ORIGINAL ARTICLE

incidence, diagnosis, sequelae, and high risk groups

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Objective: To generate national representative data on the incidence, diagnosis, severity, and nature of medically treated sports injuries and to identify high risk groups.

Methods: The first national health survey for the Federal Republic of Germany, conducted in the format of a standardised, written, cross sectional survey in the period October 1997 to March 1999, gathered data on the incidence of accident and injury and information on social demographics, injury related disability/time off work, and injury location/setting. The net sample comprised 7124 people aged 18–79.

Results: 3.1% of adult Germans said they sustained a sports injury during the previous year, corresponding to an annual injury rate of 5.6% among those engaging in regular recreational physical activity and ranking sports injuries as the second most common type of accident. About 62% of all sports injuries result in time taken off work. The period of occupational disability is 14 days or less in around two thirds of these cases. The occupational disability rate after occupational and traffic accidents is much higher by comparison. Dislocations, distortions, and/or torn ligaments make up 60% of all sports injuries, followed by fractures (18%), contusions, surface wounds, or open wounds (12%). Three out of four sports injury casualties are male. The incidence declines noticeably in higher age groups.

Conclusions: Future injury prevention measures should focus on the high risk group of young male recreational athletes. The data indicate that the fear of damage to health and injury, believed to be significant internal psychological barriers to participation in sports, is largely unwarranted for the female population and/or older age groups. Sporting injuries are a marginal phenomenon among the female population and mobile seniors actively engaged in sports.

The positive effects of regular recreational physical activity are uncontested: it can help to prevent numerous diseases[1] and to lower health related risk factors such as obesity and hypertension.[2 3] Most clinical trials and epidemiology studies show a dose-response relation between recreational physical activity and indicators of morbidity and mortality.[4] The positive psychological and social impact of physical activity is an added benefit.[5] By the same token, health economy based cost benefit studies from the United States, Austria, and Switzerland show that inactive people generate 30–50% higher direct cost of illness than physically active people.[6–8]

Sports injuries are a side effect of sporting activity. The extent to which they undermine the preventive potential of regular physical activity is largely unknown in Germany because of a hitherto deficient epidemiological database. For one thing, German Census Bureau data and Government issued healthcare bulletins are too unspecific, containing, for instance, no information on injury type, localisation, and severity.[9–13] For another, the few alternative papers on this topic are based on selective insurance company[14] or hospital[15] data or subsume sports accidents along with other domestic and recreational accidents.[13]

The purpose of this study is therefore to generate representative national sports injury incidence rates for Germany. In addition to injury severity, type, and localisation, injury statistics for the total adult population are projected. Incidence rates for separate sectors of the population are also generated in order to identify high risk groups.

The importance of such information lies in the fact that sports injuries are mostly avoidable and theoretically controllable through the implementation of preventive measures. In the light of the ongoing heated debate on removal of certain sports injuries from the list of entities covered by statutory health insurance benefits, our data may help to objectify and provide a rational basis for healthcare policy.[16]

STUDY DESIGN AND METHODS

Database

The first national health survey for the Federal Republic of Germany is a representative epidemiological study of the German speaking inhabitants of the country. This cross sectional study was the first since reunification to generate healthcare data and information on the incidence, nature, localisation, and consequences of injuries and accidents for the total post-reunification German population. The survey was conducted by the Robert Koch Institute on behalf of the Federal Ministry of Health in the period October 1997 to March 1999 and comprises a total net sample of 7124 people aged 18–79.[17–19] Not all survey respondents answered the sports injury questions. Hence, the subsequent bivariate analyses are based on a weighted total sample size of 6911 after exclusion of 213 incomplete datasets. The factor weighting according to age, sex, community size, and federal state used in the survey enables representative conclusions to be drawn for the adult population in post-reunification Germany.[18] The national health survey data were provided to our research group as a public use file as part of a cooperation agreement with Robert Koch Institute, Berlin. The necessary recoding and statistical/epidemiological analyses were performed (on the basis of the raw data files) by the first and second author. The national health survey also permits the investigation of numerous other epidemiological and medical issues, as documented on the Robert Koch Institute website (www.rki.de) under the menu item "Forschung > Publikationen" ("Research > Publications").

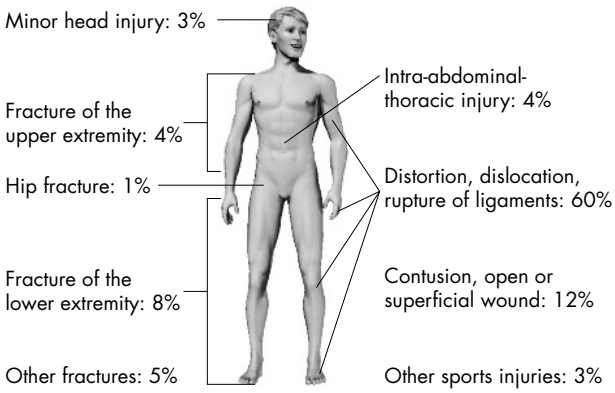

Figure 1 Relative distribution of sports injuries by type and location (both sexes). German national health survey.

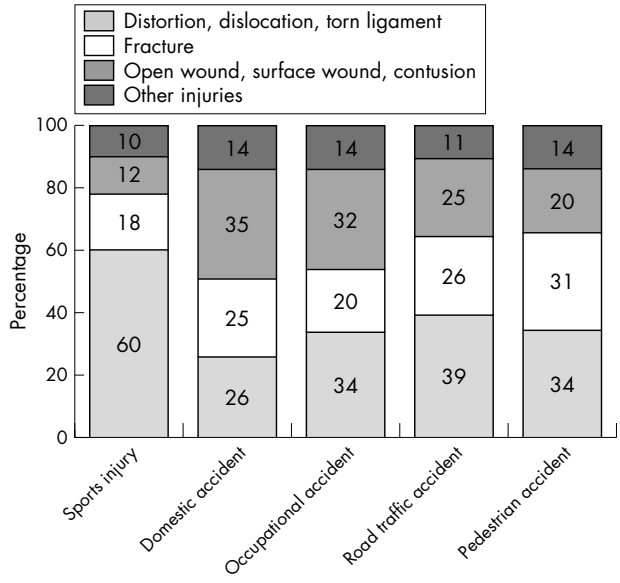

Figure 2 Diagnostic breakdown by accident setting/location. German national health survey.

Procedures

During their time spent in the mobile investigational site, study subjects were asked about the incidence of past injuries using a standardised written questionnaire on the basis of the question: ''During the past 12 months, did you experience any injury or poisoning requiring medical treatment?'' The response categories were: ''No'', ''Yes, to be more precise: During sports/games'', ''Yes, to be more precise: At home'', ''Yes, to be more precise: On the street'', ''Yes, to be more precise: On the footpath'', and ''Yes, to be more precise: At work/on the way to/from work''; or ''Yes, in another setting''. Information was also elicited on time off work/occupational disability resulting from injury, and the duration of same (including non-working days). Finally, the national health survey also contains information on the diagnosis and site of injury. To identify high risk groups, the extent of regular recreational physical activity and demographic variables (sex and age) are factored into our analyses. The sex of the subject was dummy coded with 0 = male and 1 = female. The age is expressed in whole years at the time of the interview and was divided into 10 year age groups. Time spent exercising was graded into five categories ''no sporting activity'', ''less than 1 hour per week'', ''regularly, 1–2 hours per week'', ''regularly, 2–4 hours per week'' and ''regularly, more than 4 hours per week'' on the basis of responses to the question: ''How often do you practise a sport?'' A note explained that the question related to average behaviour during the three months before the survey.

In addition, all study subjects underwent a medical check up involving measurement of blood pressure, a blood test, urinalysis, and a simple physical examination to determine basic anthropometric dimensions (height, waist to hip ratio, etc). This check up was not performed by a doctor but by trained study personnel. It did not involve differential diagnostic procedures. Therefore the above information was not included in our analyses.

Statistical design

Statistical analysis was started by determining the one year incidence of sports injuries and the types of injury sustained. Statistically speaking, this method calculated the risk of injury, also known by the term ''cumulative incidence rate''.[20] The study subject, not the event causing the injury, was defined as the unit of investigation in order to rule out misinterpretations arising from the inclusion of multiply injured individuals. Part two of the statistical analysis investigated the severity of injury and cumulative incidence rates for defined sectors of the population.

For metric variables, the arithmetic mean (SD) was calculated. Group differences with regard to the investigated factors were analysed by χ^2 test. Age specific and sex specific injury risk was identified by logistic regression analysis, with the individual sporting activity held constant. All tests were two tailed at a level of significance of $p \leqslant 0.05$. All analyses were performed using the statistics program SAS for Windows, version 9.1.3 (SAS Institute Inc, Cary, North Carolina, USA). The study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki, and necessary approval was secured.

RESULTS

Injury incidence and influencing factors

A sporting injury was sustained by 3.1% of adult Germans during the preceding year. Sports injuries thus represent the second most common type of accident after domestic accidents (3.7%) together with occupational accidents (3.1%). Traffic accidents and pedestrian accidents are much rarer, with respective incidence rates of 1.8% and 0.8%. For the physically active population alone, the annual injury rate is 5.6%.

About 62% of all sports injuries result in occupational disability/time off work. The time taken off work is no more than one week in one third and no more than two weeks in another third of the cases. Occupational disability for longer than 90 days arises in only 3% of these cases.

Sports injuries are less likely than other accidents to result in occupational disability: 82% of occupational accidents, 71% of pedestrian accidents, and 67% of road traffic accidents result in time off work. In contrast, domestic accidents seem to be less serious: 56% of those in household accidents or incidents in the domestic environment said that they were unable to go to work (or perform their usual housework).

Figure 1 shows relative incidences broken down by accident type and site: six out of 10 sports injuries are dislocations, distortions, and/or torn ligaments. The questionnaire used lay terms appropriate to the target populations as a means of eliciting information on the type of injury—for example, ''sprain, strain, torn ligament''. The second most common type of injury (18%) was fracture (''broken bone''). The most common fracture sites involved the lower extremities (fig 1). Articular and ligamentous injuries were the most common kinds of trauma and seem to be typical of sports injuries; fig 2 shows that injuries of this kind are less

Table 1 Incidence and risk of sports injuries as a function of sex, age, and time spent exercising (German national health survey)

Correlate	Sector of population	Cumulative incidence: One year incidence	Cumulative incidence: p Value and sample size	Odds ratio with no adjustment for other variables	p Value and sample size for individual regressions	Odds ratio adjusted for sex, age and time spent exercising	p Value and sample size for total regression
Sex	Female	1.5%	p<0.001	0.29 (0.21 to 0.40)	p<0.001	0.37 (0.27 to 0.51)	p<0.001
	Male	4.8%		1.00			
			n=6.954		n=6.911		
Age (in years)	70 to 79	0.4%	p<0.001	0.06 (0.02 to 0.19)	p<0.001	0.15 (0.04 to 0.48)	p=0.002
	60 to 69	0.6%		0.08 (0.03 to 0.18)	p<0.001	0.13 (0.06 to 0.30)	p<0.001
	50 to 59	2.7%		0.37 (0.25 to 0.56)	p<0.001	0.58 (0.38 to 0.90)	p=0.014
	40 to 49	2.9%		0.41 (0.28 to 0.61)	p<0.001	0.57 (0.38 to 0.86)	p=0.007
	30 to 39	3.4%		0.45 (0.32 to 0.65)	p<0.001	0.58 (0.40 to 0.84)	p=0.004
	Under 30	6.9%		1.00		1.00	
			n=6.954		n= 6.911		
Time spent exercising	4 h/week	13.1%	p<0.001	28.14 (16.44 to 48.15)	p<0.001	17.97 (10.38 to 31.13)	p<0.001
	2–4 h/week	7.6%		15.28 (8.89 to 26.27)	p<0.001	11.36 (6.57 to 19.63)	p<0.001
	1–2 h/week	2.8%		5.28 (2.95 to 9.47)	p<0.001	4.44 (2.47 to 8.00)	p<0.001
	Less than 1 h/week	2.9%		5.66 (3.14 to 10.21)	p<0.001	4.38 (2.42 to 7.94)	p<0.001
	No sport	0.5%		1.00		1.00	
			n=6.911				n= 6.911

Values in parentheses are 95% confidence intervals.

common in subjects involved in accidents occurring in other settings. Contusions, open wounds, and surface wounds are much more common in domestic and occupational accidents (fig 2). More extensive analysis of the findings collated under the residual category ''Other injuries'' shows that head injuries—for example, concussions—are significantly more common in other accident settings, especially pedestrian accidents, than in association with sporting activity.

To identify high risk groups, let us take a look at demographic distribution in terms of injury incidence. Three quarters of recreational sports casualties in Germany are male (table 1; p<0.001). The one year incidence declines significantly in association with increasing age. Whereas one in 14 (6.9%) of the 18–29 population sustains a sports injury during the space of a year, the risk among the over 60 population is less than 1% (0.4%; table 1). However, an exclusively bivariate analysis does not take into account the fact that the risk of injury correlates closely with the extent of individual sporting activity (''time spent exercising''). Finally, as our data indicate, the incidence rates rise approximately in proportion to the extent of recreational physical activity (table 1). Factoring in sex and age specific sporting activity produces the same picture. After adjustment within logistic regression analysis for participation and time spent exercising, as called for by Uitenbroek, Jones *et al* and Taimela *et al*[21–24] for injury studies of this kind, the risk pattern (presented as odds ratios in table 1) remains largely unchanged: young men represent by far the most significant risk group for sports injuries. It is also evident on the basis of the odds ratios of 4.38 to 17.97 that the risk of sports injury increases with the extent of sporting activity (''time spent exercising''). This can also be seen from fig 3, which summarises one year incidences for 16 subpopulations.

In conclusion, our data form a reliable basis for estimates on the incidence of injury in the German population aged 18–79 (table 2), yielding an annual incidence of 88 000 injuries in the over 60 population (including 27 000 in the over 70s). The total annual incidence of sports injuries estimated on the basis of national health survey data is about 2 million.

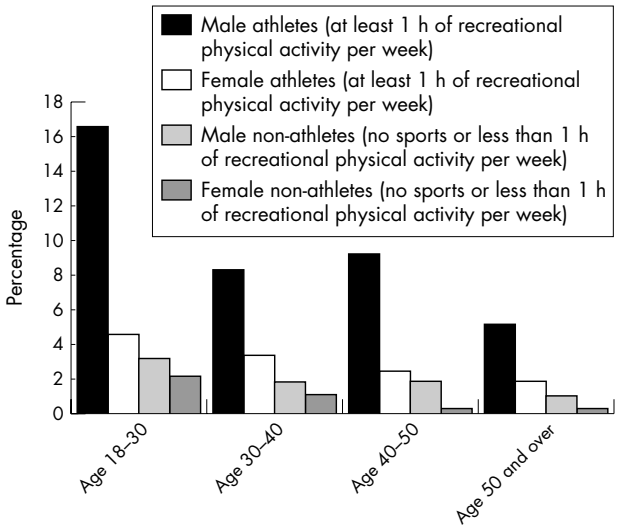

Figure 3 One year incidence of sports injuries by age, sex, and activity status. German national health survey.

DISCUSSION

Particularities of the methodology and limitations of the database

The primary end point of this study is medically treated sports injuries sustained during the 12 months preceding

Table 2 Estimation of total annual sports injuries by sex and age for the Federal Republic of Germany (German national health survey)

Sector of population	Number with sports injuries (millions)
Total	2.0
Sex	
Female	0.5
Male	1.5
Age (years)	
70 to 79	0.0
60 to 69	0.1
50 to 59	0.3
40 to 49	0.4
30 to 39	0.4
Under 30	0.8

Basis: total population aged 18–79 of the Federal Republic of Germany as on 31 December 2003 (64 028 469).

the study. This procedure follows standard international epidemiological practice.[5 25–34] We believe that the retrospective time window of one year in conjunction with the 18 month survey period effectively offsets seasonal variations with implications in terms of injury patterns and frequency.

Only 0.25% of the respondents (n = 17) said that they had both sustained a sports injury during the preceding year and not participated in sport during the preceding three months. It is possible in these 17 cases that the injury itself was the reason for the reported physical inactivity during the preceding three months. However, our occupational disability analyses indicate that sports injuries are rarely that severe. These in depth analyses provide good grounds to interpret the extent of physical activity as a causal factor contributing to the risk of injury in the vast majority of cases.

The national health survey elicited information on injuries sustained "during sports/games" (to quote the wording). We believe that it is legitimate to assume that injuries sustained by adults "during games" will in most cases refer to games or playful situations occurring during physical activity—for example, playing football in a park, Frisbee by the pool, etc; as such, the (probably) fairly low percentage of such cases can also be legitimately classified as sports injuries. As the base population comprises adults only, we believe that playtime accidents typically occurring in children—for example, in the playground or while playing about with objects—are insignificant for the purposes of our analysis. Nevertheless, this terminological indistinctness should not go unmentioned at this point.

The survey does not cover untreated or fatal sports injuries. Limiting the survey to treated cases on the one hand results in an over-representation of comparatively severe injuries, as speculated.[5 33 34] On the other hand, this procedure reduces the likelihood of recall bias, as people are more likely to remember medical consultations than minor injuries requiring no treatment—scrapes, for example.[5 30 34 35]. The German Census Bureau statistics lists 187 deaths in association with sports and games incidents for the year 2003, 154 of these accidents having occurred in the over 15 population. EHLASS, the European Home and Leisure Accidents Surveillance System, and official German statistics indicate that fatal sports accidents throughout the EU and Germany account for only 1% of all fatalities, whereas the corresponding rate for domestic and other leisure time accidents is 50–60%.[36]

Confirmation of national and international findings and new information

The unique characteristic of this paper is that it generates population based data on the basis of a nationwide German population sample with an exclusive focus on sports injuries. Federal health bulletins and representative data presented elsewhere either subsume sports injuries under the category "Domestic and leisure accidents"[9 13 37] or analyse sports injuries only in a marginal fashion with no differentiation according to diagnosis, localisation, and severity.[11 12]

Our analyses reveal what German insurance company and hospital statistics have long indicated[14 15]: a sex ratio of 3:1 and a clear age gradient, with the highest incidence in the under 30 population. National German health studies in the past have shown that the high risk group of young men presented in fig 3 typically engages in ball sports—44% of all 19–26 year old active sport club members play soccer—whereas 25% of female sport club members of the same age do gymnastics.[38] This agrees with data from other statistical analyses indicating that 46% of all sports injuries in Germany are soccer related. Another male dominated sport, handball, ranks a poor second (15% of all sports injuries). Gymnastics injuries account for only 3%.[14] The figures clearly show that, as might be expected, the sex typical choice of a particular sport plays a decisive role in determining injury patterns.

As might be expected, the risk of injury also increases with the time spent exercising and hence presents a "function of opportunity" (among other factors). Our literature search disclosed another two studies showing a similar use of the extent of sporting activity as a predictor of injury risk.[22 31] From the point of view of sports medicine, it can be assumed that injuries caused by other people (as a result of foul play, violent contact, or physical combat) would be more likely to follow the identified "function of opportunity" than other sports injuries. For these other sports injuries, the relative risk—that is, per unit of training—might be expected to decrease as a function of increasing physical fitness and more extensive training and competitive experience. For future studies, a more detailed investigation of duration, intensity, and extent would be desirable.

This typical age, sex, and participation specific pattern for sporting accidents agrees with data from Canada, the United States, Australia, and New Zealand.[5 25 28 31 33 34 39–41] Comparison of the types of injury shows, however, that data from hospital populations seem to be subject to selection processes. For instance, Steinbrück's presentation of hospital data from Stuttgart/Bad Cannstatt[15] reports more distortions (67%, suspected torn ligaments and menisci), muscle and tendon injuries, and fewer fractures (11% plus some of the deformities, a category with a reported incidence of 9%) than are indicated by our data. A probable explanation is that those who suffer a sports injury tend to seek treatment at this kind of sports hospital later and more selectively after capsular-ligamentous lesions than after sustaining fractures; our experience suggests that fractures are usually treated immediately after the trauma event in a surgical outpatients department or by a readily accessible community based accident surgeon. Our results in terms of type of injury and the body region involved are congruent with the results of descriptive studies from other countries.[5 34 39] Despite different preferences in terms of the sports performed, the observation that the lower extremities are affected two to

What is already known on this topic

- Univariate and bivariate representative data on sports injury incidence are available from a number of western industrialised countries
- However, descriptive only data do not provide a basis for calculating the actual injury risk among individual sectors of the population, as data of this kind do not address age related and sex related differences in the extent of physical activity performed

What this study adds

- This study is the first to provide representative data on the incidence, type, site, and extent of sports injuries and their implications in terms of occupational disability/time off work in the Federal Republic of Germany
- These incidence rates are set in relation to actual sporting activity, and young men present the main high risk group

three times more often than the upper extremities seems to apply across societies and cultures. We can only suppose that this relation also applies to other sports injuries (ligamentous injuries, for instance), as the national health survey provides injury site information only with regard to fractures.[5 28 26 34 39 42 43]

Our representative data correspond to insurance company and statistical data also in terms of the injury incidence of 5.6% determined by us in relation to the physically active population. Germany's most extensive database to date on sports injuries puts the injury incidence at 5.1% for those participating in sport in a club and 5.9% for physically active people who are not organised in a sports club.[14] However, the accident event number estimated on the basis of the national health survey—just below 2 million sports injury victims a year—is higher than the number generated by the Federal Work Safety and Occupational Medicine Agency in a nationwide survey of households (1.3 million). This phenomenon is already known from publications on recreational and road traffic accidents, which are also based on the national health survey.[12]

In conclusion, the national health survey provided a basis for presenting representative nationwide data on the incidence, type, and risk structure of sports injuries, data that had not previously been available in such analytical depth. Firstly, earlier, non-representative calculations from—in most cases—selective cohorts and populations have now been objectified and validated. Secondly, the data also show that sports injuries are a major cause of accidents but are fairly harmless in terms of severity and occupational disability in comparison with other types of accident. Typical injuries are distortions and other injuries of the capsular-ligamentous apparatus. Thirdly, these investigations reveal that young men actively engaged in sports are by far the main risk group. In contrast, sports injuries among seniors, even those who are mobile and do sport, are a marginal phenomenon.

We believe that future measures and interventions to prevent injury should focus primarily on the high risk group of active young men. Studies on sports participation and adherence show that psychological factors, in particular fear of injury, are significant internal barriers to an active lifestyle.[44] Our findings provide arguments against this view by showing that this fear is largely unfounded, especially in the senior population which is so important in terms of preventive policy.

The exclusion of high risk sports from the standard of care provided by the German Statutory Health Insurance system is currently a subject of heated debate. Statutory health insurance organisations, business associations, and healthcare institutes with industry affiliations argue that those engaging in (selected) sports should take out special insurance or pay an additional premium.[45 46] Sports clubs respond by arguing that excluding sports injuries would counteract efforts to implement and promote preventive healthcare programmes that are based on encouraging people to exercise more.[47 48] The (former) Chancellor of Germany pointed out in a government statement that a separate insurance obligation for sports accidents would impede, and increase the cost of, sports for children and adolescents, and would have the same effect on "sports for all" programmes that are so important in terms of helping to prevent morbidity.[16] In view of the injury incidences identified, the cost-benefit ratio presented at the start of the paper, and the in any case fairly low levels of sporting participation among lower socioeconomic groups,[49] we believe that excluding high risk sports such as soccer from standard healthcare insurance benefits would be a move in the wrong direction.

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