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Summer Camp at Sport injuries: a Tool for Safety Planning

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Abstract

This study analyses surveillance data on summer camp sport injuries. The aim of this study was to create a typology of sport injury characteristics and circumstances specifically designed to elaborate safety strategies. Seven variables describing aspects of 337 summer camp sports injuries registered over a 3 month period in 8 different camps summer were analyzed simultaneously using, in sequence, the factorial analysis of correspondence (FAC) and the hierarchical ascendant classification (HAC). Relationships between sport injury characteristics and injured pupils' age and gender were measured. Five sport injury patterns as a typology was obtained and significant relationships were found to exist amongst sport injury patterns, age and gender. Findings revealed that the construction of a sport injury typology - by means of methods similar to those employed in the current study – may be of use for those concerned with camp sport injury prevention, such as camp managers and administrators.

Keywords: camp sport injuries, pupil injuries, sport injury characteristics, sport injury typology, sport injury surveillance

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Introduction

Every year many children spend part of their summer at a camp. At summer camp, they are involved in many physical activities and live in group cabins or outdoors. The types of activities engaged in at camp coupled with the exposure of other campers, enhances the risk of injury while at camp (American Camping Association, 1990). This also seems to be the case in the contemporary Greek society. Thousands of children every year participate in the Greek summer camps (Afthinos, 1998). The care and safety of other people's children has been a priority of camp owners and directors since the first camp experience some 140 years ago. Safety is a priority for and an important factor for the owners, the managers of camp and the State which is responsible for the regulations. After all, the physical and emotional condition of a child returning home at the end of a season is the primary concern and interest of all (Key, 1998).

In the past, summer camps faced less regulations, fewer demands, children were much easier to manage and parents who were far less opinionated and interested in control. The world has changed dramatically and the camp industry has not been exempt (Schirich, 1999). Today, creating the culture of safety demands an intelligent system of examining every expected and unexpected injury that could compromise the safety of a child at a camp (Cole & Gable, 2000; Friedman, 2001).

Sport injuries constitute one of the greatest threats to the health of children in the industrialized world. They are the leading cause of childhood deaths and even when non-fatal may have major consequences for victims, their families and society at large (Laflamme & Eilert – Peterson, 1998a; Murray & Lopez, 1996; Ministry of Health, PRC, 2000; Stoddard & Saxe, 2001). Minimal research has been conducted analyzing the status of sport injuries at camps. Studies focused more at school and recreational injuries. Specifically over the past 20 years, several large studies of school and recreational injuries have been conducted in a variety of countries and communities (Cellis & Villasenor, 2001; Laflamme & Menckel, 1997; Laflamme & Eilert - Peterson, 1998a). These studies focused on identifying the injury determinants and characteristics. According to these studies, injury frequencies vary by age, gender, location and activity. Specifically, playgrounds injuries are frequent but more common among young pupils and injuries in sports tend to become more important as age increases. In some studies,

injury types and parts of the body injured have been found to vary according to age of pupil and nature of activity (Mallonee, 2000; Scheidt *et al.* 1995).

All these studies provide limited support for the targeting of safety measures and intervention in the camp environment. In the current paper, a strategy for the analysis of camp – sport injury data, based on the maintenance of a surveillance register and the application of multivariate techniques is proposed.

After an extensive literature review the researchers decided to construct a sport injury typology which is grouped on a threefold line, with direct implications for preventive work. First, despite the unique character of any sport injury similarities do exist among sport injuries, be in the characteristics of the sport injuries, in their very immediate circumstances of occurrence, or in the remote factors that led to sport injury. For example a knee injury could have been occurred during football or basketball or running. These similarities may help defining particular sport injury characteristics. Second, each of these patterns might have its own determinants and it is unlikely that any one sport injury determinants will have an identical influence in the case of all patterns. Third, for any given characteristic, a variety of preventing measures can be applied.

Methodology

Sample

The aim of the project was to map the epidemiology of sport injuries sustained in summer camps. Sport injury data were taken from 337 summer camp-sport injury reports gathered over a 3 month summer period (June 2003 to August 2003) in Greece.

Questionnaire

A standardized registration form was employed, specifically “Students Injury and Incident Reports for Use in Swedish School” (Laflamme et al., 1998b) designed in accordance with Sweden’s National Board of Health and Welfare’s classification of injuries (Swedish National Board of Health and Welfare, 1989), a further development of a classification and set of definitions constructed by the Nordic Medico-Statistical Committee (NOMESCO, 1990). These measurement instruments were for use in a Greek summer camp context.

Process

Data were collected in camp infirmaries with doctors and camps managers completing the measurement instrument. Table 1 shows the summer camp –related sport injury by age and Table 2 summer camp – related sport injury by genders.

Table 1. Camp – Sport Injuries by Age.

Age Groups	Number	%
7-9	14	4.2
10-12	205	60.8
13-15	118	35.0
Total	**337**	**100.0**

Table 2. Camp – Sport Injuries by Gender.

Gender	Number	%
Male	237	70.3
Female	100	29.7
Total	**337**	**100.0**

Statistical Analysis

To be able to characterize sport injuries, which occurred in the summer camp environment, two multivariate statistical methods were used in sequence: the factorial analysis of correspondence (FAC) and the hierarchical ascendant classification (HAC). These data reduction techniques are applicable to both qualitative and quantitative data. FAC and HAC have been extensively applied in the arena of occupational injuries and have been described in greater detail in previous studies by Laflamme et al. (1993) and Laflamme et al. (1991).

With the combined use of these methods lies the capacity of the technique to generate injuries classes that can be both portrayed and quantified. Each class is characterized by the (inter-related) attributes (categories of variables) that significantly define it (Fénelon, 1981; Greenacre, 1984; Benzécri, 1985). Analysis focuses on variable attributes (categories) rather than on the variables taken as a whole.

FAC and HAC can be applied in sequence, provided that the same distance measure in employed in both analyses (in this case, the χ^2 distance). The FIAC maximize the variance (inertia) between the classes and minimizes the one within the classes. The interclass inertia is a measure of the separateness of the classes (Fenelon, 1981; Benzecri, 1985; Laflamme & Peterson, 1998). The higher it is, the higher the difference between the classes. The intraclass inertia is a measure of the internal

consistency of a class. The lower it is, the higher the class internal consistency. The sum of the interclass and intraclass inertias is equal to 1.

In the FAC performed in the current study, seven variables were treated simultaneously: six described the sport injury and its circumstances and were treated as active (injury type, body part, sport activity, causal agent, and injury mechanism), while one other described the particular site of occurrence of the sport injury and was treated as illustrative. The difference between active and illustrative variables can be summarized as follows. Active variables contribute to the variance (inertia) in the data set and to the formation of factorial axes. In this case, they are the variables employed to address the question: what are the most typical characteristics of sport injuries and the circumstances under which they are injured? Illustrative variables, in contrast, are not employed to calculate the variance and do not contribute to the formation of the factorial axes. Their contribution can be estimated only after the axes have already been established. This may be used to search for contextual explanations for any one of the sport injury patterns, e.g. to address the question: are the sport injury patterns identified 'sport site specific'?

Once the sport injury had been classified, a χ^2 test (significance level 0.05) was applied to the relationships between sport injury elements on the one hand and age and gender on the other.

Results

From the data analysis it is suggested that five sport injury classes occurred in summer camps. HAC, performed on the first, second and third factor of the FAC, highlighted five main sport injury patterns (intraclass variance=44.59%). The distribution of the sport injuries within each class is shown in Table 3. The variable treated as active in the FAC are ordered on the basis of their contribution (as a percentage) to the formation of the first, second and third factorial axis. The categories of the variables that contributed significantly to the formation of each class ($p>0.05$) are shown in Table 3. The class descriptions that follow are based on these variable categories and the name given to each class reflects the most significant descriptors around which each class formed.

Class 1. Sprained ankle during football (81 injuries; 5.8745% variance). This class encompasses injuries as ankle sprain. The injuries were sustained during football. The most significant causal agent associated with these injuries was the ball.

Class 2. Shoulder dislocation (22 injuries; 2.1830% variance). This class encompasses injuries such as shoulder dislocation. The most significant causal agent associated with these injuries was the other person. Collisions with other people were the most significant injury mechanism.

Class 3. Cut – wound and sprained knee (161 injuries; 34.3097% variance). This class, the largest one, encompasses injuries such as cuts and wounds incurred most typically to the head and sprains to knee. The most significant causal agents associated with these injuries were other person. Sports injuries in class 3 were incurred more during basketball.

Class 4. Injuries at swimming pools during sport activities (25 injuries; 9.1313% variance). Injuries in class 4 were incurred more at swimming pool during sport activities. The most significant causal agents associated with these injuries were other types.

Class 5. Sprained fingers during beach volley (48 injuries; 3.9055% variance). This class encompasses injuries such as sprained fingers, occurred mostly during beach volley. The most significant causal agent associated with these injuries was collision with the ball. The most significant injury mechanism was crushed by object.

Table 3. Main Characteristics of the Five Classes Obtained by Factorial Analysis of Correspondence (FAC) and Hierarchical Ascendant Classification (HAC).

Class 1 (n=81)	**Class 2 (n=22)**	**Class 3 (n=161)**	**Class 4 (n=25)**	**Class 5 (n=48)**
Sprained ankle	Shoulder	Cut /wound	Other sports activities	Finger
*17.91	*11.11	*10.60	*8.10	*99.99
**97.53%	**90.91%	**67.70%	**84%	**91.67%
Ankle	Shoulder dislocation	Knee	Others	Sprained Finger
17.66	10.96	8.86	7.91	13.17
96.30%	86.36%	40.37%	64%	77.08%
Ball	Other person	Head	Other mechanism	Crushed by object
5.64	4.82	8.43	7.50	8.39
75.31%	77.27%	37.89%	44%	81.25%
Football court	Collision with other	Sprained	Swimming pool	Beach volley
4.75	person	knee	5.85	7.63
59.26%	3.72	4.59	32%	43.75%
	50%	18.01%		

*V- Test: The categories that contributed significantly to the formation of the classes; i.e. there is a greater number of sports injuries than expected in these categories, $p<0.05$.

**CLA/MOD: The percentage of individuals that is characterized by the categories and belongs in the classes;

Relationship between Injury Characteristics and Age and Gender

A strong and positive relationship between age groups and sport injury class is shown in Table 4. Class 1, was represented as frequently as expected at age group (10-12 years). However, sport injuries in classes 2 and 3 were found more frequently among younger pupils (7-9 years) and at the higher age group (13-15 years). Class 3, which is the largest numerically, was representing as frequently as expected at ages groups (7-9 years & 13-15 years). Sport injuries in class 4 were found more frequently among younger pupils (7-9 years) and age group (10-12 years). However, sport injuries in class 5, was found more frequently than expected only at the higher age group (13-15 years).

Table 4. Relationship between Sport Injury Class and Age of Injured Pupil – Observed (O) vs. Expected Values (E).

	Age Groups					
	7-9		10-12		13-15	
Sport injury class	O	E	O	E	O	E
1. Sprained ankle during football	1	3.4	61	49.3	19	28.4
2. Shoulder dislocation	3	0.9	10	13.4	9	7.7
3. Cut - wound and sprained knee	7	6.7	94	97.6	60	56.4
4. Injuries at swimming pool	2	1.0	18	15.2	5	8.8
5. Sprained finger during beach volley	1	2.0	22	29.2	25	16.8
Total	14		205		118	

χ^2=23,061; degrees of freedom=8; p<0.05

Table 5 shows that there is a strong and positive relationship between sport injury pattern and gender. Sport injuries in classes 1 and 2 were incurred as frequently as expected by male's pupils. Female's pupils recorded more sport injuries than expected in classes 3, 4 and 5.

Table 5. Relationship between Sport Injury Class and Gender of Injured Pupils – Observed (O) vs. Expected Values (E).

	Gender			
	Male pupils		Female pupils	
	O	E	O	E
Sport injury class				
1. Sprained ankle during football	75	57.0	6	24.0
2. Shoulder dislocation	18	15.5	4	6.5
3. Cut - wound and sprained knee	112	113.2	49	47.8
4. Injuries at swimming pool	14	17.6	11	7.4
5. Sprained finger during beach volley	18	33.8	30	14.2
Total	**237**		**100**	

χ^2=47,925; degrees of freedom=4; p<0.05

Discussion and Conclusions

Elements of the Camp Sport Injuries Investigated

From looking at the main elements of the summer camp sport injuries one variable at a time, it can be seen that the current study produces significant results. Sport injuries are concentrated in sports activities (football, basketball, swimming and beach volley), wounds (cuts) and sprains were the most common injuries types and lower and upper limbs are the most common parts of the body injured. Differences in sport injury characteristics by age and gender have also been found in previous research (Brudvik, 2000; Burt & Overpeck, 2001; Laflamme & Eilert - Peterson, 1998a; Patel & Nelson, 2000). Overall, findings revealed a high rate of injury among adolescents aged 10-12 years. Consistency in the findings that risk of sport injury in child increases with age is not surprising given that level of competition, contact and size typically increase with age (Armstrong *et al*. 2000; Emery, 2003). Moreover male children were at a greater risk of injury as they may be more aggressive and experience greater contact compared with girls (Emery (2003). This finding likely reflects gender based differences in behavioral factors, perception or activity patterns (Kontos, 2004; Mo, Turner, Krewski & Merrick, 2006)).

What distinguishes the results of the current study from those of investigations based in similar data but in different environments is the qualitative gain that has been procured by means of the sport injury typology. Differences and similarities between different groups of sport injuries are also clarified. This gain can be attributed in part to

the treatment applied to the data and the type of information available in the questionnaire.

Constructing Typologies: A Tool for Summer Camp – Sport Injury Prevention

The sport injury typology generated by multivariate analysis highlighted the main characteristics in the summer camp sport injuries investigated. At the same time, each element was defined in the light of a number of characteristics of both the sport injuries and their circumstances of occurrence. Furthermore, each element was given a name in accordance with the characteristics (categories of variables) that contributed most significantly to its formation. This typology permits a presentation of sport injuries that makes it apparent that the focus of preventive work should vary according to the characteristics and circumstances of the kinds of sport injuries it is designed to address. Class 3, for example, points to particular parts of the body knee and head and specific injuries types (cuts, wounds and sprains); class 2 to a specific injury type (shoulder *dislocation*); and classes 1 and 5 to different sport activities (football and beach volley).

As a complement to the typology, the cross tabulations of sport injury elements against age and gender provide a further guide to the targeting of preventive interventions (Vorko – Jovic et al., 2001). A non-specific sport injury elements, such as that of class 2 (shoulder dislocation) could be addressed in the context community – based on safety planning, whereas sport injury elements such as those in class 4 (injuries at swimming pool during sports activities) might be considered within particular summer camps (depending upon their specific pupil population). The same line of reasoning can be applied when gender specific injury prevention is contemplated. This should take into account both differences and similarities between the genders (Laflamme & Eilert - Peterson, 1998a; Stark *et al*. 1996).

Thus taken as a whole, the material offers guidelines for a variety of preventive strategies. It can be employed to focus on particular problems and then direct preventive measures at the groups most likely to benefit.

Limitation of the study

As in all epidemiological studies there are limitations. First, the results do not provide explanations for why the sport injuries were incurred. This is a shortcoming related to both the type of data analyzed and the non-causal treatment applied to them. Second and complementary to the firstly limitation is that little light is shed on the characteristics of individuals or summer camps that might have contributed to sport injury occurrence.

Summer camp-sport injury surveillance can be a very useful instrument for prevention provided that the data registered are sufficiently detailed to indicate clear safety targets. Construction of sport injury typologies enables the systematization of the sport injury experiences of a defined group of people. This makes possible the identification of targets and facilitates the selection of prevention strategies.

Once suitable material has been obtained, the identification of sport injury characteristics – the construction of a sport injury typology – by means of methods similar to those employed in the current study may prove to be of great benefit in the context of sport injury prevention in the summer camp environment. This applies to the owners and the managers of camps concerned with the setting of priorities.

In the light of evidence so far accumulated by community-based studies (Laflamm & Eilert - Petersson, 1998a; Laflamme & Menckel, 1999) it seems that greater surveillance and research efforts will have to be expected in the future to clarify the circumstances of occurrence of certain kinds of sport injuries.

Despite the possible limitations of this study, the identification of risk groups may be of use for the launching of preventive summer camps. Thus, specific tasks of summer camp teams should be the analysis of camp related sport injuries, identification of risk groups and the organization of preventive measures.

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