



# Descriptive characterization of Brazilian surfers and their injuries: a cross-sectional and retrospective study

original paper

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DOI: <https://doi.org/10.5114/hm/190498>

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## ABSTRACT

**Purpose.** The present study aimed to describe the main characteristics of Brazilian surfers and their injuries, and to analyze the probability of developing injuries according to skill level, experience in surfing, training volume, and age.

**Methods.** A total of 1829 Brazilian surfers answered an electronic survey about their characteristics and previous and current injuries. The association between participant characteristics and percentage of injuries was investigated using a chi-squared test. The statistical significance of the results was assumed at a  $p$ -value  $< 0.05$ . The prevalence ratio (PR) was also calculated to illustrate the probability of having injuries.

**Results.** Most surfers are men (84.2%), young adults (72.0%), with more than 2 years of experience in surfing (60.7%), with an intermediate level of skill (49.3%), recreational surfers (99.2%), and who practice surfing 1 to 2 days a week (79.7%) for 1 to 3 hours a day (65.9%). About 55.5% of the participants were already affected by an injury or had some surfing-related pain. In the last 12 months, 52.2% of surfers suffered injuries. For both, more than 50% of injuries occurred in the lower limbs. Brazilian surfers with higher skill levels, time of experience, hours per day of surf training, and age presented higher prevalence ratios of previous and current injuries.

**Conclusions.** In summary, Brazilian surfers are predominantly male, young adults, and non-competitive athletes. The most injured anatomical region in this group is the lower limbs. Contrary to expectation, higher experience and skill levels might not act as protective factors against injuries due to increased training volume.

**Key words:** surfing, prevalence, board sports, prevention, pain

## Introduction

The popularity and practice of surfing have increased in recent years, taking this sport to the Olympic Games. The International Surfing Association estimates that there are about 23 million worldwide surfers, with this growth occurring in both recreational and competitive levels [1, 2]. This achievement makes the surfing audience quite heterogeneous. Indeed, the group of practitioners in this sport seems to be largely composed of recreational surfers nowadays [1, 3–5]. Additionally, surfing athletes are exposed to specific demands,

which are related to the skills involved and to the environmental nature of this sport. Therefore, to safely practice the sport, compete at high levels, and keep attracting new practitioners around the world, an important concern of practitioners, athletes, and coaches has been to understand the different surfer characteristics and to avoid injuries.

Although the low injury rates observed in this sport [5–9], surfing offers challenging and risky conditions to practitioners. First, because surfing has evolved significantly over the past few years: the boards are lighter, shorter, and with better hydrodynamics [4, 7, 10, 11].

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Received: December 07, 2022

Accepted for publication: April 03, 2024

*Citation:* Oliveira MG, Takeuchi E, Mezêncio B, Santos AC, Azevedo APS. Descriptive characterization of Brazilian surfers and their injuries: a cross-sectional and retrospective study. *Hum Mov.* 2024;25(3):72–85; doi: <https://doi.org/10.5114/hm/190498>.

As a result, the maneuvers performed by surfers have become more audacious and faster, incorporating quicker changes in direction and aerial maneuvers to surf style, which could expose them to an increased risk of injuries [7, 11]. For example, there is evidence that the chances of injuries in surfers who perform aerial maneuvers are significantly higher when compared to those who do not perform this kind of movement, because the success rate of these maneuvers is less than 50%, and the impact upon landing is high, leading to high load compression injuries [12, 13]. Lundgren et al. [13] indicate that ankle sprains may be a typical surfing injury due to the modern type of maneuvers. Additionally, this sport is dependent on several external factors, including ocean currents, wind orientation, type of sea floor, contact with the board, and size of waves, which could also increase the risk of accidents during surfing practice [4, 6, 11, 14]. Literature indicates that the evolution of surfing boards and equipment has considerably increased the injuries related to lacerations to the head and face after being overtaken by a wave [11, 15]. Likewise, depending on the depth of the sea, there is an increase in the proportion of injuries resulting from collision with the ground [16]. Another concern is the experience and time practicing surfing. On the one hand, a lack of skills and less experience could be a risk factor; however, on the other hand, elevated experience and time surfing have been associated with a higher percentage of injuries [4].

Studies have shown that the most common type of injury is to the skin, followed by soft tissue injuries [10], whereas the most common body regions injured are the face/head/neck and the lower limbs [10]. Many of these injuries seem to be associated with acute traumas or repetitive movements or postures adopted during surfing [4, 6, 7, 10, 11]. Despite this data, there is still limited research on surfers' profile, characterization, participation, and epidemiology, and their association with injuries and pain in the sport. Similarly, studies about the association of different characteristics of surfers (e.g., gender, skill level, etc.) with injury incidence are sparse.

Inside the surfing world, a noteworthy country is Brazil. The number of surfers doubled in Brazil in recent years [2], and this "Brazilian Storm" has achieved impressive results on the world stage. Both the last male Olympic and World Surf League (WSL) champions were Brazilians, and 6 of the last 10 male champions of the WSL have been from Brazil. Since Brazilian surfers and athletes appear in a prominent position in the world scenery of surf nowadays, it is important to identify the main characteristics of this group of surfers and get

a set of information describing the way they practice surfing and how it relates to injury risk. It could also be important to understand more about this surfing population, what can be behind Brazilians' results, and aspects that could be used to improve training. Finally, updated information and literature are needed to gain a comprehensive understanding of surfing injuries, especially in this group of athletes and practitioners, considering various populations (age, experience, and competition levels). Thus, the purpose of our research is to access information about Brazilian surfers, to describe their main personal and training characteristics, as well as the characteristics of their injuries, and to verify the probability of injury according to skill level, experience in surfing, training volume, and age, through the prevalence ratio, an epidemiological variable.

### Materials and methods

An observational and retrospective cross-sectional study, based on an electronic survey, was conducted. A questionnaire was developed by experienced professionals in surfing and based on the literature [4–6, 11, 17]. The survey was available through Google Forms, from November 2019 to May 2020. The questionnaire (Supplemental materials) was composed of 29 questions (closed-question format), divided into 3 parts seeking information about (a) the athlete's personal and training characteristics (gender, age, skill level, training volume, and experience in surfing); (b) their history of current and previous pains and injuries (occurrence of injuries, body parts involved in each injury, etc.); and c) relationship of pain and injuries with maneuvers and specific positions during surfing (surfing base, drop, aerials, etc.). All information, including the classification of the surfer's skill level, was self-reported.

To provide uniformity to injury surveillance in surfers, an injury definition proposed by previous work was adapted to our population and adopted for the study [18, 19]. It was stated that a surfing-related injury is a "surfing-related (training or competition) musculoskeletal or skin pain that causes a restriction on or prevents surfing (distance, speed, duration, or training) for, at least, 7 days or 3 consecutive scheduled training sessions" [18]. Furthermore, any pain experienced by the participant related to surfing was taken into account, regardless of whether it was acute or chronic. To minimize memory recall bias, questions about surfing-related injuries and pain considered the current situation and the history was restricted to the previous 12 months, considering the survey's answer date.

Surfers were invited via social media (Facebook and Instagram), where the link to the survey was available on the profiles of researchers and experienced professionals in surfing involved in the study. In addition, these professionals shared the survey link by e-mail and WhatsApp (using broadcast network tools) to a list of their contacts, including other coaches and people of confederations and institutions linked to surf throughout Brazil. Thus, the sample included surfers from different parts of the country. The inclusion criteria were to be Brazilian, to have a minimum experience of two months of surfing practice, to have internet access, and to be capable of understanding and answering the questionnaire. Possible pre-existing conditions before the study design were not considered. Participants with duplicated information, and inconsistent answers, and those who did not complete the survey were excluded.

A database was created in Microsoft Office Excel for the answers obtained from the online questionnaire. This set of responses was analyzed and categorized to characterize the surfers and the prevalence of injuries (new and existing cases at the determined period) in the Brazilian surfers, allowing a descriptive approach, as well as accomplishing the appropriate comparisons and correlations. Percentage results, descriptive statistics, and frequency analyses were used to present the data.

The association between a participant’s skill level, time of experience in surfing practice, hours per day of surf training (STR), and age with injury frequency (percentages) was investigated using a Chi-squared test of independence. A post hoc using the moment-corrected standardized residual method was employed [20]. Cramer’s *V* effect size was also calculated, a value of 0.1 was considered a small effect, 0.3 a medium effect, and 0.5 a large effect. The statistical significance of the results was assumed at  $p < 0.05$ . The prevalence ratio (PR) was also calculated to illustrate the probability of having injuries in each circumstance. The PR

is obtained by dividing two prevalences. Therefore, for the present study, the beginner group, with 0 to 6 months of experience in surfing experience, less than an hour per day of training, and the age group 12–19 was considered as references to calculate the prevalence ratio according to skill level, time of experience in surfing, hours per day of training, and age, respectively. Microsoft Office Excel and GraphPad Prism 9.4.1 (GraphPad Software, Inc., USA) were adopted for the analysis and graphs.

**Results**

Brazilian surfers’ description

A total of 1829 Brazilian surfers completed the survey and were included in the analysis. Most surfers who participated in our survey were male (84.2%;  $n = 1541$ ; female: 15.8%;  $n = 288$ ) (Table 1) and aged between 12 and 64 years (Table 2). Of all surfers, 45.4% ( $n = 830$ ) were 20 to 29 years old, and 60.7% ( $n = 1110$ ) had been surfing for more than 2 years (Table 2). Considering the age groups, the prevalence of experienced surfers (2+ years) increased with age (12–19 = 45.8%; 20–29 = 57.2%; 30–39 = 78.2%; 40–49 = 89.3%; 50+ = 87.5%, Table 2). The most prevalent surfing base among Brazilian surfers was “regular” (53.2%;  $n = 973$ ), whose prevalence varied between 50% (50+) and 58.1% (40–49) with these age groups (Table 2).

Table 1. Absolute (*n*) and relative (%) distribution of Brazilian surfers according to gender

Gender	<i>n</i>	%
Female	288	15.8
Male	1541	84.2
Total	1829	100.0

Table 2. Absolute (*n*) and relative (%) distribution of Brazilian surfers according to age, experience surfing, and feet/stance position on board

Experience and position on board	Age (years old)					Total (%)
	12–19	20–29	30–39	40–49	50+	
Time of experience in surfing						
0–6 months	90	160	39	3	1	293 (16.0)
6 months – 1 year	86	88	25	4	0	203 (11.1)
1–2 years	88	107	24	3	1	223 (12.2)
2+ years	223	475	315	83	14	1110 (60.7)
total	487	830	403	93	16	1829 (100.0)
Feet/stance position						
goofy	220	405	183	39	8	855 (46.8)
regular	267	425	220	54	8	973 (53.2)
total	487	830	403	93	16	1829 (100.0)

Most Brazilian surfers dedicate 1 to 2 days per week to STR (79.7%;  $n = 1457$ ), while participants practicing this sport for more than 5 days was only 5.8% ( $n = 107$ , Table 3). This frequency of STR per week was consistent for all age groups, varying from 70.4% (12–19) to 87.5% (50+). In general, Brazilian surfers are used to spending 1 to 2 hours (33.3%;  $n = 627$ ) or 2 to 3 hours per day (32.6%;  $n = 595$ ) training (Table 3). One to 2 hours and 2 to 3 hours per day were the most prevalent training session durations according to age groups, varying between 27.5% and 43.8%. Considering the complementary training (CTR), most surfers dedicate 3 to 4 days per week (37.2%;  $n = 680$ , Table 3), with 1 to 2 hours per day (58.8%;  $n = 1076$ ) in this type of training

(Table 3). The adoption of 3 to 4 days per week of CTR seems to be more prevalent as age increases (12–19 = 32.2%; 20–29 = 35.5%; 30–39 = 43.9%; 40–49 = 48.4%; 50+ = 37.5%, Table 3). Similarly, most surfers in each age group dedicate 1 to 2 hours per day to CTR; however, the proportion of training session duration increases in value as age increases (12–19 = 54.6%; 20–29 = 60.4%; 30–39 = 59.1%; 40–49 = 63.4%; 50+ = 75.5%, Table 3).

Among the different skill levels, the intermediate level presented the highest number of participants (49.3%;  $n = 902$ ), followed by the beginners level (35.6%;  $n = 651$ ), while the advanced and professionals levels were represented by a very lower number of participants (Figure 1a). Considering the participation in com-

Table 3. Absolute ( $n$ ) and relative (%) distribution of Brazilian surfers according to the age, number of training days per week, and hours per day of surf training (STR) and complementary training (CTR)

	STR					total (per day or hour) (%)	CTR					total (per day or hour) (%)
	age (years old)						age (years old)					
	12-19	20-29	30-39	40-49	50+		12-19	20-29	30-39	40-49	50+	
<b>Days of week</b>												
no day	0	0	0	0	0	0 (0.0)	68	85	42	11	0	206 (11.3)
1-2 days	343	691	337	72	14	1457 (79.7)	135	210	85	17	5	452 (24.7)
3-4 days	89	99	57	19	1	265 (14.5)	157	295	177	45	6	680 (37.2)
> 5 days	55	40	9	2	1	107 (5.8)	127	240	99	20	5	491 (26.8)
total (per age group)	487	830	403	93	16	1829 (100.0)	487	830	403	93	16	1829 (100.0)
<b>Hours per day</b>												
< 1 hour	29	70	29	0	2	130 (7.1)	134	252	139	27	3	555 (30.3)
1-2 hours	150	269	165	38	5	627 (34.3)	266	501	238	59	12	1076 (58.8)
2-3 hours	134	282	138	34	7	595 (32.6)	59	61	22	6	1	149 (8.2)
3-4 hours	108	124	46	16	0	294 (16.1)	23	11	2	1	0	37 (2.0)
4-5 hours	43	64	21	4	2	134 (7.3)	2	3	1	0	0	6 (0.3)
> 5 hours	23	21	4	1	0	49 (2.7)	3	2	1	0	0	6 (0.3)
total (per age group)	487	830	403	93	16	1829 (100.0)	487	830	403	93	16	1829 (100.0)

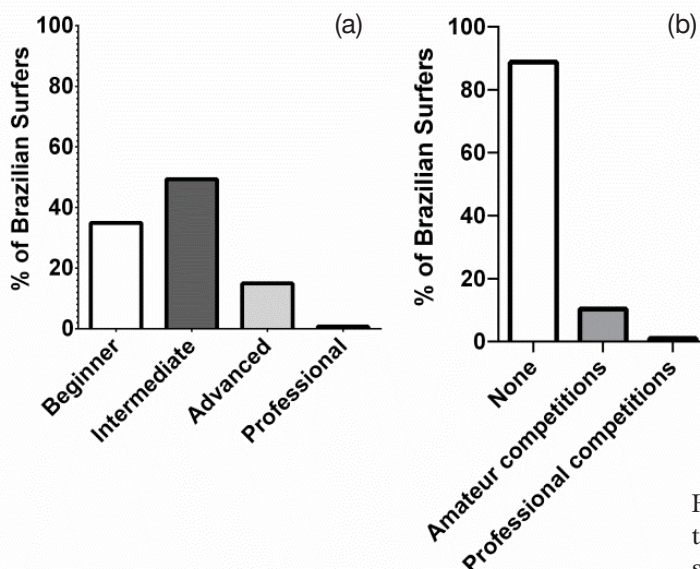


Figure 1. (a) Distribution of Brazilian surfers according to skill level; (b) Distribution (in percentage) of Brazilian surfers according to their participation in competitions

petitions, 9.5% ( $n = 173$ ) of surfers had participated in amateur competitions, while just 0.8% ( $n = 15$ ) competed in professional tournaments (Figure 1b). The majority (89.7%;  $n = 1641$ ) did not get involved in competitions.

Injuries

Of the total number of participants ( $n = 1829$ ), 1015 have already been affected by an injury or had some type of surf-related pain, representing a prevalence of injury of about 55.5%. In 12 months, 954 surfers had injuries, which represents an injury prevalence of 52.2% (Figure 2a). Despite that, only 434 of them currently have pain or injury (Figure 2a), representing an injury prevalence of about 23.7%. Both injuries in the last 12 months and current injuries occurred predominantly during surfing (33.1%;  $n = 605$ ) and complemen-

tary ( $n = 562$ ; 30.7%) training. The beginning of the season (44.6%;  $n = 816$ ) was reported by Brazilian surfers as the period with a higher percentage of injured participants (Figure 2b).

The body regions most affected by injuries and pain in the previous 12 months were knees (19.7%;  $n = 359$ ), shoulders (17.6%;  $n = 319$ ), and spine/trunk (14.3%;  $n = 259$ , Table 4). However, this pattern may change when the analysis is done according to age. For example, beyond the knees (17.1%), the age group 12–19 presents ankles (12.9%) and upper limbs (12.7%) as the body regions most affected by injuries or pain; while legs (16.7%) were one of the most affected body regions for the age 50+ group, along with shoulders (33.3%) and knees (27.8%). Most of these injuries (57.0%;  $n = 480$ ) were classified as mild injuries (which means, there was no withdrawal from training or competition, Figure 3). With current injuries, the body regions most re-

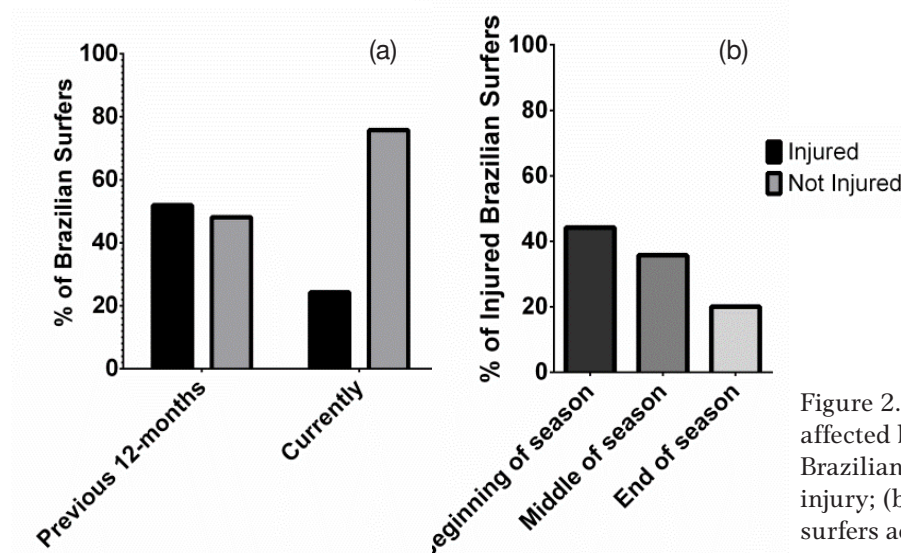


Figure 2. (a) Distribution of Brazilian surfers affected by injury in the last 12-month period and Brazilian surfers who are currently affected by injury; (b) Distribution (in percentage) of Brazilian surfers according to the period of season in which injuries occurred

Table 4. Absolute ( $n$ ) and relative (%) distribution of Brazilian surfers affected by injury in the last 12-month period and Brazilian surfers who are currently affected by injury according to the injured body regions and age

Injured body region	12-month period						Currently					
	12–19	20–29	30–39	40–49	50 +	total (%)	12–19	20–29	30–39	40–49	50 +	total (%)
Foot	60	65	27	4	0	156 (8.6)	18	13	9	2	0	42 (5.5)
Ankle	70	88	44	7	1	210 (11.6)	21	40	17	0	0	78 (10.1)
Leg	58	36	10	6	3	113 (6.2)	12	11	5	2	0	30 (3.9)
Knee	93	149	84	28	5	359 (19.7)	43	71	47	17	4	182 (23.7)
Thigh	48	41	16	2	0	107 (5.9)	10	12	3	1	2	28 (3.6)
Hip	15	32	22	8	0	77 (4.2)	2	17	7	1	0	27 (3.5)
Spine/Trunk	47	98	91	21	2	259 (14.3)	17	52	64	14	3	150 (19.5)
Shoulder	59	137	96	21	6	319 (17.6)	25	65	52	15	3	160 (20.8)
Upper Limbs	69	67	25	9	1	171 (9.4)	18	30	9	6	1	64 (8.3)
Head	24	9	12	1	0	46 (2.5)	5	2	1	0	0	8 (1.0)
Total	543	722	427	107	18	1817 (100.0)	171	313	214	58	13	769 (100.0)

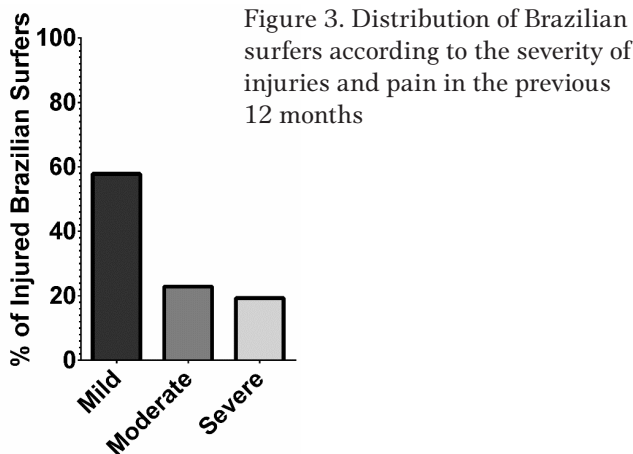


Figure 3. Distribution of Brazilian surfers according to the severity of injuries and pain in the previous 12 months

ported by participants suffering injuries and pain were also the knees (23.7%;  $n = 182$ ), shoulders (20.8%;  $n = 160$ ), and spine/trunk (19.5%;  $n = 150$ , Table 4). Similar patterns and proportions were observed according to age (Table 4). Only 10 (0.5%) participants had already undergone surgical procedures due to injuries related to surfing. Of those surfers who reported current injuries and pain, 29% ( $n = 529$ ) have been injured for 3 to 12 months (Table 5). The same pattern occurs according to age, with the percentage of surfers injured for 3 to 12 months varying between 26.6% (20–29) and 31.6% (50+).

The maneuvers or specific surfing positions in which participants most felt pain were drop (9.4%;  $n = 172$ ) and re-entry (8.4%,  $n = 154$ ), followed by aerials (5.4%;  $n = 98$ ). However, most surfers did not feel pain with any specific maneuver or position (72.5%;  $n = 1327$ ). Additionally, the main difficulties reported in performing aerials were drop landing ( $n = 257$ ) and force production ( $n = 257$ ), as reported by 14.1% and 13.8% of surfers, respectively.

Considering Brazilian surfers who have already been affected by an injury or pain related to surfing during their life, our results indicated that there is an association between participants' skill level ( $X^2(3) = 215.09$

[163.30–278.55];  $p < 0.001$ ;  $V = 0.343$ ; Power = 1), time of experience in surfing practice ( $X^2(3) = 209.18$  [158.19–271.85];  $p < 0.001$ ;  $V = 0.338$ ; Power = 1), hours per day of STR ( $X^2(5) = 54.12$  [32.56–91.30];  $p < 0.001$ ;  $V = 0.172$ ; Power = 1), and age ( $X^2(4) = 49.91$  [28.61–84.84];  $p < 0.001$ ;  $V = 0.165$ ; Power = 1) and injury percentages. The groups with elevated skill levels presented a higher prevalence of injuries than beginner levels (Table 6). Likewise, the groups of Brazilian surfers with more experience in surfing, a higher number of hours spent in specific STR, or a higher age presented a higher prevalence of injured surfers (Table 6). According to prevalence ratios (PRs), the probability of intermediate, advanced, and professional surfers having an injury or pain during their life was 1.8, 2.4, and 2.2 times the probability of beginners, respectively (Table 6). In terms of experience in surfing, the probability of surfers with more than 2 years of experience having an injury or pain in their history was 3.2 times the probability of inexperienced surfers (0–6 months of experience) having the same outcome; whereas the probability of Brazilian surfers with 6 months to 1 year and with 1 to 2 years of experience had injuries or pain corresponding to 2.1 and 2.5 the probability of inexperienced surfers, respectively (Table 6). The chances of having a surfing injury during their life also increase according to the number of hours of training per day: surfers with a higher number of hours have a probability of suffering an injury ranging from 1.6 to 2.1 times the probability of those who practice surfing less than 1 hour per day (Table 6). Regarding age, individuals from the 20–29 group had a 30% less chance of having a surfing injury or pain than those from the 12–19 group; whereas surfers from the 30–39 group have the same probability of injuries compared to the youngest group. In contrast, the probability of older surfers (40–49 and 50+) having an injury or pain during their life is 1.1 times that of surfers from the 12–19 group (Table 6).

Table 5. Absolute ( $n$ ) and relative (%) distribution of Brazilian surfers currently affected by injury related to surfing according to the time window they have been injured and age

The time window of current injuries (in months)	12–19	20–29	30–39	40–49	50+	Total (%)
Uninjured	303	524	190	36	4	1057 (57.8)
3	97	108	69	11	3	288 (15.8)
4–7	27	54	22	5	1	109 (6.0)
8–12	25	59	35	12	1	132 (7.2)
13–24	3	36	20	2	0	61 (3.3)
25+	16	39	56	20	5	136 (7.4)
Did not mention the time window of the current injury	16	10	11	7	2	46 (2.5)
Total	487	830	403	93	16	1829 (100.0)

Table 6. Absolute (n) and relative (%) distributions of Brazilian surfers who have already been affected by an injury or pain related to surfing in the last 12 months, according to skill level, time of experience in surfing, hours per day of surf training and age; and the prevalence ratio (PR) of previous injury considering the beginner group (0–6 months of experience), < 1 hour per day of training, and the 12–19 age group as reference for each category

Skill, experience, training volume, and age	Injured		Not injured		Total		PR
	n	%	n	%	n	%	
<b>Skill level</b>							
beginner	228	35.0	423	65.0	651	100.0	1 (reference)
intermediate	555	61.5	347	38.5	902	100.0	1.8
advanced	225	84.3	42	15.7	267	100.0	2.4
professional	7	77.8	2	22.2	9	100.0	2.2
<b>Time of experience in surfing</b>							
0–6 months	62	21.2	231	78.8	293	100.0	1 (reference)
6 months – 1 year	90	44.3	113	55.7	203	100.0	2.1
1–2 years	120	53.8	103	46.2	223	100.0	2.5
2+ years	743	66.9	367	33.1	1110	100.0	3.2
<b>Hours per day</b>							
< 1 hour	41	31.5	89	68.5	130	100.0	1 (reference)
1–2 hours	315	50.2	312	49.8	627	100.0	1.6
2–3 hours	372	62.7	223	37.3	595	100.0	2.0
3–4 hours	173	58.8	121	41.2	294	100.0	1.9
4–5 hours	82	61.2	52	34.7	134	100.0	1.9
> 5 hours	32	65.3	17	34.7	49	100.0	2.1
<b>Age (years old)</b>							
12–19	270	55.4	217	44.6	487	100.0	1 (reference)
20–29	400	48.2	430	51.8	830	100.0	0.7
30–39	264	65.5	139	34.5	403	100.0	1.0
40–49	69	74.2	24	25.8	93	100.0	1.1
50+	12	75.0	4	25.0	16	100.0	1.1

A similar pattern was observed for Brazilian surfers and current injuries. Results indicated an association between a participant’s skill level ( $X^2(3) = 83.27$  [53.11–125.08];  $p < 0.001$ ;  $V = 0.213$ ; Power = 1), experience in surfing ( $X^2(3) = 73.27$  [45.32–112.89];  $p < 0.001$ ;  $V = 0.200$ ; power = 1), hours per day of STR ( $X^2(5) = 12.56$  [5.27–35.26];  $p = 0.027$ ;  $V = 0.083$ ; Power = 0.790), and age ( $X^2(4) = 51.49$  [29.77–86.84];  $p < 0.001$ ;  $V = 0.168$ ; Power = 1) and current injuries (Table 7). The probability of current injuries in an advanced and professional surfer ranged from 3 and 3.5 times the probability of beginners being injured, respectively (Table 7). Even intermediate surfers were 1.7 times more likely to be injured than beginners (Table 7). More experienced surfers have a higher chance of being injured than less experienced surfers. The probability of surfers with more than 6 months of experience in surfing being injured is 1.6 to 3.2 times the probability of surfers with less than 6 months of experience in the sport (Table 7). Likewise, individuals with longer training sessions had a chance of being injured, ranging from 1.7 to 2.0 times the chance of indi-

viduals with less than an hour of STR per day (Table 7). In terms of age, the probability of current injuries increased according to age, with individuals from the age groups 30–39 and 50+ presenting 1.8 and 1.7 times the probability of individuals from the 12–19 group being injured, respectively (Table 7).

Finally, results indicated an association between a participant’s skill level ( $X^2(6) = 46.38$  [27.76–82.59];  $p < 0.001$ ;  $V = 0.113$ ; Power = 0.970), experience in surfing ( $X^2(6) = 54.25$  [33.51–92.58];  $p < 0.001$ ;  $V = 0.122$ ; Power = 0.980), hours per day of STR ( $X^2(10) = 20.72$  [13.67–53.11];  $p = 0.023$ ;  $V = 0.075$ ; Power = 0.561), and age ( $X^2(4) = 51.49$  [29.77–86.84];  $p < 0.001$ ;  $V = 0.168$ ; power = 1) and the number of injuries within the previous 12 months (Table 8). In general, the prevalence of 1 to 3 injuries in the last 12 months in Brazilian surfers presenting elevated skill, more experience in surfing, more hours per day of STR, and older age was higher than the prevalence in beginners, less experienced, shorter training sessions, and younger surfers (except for the 12–19 age group, Table 8).

Table 7. Absolute (*n*) and relative (%) distribution of Brazilian surfers currently affected by injuries, according to skill level, experience in surfing, hours per day of surf training, and age; and the prevalence ratio (PR) of current injuries considering the beginner group, 0–6 months of experience, < 1 hour per day of training, and the 12–19 age group as reference for each information category

Skill, experience, training volume, and age	Injured		Not injured		Total		PR
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
<b>Skill level</b>							
beginner	92	14.8	559	85.9	651	100.0	1 (reference)
intermediate	227	25.2	675	74.9	902	100.0	1.7
advanced	111	51.6	156	58.4	267	100.0	3.5
professional	4	44.4	5	55.6	9	100.0	3.0
<b>Time of experience in surfing</b>							
0–6 months	28	9.6	265	90.4	293	100.0	1 (reference)
6 months – 1 year	30	14.8	173	85.2	203	100.0	1.6
1–2 years	39	17.5	184	82.5	223	100.0	1.8
2+ years	337	30.4	773	69.6	1110	100.0	3.2
<b>Hours per day</b>							
< 1 hour	17	13.1	113	86.9	130	100.0	1 (reference)
1–2 hours	143	22.8	484	77.2	627	100.0	1.7
2–3 hours	156	26.2	439	73.8	595	100.0	2.0
3–4 hours	78	26.5	216	73.5	294	100.0	2.0
4–5 hours	31	23.1	103	76.9	134	100.0	1.8
> 5 hours	9	18.4	40	81.6	49	100.0	1.4
<b>Age (years old)</b>							
12–19	88	18.1	399	81.9	487	100.0	1 (reference)
20–29	170	20.5	660	79.5	830	100.0	1.1
30–39	131	32.5	272	67.5	403	100.0	1.8
40–49	36	38.7	57	61.3	93	100.0	1.2
50+	9	56.6	7	43.8	16	100.0	1.7

Table 8. Absolute (*n*) and relative (%) distribution of Brazilian surfers and their number of injuries in the previous 12 months, according to skill level, experience in surfing, hours per day of surf training, and age

Skill, experience, training volume, and age	Number of injuries						Total	
	0		1–3		4 or more		<i>n</i>	%
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
<b>Skill level</b>								
beginner	378	58.1	264	40.6	9	1.4	651	100.0
intermediate	394	43.7	489	54.2	19	2.1	902	100.0
advanced	100	37.5	162	60.7	5	1.9	267	100.0
professional	3	33.3	6	66.7	0	0.0	9	100.0
<b>Time of experience in surfing</b>								
0–6 months	197	67.2	91	31.1	5	1.7	293	100.0
6 months – 1 year	94	46.3	105	51.7	4	2.0	203	100.0
1–2 years	93	41.7	126	56.5	4	1.8	223	100.0
2+ years	491	44.1	599	54.0	20	1.8	1110	100.0
<b>Hours per day</b>								
< 1 hour	82	63.1	47	36.2	1	0.8	130	100.0
1–2 hours	307	49.0	310	49.4	10	1.6	627	100.0
2–3 hours	264	44.4	322	54.1	9	1.5	595	100.0
3–4 hours	143	48.6	143	48.6	8	2.7	294	100.0
4–5 hours	59	44.0	72	53.7	3	2.2	134	100.0
> 5 hours	20	40.8	27	55.1	2	4.1	49	100.0
<b>Age (years old)</b>								
12–19	197	40.5	271	55.6	19	3.9	487	100.0
20–29	445	53.6	376	45.3	9	1.1	830	100.0
30–39	188	46.6	211	52.4	4	1.0	403	100.0
40–49	40	43.1	52	56.0	1	0.9	93	100.0
50+	5	31.3	11	68.7	0	0.0	16	100.0



## Discussion

In the present study, an online survey was used to elicit information about Brazilian surfers, to describe their main characteristics, to provide the characteristics of their injuries, and to explore injury prevalence according to skill level, time of experience in surfing, and training volume. To the best of our knowledge, this is the largest Brazilian national survey to date conducted on the personal, training, and injury characteristics of surfers.

With a focus on Brazilian surfer characterization, results revealed that, in general, Brazilian surfers are predominantly men (84.2%), young adults between the ages of 20 to 29 years old (45.4%), with more than 2 years of experience in surfing (60.7%). And, as should be expected, the proportion of experienced surfers (more than 2 years of practice) increases according to age group. In addition, the surfers mainly include non-competitive (89.7%) recreational surfers (99.2%), with an intermediate skill level (49.3%), a regular stance (53.2%), that practice surfing 1 to 2 days per week (79.7%) for 1 to 3 hours per day (65.9%), without being influenced by age. This scenario suggests that, despite the success of Brazilian athletes in many tournaments around the world, surfing remains an amateur sport inside the country.

Our results also corroborate other studies, including some conducted in specific regions of Brazil, regarding the characteristics of gender [1, 4–6, 17], age [1, 3, 4, 6], skill level [1, 4, 6], and experience in surfing [4, 6]. The number of hours spent per day training observed by our participants is analogous to those found in some previous studies [4, 6, 11]. In contrast, the training frequency per week obtained in our study was slightly less than those presented in previous studies [3, 4, 11]. One explanation is the fact that some studies recruited only competitive surfers, whose training volumes are expected to be higher than less skilled surfers. Another possible explanation for this distinction may be the significant difference in sample sizes. While the present research included 1829 participants, the sample size in the previous studies varied between 60 and 1348 surfers. In addition, our study recruited surfers from multiple regions of Brazil (even some living part of the time outside Brazil), different from the previous national research. Given that the skill and specialization levels of athletes are associated with training volume [4, 21], lower values of weekly frequency and/or daily hours of training could be expected for a sample composed of a high number of beginner and intermediate-level surfers, like ours. It suggests that our sam-

ple could bring a more precise or most current description of the scenario of surfing in Brazil, mainly when compared to national studies. The results also allow us to note that there may be low affordability or a lack of interest in competitive surfing. Even though Brazil is a country with a vast coastal area and has a growing practice of surfing throughout the territory, 89.7% of surfers did not get involved in competitions. This could mean the encouragement of the sport, the number of competitions held, and/or the organization of events promoting the sport may still be low, especially when compared to other sports, which may have hindered interest in competitive surfing. Now that the current Olympic and World champions of surfing are Brazilian, it is expected that the promotion of the sport and the number of competitions and events will increase considerably in an effort to identify, select, and train new talent. Finally, another interesting characteristic of Brazilian surfers is that most of them (88.7%) were involved in some kind of CRT, dedicating about 3 to 4 days per week (37.2%) and 1 to 2 hours per day (58.8%) to this type of training. It should be highlighted that the proportion of surfers dedicating about 3 to 4 days per week and 1 to 2 hours per day to CRT seems to increase as the age groups increase. It suggests the adoption of a healthy and physically active lifestyle beyond surfing, which is consistent with Romariz et al. [22] and Bazanella et al. [4], and a deeper concern regarding this aspect as the practitioner's maturity level increases.

In terms of injury, the prevalence in Brazilian surfers was about 55.5%, with more than half of participants (52.2%) presenting at least one episode of injury or pain related to surfing in the previous 12 months; whereas the prevalence of current injuries or pain in Brazilian surfers was 23.7%. In contrast, previous studies [1, 4, 6, 11, 17] found higher values of injury prevalence in surfers in comparison to the present research. Considering the studies of Burgess et al. [17] and Base et al. [11], the main reason for the distinct results in the previous 12 months and current injuries is that their samples were formed by competitive surfers only, while the present sample was composed predominantly of recreational practitioners. As competitive and professional surfers have higher physical and sports demands, they may be more exposed to different injury determinants, including an increased training volume and sports specialization [21, 23–25]. Although the surfers included in the studies conducted by Steinman et al. [6], Moraes et al. [1], and Bazanella et al. [4] were predominantly recreational surfers, similarly to the present research, the differences in injury prevalence could be attributed to distinct characteristics of

training according to their location or, even, the improvements and evolution of surfing practices.

Similar to previous evidence [1, 4–6, 10, 17], the lower limbs (50.3–56.2%) were the most commonly injured anatomical region, followed by the upper limbs (27.0–29.1%) and upper body (16.8–20.5%). Considering the previous 12 months, more than half of injuries occurred on the lower limbs, with an emphasis on the knees (19.7%), followed by the shoulders (17.6%) and spine/trunk (14.3%). Identically, the body regions most reported by the participants for current injuries and pain were the lower limbs (50.3%), highlighting the knees once more (23.7%), followed by the shoulders (20.8%) and spine/trunk (19.5%). Literature shows that different parts of the human body are susceptible to injuries related to contact with the board and traumas in surfing [6, 11, 17]. Beyond that, injuries and pain, notably on the lower limbs, may be associated with changes in surfing style over the past decade and the inclusion of more challenging maneuvers that impose greater loads on surfers and whose performance and safety require a more refined technique (e.g., landing floater or aerial maneuvers) [5, 26]. More intense, explosive, and aggressive turning movements [6, 11, 17], repetitive movements, and prolonged positions demand high isometric work and joint stabilization, such as tube, drop, and floater [6, 11]. Such explanations seem to be quite plausible since the maneuvers or specific surfing positions in which our participants most felt pain was the drop (9.4%), re-entry (8.4%), and aerials (5.4%); whereas one of the main difficulties reported to perform aerials was drop landing (14.1%). Considering that 45% of a surfing session involves paddling [27, 28], another possible explanation suggested by the literature for the injuries reported (mainly on the shoulders) is the repetitive effort associated with this movement [5, 6]. The isometric hyperextension of the spine/trunk for a prolonged time during paddling is also suggested as a possible source of pain and injury in this region [6]. Most of these injuries (57.0%) were classified as mild injuries, corroborating Steinman et al. [6] and Hay et al. [29], whose studies observed a predominance of low-complexity injuries. Another point to consider is that the most common body regions previously injured may be influenced by the age of participants. Literature indicates that the level of skills and experience varies with age, determining the actions and maneuvers performed during surfing, the physical and sports demands, and consequently exposing the surfers to different injury determinants [25]. Thus, it should not be unexpected that surfers of distinct age groups report different regions of injury or pain.

When our results of surfing are compared to other board sports, such as snowboarding and skateboarding, the characteristics of the participants are similar: they are predominantly male young adults, who participate recreationally in these board sports [30, 31], although a higher number of skateboarders participate frequently in competitive events [31]. Nonetheless, the peculiarities of each board sport seem to determine the trends of injuries, making surfing a safer practice than other board sports. First, other board sports seem to present a frequency of injury considerably higher than surfing [30–34]. Moreover, the upper limbs and head are the most injured anatomical regions in snowboarders and skateboarders [30, 34–38], while the lower limbs seem to be most affected by surfing. Another important difference is that injuries in surfing observed in our study were predominantly mild, whereas those reported in snowboarding and skateboarding are mainly severe traumatic injuries [30, 31, 33, 34, 39]. Probably, the distinct external and environmental challenges faced by surfers and practitioners of other board sports may explain these differences in injury characteristics.

However, an important finding of this study was the association between a participant's skill level, experience surfing, hours per day of surf training, and age and injury prevalence and the number of previous injuries. Brazilian surfers with superior skill levels, more experience, higher hours per day of surf training, and higher age presented, in general, a higher prevalence of previous and current injuries. Likewise, surfers presenting with elevated skills, more experience in surfing, more hours per day of surf training, and a higher age also showed a higher prevalence of 1 to 3 injuries in the last 12 months than beginners', less experienced, short-training surfers, and younger surfers. These results are consistent with the literature [4, 23, 24] that indicates a negative influence of variables related to the time of practice (such as early sport specialization, high training volume, high skill level, and participation in competitions) on sports injuries. More specifically in surfing, Bazanella et al. [4] indicated an increment in injury occurrence as an effect of time practicing the sport, observing that the average number of injuries increased by 2.5% for each extra year of surfing. A possible explanation is that more experienced and skilled surfers may spend more time surfing, and this higher volume of practice could increase the exposure of these athletes to the intrinsic and extrinsic risks of surfing. Additionally, more experienced and skilled surfers are supposed to perform more difficult and bolder maneuvers, which could also result in increased risk and susceptibility to injuries. In terms of age, our results also

corroborate the literature [3, 16, 25] that presents evidence of higher rates of injury in older surfers. A possible explanation is that older practitioners, mainly recreational surfers (that were predominant in our study), in general, present a wider age span and possibly more comorbidities or weaknesses in the locomotor system due to the natural aging process, which could increase the susceptibility of injuries and pain.

It is interesting to note that these factors can affect the participants of other board sports differently. On the one hand, there is evidence that skill level, experience in sport, and age are not protective factors for snowboarders and skateboarders, increasing the chances of having severe injuries [30, 31, 33, 38, 40]. More experienced, more skilled, and young adult snowboarders/skateboarders may spend more time performing the sport, and this higher volume of practice could increase the exposure of these athletes to injury. In addition, young adults (18–29 years old), more experienced, and skilled athletes of other board sports are also supposed to perform more difficult and bolder maneuvers and present increased risk-taking behavior, which could result in an increased risk and susceptibility to injuries. Evidence supports the higher incidence and severity of traumatic injuries in experienced and professional snowboarders and skateboarders, as a consequence of collisions and falls [30, 33–35, 40]. In contrast, some studies show that many injuries occur in the first weeks of practicing snowboarding and skateboarding, suggesting that the lack of experience and minimum level of skill can also increase the risk of injuries in these sports [30, 34, 36]. Similarly, elderly skateboarders present a high risk of severe injuries, which are probably related to decreased physical fitness/coordination and structural losses associated with aging [40].

The findings of the present study support that surfing presents similar, or even, lower levels of injury when compared to other sports and ways of exercise [41–44], representing a relatively safe practice. Nevertheless, it is important to highlight that, due to the intrinsic characteristics of this sport, there may be other etiologic agents besides the ones mentioned that can bring different levels of risk to surfers, such as sun exposure or accidents related to environmental conditions. As with any sport, understanding athletes' characteristics, the characteristics of their injuries, and their prevalence are the initial steps to formulating and implementing any injury prevention program. Furthermore, the current findings can bring to a close a set of extremely useful information for the coaches, athletes/practitioners, and physical therapists who deal with surfing, pre-

paring surfers appropriately for their training or interventions and improving performance simultaneously with injury prevention.

Finally, the present research has some limitations that should be considered. The study consisted of a retrospective survey based on a questionnaire. The results were dependent on the participant's memory and sincerity, which could influence these findings. To ensure as many responses as possible, the questionnaire was concise and objective. As a result, other relevant information was not obtained by the present study and deserves more attention in further research (such as the presence of pre-existing conditions, the types of injuries and pain, the differentiation of acute and chronic pain, and where these surfers live). Moreover, the participants' skill levels were self-reported, making the skill level classification criteria subjective, requiring caution in the interpretation of these findings. Likewise, relevant global events happening during the availability of the questionnaire (e.g., COVID-19 pandemic) may also exert some level of influence. Thus, results should be viewed and considered with caution. In addition, given it was an online survey, the participation was limited to those surfers who had any access to the Internet. Also, there may be a recruitment bias, since we did not obtain data on the distribution of participants by region, and the inclusion criteria were broad. On the other hand, it enabled the participation of surfers from all over the country, and those living part of the time in other countries (professionals), ensuring a significant sample. Finally, the study was conducted in a specific population (Brazilian surfers). As a result, extrapolations to other populations must be done carefully.

### Conclusions

Summarizing, Brazilian surfers are predominantly male, young adults, with intermediate skill levels, and non-competitive athletes. The most injured anatomical region in this group is the knees, followed by the shoulders and column/trunk. Finally, contrary to expectation, higher experience and skill levels might not act as protective factors against injuries due to increased training volume. The probability of injuries seems to be related to training volume, skill level, experience in the sport, and age. It means that Brazilian surfers with higher skill levels, higher experience, higher hours per day of surf training, and a higher age have a higher probability of presenting previous and current injuries. Nevertheless, surfing seems to present similar, or even, lower levels of injury when compared to other sports and ways of exercise, representing a relatively safe practice. To

the best of our knowledge, this is the largest Brazilian national survey to date conducted on surfers' personal, training, and injury characteristics.

### Acknowledgments

The authors would like to thank all participants for agreeing to participate and sharing their information. In addition, the authors thank CAPES (Brazil) for financial support to publish this article.

### Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the local ethics committee (approval No.: 3.704.983; date of approval: November 14, 2019).

### Informed consent

Informed consent was obtained from all individuals included in this study. In the case of adolescents, informed consent was provided by the parents/guardians, who were also instructed to oversee the completion of the form to ensure the participant's correct understanding.

### Disclosure statement

No author has any financial interest or received any financial benefit from this research.

### Conflicts of interest

The authors state no conflicts of interest.

### Funding

This research received no external funding.

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