ORIGINAL ARTICLE

Cost of injuries from a prospective cohort study of North Carolina high school athletes

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Injury Prevention 2007;**13**:416–421. doi: 10.1136/ip.2006.014720

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Accepted 11 September 2007

Objective: To estimate the economic cost of injuries in a population of US high school varsity athletes.
Design and Setting: The North Carolina High School Athletic Injury Study, conducted from 1996 to 1999, was a prospective cohort study of injury incidence and severity. A two-stage cluster sampling technique was used to select athletic teams from 100 high schools in North Carolina. An injury cost model was used to estimate the economic cost of injury.
Participants: Varsity athletes from 12 sports: football, girls' and boy's soccer, girls' and boys' track, girls' and boy's basketball, baseball, softball, wrestling, volleyball, and cheerleading.
Main outcome measures: Descriptive data were collected at the time of injury. Three types of costs were estimated: medical, human capital (medical costs plus loss of future earnings), and comprehensive (human capital costs plus lost quality of life).
Results: The annual statewide estimates were $9.9 million in medical costs, $44.7 million in human capital costs, and $144.6 million in comprehensive costs. The mean medical cost was $709 per injury (95% CI $542 to $927), $2223 per injury (95% CI $1709 to $2893) in human capital costs, and $10 432 per injury (95% CI $8062 to $13 449) in comprehensive costs. Sport and competition division were significant predictors of injury costs.
Conclusions: Injuries among high school athletes represent a significant economic cost to society. Further research should estimate costs in additional populations to begin to develop cost-effective sports injury prevention programs.

Despite the health benefits of sports participation, injury is a detrimental consequence and an important public health problem. Van Mechelen and others proposed a comprehensive approach to sports injury severity that emphasized economic cost as one of six severity markers, along with nature of the injury, level of medical care, time lost from sports participation, working time lost, and permanent disability.[1–4] Economic cost is based on the conversion of the other five markers into an economic estimate. To date, the majority of the sports injury literature in the USA has not addressed the costs associated with sports injuries in a comprehensive manner. Instead, the sports injury literature has generally described injury severity using different definitions based on the nature of the injury and the length of recovery time.[5–10] Using these methods, most high school sports injuries have been considered relatively minor and non-permanent[5–11]; however, large costs, including treatment and rehabilitation, may be associated with managing these apparently ''minor'' injuries.

Prior research has emphasized that interventions such as bicycle helmets and child safety seats are cost-effective because of the high cost of childhood injury.[12 13] Increased knowledge about the cost of sports injuries can similarly help to target limited resources toward preventing those injuries that are most costly to society. The primary purpose of this analysis was to describe the cost of injuries in a population of high school varsity athletes.

METHODS

Sample selection

Data for this paper came from the North Carolina High School Athletic Injury Study (NCHSAIS), a prospective cohort study conducted from 1996 to 1999. An extensive description of the study methods has been published.[14] Briefly, participants were approximately 5013 varsity athletes per school year representing 12 different sports in 100 public high schools in North Carolina: boys' and girls' soccer, boys' and girls' track, boys' and girls' basketball, baseball, softball, wrestling, volleyball, cheerleading, and football.

The sample was selected using a stratified two-stage probability proportional-to-size cluster sampling technique.[14 15] The sample was stratified by presence of a certified athletic trainer, competition division, geographic region, and average school attendance.[14]

Aggregate estimates and sample weights

Sample weights were constructed to produce aggregate statewide estimates by multiplying the product of the inverse probabilities of selection in the two stages by the response rates at the school, sport, and athlete levels.[14] Normalized weights (sample weights multiplied by the sampling fraction) were used in all analyses in this paper. These weights account for non-response and the complex survey design.[14]

Definition of injury

A reportable injury was defined as ''a result of participation in a high school sport that either limited the student's full participation in the sport the day following the injury or required medical attention by a medical professional (ie, athletic trainer, physician, nurse, emergency medical technician, emergency room personnel, or dentist)''.[14] Injuries such as

Abbreviations: BMI, body mass index; coach EQT, coaching experience, qualifications, and training; ED, emergency department; NCHSAIS, North Carolina High School Athletic Injury Study; QALY, quality-adjusted life year; RICM, Revised Injury Cost Model concussions, fractures, and eye injuries were also reportable, regardless of whether they resulted in lost participation.

Data collection

Injury and risk factor data were collected from three sources: an athlete's demographic questionnaire, a coach's demographic questionnaire, and an injury report form. An injury report form was completed for each sustained injury, so an athlete who suffered multiple injuries during one incident had multiple corresponding injury reports. Data were collected by either the school's certified athletic trainer (69%) or the athletic director (31%).

The NCHSAIS directly assessed several markers of severity, including type of injury, body site injured, level of medical treatment received, and time lost from sports participation. Type of injury and body site injured were used in this analysis to describe the nature of the observed injuries. Time lost from participation was categorized as no time lost, <1 week lost, 1–3 weeks lost, and >3 weeks lost. Type of medical treatment was categorized into three levels based on the highest level of medical care: non-emergency department (ED) medical attention (including doctors' offices, athletic trainers, or other medical personnel), an ED visit that did not result in hospitalization, and hospitalization.

Revised Injury Cost Model (RICM) methodology

Economic costs were estimated using mean costs for adolescents aged 15–19 from the RICM originally developed for the US Consumer Product Safety Commission (16, 17). Three types of cost were estimated: medical, earnings losses, and reduced quality of life (fig 1). Costs are presented in the following categories: medical, human capital (medical + loss of future earnings), and comprehensive (medical costs + loss of future earnings + reduced quality of life costs).

Medical costs

To develop estimates of long-term medical costs, the cost model used data from the 1992–1994 Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) summaries of military retirees and their dependents (including children), the 1987 National Medical Expenditure Survey, the 1987–1992 National Hospital Discharge Survey, the 1995–1996 National Electronic Injury Surveillance System (NEISS), as well as pooled five-state hospital discharge data (covering the years 1989–1995).[16 17] Medical costs were adjusted to reflect North Carolina costs based on the ratio of the consumer price index for medical care for southern US urban cities for July 1999 to the corresponding overall consumer price index for the USA.[18]

Loss of future earnings

The RICM based loss of future earnings on the product of the probability of immediate work loss, the days lost if a loss occurs, and the average value of a day's work. The RICM calculated the average daily value of wage and household work using age- and gender-stratified data from the 1987–1992 National Health Interview Survey and the US Bureau of Labor Statistics.[16 17] Work losses in this analysis represent an approximation, as there is no economic value formally associated with schoolwork. The dollar values assigned represent earnings losses for employed persons of high school age, adjusted for part-time status. The costs also include earnings losses of parents and other caregivers who must take time off work to take injured school children to medical appointments and provide other care. Future earnings losses were adjusted to North Carolina wages based on the ratio of the average annual personal income per capita for North Carolina for 1999 and the corresponding average for the USA.[19]

Quality of life

The estimates of reduced quality of life and pain and suffering costs were based on the quality-adjusted life years (QALYs) lost

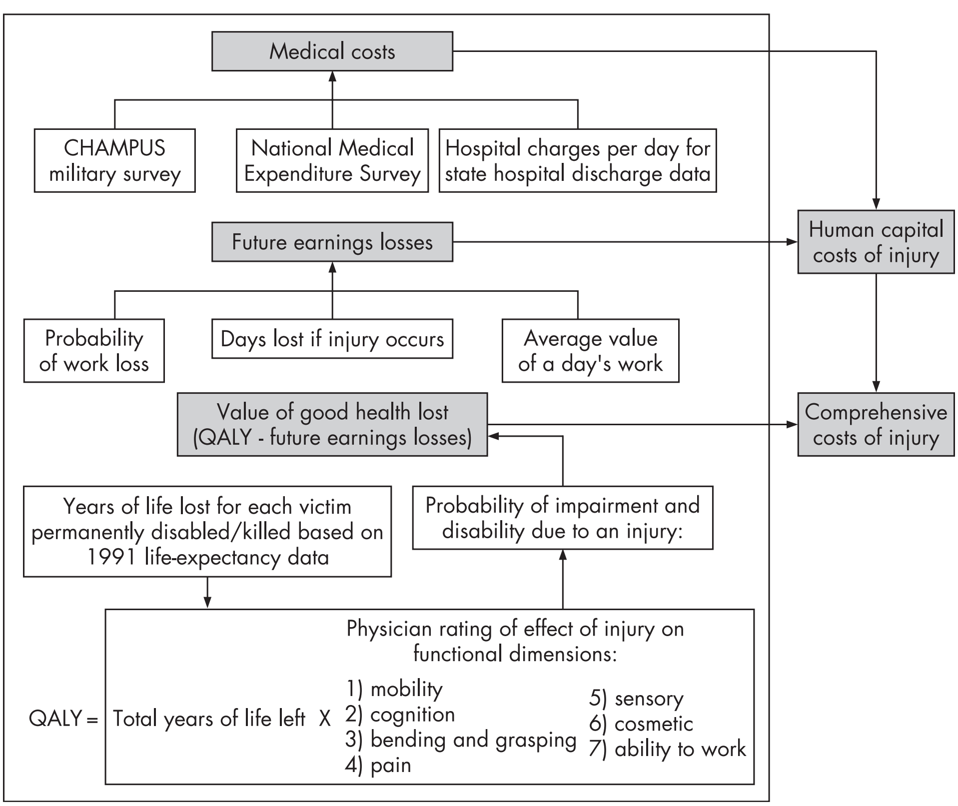

Figure 1 Derivation of how Revised Injury Cost Model cost estimates were adapted to the North Carolina High School Athletic Injury Study dataset. QUALY, quality-adjusted life year.

Table 1 Distribution and mean comprehensive cost of specific severity markers (n = 2990 injuries), North Carolina High School Athletic Injury Study, 1996–1999

Marker of severity	No of injuries*†	Percentage	Mean comprehensive cost per injury (95% CI) ($)
Type of injury			
Sprain	996	33.9	9196 (6856 to 11 536)
Strain	541	18.4	9012 (7477 to 10 547)
Bruise	386	13.1	4748 (2992 to 6504)
All other	1018	34.6	28 262 (23 599 to 32 925)
Body part injured			
Ankle	648	21.8	11 925 (10 188 to 13 662)
Knee	456	15.4	8868 (7157 to 10 579)
Shoulder	224	7.5	13 254 (7427 to 19 081)
All other	1645	55.3	15 985 (13 394 to 18 576)
Level of medical care			
Non-ED	2194	77.5	8209 (7764 to 8654)
ED	553	19.5	14 535 (13 094 to 15 976)
Hospital admission	86	3.0	166 960 (132 546 to 201 374)
Time lost from participation			
No time lost	671	22.5	15 188 (13 240 to 17 136)
<1 week	1433	47.9	8995 (7162 to 10 828)
1–3 weeks	559	18.7	12 540 (10 592 to 14 488)
>3 weeks	327	10.9	35 336 (25 830 to 44 842)

*Number of injuries and percentages reflect the use of normalized weights.
†Frequencies may not add up to 2990 because of missing data: type of injury n = 49 (1.6%); body part injured n = 17 (0.6%); level of medical care n = 157 (5.3%).

due to injury. Lost QALYs are computed using a seven-dimensional model that includes physician ratings[16 17] on functional losses in: mobility, cognition, bending and grasping, pain, sensory, cosmetic (resulting in probability of impairment), and the ability to work (based on probability of disability). The combination of these seven dimensions, when multiplied by the total number of years of life remaining, result in an estimated lost QALY. The estimated age-adjusted value for one QALY was $127 236, adjusted for 1999 inflation.[20]

Although QALY-based costing is not the default method for valuing quality of life loss in the RICM, QALY estimation is recommended by the Panel of Cost-effectiveness in Health and Medicine[21] and seemed more appropriate than the default costing based on jury awards for non-economic damages in consumer product injury lawsuits.

Computing cost per injury

To assign costs to the observed injuries, a three-way matrix was created based on NCHSAIS data about the body part injured (46 categories), type of injury (16 categories), and level of medical care received (three categories), and was stratified by gender (using RICM costs for ages 15–19). NCHSAIS codes for body part injured and type of injury were re-coded to match the NEISS diagnostic codes used in the RICM. Highest level of medical care was based on NCHSAIS categorizations of non-ED, ED only, and hospitalization. As a result, mean medical, lost earnings, and reduced quality of life costs, stratified by gender, were applied to each possible matrix combination.

A total of 592 of the reported injuries (19.8%) in this study were initially not assigned costs. This included 561 (18.8%) that were missing data from at least one of the injury descriptors and 23 that were missing all injury descriptor data. The remaining eight uncosted injuries were either too minor or the combination of descriptors did not make sense (eg, concussion to pelvic region). For the 569 injuries that were not missing all injury descriptor information, we imputed the missing values based on the mean medical, human capital, and comprehensive costs using a hierarchy of injury type, body part injured, and level of treatment from the injuries that were assigned costs. For example, a reported fracture with no assigned body part or level of treatment (and therefore missing cost data) was assigned the mean cost of a fracture in this study. Although they were included in the total reported aggregate costs, we excluded the 569 injuries from the regression analyses because including them would result in the same estimated mean costs (based on the imputation using means) but the resulting variance estimates would be incorrect. There were no meaningful differences in the covariate patterns between the injuries with estimated costs (n = 2398) and the injuries for which costs could originally not be estimated (n = 592).

The cost data were log-transformed before analysis on the basis of regression diagnostics, and outliers that indicated the data, as is often the case with cost estimates, were not normally distributed. Costs are presented in 1999 NC dollars, adjusted for inflation.[18 19]

Predictors of injury cost

The following predictors of cost were evaluated: sport, gender, grade, multiple sport participation, coaching experience, qualifications, and training (coach EQT), years of playing experience, prior injury, age, body mass index for age (BMI, centiles), and competition division. Study year was also included in the full model, but there were negligible cost changes over the course of the study, so specific results by year are not presented. A detailed description of these intrinsic and extrinsic predictors has been published previously but they are briefly described here.[22]

Prior injury included history of the following injuries: knee, ankle, shoulder, wrist, elbow, fracture, concussion, heat-related illness, and others. BMI was estimated as age- and gender-specific centiles.[22] Coach EQT was based on coaches' answers to five yes/no questions: completion of at least a college degree, completion of a coaching class, current certification in first aid or cardiopulmonary resuscitation, at least 1 year of coaching experience in that sport, and at least 1 year of playing experience in that sport. Coach EQT was categorized as ''low'' if they answered yes to up to two questions, ''medium'' if they answered yes to three questions, or ''high'' if they answered yes to four or five questions. Competition division (1A–4A) was based on school enrollment.

Statistical methods

Multivariate linear regression models on log-transformed costs were used to identify important predictors of injury cost. The

Table 2. Exponentiated adjusted mean medical costs, human capital costs, and comprehensive costs (n = 2398 injuries*), North Carolina High School Athletic Injury Study, 1996–1999

Risk factor	Mean medical cost per injury† (95% CI) ($)	Wald p value	Mean human capital cost per injury† (95% CI) ($)	Wald p value	Mean comprehensive cost per injury† (95% CI) ($)	Wald p value
Intrinsic risk factors						
Injury history						
No	476 (445 to 510)	Referent	1553 (1447 to 1666)	Referent	7719 (7208 to 8265)	Referent
Yes	501 (470 to 534)	0.33	1669 (1558 to 1788)	0.20	8336 (7875 to 8821)	0.13
Years of playing experience						
0–1 year	448 (395 to 508)	Referent	1484 (1283 to 1716)	Referent	7192 (6294 to 8217)	Referent
2–4 years	500 (469 to 534)	0.13	1675 (1573 to 1783)	0.15	8358 (7920 to 8821)	0.05
5–8 years	498 (460 to 538)	0.14	1628 (1475 to 1796)	0.26	8160 (7499 to 8879)	0.11
Age						
⩽16 years	532 (471 to 600)	Referent	1752 (1544 to 1988)	Referent	8711 (7842 to 9676)	Referent
⩾17 years	473 (442 to 506)	0.17	1570 (1471 to 1671)	0.19	7843 (7391 to 8323)	0.15
BMI‡						
Under weight	509 (349 to 744)	0.85	1536 (1222 to 1931)	0.54	8042 (6189 to 10449)	0.87
Normal weight	499 (467 to 534)	Referent	1645 (1530 to 1768)	Referent	8209 (7737 to 8710)	Referent
Risk of overweight	486 (437 to 540)	0.71	1561 (1393 to 1748)	0.52	7764 (6923 to 8707)	0.46
Overweight	480 (435 to 528)	0.46	1682 (1473 to 1922)	0.78	8354 (7437 to 9384)	0.79
Play >1 sport						
No	543 (470 to 629)	Referent	1779 (1502 to 2108)	Referent	8657 (7528 to 9955)	Referent
Yes	486 (465 to 508)	0.14	1611 (1542 to 1684)	0.25	8071 (7779 to 8374)	0.33
Extrinsic risk factors						
Grade						
9-10	509 (459 to 565)	Referent	1696 (1515 to 1899)	Referent	8385 (7559 to 9301)	Referent
11-12	489 (463 to 516)	0.51	1614 (1526 to 1707)	0.47	8075 (7684 to 8485)	0.56
Sport						
Football	577 (528 to 631)	Referent	1831 (1656 to 2024)	Referent	9311 (8567 to 10 120)	Referent
Boys' soccer	443 (388 to 507)	<0.01	1501 (1283 to 1756)	0.06	7678 (6725 to 8766)	0.03
Girls' soccer	463 (408 to 527)	0.01	1670 (1476 to 1888)	0.29	7196 (6201 to 8350)	<0.01
Boys' track	452 (334 to 611)	0.13	1641 (1308 to 2060)	0.51	8620 (6435 to 11 545)	0.60
Girls' track	377 (320 to 445)	<0.01	1619 (1381 to 1897)	0.22	7637 (6674 to 8740)	0.02
Boys' basketball	401 (348 to 463)	<0.01	1337 (1184 to 1509)	<0.01	7011 (6353 to 7738)	<0.01
Girls' basketball	354 (324 to 386)	<0.01	1257 (1124 to 1406)	<0.01	6162 (5584 to 6799)	<0.01
Baseball	466 (396 to 550)	0.03	1454 (1249 to 1692)	0.02	7385 (6433 to 8478)	0.01
Softball	416 (347 to 499)	<0.01	1343 (1095 to 1647)	0.01	5549 (4461 to 6901)	<0.01
Wrestling	670 (573 to 784)	0.08	2080 (1782 to 2428)	0.14	10212 (8607 to 12 115)	0.34
Volleyball	322 (285 to 362)	<0.01	1181 (1058 to 1317)	<0.01	5918 (5335 to 6564)	<0.01
Cheerleading	465 (389 to 555)	0.05	1640 (1341 to 2007)	0.37	7366 (6142 to 8833)	0.04
Coach EQT						
Low	520 (473 to 572)	Referent	1781 (1632 to 1945)	Referent	8684 (8027 to 9394)	Referent
Medium	474 (444 to 505)	0.11	1529 (1428 to 1637)	0.01	7694 (7248 to 8168)	0.02
High	497 (461 to 537)	0.46	1651 (1542 to 1767)	0.24	8275 (7677 to 8920)	0.38
Competition division¶						
1A	545 (477 to 623)	Referent	1815 (1672 to 1969)	Referent	8920 (7916 to 10 050)	Referent
2A	539 (490 to 592)	0.89	1783 (1570 to 2026)	0.83	8866 (8054 to 9760)	0.94
3A	450 (414 to 488)	0.02	1475 (1360 to 1600)	<0.01	7427 (6902 to 7992)	0.01
4A	470 (434 to 509)	0.07	1565 (1444 to 1697)	0.01	7817 (7293 to 8379)	0.07

BMI, body mass index; coach EQT, coaching experience, qualifications, and training.
*Cost data were estimated for 2398 of 2990 reported injuries.
†Mean medical, human capital, and comprehensive costs are adjusted for prior injury, study year, sport, grade, multiple sports participation, coach EQT, years of playing experience, age, BMI, and competition division.
‡Underweight, ⩽5th centile; normal weight, >5th centile to <85th centile; at risk of overweight, ⩾85th centile to <95th centile; overweight, ⩾95th centile.
¶Division 1A, <668 students; division 2A, 668–957 students; division 3A, 967–1308 students; division 4A, 1314–2600 students.

models adjusted for sport, injury history, multiple sport participation, age, years of playing experience, BMI, grade, coach EQT, competition division, and study year. Separate adjusted mean costs were estimated for all 12 sports and for the eight gender-comparable sports: boys' and girls' basketball, boys' and girls' soccer, boys' and girls' track, and baseball and softball. Statistical analyses were performed using SAS-Callable SUDAAN V.8.0 in order to produce valid variance estimates.[23]

RESULTS

An estimated 15 038 athletes were observed for all 12 sports over the 3-year study period. There were 2990 injuries reported for the entire study period; some athletes sustained multiple injuries. We excluded from the regression analyses the 592 injuries for which cost data were originally not estimated. Most injuries (77.5%) were medically treated outside the ED, 19.5% were treated in the ED, and 3.0% required hospitalization.

For the study population, the medical, human capital, and total economic costs per year were $940 608, $4.2 million, and $13.7 million, respectively. Per athlete, the yearly medical cost was $187, human capital cost was $838, and the comprehensive cost was $2733. Annually statewide, this translated into $9.9 million in medical costs, $44.7 million in human capital costs, and $144.6 million in comprehensive costs.

Nature of the injury

The ankle, knee, and shoulder were the most commonly injured sites of the body and, of these, shoulder injuries had the highest mean comprehensive cost per injury (table 1). Sprains were the most common injury and accounted for the greatest percentage of costs, followed by strains and bruises.

Time lost from sports participation

About one in five injuries resulted in no lost time; about 11% resulted in more than 3 weeks lost (table 1). Knees and

Table 3 Exponentiated adjusted mean medical, human capital, and comprehensive costs, associated with gender, adjusted for other risk factors, in 1999 dollars (n = 2398 injuries*), North Carolina High School Athletic Injury Study, 1996–1999

Risk factor	Mean medical cost per injury† (95% CI) ($)	Wald p value	Mean human capital cost per injury† (95% CI) ($)	Wald p value	Mean comprehensive cost per injury† (95% CI) ($)	Wald p value
Gender						
Boys‡	526 (493–561)	<0.01	1701 (1590–1818)	<0.01	8682 (8201–9192)	<0.01
Girls	400 (374–429)	Referent	1432 (1337–1532)	Referent	6595 (6190–7026)	Referent
Boys¶	434 (400–470)	0.13	1450 (1335–1575)	0.74	7514 (7027–8035)	<0.01
Girls	401 (375–429)	Referent	1427 (1338–1521)	Referent	6490 (6042–6971)	Referent

*Cost data were estimated for 2398 of 2990 reported injuries.
†Mean medical, human capital, and comprehensive costs are adjusted for gender, prior injury, study year, grade, multiple sports participation, coach EQT, years of playing experience, age, BMI, and competition division.
‡Adjusted mean costs include all 12 sports.
¶Adjusted mean costs are restricted to four pairs of gender-comparable sports (girls' and boys' soccer, girls' and boys' track, girls' and boys' basketball, and baseball and softball).

fractures were the most common injury site and type of injury that resulted in more than 3 weeks lost participation (25.0% and 41.7%, respectively). When site and type of injury were combined, other types of knee injury, particularly injuries to the knee ligaments, resulted in more than 3 weeks lost (15.0%).

Overall estimated costs of injury

Table 2 shows the exponentiated adjusted mean medical, human capital, and comprehensive costs stratified by the predictor variables. The adjusted mean medical cost per injury was $709 (95% CI $542 to $927), the adjusted mean human capital cost per injury was $2223 (95% CI $1709 to 2893), and the adjusted mean comprehensive cost per injury was $10 432 (95% CI $8062 to $13 449) (table 2).

Comprehensive costs

Sport, competition division, and coach EQT were strong predictors of the adjusted mean comprehensive cost (table 2). For intrinsic risk factors, the highest adjusted mean comprehensive costs were associated with having a prior injury, 2–4 years of playing experience, being 16 years of age or younger, being overweight, and playing a single sport, although there were no significant differences between adjusted mean comprehensive costs between levels of each risk factor nor were they significant predictors of the comprehensive cost. The same pattern was observed for medical costs and human capital costs, with the exception of BMI. Being underweight, rather than overweight, was associated with the highest adjusted mean medical costs.

Among extrinsic risk factors, 9th–10th graders, low coach EQT, and division 1A competition division had the highest adjusted mean comprehensive cost. Wrestling had the highest cost per injury, followed by football. There were significant differences between adjusted mean comprehensive costs (and medical and human capital costs) within the levels of sport, competition division, and coach EQT, but not within grade.

For all 12 sports, the mean medical cost for boys was higher than for girls ($p<0.01$) (table 3). Gender and age were the only significant predictors of the adjusted mean comprehensive cost. When restricted to gender-comparable sports, the gender difference decreased slightly but remained significantly different ($p<0.01$), and gender and competition division, but not age, remained significant predictors.

DISCUSSION

This study quantified the cost of sports injuries in a population of high school varsity athletes. Most injuries resulted in less than 1 week's loss of sports participation. However, even these relatively ''minor'' injuries resulted in a substantial cost to society. These injuries resulted in approximately $941 000 per year in medical costs ($187 per athlete), $4.2 million per year in human capital costs ($838 per athlete), and $13.7 million per year in comprehensive costs ($2733 per athlete).

Significance of findings

Most injuries were sprains and strains and occurred to the ankle or the knee, reflecting a common finding in the literature.[5 8 9 24–30] Sport was a significant predictor of cost. Although wrestling was associated with the highest mean costs per injury, it accounted for only 7.2% of all injuries and 7.1% of comprehensive costs. Football, which accounted for 41.4% of observed injuries, accounted for 57.0% of medical costs, 58.1% of human capital costs, and 53.8% of comprehensive costs.

The overall cost of high school sports injuries has not, until now, been adequately investigated or reported in the literature. Other studies have attempted to quantify medical costs by retrospectively examining insurance claims, but have underestimated medical costs by including only those injuries for which an insurance claim was filed.[28 31 32] The only national estimate of sports-related medical costs comes from the 1997–1998 National Hospital Ambulatory Medical Care Survey, which estimated $680 million in medical costs for the 2-year period of 1997–1998.[33] However, this figure excluded costs associated with lost wages and reduced quality of life.

Strengths and limitations

These cost data are subject to important limitations. We did not track individual expenditures in this population but estimated them from a cost model. As part of this, we did not estimate the cost of lost earnings among athletes who may or may not have also held part-time employment. As a result, we presented the loss of future earnings as part of a broader human capital cost. Finally, the cost estimates also exclude the time that coaches and school administration spent in investigating the injury event and filing paper work. Despite the limitations of the

Key points

- The total annual medical cost of injuries in the NCHSAIS athletes/study population/study's athletes was $940 608.
- The total annual human capital cost was $4.2 million.
- The total annual comprehensive cost was $13.7 million.
- Although wrestling injuries were the most expensive per injury, football injuries accounted for 53.8% of the comprehensive costs.

RICM, these estimates provide strong evidence that sports injuries in this population incur a substantial cost to society.

Very few studies have attempted to quantify the economic severity of high school sports injuries in the USA. Most used time lost from sports participation rather than cost as the primary marker of severity, and our results suggest that this may be misleading. The results of this study also suggest that ED-based studies may miss up to 70% of injuries, thereby underestimating both the incidence and cost of injuries. Finally, although these results may not be generalizable to other study populations, the RICM methods can and should be adapted and applied in multiple settings.

IMPLICATIONS FOR PREVENTION

The annual comprehensive cost of high school sports injuries in this population was estimated at $13.7 million and $2733 per athlete. Our findings highlight the fact that even so-called relatively "minor" injuries result in significant costs to society. The comprehensive method used in this analysis should be applied in different populations as well as national athlete samples to provide additional critical information about the economic burden of sports injuries. This increased knowledge can help to direct limited research funding to developing cost-effective interventions to reduce injury risk among young athletes.

ACKNOWLEDGEMENTS

We express our appreciation to Nancy L Weaver, William Kalsbeek, John Sideris, Brian Sutton, Dick Knox, and William E Prentice Jr. We acknowledge the invaluable contribution of the high school athletic trainers and athletic directors who participated in this project.

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Funding: This study was supported by a grant from the National Institute of Arthritis, Musculoskeletal, and Skin Diseases (R01/AR42297) to the University of North Carolina Injury Prevention Research Center (R49/CCR402444). The funding sources had no involvement in the preparation of this manuscript.

Competing interests: None.

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