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Pain, discomfort and psychobiological factors in wheelchair tennis athletes following COVID-19 lockdowns

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Abstract

Introduction: Wheelchair tennis (WT) players are prone to developing shoulder and upper-limb injuries due to the combination of wheelchair propulsion, overhead activities, and training loads. Despite these characteristics, little is known about possible associations between reported pain and injuries and the psychological health perceptions of experienced athletes. The objective of this study was to verify the existence of correlations between pain in the upper limbs (UL) with psychobiological aspects after the return to activity following the confinement period of the COVID-19 pandemic.

Material and methods: 18 WT athletes (16 males and 2 females; age: 31.2 ± 10.4; weight: 65.8 ± 16.8; height: 160 ± 30; BMI: 29.6 ± 21.5) participated in the study. For data collection, five instruments were used: (1) the Disabilities of the Arm Shoulder and Hand questionnaire, (2) the Nordic Musculoskeletal Questionnaire, (3) the Athlete Burnout Questionnaire, (4) the Generalized Anxiety Disorder questionnaire and, (5) the Pittsburgh Sleep Quality Index. Data were analyzed by correlation and simple linear regressions. We adopted $p < 0.05$ as the significance threshold.

Results: No significant correlations were found between pain in the upper limbs and psychobiological aspects. However, the dimension of physical and emotional exhaustion correlated with anxiety ($R^2 = 0.257$; $p = 0.032$) and devaluation in sport was associated with poor sleep quality ($R^2 = 0.324$; $p = 0.014$).

Conclusions: Although there are no correlations between pain in the upper limbs and psychobiological strain, mental aspects influence each other.

Keywords: Anxiety, Burnout, Sleep Quality, Discomfort, Upper Limbs

Introduction

Wheelchair tennis (WT) is an adaptation of traditional tennis for people with disabilities in which the ball can bounce up to twice on the playing court. WT has two competition categories, namely "open", in which there is only the need for medical proof of limitation of one or both lower limbs, and the "quad" category, where there is a need for medical proof of mobility limitation of three or more extremities [1]. The sport's first appearance in the Paralympics was in 1988 (Seoul), as an exhibition. Only in 1992 (Barcelona) were medals awarded. Since then, there has been considerable investment in technology and the physical preparation of

athletes, demanding higher levels of performance and dramatically increasing training and competition demands around the world [1,2].

In conjunction with the move toward high performance, it is necessary to improve techniques such as change of direction, braking, acceleration, sacks, and hits [3,4]. As a result, exposure to physical and psychobiological exhaustion has become increasingly evident. WT is a sport based on reaction time, motor control, maneuverability, and physical capacity (aerobic and anaerobic) to withstand explosive actions and the duration of matches. In relation to manual propulsion capacity in wheelchairs, WT differs from other sports in wheelchairs because most of the displacement actions occur in a forward direction, generating a frequent neuromuscular imbalance in the joints of the upper limbs (UL), especially around the shoulders. This is the crucial aspect for episodes of pain and discomfort in WT athletes [5,6].

Reports of pain and discomfort (reduction of the full capacity to perform a motor action as usual) in the UL have gained prominence among wheelchair athletes due to the level of effort applied in locomotion and movements above the head [7]. It is known that an athlete's career can be exhausting because of the excessive volume of activity, which can cause some disorders [8]. An example of this is burnout syndrome. This syndrome is known to be a form of exhaustion caused by excess demands on energy, strength, or general resources, and it can affect all types of athletes [9]. It is important to report that such excesses can lead to a negative physical condition called overtraining, which in turn increases the exposure of athletes to injuries and discomfort [10].

Due to the high physical and psychological demands of the routines that Paralympic athletes engage in, good sleep quality is necessary for an efficient recovery [11]. However, due to the restrictions imposed by the COVID-19 pandemic, the scientific literature does not report information for this context, since the SARS-CoV-2 virus imposed the need to adhere to strategies such as social distancing and cancellation of events [12]. Despite the limited information, investigations have found that the COVID-19 pandemic caused significant effects on the behavior of Paralympic athletes who were on their way to Tokyo, as well as stress and changes in their training patterns [13]. Other information corroborates that the mental health of high-level athletes was severely affected by this period – for example, increasing gambling addiction, depression, anxiety, and concern for their future within the sport [14].

There is a behavioral relationship between mental health and the pain and discomfort of Paralympic athletes; however, this information is not conclusive in the field of WT. For example, Mayrhuber et al. [15] demonstrated that muscular imbalance, increase in external range of motion, decrease in internal range of motion and reduced total arc of motion were the most common proposed musculoskeletal adaptations due to an unbalanced load. However, no information is available about the possible psychological repercussions caused by the pain and discomfort in WT athletes. Thus, observing the need for information related to the period imposed by COVID-19 and the possible relationship of pain and discomfort conditions with exhaustion and psychological health symptoms, the objective of this study was to verify the associations between pain and discomfort in the UL of WT athletes with anxiety, burnout, and poor sleep quality after returning to their activities after the lockdown period imposed by the COVID-19 pandemic.

Materials and methods

Participants

The subjects of this study participated voluntarily through meetings that took place at the "Wheelchair Brazil – ITF Tennis International 2", a WT tournament held between November 25 and 28, 2021 at the Tênis Clube de Santos (Santos/São Paulo), organized by the Brazilian Tennis Confederation (CBT). A total of 18 athletes (16 males and 2 females; age: 31.2 ± 10.4; weight: 65.8 ± 16.8; height: 160 ± 30; BMI: 29.6 ± 21.5) took part. Only 2 athletes had experience in regional competitions and 5 athletes had competed for less than 5 years. The rest had already competed in international tournaments and practiced in a WT for more than 5 years. Their experience in regional and national championships was evaluated. The study sample was recruited following the convenience sampling model since the participants were there for the tournament. The inclusion criteria defined were: a) having their functional classification defined; b) having participated in at least one championship at the regional level; and c) having affiliation with the CBT. All procedures were approved by the Ethics Committee of the institution affiliated with one of the authors (no.: 4.797.378; CAAE: 46258621.0.0000.9430).

Procedure

A total of 5 forms were used for this study: (a) The Disabilities of the Arm Shoulder and Hand (DASH) questionnaire, which asks about symptoms and the ability to perform certain activities and/or movements of the UL. The answers to all questions were based on the last week before completion [16]. This instrument was validated and adapted for Brazil, and the Spearman's correlation coefficient was found to be 0.99 and the

intraclass correlation coefficient (ICC) for reliability was also significant ($p < 0.01$), being 0.90 for the DASH scores. In the DASH questionnaire, the complete score and the specific score of questions related to music/sport were used. (b) The Nordic Musculoskeletal Questionnaire (NMQ), which consists of 36 questions related to pain and injury in the whole body, with an interval of up to 12 months. It was validated for Brazilian Portuguese [17]. The test-retest reliability indices investigated in three subsamples showed a percentage of non-identical responses that varied between 0% and 23%, while the correlation coefficient with clinical history varied between 0.80 and 1.00. (c) The Athlete Burnout Questionnaire (ABQ), which is a tool consisting of 15 questions divided into three parts, with these parts referring to three dimensions (physical and emotional exhaustion, reduced sense of accomplishment and sports devaluation) of burnout in sports [18]. It was translated, adapted and validated into Brazilian Portuguese presenting a Cronbach's α of 0.82. (d) The Generalized Anxiety Disorder questionnaire (GAD – 7), which is used to assess generalized anxiety disorder [19]. Its reliability was confirmed with a Cronbach's α of 0.88, and it is commonly used in psychometrics. Its reliability and validation were carried out by Sousa et al. [19], supported by Pfizer®. (e) The Pittsburgh Sleep Quality Index (PSQI), which is a questionnaire that assesses sleep quality and disturbances over 1 month [20]. The result of the validation study presented a Cronbach's α of 0.82.

Outcome

Two questionnaire formats were chosen: a physical (printed) form and online, since some para-athletes may have preferred not to have contact with any type of external material to maintain the social distancing restrictions imposed during the COVID-19 pandemic. The average time to answer all questionnaires was 30 minutes. The collection period began on November 25, 2021, and ended on November 28, 2021. The study followed the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) instrument [21]. It is noteworthy that there were meetings with the athletes and coaches present to explain the study. The questionnaires were explained and those present were shown how to answer them. A meeting point with the researcher was also provided in case there was a need for more information.

Statistical analysis

Data normality was verified using the Shapiro-Wilk test. Logarithmization was performed for data which were not normally distributed to calculate the means and standard deviations. A Pearson's statistical correlation matrix and simple linear regressions were performed. For the parameter effects, values of "r" between 0.1 and 0.3 were considered weak; between 0.4 and 0.6 moderate; and between 0.7 and 0.9 strong [22]. Tests were also carried out for the effect size (ES) and power analysis. For the effect size, $f^2 \geq 0.15$ was considered moderate and $f^2 \geq 0.35$ was considered large [22]. The data were analyzed using the JAMOVI 2.3.2 program (Jamovi, USA) using a significance level of 5% ($p < 0.05$).

Results

Table 1 presents the descriptive data for the participants and the mean scores of the DASH, ABQ, PSQI, and GAD-7 questionnaires, as well as sociodemographic data.

In the responses to the NMQ questionnaire (Tab. 2), 61% of the markings were in the shoulder region and 50% of the athletes presented with some complaint in some part of the UL.

No significant correlations were found between pain and sports devaluation (Tab. 3). However, the physical and emotional exhaustion (EFE) dimension presented a significant correlation with the GAD – 7 ($r = 0.507$; $p = 0.032$) and devaluation of the sport modality (DE) was significantly correlated with the PSQI ($r = 0.569$; $p = 0.014$).

The regression did not present outliers, and collinearity was consistent with the assumptions of the analysis and presented a normal "p" value ($p = 0.622$), meeting all the assumptions for linear regression. Simple linear regression was performed between the DE and the PSQI, in which the value of R^2 was 0.324, the result of the F test was 7.66, the effect size was $f^2 = 0.479$, and the result of the power analysis was 0.657. There were no outliers, and the collinearity of the variables was consistent with assumptions of the analysis (VIF = 1.00, tolerance = 1.00) and presented a normal "p" value ($p = 0.300$), meeting all assumptions (Tab. 4).

Discussion

The present study aimed to verify the association of pain and discomfort in the UL of WT athletes with anxiety, burnout, and poor sleep quality after returning to activities after the lockdown period due to the COVID-19 pandemic. The findings indicate that 83% of participants used a wheelchair all day and that pain was present in some regions of the MS in 50% of them, but with low intensity. This may reflect the protective effect of physical exercise on pain related to wheelchair use [23]. In addition to the pain in the UL, 61% of the

Tab. 1. Descriptive information for the variables analyzed in the studied sample (n = 18)

	n (18)	%	Mean	Standard deviation	p
Gender					
Male	16	89	–	–	–
Female	2	11	–	–	–
Functional classification in WT					
Open	16	88	–	–	–
Quad	2	12	–	–	–
Disability type					
Spinal cord injury	12	66.67			
Amputation and others	6	33.33			
Education					
Post-secondary complete	3	17	–	–	–
Incomplete post-secondary	4	22	–	–	–
Complete high school	7	39	–	–	–
Incomplete high school	4	22	–	–	–
Income					
Above 5 minimum monthly salaries	3	17	–	–	–
Between 2 and 5 minimum monthly salaries	7	39	–	–	–
Up to 2 minimum monthly salaries	8	44	–	–	–
Contracted COVID-19?					
Yes	4	22	–	–	–
No	14	78	–	–	–
Confinement					
Remained	2	11	–	–	–
Did not stay confined	16	89	–	–	–
Pain medicine					
Uses	1	6	–	–	–
Does not use	17	94	–	–	–
Daily time of use of WC					
All day	15	83	–	–	–
Between 5 and 10h/day	1	6	–	–	–
Less than 5h/day	2	11	–	–	–
DASH	–	–	9.8	14.0	0.410
Sports DASH	–	–	18.8	20.8	0.465
ABQ	–	–	2.2	0.7	0.643
PSQI	–	–	8.8	6.0	0.875
GAD-7	–	–	6.9	3.2	0.524

ABQ – Athlete Burnout Questionnaire, BMI – Body Mass Index, DASH – Disabilities of the Arm Shoulder and Hand, GAD-7 – General Anxiety Disorder – 7 items, PSQI – Pittsburgh Sleep Quality Index, WC – Wheelchair, The significance level adopted was $p < 0.05$ (Shapiro-Wilk normality test).

Tab. 2. Scores noted of the Nordic Questionnaire of Musculoskeletal Symptoms

Body regions	In the last 12 months you have had problems (such as pain, tingling/ numbness) in:	In the last 12 months you have been prevented from performing normal activities (e.g., work, household, chores, and leisure activities because of these problems in:	In the last 12 months you have consulted some health professional (doctor or physiotherapist) because of these conditions in:	In the last 7 days you've had problems in:
Neck	4	0	3	2
Shoulders	11	2	6	5
Upper back	6	1	2	2
Elbows	9	3	5	7
Wrists/Hands	7	0	4	3
Lower back	9	1	4	5
Hip/Thigh	3	0	1	0
Knees	0	0	1	0
Ankles/Feet	0	0	0	0

The numbers are related to the number of times the athlete reported having some level of pain/discomfort in each region of the body. In other words, the higher the number (closer to 18), the greater the number of athletes who reported such signs in the respective region.

Tab. 3. Pearson's correlation matrix between DASH, sports DASH, ABQ, burnout dimensions, PSQI and GAD-7

		DASH	Sports DASH	ABQ	RSSA	EFE	DE	PSQI
DASH	Pearson *r*	–	–	–	–	–	–	–
	p–value	–	–	–	–	–	–	–
Sports DASH	Pearson *r*	0.401	–	–	–	–	–	–
	p–value	0.222	–	–	–	–	–	–
ABQ	Pearson *r*	0.386	0.141	–	–	–	–	–
	p–value	0.114	0.679	–	–	–	–	–
RSSA	Pearson *r*	0.296	0.086	0.827***	–	–	–	–
	p–value	0.233	0.801	< 0.001	–	–	–	–
EFE	Pearson *r*	0.086	–0.076	0.730***	0.846***	–	–	–
	p–value	0.734	0.824	< 0.001	< 0.001	–	–	–
DE	Pearson *r*	0.336	–0.007	0.845***	0.510*	0.413	–	–
	p–value	0.172	0.983	< 0.001	0.031	0.088	–	–
PSQI	Pearson *r*	–0.035	–0.547	0.457	0.152	0.313	0.569*	–
	p–value	0.890	0.082	0.057	0.547	0.207	0.014	–
GAD–7	Pearson *r*	0.099	–0.361	0.343	0.361	0.507*	0.207	0.440
	p–value	0.696	0.275	0.164	0.141	0.032	0.409	0.068

ABQ – Athlete Burnout Questionnaire, DASH – Disabilities of the Arm Shoulder and Hand; DE – devaluation of the sport modality, EFE – physical and emotional exhaustion, GAD-7 – General Anxiety Disorder – 7 items, PSQI – Pittsburgh Sleep Quality Index, RSSA – reduced sense of sporting achievement, * $p < 0.05$, *** $p < 0.001$.

Tab. 4. Simple linear regression, effect size and power analysis between EFE and GAD-7, and DE and PSQI

General Model Testing								
Model	R	R^2	F	df1	df2	p	ES	Power
1	0.507	0.257	5.53	1	16	0.032*	0.345	0.510
Model coefficients – EFE								
Predictors			Estimates	Standard error	t	p		
Intercept			1.9879	0.2811	7.07	<0.001***		
GAD-7			0.0621	0.0264	2.35	0.032*		
General Model Testing								
Model	R	R^2	F	df1	df2	p	ES	Power
1	0.569	0.324	7.66	1	16	0.014*	0.479	0.657
Model coefficient – DE								
Predictors			Estimates	Standard error	t	p		
Intercept			0.0492	0.0799	0.616	0.547		
PSQI			0.0290	0.0105	2.767	0.014*		

DE – devaluation of the sport modality, df – degrees of freedom, EFE – physical and emotional exhaustion, ES – effect size, F – result of F-test, GAD-7 – General Anxiety Disorder – 7 items, PSQI – Pittsburgh Sleep Quality Index, t – result of T-test, *$p < 0.05$, ***$p < 0.001$.

sample reported pain in the shoulder region. It was also found that 89% of para-athletes did not totally adhere to the lockdown restrictions during the COVID-19 pandemic. This indicates that the majority of the subjects evaluated participated in training activities inside and outside the home.

On the basis that pain is associated with some isolated psychobiological factors (i.e. when there is poor sleep quality), athletes are more exposed to the appearance of injuries [11]. As a result, we collected data on multiple psychobiological variables, but no significant associations were found between pain and discomfort in the UL and these psychobiological variables. However, our findings indicated a moderate positive correlation ($r = 0.507$, $p = 0.032$) for the EFE dimension with anxiety and a moderate positive correlation ($r = 0.569$, $p = 0.014$) between DE and PSQI score.

EFE is related to an intense training routine and competitions [24]. Fears and uncertainties about the future during the COVID-19 pandemic, whether related to new training routines or competition, are notorious, since changes in timelines due to the pandemic impacted everyone in the world. This included important competitions that would qualify the athletes for possible selection to compete in the upcoming Paralympics. Furthermore, when an athlete does not have good sleep quality, the literature presents robust information about a deficit in the production of endorphins, the recovery of vigor, and an increase in the secretion of stress hormones such as cortisol [25]. The dimension of EFE is associated with a negative attitude towards important events in sports. Para-athletes with lower recovery levels, which are associated with low functionality, may present with a lack of interest in sport, such as in maintaining fitness for the next competition. In addition, the uncertainties of the COVID-19 pandemic could have aggravated such conditions because of the need to adapt to sanitary measures [26,27].

Despite these aspects, we observed low associations between pain and discomfort and psychobiological factors. Psychobiological variables have previously shown an indirect correlation with pain and discomfort, especially when another variable (i.e., overtraining) acted as a mediator, denoting the complexity of these associations [28,29]. However, the variables evaluated in this study did not show evidence of mediation or even covariation, probably due to the low number of athletes evaluated.

Some limitations of the study should be highlighted. The first is the total number of participating subjects and the difference between the number of male and female participants. A larger sample size may reveal a significant correlation between pain and discomfort in UL and psychobiological factors. The second limitation

concerns the tools used, since self-report questionnaires may lead to bias in the response process. The third limitation is in the use of questionnaires that are not specific to people who use a wheelchair but are easy to apply and are used for the general public. Future empirical studies may use other tools, promote controlled clinical trials, and use longitudinal methodologies.

As practical implications, we can report the following: a) the potential for increased pain and discomfort caused by substantial changes in training routines may suggest considerable drops in the performance of WT athletes; b) an increase in reports of pain and discomfort may be associated in the future with a negative perception of sports routines, further increasing the chances of reduced performance; and c) exhaustion and anxiety may be closely associated with sleep quality in WT athletes. This reinforces the importance of maintaining sports routines with positive habits (nutrition, sleep, exercise and recovery), even for athletes who are temporarily away from their teams for various reasons.

Conclusions

In conclusion, no associations between pain in the UL and psychobiological aspects were observed. However, the dimension of physical and emotional exhaustion correlated with anxiety and devaluation in sports was associated with poor sleep quality. Finally, two of the three dimensions of burnout (EFE and DE) were correlated with anxiety and poor sleep quality, respectively, indicating that mental aspects can influence each other. Finally, pain and discomfort in the UL are present in the life of any high-performance athlete; however, Paralympic athletes have aggravating factors arising from their disabilities. So, the characteristics of paralympic athletes are important variables to consider for coaches and sports scientists during training routines.

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Conflicts of interest
The authors declare no conflicts of interest.

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