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ORIGINAL RESEARCH

SPORTS INJURIES AND THEIR RISK FACTORS IN ADOLESCENTS WHO PRACTICE SWIMMING

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Abstract

Introduction: swimming is a popular sport among adolescents; however, your practice can lead to injuries. **Objectives:** to characterize the sport injuries and associate them with risk factors in teenage swimmers from different levels of competitiveness. **Methods:** 251 swimmers were interviewed, it an average age of 12.43±2.10, both sexes, recruited randomly and they were classified into three competitive levels: initiation, development, and training category. It was used the morbidity survey adapted to the characteristics of swimming as collection instrument containing personal and training of volunteers data, as age, anthropometric variables and training variables and information relating to injuries sustained during a period of 12 months. All findings were described at the 5% significance level. **Results:** It was verified that there is an association between the presence and absence of injury with the variable height and variable time. The causal mechanism most common was the non-contact mechanism for the categories of initiation and training. The most affected anatomical site was the lower limb and upper limb for all competitive levels. The mild severity, the training time and the absence of recurrence predominated. The asymptomatic return was more frequent for initiation, whereas the symptomatic return prevailed in the training category. **Conclusion:** the injury rate in teenage swimmers was low. The variables height and training time were associated with the occurrence of injuries. The characteristics of the injuries depended on the competitive level of the swimmers.

Key words: athletic injuries, risk factors and morbidity surveys, swimming.

INTRODUCTION

The practice of sports, irrespective of the competition level, has become a routine activity. Care must be taken, however, as sports training can represent a risk factor for the occurrence of sporting injuries (SI). The beginner period, when the individual receives his or her first instruction in the sport, is of particular concern as the target population is comprised of children and adolescents who are still maturing and are exposed to possible causal factors[1,2].

Swimming is a popular sport[3] that is practiced from infancy both as a form of recreation and for training and competition. Like other physical activities it is recommended as a way of maintaining cardiovascular and musculoskeletal health[4], as well as resulting in improved body perception[5].

Despite these advantages, constant exposure to repetitive motor movements and strain represents a risk to body structures among swimmers[6]. In children, injuries related to the locomotor equipment may, depending on their nature, compromise future motor movements and therefore merit further attention[6]. Adirim and Barouh[7] found that children practicing an athletic activity are exposed to injuries and that their musculoskeletal immaturity represents a risk factor. Tanaka[3] found that SI are more frequent when the athlete is exposed to increased force when seeking improved performance.

In relation to risk factors for the occurrence of SI among swimmers, intrinsic factors inherent to the athlete, such as age and gender[8] and extrinsic factors related to the training itself, such as level of effort, intensity of force and the specific athletic movement used in the type of sport are important [8].

Some studies have investigated the mechanisms of injuries among swimmers and, in the majority of these, repetitive movement represents the main risk factor[9]. The shoulder is the region where most injuries occur in this

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population group, where strain resulting from repetitive movements together with musculature imbalance may lead to musculoskeletal injuries[10].

In summary, the benefits of the practice of physical and sporting activities are well known and well documented, and the participation of children and adolescents in sport is becoming more popular and more widespread. As the majority of these involve dynamic mechanisms and actions [11], the practice of sport raises concerns about the risk of SI in children and adolescents[11].

Despite the studies mentioned above, there is a lack of epidemiological information on the subject, especially in relation to the different levels of competition of the sport. Therefore, increased knowledge of the risk factors, mechanisms and characteristics of swimming injuries can help health professionals with the prevention, diagnosis and treatment of these injuries, representing an important contribution to Health and Sports Sciences. The aim of this study was to characterize sports injuries and associate them with risk factors in swimmers at different competition levels.

METHODS

Subject

The study included 251 swimmers from the Secretariat Municipal Sports Presidente Prudente/SEMEPP, Brazil, chosen at random, of both sexes with a mean age of 12.43±2.10 years, body mass 48.68±10.55 kg, height 1.55±0.11 m, body mass index of 19.96±2.70 kg.m2, training time of 1.80±1.25 years and weekly hours of sports practice 3.53±3.65 hours.

The volunteers were divided into three groups according to the level of competitiveness: Beginner Category (n=193) in which volunteers received their first lessons in a period of one year; Advanced Category (n=27) in that order was to improve the skills and knowledge about swimming and may participate in internal competitions and Training Category (n=31) in which the swimmers participated of competitions regional and/or federated. This study was assessed and approved by the Ethics Committee of the Faculty of Science and Technology - FCT/UNESP, campus Presidente Prudente/SP, protocol number 08/2010.

Study design and field procedures

Data were collected through individual interviews that addressed the occurrence of injury and their characteristics during the last 12 months of training and/or competition. The interviews were held before or after workouts, in order not to interfere with the normal dynamics and sports routine.

To collect the data was used a reported morbidity survey, an instrument used to obtain information about the general health of a specific population, mainly due to their applicability and objectivity[4,12,13-15]. A pilot study was conducted to test its applicability in the target population of the survey.

Samplings were conducted by a single interviewer familiar with the instrument, and the participants answered the inquiries conducted by the researcher, who also had the responsibility of making annotations in the investigation. This procedure was suggested by Pastre et al. [12] in their study, based on different levels of understanding for noting responses from interviewees themselves. The information could be provided not only by the volunteer himself but also by his trainer, responsible, or both, as suggested Pereira [16] to obtain data related to morbidity.

Description of reported morbidity survey

The reported morbidity survey contained personal data of volunteers as age, weight, height, time of training in years and weekly hours of sports practice. To obtain body weight was used Filizola a scale with accurate to 0.1 kg and for the verification of a height was used portable estatiômetro with millimeter measurements. In addition, the survey included questions on SI as anatomical site affected, mechanism of injury, time of injury, severity of injury, return to normal activities and recurrence.

For anatomical location, an illustrative figure of the human body was shown to volunteer for the purpose of facilitating the identification by the same. Another aspect addressed was the mechanism of injury that was the perception of volunteer about the exact contact or gesture performed at the time the typical signs and symptoms of acute episodes and/or the type of activity that such demonstrations have widened, divided in direct contact, non-contact and overuse[17-18]. Besides these, it was also observed the moment of the occurrence of injury that was analyzed by specific phase of training or competition. Already the injury severity was graded according to the National Athletic Injury Reporting System (NAIRS) according to the time of recovery[19]. The return to normal physical activities aimed to observe whether the return to sport without any changes in normal training occurred with or without the presence of signs and/or symptoms. Finally, recurrence was questioned to detect whether such occurrence has already manifested on other occasions and in the same anatomical location[18].

For this study, SI was considered any physical complaints resulting from training and/or competition that limited the participation of the individual for at least one day, regardless of the need for medical attention, as already used in other research[13,20].

Organization and description of the categories of variables

In order to facilitate the analysis and presentation of results, the variables were divided into categories from clusters to represent the most significant blocks results without, however, changing the essence of its origin or the conclusions of the study.

With respect to anatomical site, referring to the symptom of pain or discomfort brought by the volunteer, the questionnaire presented 20

body regions. To facilitate data analysis, the following segments were chosen: upper limb (UL) which included shoulder, arm, elbow, forearm, wrist and hand, lower limbs (LL) representing anterior thigh, posterior thigh, knee, leg, calf, ankle and foot and trunk covering chest, abdomen, head, cervical spine, lumbar spine, pelvis and groin.

It was considered three mechanism of injury: i) injury by direct contact that those that were caused by a single traumatic incident such as trauma to the edge of the pool[18] ii) injury by non-contact that were inherent in the sport itself, as rapid changes of motion and swimming style[18] and iii) injury by overuse that were presented as chronic injuries that occur as a result of repetitive stress of the musculoskeletal system over time, without allowing adequate rehabilitation[17].

The severity of injury was divided into three grades: mild injuries (from one to seven days off), moderate injury (eight to 21 days out) and serious injuries (over 21 days away or permanent injury)[19].

Statistical Analysis

Data analysis of the population profile and description of the variables we used the descriptive statistical method and the results were presented as mean values, standard deviation, confidence interval, percentages and absolute numbers.

The *Kolmogorov Smirnov* test was used to test the normality of the data. When normal distribution was accepted was applied the unpaired data *Student's t* test and for the non-normal distribution was applied the *Mann-Whitney*.

The association between anatomic site, mechanism, timing, severity, return to normal activities and recurrence according to the populations studied was done by the *Goodman* test for contrasts between and within multinomial populations according to the characteristics of the group of variables be analyzed.

Statistical analyzes were performed using analysis software *Minitab* version 13.3. It was used 5% level of significance.

RESULTS

As the findings did not vary in terms of gender, no distinction was made between male and female in analyzing the results. Of the 251 swimmers participating in the study, a total of 30 injuries were described by 29 athletes. The injury rate was 0.11 and the injury rate per injured athlete was 1.03.

Table 1 shows the association between intrinsic risk factors (anthropometric data) and extrinsic risk factors (training data) according to the presence and absence of lesions. The intrinsic characteristic height and the extrinsic characteristic training time in years were risk factors for the occurrence of injuries, in that individuals with higher median values for these variables were more affected by injuries.

Table 1: Distribution of mean, standard deviation, median and confidence interval of descriptive measures of the characteristics of swimmers according occurrence of injury

Variable	Injury		
	Absent	Present	p-value
Age(2)	12,36 ± 2,14 (13,00) [12,07 – 12,64]	13,03 ± 1,67 (13,00) [12,40 – 13,65]	0,156
Weight(1)	48,24 ± 10,34 (48,25) [46,88 – 49,60]	52,54 ± 11,80 (52,20) 48,13 – 56,94]	0,066
Height(2)	1,54 ± 0,11 (1,56) [1,53 – 1,56]	1,59 ± 0,09 (1,60) [1,55 – 1,63]	0,036*
BMI(1)	19,92 ± 2,68 (20,04) [19,56 – 20,27]	20,40 ± 2,95 (20,44) [19,30 – 21,50]	0,400
Training time(2)	1,73 ± 1,20 1,00 [1,57 – 1,89]	2,33 ± 1,41 (2,00) [1,80 – 2,86]	0,0009*
Weekly hours(2)	3,32 ± 3,38 (2,00) [2,88 – 3,77]	5,46 ± 5,30 (2,00) [3,48 – 7,44]	0,062

(1) Student's t test
(2) Mann-Whitney test
Normality test Kolmogorov-Smirnov
* Statistically significant difference between the affected athletes and unaffected for injury

Table 2 shows the association between competition levels and the anatomic region, mechanism and severity of the injury. In relation to the anatomic region affected, the results for the upper limbs and the lower limbs were statistically different from the torso in both the advanced and the training categories. With respect to causal mechanism, there was a significant difference between non-contact and direct contact and overuse in both the beginner and the training categories. In terms of the severity of the injury, no significant differences were observed between competition levels, as all the injuries described were classified as mild.

Table 2: Frequency distribution absolute (n) and relative (%), of the anatomic site, mechanism and severity of injury according to category of competitive swimmers

Category	Anatomical Site			
	Upper Limb	**Lower Limbs**	**Trunk**	**Total**
Beginner	7 (50)	5 (35,71)	2 (14,29)	14 (100)
Advanced	2 (28,57)#	5 (71,43)#	0 (0,0)	7 (100)
Training	4 (44,44)#	5 (55,56)#	0 (0,0)	9 (100)
Category	**Mechanism of Injury**			
	Direct Contact	**Non-Contact**	***Overuse***	**Total**
Beginner	0 (0,0)	14 (100)*	0 (0,0)	14 (100)
Advanced	1 (14,29)	5 (71,42)	1 (14,29)	7 (100)
Training	0 (0,0)	8 (88,89)*	1 (11,11)	9 (100)
Category	**Severity of Injury**			
	Mild	**Moderate**	**Serius**	**Total**
Beginner	14 (100)	0 (0,0)	0 (0,0)	14 (100)
Advanced	7 (100)	0 (0,0)	0 (0,0)	7 (100)
Training	9 (100)	0 (0,0)	0 (0,0)	9 (100)

Goodman test for contrasts between and within multinomial populations.
* Difference from direct contact mechanism and overuse;
\# Difference from trunk.

In relation to moment of injury, there was a significant difference between the number of injuries occurring during training and during competition for both the beginner and the advanced categories. Additionally, there was a difference between the beginner category and the advanced and training categories in terms of the number of injuries that occurred during training. In relation to return to normal activities (Table 3) it can be seen that there was a difference between the beginner and the training categories for both return without signs and/or symptoms and symptomatic return. There was a difference between asymptomatic return and return with signs and/or symptoms for the beginner and advanced training. In terms of recurrence of the injury, absence of recurring injuries was more frequent and statistically different from presence of recurring injuries.

Table 3: Frequency distribution absolute (n) and relative (%) of moment, return to normal activity and recurrence according to category of competitive swimmers.

Category	Momento of Injury		
	Training	**Competition**	**Total**
Beginner	14 (100)*#	0 (0,0)	14 (100)
Advanced	7 (100)*	0 (0,0)	7 (100)
Training	7 (77,78)	2 (22,22)	9 (100)
Category	**Return to Normal Activities**		
	Asymptomatic	**Symptomatic**	**Total**
Beginner	14 (100)†‡	0 (0,0)	14 (100)
Advanced	7 (100)†	0 (0,0)	7 (100)
Training	3 (33,33)	6 (66,67)•%	9 (100)
Category	**Recurrence of Injury**		
	Yes	**No**	**Total**
Beginner	3 (21,43)	11 (78,57)Δ	14 (100)
Advanced	1 (14,29)	6 (85,71)Δ	7 (100)
Training	1 (11,11)	8 (88,89)Δ	9 (100)

Goodman test for contrasts between and within multinomial populations.
* Difference in relation to competition moment;
\# Difference in relation the categories of advanced and training;
† Difference in relation to symptomatic return;
‡ Difference in relation the category of training;
• Difference in relation to the category of beginner;
Δ Difference in relation to presence of recurrence.

DISCUSSION

The present study aimed to characterize SI in adolescent swimmers, by associating them with risk factors specific to the type of sport and the athlete through the application of a reported morbidity survey (RMS).

The injury rate of swimmers that suffered at least one injury during the current study was 0.11 of the total number of participants, which represents a low injury rate. According to Maffulli, Baxter-Jones and Grieve[21] and McMaster[22], swimming has a lower injury rate than other sports as it does not involve direct contact.

In terms of risk factors, there was a significant difference between the intrinsic factor height and the extrinsic factor training time for the occurrence of injury, as athletes above average height and who had trained for longer periods had a greater risk of injury.

According to Ackland[23], greater limb length among athletes of greater stature can generate greater propulsion. From this the hypothesis arises, to be tested in future studies, that this specific factor may generate not only improved functional performance but also risks to the integrity of follow-up actions due to the greater intensity of force related to the athletic movement. In terms of training time, greater exposure to training represents an increased risk of injury[24].

In relation to anatomic region, the upper and lower limbs were statistically different from the torso for the advanced and training categories. Injuries to the shoulder are described as the most frequent type of swimming injury by a number of authors[20,25], who report that 90% of the force of propulsion of swimmers comes from the upper extremities. Biomechanically, Aguiar *et al.* [4] describes that the shoulder joints of swimmers suffer from repetitive use and joint strain especially at the moment when the hand enters the water, when the angle of elevation of the shoulder is at its physiological peak, and also during the recovery phase of the stroke, when there is excessive internal rotation of the shoulder.

Furthermore, Borsa *et al.*[26] describes how injuries among athletes who perform movements with the upper limbs above the level of the head, such as swimmers, occur due to excessive mobility, which can also have the secondary effect of causing changes to the structure of the ligaments, capsules, muscles and bones of the glenohumeral joint, making them susceptible to injuries.

Some authors have shown the knee to be the region second most affected by injuries, the majority of which are associated with the breast stroke[27,28]. This can be explained by the importance of the lower limbs in providing propulsion in such stroke, meaning that the flexor and adductor muscles of the hip joint can suffer acute injury or strain related to leg movements[27]. According to Kenal and Knapp[28] pains in the knee, when related to the breaststroke, are located in the medial border, and are caused by rotational stress and excessive valgus stress causing chondromalacia, the syndrome of medial collateral ligament injury and medial synovitis.

In relation to the mechanism of the injury it was found that the beginner and training categories had a more frequent non-contact mechanism, which is significantly different when compared to direct contact and overuse. Weldon and Richardson [29] and Banks *et al*. [30] reported that the volume of training is responsible for the majority of injuries in swimmers, being the principal cause of absences from competition and training.

In relation to the severity of injuries as reported by the participants, the injuries were predominantly mild for all the categories studied. It may be suggested that the greater occurrence of mild injuries is due to the characteristic of the sample group of the present study, which is predominantly formed by beginners, among whom training intensity is less than in the training category.

For injuries that occurred during training, the beginner category was different from the advanced and training categories. This finding may be related to the greater exposure to training[19] of beginner adolescents, whose participation in competitive events is minimal.

For the beginner and advanced categories it was found that the majority of athletes returned to normal activities after injury without the presence of signs and/or symptoms. However, there was a significant difference between the training category and the beginner category for symptomatic return. The high prevalence of symptomatic athletes in training categories can be explained by the fact that these athletes may be exposed to risk factors inherent to the early return to activity and inadequate rehabilitation, as some technical and tactical situations are practiced repeatedly and exhaustively in an attempt to achieve maximum performance, especially after injury in order to recover physical conditioning[20].

One limitation of the present study may be that the RMS used as a data collection tool was not validated. However, its use was justified by the need for a tool capable of collecting information related to SI in the sporting environment. Additionally, other limitations can be identified: injury frequency per 1000 hours of training and information related to the swimming style of each participant were not gathered and the anatomic region affected was not specified.

Stracciolini *et al.*[31] concluded that while athletic activity can improve the health of some children and adolescents, it may, in some cases, create serious medical problems. As a result, the authors propose that studies that examine the correlation of SI in children and adolescents and identify risk factors should be encouraged. It is hoped that the results of the present study may contribute to a greater understanding of injuries in adolescent swimmers, leading to better planning and improved training and injury prevention strategies.

In conclusion, adolescent swimmers have a low injury rate. The most frequent causal

mechanism for the beginner and training categories was non-contact. The most affected anatomic regions were the upper and lower limbs for all competition levels and most injuries occurred during training. Mild severity of injury and absence of recurrence also predominated. Asymptomatic was the most frequent return category for beginners, while symptomatic return was most frequent for the training category. There was an association between the presence of injury and height and training time of swimmers.

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