




Factors associated with injuries in Hawaiian canoe paddlers

Fatores associados a lesões em remadores de canoa havaiana

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Abstract

Introduction: The Hawaiian canoe has numerous benefits for those who use it. Furthermore, it is considered a moderate/high-intensity cyclic sport that can cause injuries. Studies on factors associated with injuries in Hawaiian canoe paddlers are considered limited and scarce. **Objective:** To identify the profile of canoe paddlers and determine the main factors associated with injuries. **Methods:** A cross-sectional study was conducted with 100 Hawaiian canoe paddlers (54% females, 45.6 ± 10.0 years old; 46% males, 44.8 ± 11.7 years old) using an online survey, with questions on sociodemographic and anthropometric information and practice and injuries. **Results:** Participants reported having at least four years of experience with the modality, training approximately four times a week for a total of six hours. Almost half (45%) of the sample reported having been injured at least once while canoeing. The back/spine was the body region with the highest injury prevalence, with 38.6%. Intense training was considered the only associated factor for injuries (odds ratio: 3.98; 95% confidence interval: 1.71 - 9.26). **Conclusion:** This pioneering study in Brazil allowed us to profile Hawaiian canoe paddlers and identify the main factors associated with injuries. Paddlers who train intensely are more likely to develop injuries during practice. Therefore, this variable must be considered when planning sessions.

Keywords: Athlete injury. Epidemiology. Sports. Water sports.

Resumo

Introdução: A canoagem havaiana apresenta inúmeros benefícios para os praticantes. Apesar disso, é uma prática considerada com gestos cíclicos, realizada com intensidade moderada/intensa e que pode ocasionar lesões. As evidências sobre os fatores associados às lesões em remadores de canoa havaiana são consideradas limitadas e escassas. **Objetivo:** Identificar o perfil dos remadores brasileiros de canoa havaiana e verificar os fatores associados às lesões. **Métodos:** Trata-se de um estudo transversal conduzido em 100 remadores de canoa havaiana (54% sexo feminino, $46,2 \pm 8,5$ anos; 46% do sexo masculino, $44,8 \pm 11,7$ anos) por meio de uma pesquisa online. O instrumento utilizado continha perguntas sobre as variáveis sociodemográficas, antropométricas, prática da modalidade e lesões. **Resultados:** Os participantes reportaram ter experiência de pelo menos quatro anos com a modalidade, treinando aproximadamente quatro vezes por semana e totalizando seis horas de treino semanal. Quarenta e cinco por cento da amostra relatou ter sido lesionada pelo menos uma vez durante a prática da modalidade. As costas/columa foi a região corporal com maior prevalência de lesão, com 38,6%. Treinos intensos foram considerados os únicos fatores associados para lesões (razão de chance: 3,98; intervalo de confiança: 1,71 - 9,26). **Conclusão:** Este estudo pioneiro no Brasil permitiu traçar o perfil dos remadores de canoa havaiana, bem como identificar os principais fatores associados a lesões. Remadores que treinam intensamente estão mais propensos a desenvolver lesões durante a prática, portanto, esta variável deve ser levada em consideração no planejamento das sessões.

Palavras-chave: Traumatismos em atletas. Epidemiologia. Esportes. Esportes aquáticos.

Introduction

The Hawaiian (most common nomenclature in Brazil), Polynesian or Tahitian canoes, which by nomenclature are called Va'a or Vaa, date back to the conquest of the Pacific islands and the development of these cultures, increasing territorial coverage leading to the colonization of the Hawaiian Islands. Historical accounts of this modality go back more than 3,000 years as a versatile canoe due to its ability to be used in calm waters and large ocean crossings as well.¹⁻⁴

From the 1960s/1970s, contemporary paddlers began to popularize the sport around the world, performing short- and long-distance competitions called, respectively, sprint and crossing.^{1,3,4} In Brazil, the sport only arrived in 2000, when pioneers brought the first Hawaiian canoe from California to Rio de Janeiro. In less than a year, there were already two paddling clubs with four canoes. The frank expansion of the sport in Brazil and in the world in the last decade happened exponentially. A franca expansão do esporte no Brasil e no mundo na última década deu-se de maneira exponencial.

Canyon and Sealey⁵ carried out a systematic review of scientific production in Hawaiian canoes. In all, 27 studies were included and of these, only two are specifically focused on the prevalence of injuries in Hawaiian canoe paddlers.^{6,7} One of the main studies on the subject found that the most prevalent injuries were sprains and strains in the shoulder with an incidence of 1.82 injuries per thousand hours of exposure to Hawaiian canoeing. Haley and Nichols⁷ showed that the most recurrent sites of injuries were the shoulders and back. In addition to injuries, the authors reported that the practice site can lead to negative health effects, such as heat illness and injuries by sea creatures.⁷ Some studies carried out with paddling/rowing athletes from different water sports show that Hawaiian canoe paddlers have a prevalence of injuries in the shoulder and lumbar girdle, predominantly tendinous.⁸⁻¹⁰ On the contrary, kayaking, its variations and Olympic rowing report more incident injuries in wrists, hands, ribs and legs.⁸⁻¹⁰

From this perspective, it is important to understand the injury mechanisms to which Brazilian Hawaiian canoe paddlers are exposed, as well as to identify the most common injuries, which can serve as a guide for athletes and coaches to improve performance and reduce the occurrence of injuries and thereby the time away from the routine of training and competitions. The objective of this study was to identify the profile of Brazilian Hawaiian canoers and to determine the factors associated with injuries.

Methods

This was an epidemiological cross-sectional study,¹¹ approved by the Research Ethics Committee of the State University of Santa Catarina (CAAE: 79514017.3).

0000.0118, Ethical Approval No. 2.438.227/2017). The sample consisted of Hawaiian canoe paddlers with at least one year of experience in the modality, aged over 18 years and residing in Brazil.

Data collection took place during the first half of 2018. Initially, the project was publicized on digital social media (Facebook and Instagram), sending messages to emails and WhatsApp groups, in addition to displaying posters and direct approach in competitions and sports events. Coaches and instructors of the Hawaiian canoeing in Brazil were contacted and received information about this research, as well as its scientific relevance, and helped in its dissemination to students and practicing athletes. Hawaiian canoe coaches and instructors are professionals who work by teaching classes to those who want to learn about the modality, as well as planning training with the aim of competition. The study took place virtually, in view of the possibility of covering the largest number of practitioners from different regions of Brazil and without the need to allocate financial resources for researchers to travel. This procedure was similar to another study.⁶

For the acquisition of information, a structured questionnaire with closed questions was administered, developed in an online spreadsheet of the Google Forms program, through the Google platform. The platform was open to receive responses from January 8 to July 31, 2018. Subjects who accepted and agreed to participate in this study received a link to complete the questionnaire. In all, 118 individuals showed interest in participating in the study. Of these, 18 were excluded for not being Brazilian, for not providing a valid CPF and/or for incorrectly filling out the research instrument, resulting in a final sample of 100 people.

The instrument used was adapted on the basis of the study by Neville et al.¹² and validated using the procedure adopted by Azevedo et al.¹³ This procedure has the function of making the questionnaire more adequate to the objectives of the study and more relevant to the practice of the modality, since specialists contribute with suggestions for modifying the form and content of the questions and answers, and individuals with the same sample profile and no experience with scientific research analyze whether the questions and answers are understandable.

After preparing the adapted version, it was submitted for evaluation by ten specialists in areas such as Hawaiian canoe coaches and/or instructors, physical education professionals and/or physiotherapists and/

or doctors specializing in sports injuries, and sports scientists. Each could suggest changes such as adding and deleting questions, modifying the wording and question and answer formats. Among the modifications, the specialists suggested using, whenever possible, categorical answers: for example, the characteristic of the injury presents only two response options, namely acute or chronic. After the proposed modifications, the second version of the questionnaire was generated, and this was submitted for evaluation by five Hawaiian canoe paddlers with no experience with scientific research and who would not be part of the sample. These individuals could suggest that technical vocabulary and scientific jargon be explained or translated into lay and informal language. After making the changes suggested by the paddlers, the final questionnaire was generated.

This questionnaire contained information regarding sociodemographic and anthropometric variables, practice of the Hawaiian canoe modality and injuries. The sociodemographic variables used were sex (male or female), age (in years) and region where they train (South, Southeast, Central-west, North or Northeast). Anthropometric outcomes were self-reported and questioned regarding body mass (kg) and height (m).

Regarding the practice of the modality, the participants were asked about the time of experience with Hawaiian canoeing (in years); weekly training (times a week); total hours per week spent training; type of vessel: collective canoe (multi), individual (single) or both; practicing another sport and/or recreational modality (bodybuilding, functional training, cycling, running, swimming, Pilates, no activity or others); participation in competitions (yes/no) and, if so, what type (international, national, state, municipal or internal club competitions); receiving some type of financial aid (from the club, athlete scholarship or equipment aid); type of guidance during training (physical education professional, other professionals, other athletes or the athlete himself); and training intensity (moderate and intense).

Regarding the injuries that affect Hawaiian canoe athletes, the participants were asked about the type (muscle, tendon, bone, disc, contusion, abrasion, nerve, vascular); characteristic (acute or chronic), being the acute ones characterized as a single, traumatic and specific event, and the chronic ones as developed by constant training, exposure or overtraining/overuse; and types of treatment (physiotherapy, rest/interruption of practice, drug treatment, massage, ice, acupuncture or

others). An injury was considered to be any traumatic event that occurred during or after any paddling¹⁴ and that required at least one treatment intervention, medication and/or rest.

Statistical analysis

Data were tabulated and stored in Microsoft Excel and analyzed using the Statistical Package for Social Sciences - SPSS, version 20.0 (IBM Inc., USA). First, the normality of the data was verified using the Kolmogorov-Smirnov test and performing a descriptive analysis of the data (mean, standard deviation and frequencies) as well.

Second, crude binary logistic regression was performed, adjusted to verify the associated factors and estimate the odds ratio, along with the respective confidence intervals (95%CI) between the dependent variable (presence of injury, regardless of whether characterized as acute or chronic) and independent variables (sociodemographic and anthropometric and practice of the modality). Crude analysis was performed separately with each independent variable, while adjusted analysis was performed with all independent variables in the model. In all analyses, the significance level used was 5% ($p < 0.05$).

Results

Table 1 presents the profile of Brazilian Hawaiian canoe paddlers according to sociodemographic variables.

Table 2 presents the profile of these paddlers regarding the practice of the modality.

Table 3 presents the profile of Brazilian Hawaiian canoe paddlers in terms of types and characteristics of injuries. Of the 100 participants included in this study, 45% had at least one injury related to Hawaiian canoeing. Regarding the site, 38.6% of the injured paddlers reported involvement in the back/spine region, followed by the shoulder girdle (27.3%), upper limbs (27.3%), lower limbs (4.5%) and pelvis (2.3%).

Table 4 presents the profile of Brazilian Hawaiian canoe paddlers in terms of therapeutic methods for recovering from injuries. Forty-five percent of paddlers

reported having been diagnosed by a medical professional, followed by a physical therapist (21%) and self-diagnosis (20%). The other 9% are divided between masseuses, technicians, yogis and complementary examinations, and 5% had no type of diagnosis.

Table 5 presents the binary logistic analysis to estimate the odds ratio and the confidence interval between the presence of injury and the independent variables. We observed that only training intensity was associated with injuries ($p < 0.05$). Hawaiian canoe paddlers who described their training as intense were 3.98 times more likely to have injuries compared to those who described their training as moderate.

Table 1 - Characterization of the sample according to sex, age, height, weight and region in Brazil where there is Hawaiian canoeing

Variables	Frequency
Sex - n (%)	
Male	46 (46)
Female	54 (54)
Age - mean (SD)	
Males	44.8 (11.7)
Females	46.2 (8.5)
Height - mean (SD)	
Males	174.8 (5.5)
Females	163.3 (6.2)
Weight - mean (SD)	
Males	81.8 (12.7)
Females	64.6 (9.2)
Region - n (%)	
South	47 (47)
Southeast	48 (48)
Central-west	3 (3)
North	1 (1)
Northeast	1 (1)

Note: SD = standard deviation; n = absolute frequency; % = relative frequency.

Table 2 - Characterization of the sample regarding Hawaiian canoeing

Variables	Mean (SD)	n (%)
Years of experience*	4.7 (2.8)	-
Workouts per week*	3.6 (1.4)	-
Hours per week*	5.6 (3.8)	-
Type of vessel		
Multi	-	56 (56)
Single	-	43 (43)
Both	-	1(1)
Intensity of training		
Intense	-	53 (53)
Moderate	-	47 (47)
Other modalities*		
Bodybuilding	-	40 (26)
Functional training	-	26 (17)
Cycling	-	25 (25)
Running	-	22 (14)
Swimming	-	12 (8)
Pilates	-	7 (5)
Others	-	22 (14)
None	-	24 (24)
Competition		
Yes	-	71 (71)
No	-	29 (29)
Type of competition*		
International	-	16 (10)
National	-	54 (34)
State	-	43 (27)
Municipal	-	23 (14)
Club	-	24 (15)
Financial assistance		
Receives	-	2 (2)
Does not receive	-	98 (98)
Training guidance		
Physical education professional	-	53 (53)
Other professionals	-	15 (15)
Other athletes	-	14 (14)
Athlete themselves	-	18 (18)

Note: SD = standard deviation; n = absolute frequency; % = relative frequency; Multi = collective canoes; Single = individual canoes. *The participants answered more than one modality, so the total sum is greater than the sample.

Table 3 - Characterization of the sample regarding the types of injuries

Type of injuries	Acute	Chronic	Total
Muscle	12 (48)	21(50)	33 (47)
Tendon	4 (16)	11 (26)	15 (22)
Bone	3 (12)	2 (5)	5 (7)
Ligament	-	5 (12)	5 (7)
Disc	2 (8)	-	2 (3)
Contusion	3 (12)	-	3 (4)
Abrasion	1 (4)	-	1 (1)
Nervous	-	2 (5)	2 (3)
Vascular	-	1 (2)	1 (1)
Total injuries	25	42	67

Note: Values presented in absolute and relative frequency: n (%).

Table 4 - Characterization of the sample regarding therapeutic methods for recovery from injury

Therapeutic methods	Injuries		
	Acute	Chronic	Total
Physiotherapy	16 (79)	23 (61)	38 (67)
Rest/interruption of canoeing	13 (63)	25 (66)	37 (65)
Drug treatment	8 (37)	17 (44)	24 (41)
Massage	-	3 (8)	3 (5)
Ice	-	3 (8)	3 (5)
Acupuncture	3 (11)	-	3 (3)
Others*	-	6 (14)	6 (9)

Note: Values presented in absolute and relative frequency: n (%).

*RPG, pilates, stretching or bodybuilding.

Discussion

The practice of canoeing is directly associated with the historical and cultural characteristics of each region. There was a greater representation of the South and Southeast regions in Hawaiian canoeing, given the influence of the beginning of the modality in Brazil.² In studies of similar approaches^{6,7} carried out in countries originating the Hawaiian canoe, a much smaller territorial coverage can be verified, for example, Hawaii (28,311 km² and 1.42 million inhabitants) and New Zealand (268,021 km² and 4.794 million inhabitants). These two

regions are large archipelagos originally colonized by people who traveled by Hawaiian canoes, which led to the adoption of the culture of this sport by the entire population, making the Vaa culture a cultural and intangible heritage of these populations.^{1,3,4}

The number of training hours per week of Brazilian paddlers (4.66 ± 2.83 hours/week) is similar to that found by Bell et al.⁶ in a sample with similar characteristics (5.8 ± 3.2 hours/week). Stanton et al.,¹⁵ on the other hand, carried out a survey with paddlers during the 1998 Australian national championship and found a smaller training extent, 1.7 ± 0.6 hours per training session, with

single paddlers training 0.8 ± 1.2 days per week and multi-paddlers, 3.2 ± 0.8 days per week.

We found that 56% of the Brazilian canoe paddlers surveyed practiced and/or competed with multi canoes, and that 43% used single canoes. Bell et al.⁶ also pointed out the differences between types of canoes and injuries. Of those athletes who had some type of injury, 57% paddled a multi-type canoe.⁶ Taking this information into account, these data corroborate our study. When carrying out a detailed analysis, it was identified that, of those who were injured, a higher percentage also used a multi-canoe (56%).

Table 5 - Binary logistic analysis to estimate the odds ratio (OR) and 95% confidence interval (95%CI) between the presence of injury and the independent variables

Variables	Crude analysis OR (IC 95%)	Adjusted analysis OR (IC 95%)
Sex		
Male	1	1
Female	0.81 (0.37 - 1.78)	1.14 (0.46 - 2.81)
Canoe		
Multi	1	1
Single	2.37 (1.05 - 5.32)	1.46 (0.54 - 3.92)
Complementary training		
Yes	1	1
No	0.77 (0.31 - 1.93)	2.18 (0.75 - 6.35)
Participates in competition		
No	1	1
Yes	2.28 (0.92 - 5.70)	1.20 (0.38 - 3.72)
Training intensity		
Moderate	1	1
Intense	3.98 (1.71 - 9.26)	3.34 (1.31 - 8.46)
Workouts per week (sessions)	1.48 (1.09 - 2.01)	1.04 (0.62 - 1.75)
Hours per week (hours)	1.17 (1.03 - 1.33)	1.08 (0.88 - 1.33)
Experience (years)	1.09 (0.94 - 1.25)	1.03 (0.86 - 1.23)

Note: Multi = collective canoes; Single = individual canoes. Values in bold showed a significant association.

The slight predominance of female paddlers, who made up 54% of the sample, can be explained by the collective nature of the sport, given that 99% of the sample paddles/trains in collective canoes, as well as the presence of mixed teams in competitions that may have an influence in the population analyzed.

In the literature, only one study mentions that canoe paddlers participate in some type of complementary training, but it does not discriminate the chosen modalities, only reporting the inclusion of strength and aerobic training in the routine.¹⁴ The data from the present study demonstrate a strong demand from paddlers by

strength training (bodybuilding) complementary to the practice of the modality. This reinforces the need to increase knowledge about complementary practices in canoeing, since they are factors that can contribute both to the prevention and to the increase of injuries in paddlers.

The interest in participating in competitions was predominant in the sample of paddlers (71%), especially at the state and national level. On the other hand, 98% of the subjects stated that they did not receive any type of financial aid or athletic scholarship that could support some type of compensation for the time and effort spent, or even for the equipment purchased. This reality is common in several modalities in Brazil, making it difficult for athletes to invest in the quality of their training through nutrition, psychology, sports physiotherapy, equipment, better training conditions, etc., so people who do not have the minimum income cannot practice canoeing.

Another predominant characteristic in the sample of the present study is the guidance of training provided by professionals (68%), which meets the need to manage good academic practices in the training of professionals who will be at the forefront of the training of these paddlers in the future, both in the attempt to optimize the performance of athletes and to reduce the possibility of future injuries. However, the remaining portion, greater than a third of the sample, handles their training on their own or has the help of another athlete, indicating an important gap for professionals in the area.

The main area affected by injuries is the region of the shoulder girdle and shoulders, with 21% of occurrences, followed by the lumbar region, with 18%, which corroborates the findings of Haley and Nichols,⁷ whose sample showed 40% of injuries in the shoulders and shoulder girdle and 26% in the column. Stanton et al.¹⁵ reported that 28% of the injuries occurred in the shoulders and 25% in the lumbar region. Bell et al.⁶ found 35% of injuries in the shoulders, followed by 27% in the spine; however, as a limitation to the data presented by these authors, it should be noted that 20% of the injuries occurred while transporting or handling the canoes and equipment and 67% during the paddling itself.

Thornton et al.⁹ states that paddling sports tend to have a high incidence of injuries linked to low back pain, wrists and rib fractures. The author also demonstrated that high training loads, as well as inadequate recovery, can increase the prevalence of injuries to paddlers to

50%. Possible fatigue and excess trunk flexion may be linked to an increase in lumbar injuries in paddlers, which may corroborate the study by Bell et al.⁶ where a higher incidence of injuries was found in the population that paddles long distances. (> 10 km) (1.44 injury incidence) compared to the short-race population (0.81 injury incidence). Haley and Nichols⁷ points out that long-distance paddlers have a higher incidence of injuries (51%) when compared to short-distance paddlers (14%). Considering that the national race calendar is predominantly long-distance races, which can reach more than 90 km, our study sample did not show higher injury percentages than those analyzed by other researchers.^{6,7}

Taking into account the mean time away from sports activities, chronic injuries keep subjects away for 21 ± 38.9 days and acute injuries for 14.7 ± 26.4 days. In the study by Bell et al.,⁶ 37% of paddlers stayed less than a week away from sports due to injury and 66% less than two weeks. In the study conducted by Haley and Nichols,⁷ 11% reported absences of less than one week, 25% less than two weeks, 25% more than two weeks and 34% more than one month, with 6% of the sample reporting having developed permanent damage. Data presented by Haley and Nichols⁷ showed that of the 62% individuals who had musculoskeletal injuries, 56% did not seek any type of treatment, only 35% sought medical help and 2% sought emergency medical care. Similarly, in the study by Bell et al.,⁶ with 42% of the injured sample, 53% did not undergo any type of treatment, while 47% sought specialized treatment. According to the authors, some athletes sought more than one type of treatment, with 36% looking for doctors, 76% for physiotherapists, 6% for coaches and 16% for help from other professionals (osteopaths, chiropractors, massage therapists and acupuncturists).⁶ In this aspect, the profile of the Brazilian paddler is divergent, since 45% of the sample of the present study reported having suffered at least one injury, and of these, 82% sought professional help for their treatment, indicating a profile of positive and desirable behavior on the part of the Brazilian paddlers. This is perhaps due to the fact that the populations previously analyzed by other researchers are from countries where health is private and not public.^{6,7}

Training intensity was the only significant associated factor for injuries in Hawaiian canoe paddlers. Although the training intensity was evaluated subjectively, it

should be noted that this is a valid measure and that it is associated with other direct measures of training intensity.¹⁶ The present study identified that paddlers who described their training as intense were 3.34 times more likely to develop injuries compared to those reporting moderate training. These findings are in accordance with the principles of physical training (volume x intensity relationship, overcompensation), which determine that loads and volumes must be balanced with adequate rest to generate desired body adaptations. If this relationship is unbalanced, it can generate little or no adaptation or potentiate overtraining and the risk of injury.¹⁷ In other modalities, this relationship is also found in the sample of triathletes. Jacobson et al.¹⁸ reported that high training intensity (assessed in a self-reported manner) and large weekly volume (in hours) are risk factors for injuries. It is important that Hawaiian canoe coaches know the means of identifying the perception of training intensity so that they can consider the variables of volume and intensity within the planning of the modality. In this way, it will be possible to contribute to the reduction of possible future injuries.

One aspect to be raised is the type of guidance during the modality training. Of the 53 athletes who trained intensely, only 28 (approximately 53%) had their training prepared by coaches and/or physical education professionals. This finding is relevant, as it can point to other factors such as the process of teaching the proper technique, which is also associated with injuries,⁹ and the development of training programs that respect the stimulus/rest ratio. These elements are intrinsically related to the training of physical education technicians and professionals.

Conclusion

The Hawaiian canoe is a modality that is still being popularized in Brazil. Because of this, this is the first national study of this modality. Regarding the profile of the Brazilian Hawaiian canoe paddlers, they are mostly female, with an average age of over 40 years, with at least five years of practice, training an average of four times a week, totaling six hours of training weekly. Most perform complementary training along with canoeing and participate in competitions. Regarding the factors associated with injuries, there is evidence that training with a high perceived intensity is more likely to cause

injuries while canoeing. Therefore, it is suggested that the perceived exertion be taken into account when planning training sessions. We emphasize the need for future studies conducted with this population, expanding the sample size and study design, preferably prospective. The results regarding injury exposure factors need to be better explored in this population so that it is possible to minimize or even reduce the impact that this sport modality can have on the lives of these paddlers.

Authors' contributions

NEP conceptualized this research and was responsible for creating, validating and administering the research instrument, collecting, processing and analyzing data and preparing the text of the article. OJBA, CKC and MOP helped with data analysis and writing of the article. HR and SMP contributed to the preparation and review of all stages of the work. All authors reviewed and approved the final version.

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