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# Prevalence of dental trauma in Pan American Games athletes

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Correspondence to: Dr Dennis N. Ranalli, Professor and Senior Associate Dean, University of Pittsburgh, School of Dental Medicine, 3501 Terrace Street, Suite 440, Pittsburgh, PA 15261, USA Tel.: 412-648-8472 Fax: 412-648-8219 e-mail: dnr4@pitt.edu Accepted 3 February, 2010 Abstract – The aim of this cross-sectional epidemiological survey was to assess the prevalence of dental trauma in athletes representing 42 countries competing at the most recent Pan American Games (XV Pan Am) held in Rio de Janeiro, Brazil in July of 2007, and to determine prior use and type of mouthguard among this group of athletes. The examiners participated in standardization and calibration training sessions before the field phase began. Invitations were sent to >5500 participating athletes competing in 41 sports and to the Medical Committee of the Pan American Sports Organization before and during the XV PAN. A convenience sample of 409 athletes was recruited. After signing an informed consent, all athletes answered a questionnaire. Data were collected at the clinical examination and recorded on a specific trauma form. The mean age of the athletes was 24.4  $\pm$  5.3 years. Males comprised 55% of the sample; females 45%. The prevalence of dental trauma among the athletes was 49.6% (n = 203) with no gender-based differences. Most of these injuries (63.6%) were related to activities during training or competition. Sports with the highest injury prevalence were wrestling (83.3%), boxing (73.7%), basketball (70.6%) and karate (60%). The most common injury was enamel fracture (39.8%); root fracture was the least common (0.4%). The teeth most affected were the maxillary permanent central incisors (n = 113), followed by the mandibular central incisors (n = 19). Based on the results of this study, nearly one-half of the subjects had experienced previous dental trauma; the majority related to sports activities. Furthermore, only 17% of the athletes reported prior mouthguard use; the most frequent mouthguards reported were boil-and-bite. These results suggest the importance of enhanced educational efforts and the use of properly fitted mouthguards to reduce dental trauma among athletes in international sports competition, especially in sports where mouthguards are not mandatory.

The Pan American Games are a multi-sport event held every 4 years since 1951. These games are intended as a competitive athletic venue for all nations of the Americas. The most recent event, XV Pan Am games were held in Rio de Janeiro, Brazil in July of 2007. A total of 5634 athletes participated in the XV Pan Am, representing 42 nations in 41 sports.

Causal factors for dental trauma have been attributed to falls, assaults, motor vehicle accidents and seizure disorders among others (1, 2). As sports activities continue to expand throughout the world, there is an associated risk for increases in dental trauma among athletes. While several studies appear in the dental literature related to traumatic dental injuries from all causes including sports, no known literature was found related to the prevalence of dental trauma in Pan American Games athletes. The presence of dental trauma in world-class athletes emphasizes the need for epidemiological studies in this high performance group (3). The prevalence of dental trauma varies depending on the sport. One study determined the occurrence of dental trauma among 1189 male athletes and reported that 28.8% had previous dental trauma (4). In that same study, considering each sport separately, 41.2% of the athletes in jiu-jitsu had experienced dental trauma, 37.1% in team handball, 36.4% in basketball, 23.2% in soccer, 22.3% in judo and 11.5% in field hockey (4).

Other authors have reported the prevalence of dental trauma ranging from 8% to 45% depending on the sport. For example in sports such as volleyball, which is not considered a contact sport, the prevalence of dental trauma was reportedly lower than in sports with contact such as taekwondo or ice hockey (5–8). In addition, the prevalence of dental trauma varies depending on whether or not athletes are required and comply with the rules regulating the use of properly fitted athletic mouthguards (9).

The objective of this cross-sectional epidemiological survey was to assess the prevalence of dental trauma in athletes representing 42 countries competing at the most recent Pan American Games (XV Pan Am) held in Rio de Janeiro, Brazil in July of 2007, and to determine prior use and type of mouthguard among this group of athletes.

#### Material and methods

This study was approved by the Research Ethics Committee of the Pedro Ernesto University Hospital of the University of the State of Rio de Janeiro, Brazil and was administered in July of 2007 by three examiners. The examiners included one periodontist and two general dentists who were calibrated for intra- and inter-judge reliability using kappa values obtained through the statistical program spss version 8.0. The intra- and inter-kappa values varied between 0.0902–0.0987 and 0.0859–0.0875, respectively.

Prior to the games, the project was presented and informational leaflets distributed at a meeting of the Medical Committee of the Pan American Sports Organization. All medical directors of the 42 countries participating in the games were present. The informational leaflets subsequently were sent by the Organizing Committee of the Pan American Games in Rio to all athletes in residence at the Pan American Village. In addition, during the games, two announcements were placed in the village newsletter, which was distributed to all athletes. Moreover, personal recruitment was conducted in the international zone and outside the village restaurant, as these were high volume traffic areas for athletes from all countries participating in the games.

Athletes who agreed to participate in the study signed an informed consent and completed a questionnaire on their own. The questionnaire was available in English Portuguese or Spanish, and the examiner assisted only when requested. Questionnaires identified the following information from participants: name, country of birth, age, date of birth, sex, type of sport, and whether or not the athlete previously had sustained a traumatic dental injury, either when participating in any sport or otherwise, as well as prior use and type of mouthguard.

After completing the questionnaire, participants received a clinical examination by one of the previously trained and calibrated dentists. The examinations were conducted using appropriate infection control measures. All intraoral examinations were conducted in a dental chair with standard light source and air jet. Dental trauma was categorized according to the Ellis classification system (10).

Differences between proportions were calculated using the chi-squared test and the alpha level was set at 0.05. Data were presented as mean, with standard deviations and 95% confidence intervals were calculated.

#### **Results**

Over 5500 athletes were registered for the games. A convenience sample of 409 athletes agreed to participate in the study. The overall gender distribution included

Table 1. Frequency and distribution of examined athletes (N) and sports-related dental trauma (n) according to sport

Sport	N	Distribution of sports-related dental trauma, n (%: 95% Cl)
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Triathlon	1	1 (100)
Wrestling	12	10 (83.3% ± 21.1)
Boxing	19	14 (73.7% ± 19.8)
Basketball	17	12 (70.6% ± 21.7)
Synchronized swimming	3	2 (66.7% ± 53.3)
Karate	5	$3 (60.0\% \pm 42.9)$
Team handball	14	8 (57.1% ± 25.9)
Judo	19	10 (52.6% ± 22.5)
Soccer	61	24 (39.3% ± 12.3)
Water polo	20	7 (35.0% ± 20.9)
Diving	3	1 (33.3% ± 53.3)
Fencing	3	1 (33.3% ± 53.3)
Field hockey	32	10 (31.3% ± 16.1)
Baseball	14	4 (28.6% ± 23.7)
Taekwondo	7	$2 (28.6\% \pm 33.5)$
Track and field	90	14 (15.6% ± 7.5)
Rowing	7	1 (14.3% ± 25.9)
Shooting sports	7	1 (14.3% ± 25.9)
Swimming	19	2 (10.5% ± 13.8)
Volleyball	17	1 (5.9% ± 11.2)
Weightlifting	17	1 (5.9% ± 11.2)
Aquatic marathon	1	0 (0%)
Archery	6	0 (0%)
Artistic gymnastics	2	0 (0%)
Badminton	2	0 (0%)
Beach volleyball	6	0 (0%)
Biking	2	0 (0%)
Figure skating	2	0 (0%)
Rafting	6	0 (0%)
Rhythmical gymnastics	2	0 (0%)
Sailing	2	0 (0%)
Squash	3	0 (0%)
Table tennis	5	0 (0%)
Tennis	0	0 (0%)
Water skiing	0	0 (0%)
Total	424	129 (30.4% + 4.4)

225/409 (55%) males; 184/409 (45%) females. The athletes ranged in age from 13 to 46 years with a mean age of 24.4 years ( $\pm$ 5.3).

The overall distribution of athletes participating in this study by sport is presented in Table 1. Among the 203 athletes who reported prior dental trauma, only 36.5% ( $\pm 6.6.95\%$  CI) indicated that the dental trauma was not associated with practicing for or competing in their respective sport (Table 2). Some athletes had more than one injury event, which most frequently occurred during practice or game situations ( $19.2\% \pm 5.4$ ).

The range in age of the athletes who reportedly had sustained a prior dental trauma was 13 to 46 years; mean age was 24.3 years ( $\pm$  5.0). By gender, 59.1% were male and 40.9% female, which was determined not to be a statistically significant difference (P = 0.143).

The distribution of injuries by sport, demonstrates that triathlon (100%), wrestling (83.3%, 95% CI  $\pm$  21.1), boxing (73.7% CI 95%  $\pm$  19.8) and basketball (70.6%, 95% CI  $\pm$  21.7), were the sports, proportionately, with more dental trauma (Table 1).

*Table 2.* Distribution of dental trauma according to the situation when it occurred

Injury situation	n (%; 95% CI)
During practice	52 (25.6% ± 6.0)
During game	27 (13.3% ± 4.7)
In another situation (not related to the sport)	74 (36.5% ± 6.6)
During practice + during game	39 (19.2% ± 5.4)
During practice + in another situation	3 (1.5% ± 1.7)
During game + in another situation	3 (1.5% ± 1.7)
During practice + during game + in another situation	5 (2.5% ± 2.1)
Total	203 (100%)
Some athletes presented with more than one injury.	

Among the sports that reported any prior dental trauma, the least affected sports were: track and field (15.6%, 95% CI  $\pm$  7.5), swimming (10.5%, 95% CI  $\pm$  13.8), weightlifting (5.9%, 95% CI  $\pm$  11.2) and volleyball (5.9%, 95% CI  $\pm$  11.2).

In this study, the majority of dental trauma occurred to the maxillary permanent central incisors (n = 113; 56.5%), followed by the mandibular permanent central incisors (n = 19; 9.5%), then both the maxillary and mandibular permanent lateral incisors (n = 18 each; 9%).

The type of injury with the highest prevalence was enamel only fracture n = 111 (39.8%, 95% CI  $\pm$  5.7) (Fig. 1). Of the teeth with enamel only fractures, 21.9% (95% CI  $\pm$  4.8) n = 61, occurred during practicing for or competing in their respective sports (Fig. 1). Conversely, only one athlete previously had sustained a root fracture (0.4%, 95% CI  $\pm$  0.7) during athletic participation. The distribution of non-complicated (enamelonly lesions; enamel + dentin lesions) and complicated dental injuries (enamel + dentin + pulp lesions, root fracture, dislocation, avulsion) according to use of mouthguard and sport is presented in Table 3.

The overall use of mouthguards reported among this sample was low. Only 68/409 (17.0%) participants reported prior use. Thus, the vast majority 341/409 (83.0%) reported never having used a mouthguard. Of those who reported prior mouthguard use, the type of

mouthguard reported is as follows: stock 9/68 (13.3%); boil-and-bite 30/68 (44.1%); custom 29/68 (42.6%). Among the 203 athletes who reported prior dental injuries 161/203 (79.3%) reported that were not wearing a mouthguard at the time of injury.

It is important to note that the results shown in Table 3 support the contention that mouthguards reduce traumatic lesions. With a mouthguard in place, there were fewer complicated lesions (n = 3) than without a mouthguard in place (n = 5). With a mouthguard in place there were fewer non-complicated lesions (n = 38) than without a mouthguard in place (n = 83). Overall with a mouthguard in place there were fewer lesion (n = 41) than without a mouthguard in place (n = 88). Thus, of the 129 traumatic lesions in this sample over two-thirds (n = 88/129) occurred among athletes not wearing mouthguards.

In Table 4, we show the prevalence of dental injuries in three different sport clusters: A – high-risk contact sports where use of mouthguard is required; B – highrisk sports where use of mouthguard is not required; and C – low-risk sports where use or mouthguard is not required. The number of dental injuries was significantly higher in groups A and B when compared with group C (P < 0.05). There was no significant difference between groups A and B (P > 0.05).

#### Discussion

The prevalence of dental trauma varies based on the type of sport. Previous studies with different groups of amateur and professional athletes in different countries have demonstrated that sports-related dental trauma ranges from 8% to 45% (3–9). The current study demonstrates a slightly higher prevalence (49.9%) for dental trauma among this group of world-class athletes, with large variation among sports. In our sample, 63% of the injuries were sports-related. Elite athletes are exposed to many hours of intensive training and competition that may, in part, account for these results.

While some studies have reported no statistical differences between genders related to dental trauma



*Fig. 1.* Distribution of total dental trauma and sports-related dental trauma by type of injury.

	Mouthguard				No mouthguard				
	No. no lesions	n-complicated		No. cor lesions	mplicated				
	Type of mouthguard used					No.	No.		
Sport	S <sup>3</sup>	$B^4$	C <sup>5</sup>	S <sup>3</sup>	$B^4$	C <sup>5</sup>	lesions <sup>1</sup>	lesions <sup>2</sup>	N
Soccer	0	0	2	0	1	1	18	0	22
Boxing	1	9	3	0	0	0	0	1	14
Basketball	0	0	2	0	0	0	10	0	12
Track and field	0	0	0	0	0	0	11	1	12
Field hockey	0	3	1	0	1	0	5	0	10
Wrestling	0	1	1	0	0	0	8	0	10
Judo	0	0	0	0	0	0	7	1	8
Team handball	0	0	0	0	0	0	7	0	7
Water polo	0	1	0	0	0	0	6	0	7
Baseball	0	0	0	0	0	0	2	1	3
Karate	0	2	0	0	0	0	0	0	2
Synchronized swimming	0	0	0	0	0	0	1	1	2
Taekwondo	1	1	0	0	0	0	0	0	2
Diving	0	0	0	0	0	0	1	0	1
Fencing	0	0	0	0	0	0	1	0	1
Rowing	0	0	0	0	0	0	1	0	1
Shooting sports	0	0	0	0	0	0	1	0	1
Swimming	0	0	0	0	0	0	1	0	1
Triathlon	0	0	0	0	0	0	1	0	1
Volleyball	0	0	0	0	0	0	1	0	1
Weightlifting	0	0	0	0	0	0	1	0	1
Total	2	17	9	0	2	1	83	5	129
	20			0					

Table 3. Distribution of complicated and non-complicated traumatic dental lesions according to use of mouthguard and sport

<sup>1</sup>Non-complicated (enamel-only lesions; enamel + dentin lesions).

<sup>2</sup>Complicated dental injuries (enamel + dentin + pulp lesions, root fracture, dislocation, avulsion).

<sup>3</sup>Stock mouthguards.

<sup>4</sup>Boil and Bite mouthguards.

<sup>5</sup>Custom mouthguards.

(12–15), others have reported that males demonstrated a higher prevalence than females (11, 16, 17). In this study, while males did demonstrate a higher frequency of dental trauma, this gender difference was not determined to be statistically significant.

The current study demonstrates that maxillary permanent central incisors were the most frequently traumatized teeth and that crown fractures were the most frequent type of dental injury. In addition, enamel-only fractures (40%) occurred most frequently, followed by enamel + dentin fractures (20%), then fractures involving enamel + dentin + pulp (3%). Although the prevention of oral injury events during sports involves other variables such as intensity and duration of training, it seems clear that the effects of traumatic dental lesions can be substantially limited with the use of mouthguards.

The prevalence of dental trauma has been shown to be related to predictable factors such as intensity and speed of the sport, level of contact among participants, and the use and type of protective athletic equipment, including mouthguards (19). A recent study among a sample of amateur sportsmen in the Israeli Defense Forces demonstrated that the number of self-reported sports-related oral/dental trauma cases was similar between mouth-

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guard users and non-users, but the users group showed less severe injuries (18). In this study, 68.6% of the noncomplicated lesions and 62.5% of the complicated lesions among world-class athletes occurred when they were not using a mouthguard (Table 3). Conversely, the athletes using mouthguards suffered only one-half the number (31.8%) of complicated and non-complicated lesions suffered by athletes who were not using mouthguards (68.2%). These results together suggest that the use of mouthguards not only protects against more serious lesions, but also may influence the prevalence of injury events.

Interestingly, in this study, most of the non-complicated lesions occurred in soccer (n = 18), followed by basketball (n = 10), track and field (n = 11), judo (n = 7), team handball (n = 7) and water polo (n = 6), which are sports that do not mandate the use of mouthguards. In addition, four of the five complicated lesions also occurred in sports in which the use of mouthguards is not required, such as judo (n = 1), synchronized swimming (n = 1), baseball (n = 1), and track and field (n = 1). The results in Table 4 showed no statistically significant difference between the clusters of sports in group A (high-risk contact sports where use of mouthguard is required – wrestling, boxing, karate,

*Table 4.* Prevalence of dental injuries for sports groupings based on injury risk and mouthguard mandates

Sport	N	<i>n</i> (%; 95%Cl)
<ul> <li>A – high-risk contact sports where use of mouthguard is required (wrestling, boxing, karate, taekwondo, field hockey)</li> </ul>	75	39 (52%; ± 11.3)
<ul> <li>B – high-risk sports where use of mouthguard is not required (basketball, team handball, soccer, water polo, baseball, judo, diving, synchronized swimming)</li> </ul>	151	68 (45%; ± 7.9)
C – low-risk sports where use or mouthguard is not required (aquatic marathon, archery, artistic gymnastics, badminton, beach volleyball, biking, fencing, figure skating, rafting, rhythmical gymnastics, sailing, squash, table tennis, tennis, water skiing)	200	22 (11%; ± 4.6)

Comparisons between groups: no statistically significant differences between groups A and B; statistically significant differences between groups A and C and groups B and C (P < 0.05).

taekwondo, field hockey) and group B (high-risk sports where use of mouthguard is not required – basketball, team handball, soccer, water polo, baseball, judo, diving, synchronized swimming). With the exception of judo, which is an intentional full-contact sport, the other sports in group B involve non-intentional contact with opponents, teammates or objects. This suggests that risk of dental trauma in some sports with no intentional contact among participants can be as high as some fullcontact sports where the use of mouthguards is mandatory. Therefore, the use of mouthguards should be strongly considered and recommended even in sports with non-intentional or limited contact among participants.

The type and quality of the mouthguards most likely influence the athlete compliance with mouthguard use (20). Among this group of world-class athletes, where the focus for performance is intense, the reported use of more comfortable custom-fabricated mouthguards (42.6%) was slightly lower than the use of boil-and-bite mouthguards (44.1%). Considering the overall low number of individuals in this study who reported the use of mouthguards (17%) and the higher costs associated with custom-fabricated mouthguards, one could speculate that this factor may have influenced compliance, especially among athletes from disadvantaged regions competing at the Pan American Games.

The variation in reported prevalence of dental trauma is related, in part, to methodological differences in study design (16), many of which were conducted using questionnaires (4, 6, 8). In the current study, a questionnaire was used along with a clinical examination.

This study used a convenience sample that was recruited during the XV Pan American Games. This may have resulted in a sample bias of those athletes who were concerned about their dentition. The researchers had no control over who chose to participate, as this activity was entirely voluntary and was taking place during a major international sporting competition involving several different countries. Larger studies during international sporting events offer a unique opportunity to screen such heterogeneous populations in a rather short period of time.

The results of this study suggest the importance of enhanced educational efforts and the use of properly fitted mouthguards to reduce dental trauma among athletes in international sports competition, especially in sports where mouthguards are not mandatory.

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### Conflict of interest statement

None of the authors have a conflict of interest to report.

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