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# Ball Sports Injuries in School Sport and Means of Prevention

## Ballspielverletzungen im Schulsport und Möglichkeiten der Prävention

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### ZUSAMMENFASSUNG

Ballsportarten stehen in der Beliebtheitsskala bei Schülerinnen und Schülern sehr weit oben. Es ist daher nicht verwunderlich, dass Ballspiele einen großen Anteil an der Unterrichtsgestaltung im Schulsport einnehmen. Ballsportverletzungen im Schulsportunterricht haben aber eine erhebliche Prävalenz. Material und Methoden: Während des Schuljahres 2010/11 wurden 976 Schulsportverletzungen von allen Tiroler Hauptschulen (Sekundarstufe I) mit 22.711 Schülerinnen (n = 10890) und Schülern (n = 11821) an die Allgemeine Unfallversicherungsanstalt (AUVA) gemeldet. Ergebnisse: Ballsportarten waren an den Gesamtverletzungen mit einem Anteil von 51% am häufigsten vertreten ( $p < 0,001$ ). Die meisten Verletzungen (n = 203) gab es bei den so genannten „Kleinen Ballspielen“, wie etwa Völkerball oder Jägerball ( $p < 0,001$ ). Beim Basketball kam es zu n = 93, beim Fußball zu n = 76 und Volleyball zu n = 59 Verletzungen. Bei den „Kleinen Ballspielen“ sowie beim Basketball und Volleyball dominierten Distorsionen, während die häufigsten Verletzungsarten beim Fußball Prellungen waren. Bei Basketball, Volleyball, Handball und den „Kleinen Ballspielen“, dominierten wie auch bei den „Sonstigen Ballspielen“ (z.B. Tennis oder Hallenhockey) mit über 50% die Fingerverletzungen. Schlussfolgerung: Ballsportarten sind für einen wesentlichen Anteil der Schulsportverletzungen verantwortlich. Verletzungen der oberen Extremität dominieren das Verletzungsbild. Koordinative Schwächen sowie Überforderung und mangelnde technische Grundfertigkeiten scheinen mögliche Unfallverursacher zu sein. Das Erlernen der ballspieltechnischen Grundfertigkeiten sowie ein in den Sportunterricht integriertes Koordinationstraining mit propriozeptivem Schwerpunkt, könnten neben dem Einhalten anderer primärpräventiver Maßnahmen die Verletzungshäufigkeit in den Ballsportarten reduzieren helfen.

**Schlüsselwörter:** Schule, Sportverletzungen, Ballspiele, Prävention.

### INTRODUCTION

Ball sports are still at the top of the popularity scale for school children and play an important role in designing the lessons. Besides the four “big ball games” football, basketball, volleyball and handball, the “small ball games” like dodge ball (Völkerball) are a regular part of the school sport lessons. Because of the easy and fast practicability, the simple set of rules and the constantly changing game situations, the joy of playing is intense for all those involved. Even though these ball games have proven positive effects on the overall physical, psychological and social development of school children, they are also responsible for a large share of all school sport injuries (10). Depending on the gender, the age and the physical and sport-related performance capabilities of the school children, the school sport morbidity is described as up to 51% (1). It should be one of the essential aims of school sport education to

### SUMMARY

Ball sports are very popular and so it is therefore no surprise that a large number of the school sports classes consist of ball games. Injuries suffered while participating in ball sports during sports classes at school have a high prevalence. Methodology: During the school year 2010/11, 976 school sports injuries in all secondary modern schools (Hauptschule) in Tyrol (Austria) with 22.711 pupils were reported to the general accident department (Allgemeine Unfallanstalt [AUVA]). Results: 51% of the injuries (n = 496) occurred while playing ball sports, most notably while playing the “small ball games” (n = 203), basketball (n = 93), soccer (n = 76) and volleyball (n = 59). Distortions were most dominant among the injuries suffered while playing basketball, volleyball and the “small ball games”. The most common injuries suffered while playing soccer were contusions. Finger injuries were dominant (> 50%) in volleyball, just like in basketball, handball and “small ball games”. Conclusion: Ball sports are responsible for a substantial share of injuries suffered during school sports classes. Injuries to the upper extremities are dominant. Coordinative deficits as well as excessive demand and inadequate levels of basic skills seem to be the causes of the injuries. Learning the basic sport-specific skills and integrating coordinative training with a focus on proprioception along with measures of primary prevention may reduce the frequency of injuries while playing ball sports.

**Key Words:** School, sport injuries, ball sports, prevention.

encourage the children and adolescents to engage in sustainable physical exercise. Negative experiences, like injuries suffered during a school sport lesson, challenge the chances of fulfilling this goal (13,14). As a consequence, preventive measures to reduce the risk of injury have a high priority (2,5,22). The aim of this study is to identify and show forms and circumstances of these injuries in order to develop preventive approaches to injury in school sports.

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## MATERIAL AND METHOD

All 976 school-sport injuries of pupils of secondary modern schools (Hauptschulen) that occurred during the 2010/2011 school year in the federal state of Tyrol (Austria) during regular school sports and were reported to the general accident department (Allgemeine Unfallversicherungsanstalt [AUVA]) were considered and analysed for this study. The AUVA is the social accident insurance for all school children in Austria. The term injury is used in this study for all physical harm suffered during school sports and resulting in the consultation of a doctor. This results in the mandatory filing of a report about the accident (AUVA accident reporting). This report contains data about the school and the accident victim as well as a description of the accident itself. The type of sport, details about how the accident happened, scene of the accident and the mechanism of the injury are documented by the teacher, while the doctor makes the diagnosis.

The secondary modern school (Hauptschule) is a four-year school for pupils 10 to 14 years old. In the school year 2010/2011 a total number of 22,711 pupils attended the 106 secondary modern schools (Hauptschulen) of Tyrol. The data about the number of pupils (population at risk) was kindly made available by the education authority of the state. With an average of three school sport lessons a week, the pupils were all exposed to approximately the same risk of injury in school sport. The "small ball games" (for example dodge ball, burning ball or ball relays) were all put in one category, which is why no more detailed analysis was possible. The same was the case for the group of "other ball games" like tennis, squash, indoor hockey and badminton. Only the "big ball games" basketball, football, volleyball and handball were documented in a detailed way and were therefore accessible for detailed analysis.

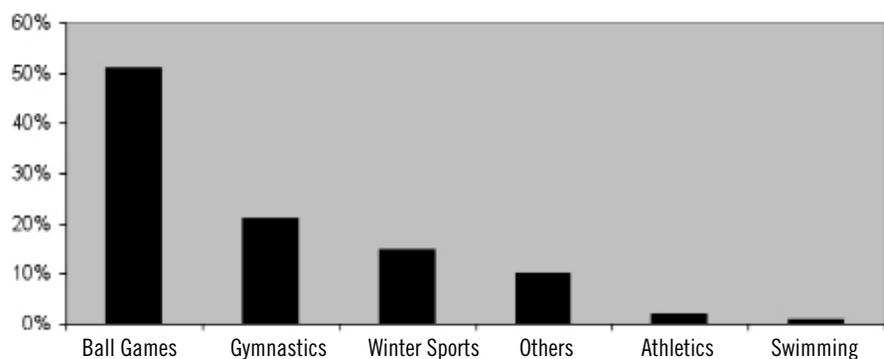
The comparison of frequencies was done using Chi-Squared tests, the comparison of the proportions using a z-test with Bonferroni correction. Differences in the observed frequencies and proportions were accepted if the alpha error was less than 0.05. The calculations were done using the software SPSS (version 19).

## RESULTS

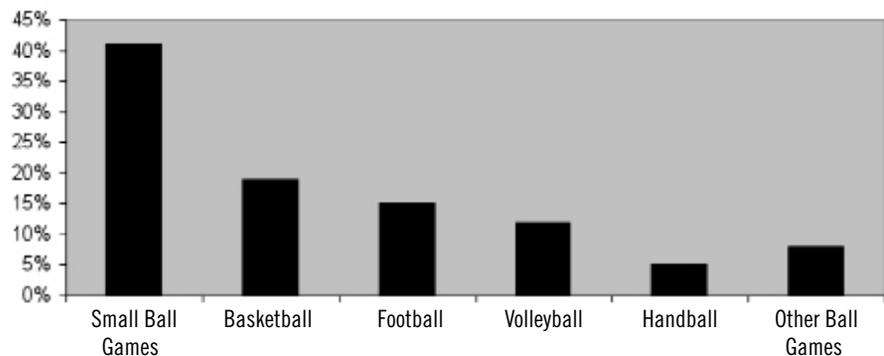
During the evaluation period, a total of 976 school sport injuries were reported to the AUVA. The population at risk – the total number of pupils of modern secondary schools between the age of 10 and 14 in the school year 2010/11 – amounted to 22,711, with 11,821 males and the remaining 10,890 females. The frequency of school sport injuries did not correlate with the gender ( $p > 0.5$ ). School sport injuries occurred in different frequencies in the different types

of sport analysed ( $p < 0.001$ ). The types of sport responsible for the majority of the overall number of school sport injuries were ball sports ( $n = 496$ , which accounts for 51% of all school sport injuries analysed) with an incidence of 22/1000 pupils/year. The remaining injuries occurred during (artistic) gymnastics ( $n = 202$ ; 21%), winter sports ( $n = 149$ ; 15%) and other types of sport like inline skating, cycling etc. with  $n = 98$  (10%). Injuries from athletics ( $n = 18$ ; 2%) and swimming ( $n = 13$ ; 1%) were less common (Fig. 1).

Looking specifically at the ball sport injuries, different frequencies of injury were apparent in relation to the sport practised ( $p < 0.001$ ). The "small ball games" were responsible for 41% ( $n = 203$ ) of all ball sport injuries. The "big ball games" contribute to the total number of ball sport injuries as follows: basketball ( $n = 93$ ; 19%), football ( $n = 76$ ; 15%), volleyball ( $n = 59$ ; 12%) and handball ( $n = 27$ ; 5%). "Other ball games" like tennis or badminton contributed another  $n = 38$  (8%) ball sport injuries (Fig. 2). The gender-specific analysis of the 496 ball sport injuries showed a balanced distribution with 264 injuries to the male and 232 injuries to the female pupils. Focusing on specific types of sport, gender-specific differences were recorded in the frequency of injuries. For football, for example, disproportionately more injuries were reported for boys than for girls (standardised residuum 3.4;  $p < 0.05$ ) while in volleyball disproportionately more injuries were reported for girls (standardised residuum 2.2;  $p < 0.05$ ). In the total collective of ball sport injuries, injuries to the upper extremities ( $n = 292$ ) were 1.85 times more common than injuries to the lower extremities ( $n = 158$ ). Minor injuries like lacerations, contusions and distortions ( $n = 320$ ) were 2.1 times more



**Figure 1:** Distribution of 976 school sport injuries during the school year 2010/11 at all 106 secondary modern schools (Hauptschulen) in Tyrol.



**Figure 2:** Distribution of 496 ball sport injuries during the school year 2010/11 at all 106 secondary modern schools (Hauptschulen) in Tyrol.

common in the total collective than serious injuries like fractures and torn ligaments (Fig. 2).

### Small ball games-related injuries

The incidence for injury within the group of “small ball games” was nine injuries per 1,000 pupils per year. Distortions (45%) dominate the types of injuries, followed by contusions with 27%. Injuries to the upper extremities (60%), with 53% finger injuries (Tab.1-2), were more common than injuries to the lower extremities, even though they did not occur disproportionately often compared to the total collective ( $p < 0.05$ ). Compared to the relation in the total collective, serious injuries like fractures and torn ligaments ( $n = 44$ ) were proportionally less common than minor injuries like lacerations, contusions and distortions ( $n = 153$ ;  $p < 0.05$ ).

### Basketball-related injuries

The incidence in school basketball was four injuries per 1,000 pupils per year. Most injuries occurred during individual ball drills without the influence of a fellow pupil (47%), followed by injuries suffered while performing running movements without the ball (14%). Most times the upper extremity was affected, proportionally to the total collective ( $p < 0.05$ ). The major injuries in basketball were distortions with 40% and fractures with 24% (Tab.1-2). Serious injuries like fractures and torn ligaments ( $n = 40$ ) were overproportionally common compared to the total collective ( $p < 0.05$ ).

### Football-related injuries

School football displayed an incidence of three injuries per 1,000 pupils per year. Contact with an opponent was the cause of the injury in 34% of the cases. Individual ball drills led to 21% and performing running movements without the ball to 14% of the injuries. Compared to the other types of sport, the lower extremities were overproportionally affected ( $p < 0.05$ ). Within these lower extremity injuries, ankle and knee injuries dominate with 17% and 14%, respectively (Tab.1-2). The most common types of injury in football were contusions (30%) and fractures (23%). The ratio of serious injuries like fractures or torn ligaments and minor injuries like lacerations, contusions and distortions did not differ from other types of sport ( $p < 0.05$ ).

### Volleyball-related injuries

School volleyball showed an incidence of three injuries per 1,000 pupils per year. Direct impact of the ball without the influence of an opponent caused the largest share (54%) of the injuries. The upper extremities (79%) were affected overproportionally compared to other types of sport ( $p < 0.05$ ). In volleyball, minor injuries like lacerations, contusions and distortions were overproportionally frequent compared to serious injuries. Distortions (42%) and torn ligaments (23%) are the dominant types of injuries here (Tab.1-2).

**Table 1:** Types of injuries of 496 ball sport injuries of pupils of secondary modern schools (Hauptschulen) in Tyrol during the school year 2010/11.

Type of Injury	Ball Sports total	Small Ball Games	Basketball	Football	Volleyball	Handball	Other Ball Games
Fracture	87 (18%)	28 (14%)	22 (24%)	17 (23%)	11 (19%)	6 (22%)	3 (8%)
Contusion	110 (22%)	54 (27%)	7 (8%)	23 (30%)	5 (9%)	9 (33%)	12 (31%)
Distortion	192 (39%)	91 (45%)	37 (40%)	15 (20%)	25 (42%)	5 (19%)	19 (50%)
Torn Ligament	65 (13%)	16 (7%)	18 (19%)	11 (14%)	14 (23%)	3 (11%)	3 (8%)
Lacerations	18 (4%)	8 (4%)	2 (2%)	6 (8%)	1 (2%)	0	1 (3%)
Concussions	16 (3%)	2 (1%)	6 (6%)	4 (5%)	1 (2%)	3 (11%)	0
Others	8 (1%)	4 (2%)	1 (1%)	0	2 (3%)	1 (4%)	0
Total	496	203	93	76	59	27	38

Percentages (%) are rounded

### Handball-related injuries

Most injuries in handball occurred during individual ball drills without the influence of an opponent (37%). The ratio of injuries to the upper extremities to injuries of the lower extremities did not differ from the ratio within the total collective ( $p < 0.05$ ). With an overall incidence of one in 1,000 pupils per year, contusions (33%) and fractures (22%) were the most common forms of injuries in school handball (Tab.1-2). The ratio of minor injuries like lacerations, contusions and distortions and serious injuries like fractures and torn ligaments did not differ from the ratio within the total collective.

### Other ball games-related injuries

The prevalent types of injuries in ball games like tennis, badminton or squash were distortions (50%) and contusions (31%). The sample showed an incidence of 1.6 injuries per 1,000 pupils per year and a dominance of injuries to the lower extremities of 43% (Tab.1-2).

## DISCUSSION

All ball sport-related injuries (incidence: 22/1,000 pupils/year) that occurred in modern secondary schools (Hauptschulen) in Tyrol, Austria, in the school year 2010/11 were analysed as part of this exhaustive survey. In ball sports, a total of 496 injuries occurred during the analysed school year. Accordingly, 51% of all school sport injuries during the evaluation period occurred while playing or practising ball sports. It has to be factored in that ball games probably enjoy a dominant standing when it comes to designing the school sport lessons (20).

The “small ball games” had the highest share of all ball sport injuries with 41%. It has to be taken into consideration that these forms of ball games are used in almost every lesson as either a warm-up or as a cool-down at the end of the lesson. Every second injury occurring in the “small ball games” affected the fingers. In this context Knobloch et al. (17) refer to deficits in the technical skills of the pupils. Therefore, passing and catching should be specifically practised.

**Basketball** is the sport among the big ball games that caused the most injuries during the evaluation period ( $n = 93$ ). These results are supported by other studies (9,18). The dominance of injuries to the upper extremities (65%) in school basketball is remarkable,

**Table 2:** Localisation of the 496 ball sport injuries of pupils of secondary modern schools (Hauptschulen) in Tyrol during the school year 2010/11.

Type of Sport Localisation	Ball Sports total	Small Ball Games	Basketball	Football	Volleyball	Handball	Other Ball Games
Head	37 (7%)	9 (4%)	7 (8%)	8 (11%)	2 (3%)	4 (15%)	7 (18%)
Torso/Spine	9 (2%)	4 (2%)	3 (3%)	1 (1%)	0	0	1 (2%)
Finger	228 (46%)	108 (53%)	54 (58%)	11 (14%)	32 (54%)	14 (52%)	9 (25%)
Wrist	38 (8%)	11 (5%)	4 (4%)	9 (12%)	11 (19%)	3 (11%)	0
Forearm	6 (1%)	2 (1%)	2 (2%)	2 (3%)	0	0	0
Elbow Joint	6 (1%)	2 (1%)	1 (1%)	0	2 (3%)	0	1 (2%)
Upper Arm	4 (1%)	0	0	1 (1%)	0	0	3 (8%)
Shoulder	10 (2%)	3 (2%)	0	2 (3%)	2 (3%)	2 (7%)	1 (2%)
Toes	21 (4%)	8 (4%)	2 (2%)	8 (11%)	1 (2%)	0	2 (5%)
Ankle	87 (18%)	40 (20%)	11(12%)	13 (17%)	8 (14%)	4 (15%)	11 (30%)
Lower Leg	10 (2%)	2 (1%)	2 (2%)	6 (8%)	0	0	0
Knee Joint	30 (6%)	9 (4%)	6 (7%)	11 (14%)	1 (2%)	0	3 (8%)
Upper Leg	10 (2%)	5 (3%)	1 (1%)	4 (5%)	0	0	0
Groin/Hip	0	0	0	0	0	0	0
Total	496	203	93	76	59	27	38

Percentages (%) are rounded

with the majority of these injuries affecting the fingers. Knobloch et al. (18) attribute this to deficits in the basketball-related skills and proprioception of the pupils. Since the fingers are at biggest risk while dribbling, shooting and playing defence (19), learning the fundamental skills and basics of the game has priority over practising more advanced and specific skills (15,17). Sensorimotor training, like studies conducted by Emery et al. in Canadian high schools, suggest (6,8), could reduce injuries to the lower extremities and especially to the ankle.

In **Football**, the lower extremities (55%) were mostly affected. 73% of all documented football injuries occurred while playing indoors. The high number of injuries occurring while playing indoor football in this study is probably affected by the climatic conditions in Tyrol and the lack of outdoor sport areas in the school vicinities. Betz et al. (3) found a higher rate of injury for indoor football in their study named "Indoor Football versus Outdoor Football", while Emery et al. (7) could not confirm this in their study (7). Easily implementable preventive measures in school football include for example individual variations of the rules like time penalties, which would make committing a foul unattractive or the adherence to certain game rules that are different from regular club football play. Similar to basketball, sensorimotor training accompanying the regular school sport lessons could lower the risk of injury to the ankle (4,6,8,11,23).

**Volleyball** is the youngest of the four big ball games. Finger injuries were dominant with 54%. Knobloch et al. (17), dealing with the high rate of finger injuries in school volleyball, raise the question whether the preventive use of tape bandages on the fingers might reduce the injury rate. However, taping in school sports is hardly feasible. Specific training of the basic techniques and skills in order to minimise the technical and game-related deficits would be more rewarding and target-aimed (15,16). Verhagen et al. (21) in their study refer to an accompanying sensorimotor training as injury prevention for the lower leg/ankle area.

In **Handball** finger injuries (52%) and contusions (33%) accounted for the most common injuries. Basic and fundamental technique training and the use of age-appropriate balls could result in a reduction of injuries in school handball (17). Holm et al. (12) found in their study that a combination of sensorimotor training and a specific warm-up program significantly lowers the frequency of injury in handball.

In the "other ball games" like tennis, squash, hockey or badminton, ankle and finger injuries are most dominant. Therefore, the effort to learn the basic and fundamental skills of the games should be increased in order to minimise the risk of injury. Due to the lack of infrastructure (for example tennis courts and squash halls) these sports are rarely part of school sport lessons.

### Limitations

This study is a secondary analysis of data from the general accident department (Allgemeine Unfallversicherungsanstalt [AUVA]) of Tyrol, Austria, about school sport injuries. All school sport injuries in Tyrol are recorded by the AUVA, so the data can be regarded as sufficiently representative. The population at risk is well known through the numbers of the education authority of the state of Tyrol. However, it has to be mentioned that special individual risk factors, like overweight or having motor performance deficits, are not known. Beyond this, the potential deficiencies in the data collection by teachers or doctors cannot be assessed.

A further disadvantage of secondary data is the lack of standardisation. Even when using questionnaires, different diagnostic formulations can lead to biases, for example. The grave disadvantage of this study is the fact that no data about the duration, frequency and intensity in which the analysed sports were represented in the school sport lessons is available.

## CONCLUSIONS

In the period of evaluation, ball sport injuries had an incidence of 22/1,000 per pupil per year. The "small ball games" and the sports basketball and football were responsible for the majority of all ball sport injuries in school sports. The dominance of injuries to the upper extremities can probably be traced back to the lack of basic technical skills of the pupils. Accordingly, targeted training of these ball-related basic skills presents an essential and feasible preventive measure in school sports. The basic skill level should be urgently increased before games with a competitive character are conducted. Recent studies show that sensorimotor training can reduce injuries to the lower extremities, specifically to the ankle area.

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