=0.601, p<0.001), left biceps (r=0.618, p<0.001), and left-hand grip strength. Although correlations in the triceps muscle groups were also significant (right triceps: r=0.527, left triceps: r=0.500), the correlation strength was slightly lower compared to the biceps and deltoid muscles (Table 2).

The correlation analyses revealed generally weak and statistically non-significant relationships between algometer-measured pain thresholds and reaction time or accuracy parameters (p>0.05), suggesting no strong direct association between pain perception and visual-motor responses. However, a statistically significant negative correlation was found specifically between the right biceps and the number of missed LEDs (r=-0.369, p=0.045).

Regarding the relationship between algometer values and Quick-DASH scores, all values showed significant correlations (p<0.05) except for the right triceps (p>0.05). Detailed results are presented in Table 3.

No significant correlations were observed between algometer parameters and respiratory muscle strength (p>0.05). Strong and significant positive correlations were found between both the right- and left-hand grip strength and MIP (r=0.678 and r=0.660, p<0.001) and MEP (r=0.562 and r=0.592, p=0.001).

Regarding Blazepod reaction time performance, moderate and significant negative correlations were found between MIP and MEP, and parameters such as right and left response time, and the number of missed LEDs. For example, right-side response time correlated with MIP (r=-0.593, p=0.001) and MEP (r=-0.639, p=0.000). These findings suggest that as respiratory muscle strength increases, reflexive response times and error rates decrease.

Finally, when analyzing correlations with chest expansion measurements (axillary, epigastric, and subcostal), a significant positive relationship was found particularly between subcostal expansion and right-hand grip strength (r=0.421, p=0.021) and left-hand grip strength (r=0.579, p=0.001). This suggests that trunk mobility may be associated with upper extremity strength.

DISCUSSION

In this study, the relationships between shoulder pain, upper extremity functionality, and respiratory parameters were comprehensively evaluated in wheelchair athletes. The findings revealed significant positive correlations between pain threshold and hand grip strength. This suggests that as muscle pain sensitivity decreases, grip strength increases; in other words, individuals who experience less pain may be able to utilize their motor functions more effectively (23,24). The negative correlation observed between Quick-DASH scores and pain threshold indicates that as subjective functional capacity decreases, pain sensitivity increases. This finding suggests that functional limitations in the upper extremity may be directly associated with pain. One of the most noteworthy findings of the study is the relationship established between respiratory muscle

Table 2. Relationship between algometry and grip strength

	Grip strength (right) (r, p)	Grip strength (left) (r, p)
Deltoid (right)	0.655, <0.001	0.641, <0.001
Deltoid (left)	0.621, <0.001	0.601, <0.001
Biceps (right)	0.647, <0.001	0.704, <0.001
Biceps (left)	0.612, <0.001	0.618, <0.001
Triceps (right)	0.527, 0.003	0.533, 0.002
Triceps (left)	0.500, 0.005	0.498, 0.005

p: Statistical significance value, r: Pearson correlation coefficient

Table 3. Relationship between algometry and quick DASH scores

	Quick DASH (r, p)
Deltoid (right)	-0.392, 0.032
Deltoid (left)	-0.472, 0.008
Biceps (right)	-0.482, 0.007
Biceps (left)	-0.477, 0.008
Triceps (right)	0.318, 0.087
Triceps (left)	-0.365, 0.047

p: Statistical significance value, r: Pearson correlation coefficient, DASH: Disabilities of the Arm, Shoulder and Hand strength and upper extremity functionality. Significant and strong positive correlations were found between hand grip strength and both MIP and MEP. This supports the idea that upper extremity muscles play an active role not only in motor function but also in inspiratory and expiratory processes. In particular, the involvement of muscles such as the pectoralis major and latissimus dorsi in both grip strength and ventilatory function highlights the importance of a holistic, system-based approach to assessment.

Yalçın (25) reported that physical fitness parameters and sport-specific skills of the upper extremity differ among athletes with varying classification scores. In this context, the influence of disability types on classification scores in our study may be an important factor in explaining the variations observed in parameters such as motor skills and respiratory muscle strength (25). In a comparative study by Başar et al. (26), it was reported that individuals with CP demonstrated lower scores in muscle strength and anaerobic power compared to other groups. Considering the 26.7% prevalence of CP among participants in our study, this condition should be regarded as an important variable when interpreting findings related to upper extremity muscle strength and functionality. Additionally, Cömert et al. (27) in their study on the evaluation of upper extremity functions in wheelchair basketball players reported limitations in parameters such as grip strength, coordination, and range of motion in individuals with neurological disabilities such as CP and post-polio syndrome. These findings may directly influence our clinical outcomes, since these groups were represented by a substantial proportion—36.7%—in our study.

The respiratory parameter findings in our study are consistent with those reported by Pereira et al. (28), who stated that upper extremity muscles actively function as accessory respiratory muscles during inspiration and may be directly associated with respiratory function. At the same time, lower pain sensitivity in these muscles (i.e., higher pain thresholds) may contribute to more effective functional endurance and ventilatory support. Our findings are consistent with the literature emphasizing the dual role of shoulder girdle muscles in both motor performance and respiratory capacity. For instance, Curtis et al. (29) and Finley et al. (30) highlighted the limiting effects of shoulder pain on functional capacity, noting that muscle fatigue and pain in the deltoid and triceps muscle groups negatively impact wheelchair maneuverability and postural stability. The fact that these muscles also serve as accessory respiratory muscles suggests that increased pain levels may indirectly limit ventilatory performance. Although no significant relationship was found for the triceps muscle in our study (e.g., left triceps and MEP: p=0.555), this may indicate that the triceps muscle contributes less to both sensory and ventilatory functions compared to other muscle groups. The limited correlations observed between muscle pain thresholds and respiratory function suggest that this relationship is likely indirect and subject to individual variability. Samuelsson et al. (31) and Gironda et al. (32) reported that shoulder pain and upper extremity muscle dysfunction can restrict both daily living activities and functional capacity in individuals with spinal cord injury; and that upper extremity muscle dysfunction may also interact with ventilatory function.

In our study, when examining the relationship between grip strength and reaction time parameters in wheelchair basketball athletes, significant negative correlations were found, particularly between grip strength and the number of missed LEDs. For right-hand grip strength, significant correlations were identified with both the right and left missed LEDs (r=-0.423, p=0.020, and r=-0.421, p=0.021, respectively). These correlations were even more pronounced for left-hand grip strength (r=-0.426, p=0.019; r=-0.477, p=0.008). These findings suggest that grip strength is not only an indicator of physical capacity but also plays an important role in reactive tasks that require visual-motor integration and attention. The results are consistent with previous studies in the literature. Notably, Zacharakis (33) reported similar findings, demonstrating significant correlations between grip strength and technical skill tests. That study emphasized that grip strength is a key determinant of both muscle functionality and reaction time (33). Similarly, Molik et al. (34), in their evaluation of the relationship between anaerobic performance and on-court skill tests, found that upper extremity strength was positively associated with reaction time. Additionally, Yüksel (35), in a study conducted with elite athletes with physical disabilities, evaluated visual-reactive agility not merely as an output of the central nervous system, but also as a combination of motor response capacity and muscle control. This perspective supports the notion that the correlations observed in our study are not solely related to reflexive speed but are also associated with physiological power generation and the ability to apply that power effectively.

Study Limitations

This study has several limitations. As it was conducted with wheelchair athletes from a single rehabilitation and sports center, the findings may not fully reflect the diversity of the wider population of wheelchair users. Additionally, the use of performance-based and self-reported outcome measures may have been influenced by individual factors such as attention, motivation, or subjective perception.

Despite these limitations, the study aimed to provide a comprehensive, multidimensional evaluation of the interplay between pain, upper limb function, and respiratory capacity, and the results offer valuable insights for clinical and sports-related rehabilitation planning.

CONCLUSION

This study investigated the relationships among pain levels in the shoulder girdle muscles, upper extremity functionality, and respiratory parameters in wheelchair athletes using a holistic approach. The findings revealed significant positive correlations between pain thresholds and both grip strength and functional questionnaire scores. However, the relationships between pain levels and reaction time parameters were found to be weaker and more limited.

Strong correlations between upper extremity strength and respiratory muscle strength (MIP and MEP) suggest that these two systems are clinically interconnected. Moreover, the observed positive correlations between thoracic expansion and grip strength indicate that postural stability and trunk mobility may contribute to upper extremity performance. These results highlight the importance of considering these parameters collectively, especially in multidisciplinary rehabilitation processes.

Recommendations for Clinical Practice

When developing rehabilitation plans for wheelchair users, a comprehensive assessment should be conducted that includes not only pain evaluation but also respiratory function and upper extremity performance. Exercises aimed at strengthening respiratory muscles should be considered, as they may indirectly enhance upper extremity function. Regular monitoring of performance-based parameters such as grip strength and reaction time could improve training efficiency.

Recommendations for Future Research

Prospective studies with larger and more diverse samples may help clarify causal relationships between systems. Experimental research supported by objective tools such as electromyography, respiratory function tests, and postural analysis could enhance the validity of the findings. Subgroup analyses based on specific sports disciplines may help elucidate the effects of sport-specific loading patterns on the relationship between upper extremity function and overall health.

ETHICS

Ethics Committee Approval: It was designed as a cross-sectional descriptive study and approval was received from the Bezmialem Vakıf University Non-Interventional Clinical Research Ethics Committee (approval no: 2024/260, date: 10.06.2024).

Informed Consent: Informed consent was obtained from all participants.

FOOTNOTES

Authorship Contributions

Concept: E.T.D., E.S., Design: E.T.D., E.S., Data Collection or Processing: E.T.D., Analysis or Interpretation: E.T.D., E.S., Literature Search: E.T.D., E.S., Writing: E.T.D., E.S.

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

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