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Age is just a number: A look at "elderly" sport-related traumatic injuries at a level I trauma center

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ABSTRACT

Background: We aimed to describe elderly engagement in recreational activities, their injury patterns, preinjury risks and outcomes.
Methods: A 16-year retrospective trauma registry review. All trauma patients ≥65 years admitted after injury sustained during sport were evaluated, and compared to a non-sport cohort of elderly trauma patients.
Results: During the study period, 9697 admissions age ≥65 were identified. 526 (5%) were sport-related. Compared to the non-sport group, the sport cohort was younger, had fewer medical comorbidities, and was more severely injured. The common sport mechanisms were skiing, offroad vehicle use and bicycling, and common sport injuries involved lower extremity, chest, and head. Sport patients were more often discharged home than non-sport patients (73% vs 36%, $p < 0.001$). There was no difference in ICU or hospital LOS between groups. The hospital mortality rate was 3% in sport and 5% in non-sport patients ($p = 0.06$).
Conclusion: Over time, the number of elderly sport-related trauma patients increased. Our data suggest that being active may improve outcomes after trauma in older adults.

Background

As life expectancy in the United States increases, elderly trauma victims are becoming a larger percentage of all admitted trauma patients. As of July 2015 there were 49 million Americans over age 65, and this number is expected to nearly double to a projected 98.2 million by 2060.[1] This population increase, along with improvements in geriatric wellness, is causing an increase in the number of elderly people involved in sports and recreational activities who are at risk for injury.

Physiologic alterations occur with increased age, such as muscle weakness, vision deterioration, and gait instability, and place older adults at a greater risk of falling compared to younger people.[2] In recent years, a growing body of knowledge exists regarding the functional and cognitive benefits of physical activity, and its ability to curtail the rate of age-related changes.[3,4] Further, a greater emphasis in medicine on maintaining physical activity throughout life, as evidenced by programs such as the Center for Disease Control (CDC) and Prevention's Healthy Aging Initiative, has led to a more active elderly population than seen before.[5] Utah is in the top 10 of all US states[6] in terms of elderly population growth rate, and boasts a landscape and culture that encourages a lifestyle centered on outdoor recreational activity.

Limited data exist describing the epidemiology of sport-related injuries requiring hospital admission in the elderly, as well as the impact of underlying physical and mental fitness on patient outcomes in this active group. The purpose of this study was to describe elderly engagement in recreational activities, the distribution of injury patterns, preinjury risks, and outcomes, as well as to compare these older patients who were injured during sport to a non-sport injury cohort of hospitalized elderly trauma patients. We hypothesized that elderly patients injured during sport will experience shorter lengths of hospital stay and more favorable discharge dispositions.

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Methods

Intermountain Medical Center is an American College of Surgeons'-verified Level I trauma center located in the heart of the Wasatch Front, a mountainous and densely populated region of north central Utah that offers world-class outdoor recreation. We conducted a 17-year retrospective trauma registry review from January 2000 through March 2017. All trauma patients ≥65 years old admitted to our trauma service were identified and the mechanism of injury was documented and reviewed. Injuries related to sports were defined as recreational activity demanding physical strength and coordination, and included: alpine or Nordic skiing, bicycling, ATV or snowmobile use (off-road vehicle [OV]), equestrian riding or engagement with large animal, team or ball sports, hiking, and jogging. Patients who met criteria for the sport group were compared to the remaining non-sport cohort of elderly trauma patients admitted during the study period.

Baseline demographic data were recorded. Injury information was documented using the abbreviated injury scale (AIS) scoring system,[7] and was categorized as follows: head, face, chest, abdomen, cervical spine, thoracic spine, lumbar spine, upper and lower extremity. Injury severity score (ISS) was calculated based on previously described criteria.[7] Information on broad categories of comorbid conditions, including presence of preinjury coagulopathy (antiplatelet/anticoagulant use or intrinsic coagulopathy), diabetes, congestive heart failure, respiratory disease, and smoking were also collected. Outcomes included intensive care unit (ICU) and hospital length of stay (LOS), discharge disposition, and in-hospital mortality.

We compared demographic, injury, comorbidity, and outcome information for the sport and non-sport groups using t-tests, Wilcoxon rank sum tests, and Chi-squared tests as appropriate. $P < 0.05$ was considered significant. Logistic regression was also used to assess the effect of sport injury, on outcomes including in-hospital mortality and discharge disposition, where both models were controlled for age, number of comorbidities, and ISS.

Additional analyses of the sport group were performed to further investigate this cohort of trauma patients, and identify any factors affecting outcomes. Outcomes of patients with the presence of any comorbid conditions were compared to those without using Wilcoxon rank sum and Fisher's exact tests as appropriate. Similar to previous literature,[8] in an effort to broadly assess age-related trends, we divided the sport cohort into three age groups, 65–74, 75–84 and 85+, and compared outcomes and mechanism of injury among the age ranges using Fisher's exact and Kruskal-Wallis tests as appropriate. Injury patterns were evaluated by the four most common mechanisms of sport injury.

Results

During the study period, 9697 patients aged ≥65 were admitted to the trauma service. Of these, 526 (5%) had a sport mechanism of injury. Over time, the annual number of sport admissions increased 5-fold, from 13 in 2000 to 67 in 2016. The total number of elderly trauma patient admissions (sport + non-sport) also increased by a similar degree over the study period. The increase in sport admissions was most significantly noted in the 65–74 age group, differing from the equal increase observed across all age groups in the overall cohort (Figs. 1 and 2).

Table 1 displays demographic, comorbid disease and hospital outcomes data for the sport and non-sport patients. Compared to the non-sport group, the sport cohort was younger (mean age 72 vs 79 years, $p < 0.001$), and more severely injured (mean ISS 11.6 vs 10.6, $p = 0.007$). Women constituted the minority of sport admissions (24%), in contrast to non-sport admissions where they were

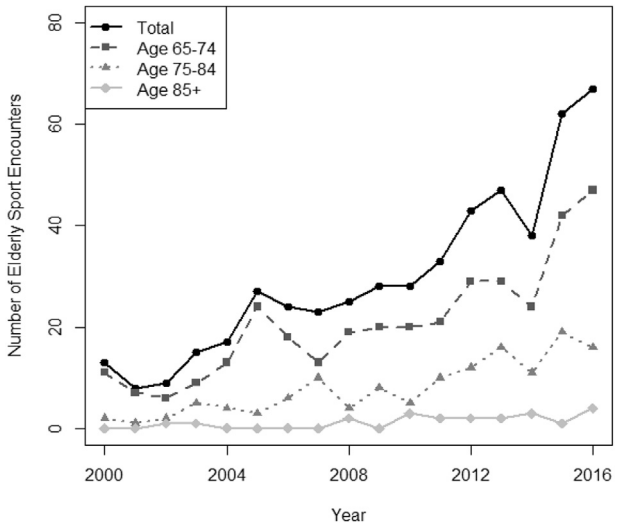

Fig. 1. Number of sport admissions over the study period, overall and by age group.

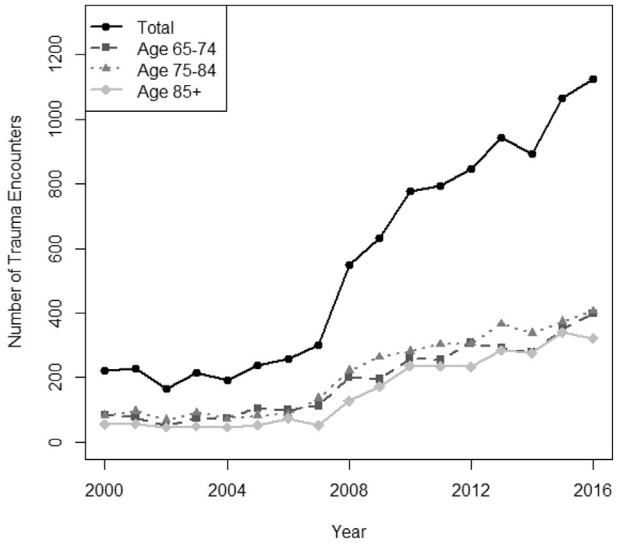

Fig. 2. Number of total elderly trauma admissions over the study period, overall and by age group.

the majority (62%, $p < 0.001$). The sport group had fewer medical comorbidities across all categories, including less preinjury anticoagulation use than the non-sport group. Regarding disposition, sport patients were more often discharged home than non-sport patients (73% vs 36%, $p < 0.001$), with 47% of non-sport patients requiring extended care facility (ECF) placement versus 14% of sport patients ($p < 0.001$). There was no difference in ICU or hospital LOS between groups. The in-hospital mortality rate was lower in the sport group than the non-sport (3% vs 5%, $p = 0.06$), with an overall rate of 5.3% for the entire study population (Table 1). Using logistic regression we found that increased age was associated with increased in-hospital mortality (OR 1.05; 95% confidence interval [CI] 1.03–1.06, $p < 0.001$); while being in the elderly sport group was not predictive of mortality (OR 0.61; 95% CI 0.33–1.04, $p = 0.09$). However, the elderly sport group was significantly more likely to discharge to home even when controlling for age, number of comorbidities, and ISS (OR 3.30; 95% CI 2.68–4.08, $p < 0.001$) (Table 2).

Mechanisms of injury among the sport group are summarized in

Table 1
Demographics and characteristics of the sport and non-sport groups.

Variable	Sport	Non-Sport	p-value
	N = 526	N = 9171	
Age; mean (SD)	72 (6)	79 (8)	<0.001
Female sex; n (%)	124 (24%)	5686 (62%)	<0.001
ISS; mean (SD)	11.6 (8.4)	10.6 (7.3)	0.007
Anticoagulation; n (%)	63 (12%)	2143 (23%)	<0.001
Diabetes; n (%)	40 (8%)	1910 (21%)	<0.001
Congestive Heart Failure; n (%)	10 (2%)	779 (8%)	<0.001
Respiratory Disease; n (%)	18 (3%)	689 (8%)	<0.001
Smoking; n (%)	14 (3%)	373 (4%)	0.14
Surgical Procedure; n (%)	253 (48%)	4071 (44%)	0.11
Interventional Radiology Procedure; n (%)	10 (2%)	80 (1%)	0.031
Discharge Disposition; n (%)			<0.001
Home	385 (73%)	3262 (36%)	<0.001
Extended Care Facility	73 (14%)	4308 (47%)	<0.001
Hospice	1 (<1%)	214 (2%)	<0.001
Acute Rehab or Psych	37 (7%)	807 (9%)	0.18
Other	7 (1%)	28 (<1%)	0.003
ICU LOS (days); median (IQR)	2 (1–4)	2 (1–4)	0.33
Hospital LOS (days); median (IQR)	4 (2–6)	4 (2–5)	0.37
Mortality; n (%)	18 (3%)	497 (5%)	0.06

Note: 5 patients in the sport group and 55 in the non-sport group had a missing discharge dispositon.
ISS – Injury Severity Score.
LOS – Length of Stay.

Table 2
Logistic regression assessing the effect of being in the elderly sport cohort, adjusted for age, number of comorbidities and ISS, for the in-hospital mortality and discharge to home outcomes.

	Odds Ratio	95% Confidence Interval	p-value
In-hospital Mortality			
Elderly Sport Injury	0.61	(0.33, 1.04)	0.09
Age	1.05	(1.03, 1.06)	<0.001
# of Comorbidities	1.20	(1.02, 1.40)	0.02
ISS	1.17	(1.15, 1.18)	<0.001
Discharge to Home			
Elderly Sport Injury	3.30	(2.68, 4.08)	<0.001
Age	0.93	(0.92, 0.93)	<0.001
# of Comorbidities	0.75	(0.70, 0.80)	<0.001
ISS	0.94	(0.93, 0.95)	<0.001

Table 3, with alpine skiing being the most common at 36%. Injury details are displayed in Table 4, reporting both incidence and severity. The most common injury patterns in the sport group, assessed by the abbreviated injury scale (AIS) score, were lower extremity (37%), chest (33%), head (32%) and upper extremity (24%). When comparing injury patterns between the two cohorts, sport patients had a higher incidence and higher severity of cervical spine (12% vs 9%, $p = 0.01$; mean AIS 2.8 vs 2.4, $p = 0.007$) and chest injuries (33% vs 16%, $p < 0.001$; mean AIS 2.8 vs 2.6, $p = 0.004$). Head injury was equally common between sport and non-sport (32% vs 31%, $p = 0.75$), but more severe in non-sport (mean AIS 2.8 vs 3.2, $p < 0.001$). Evaluating the four most common mechanisms of injury in the sport cohort, we found that leg injuries were most common in elderly skiers (34%), traumatic brain injuries in cyclists (44%), and chest injuries in those injured from OV use (44%) and equestrian or animal-related accidents (43%) (Table 5).

Table 3
Mechanism of injury in sport patients.

Mechanism	N (%)
Ski	187 (36%)
Offroad Vehicle	108 (21%)
Animal/horse riding	83 (16%)
Bicycle	86 (16%)
Fall while running/hiking	42 (8%)
Team/ball Sports	14 (3%)
Other	6 (1%)

Table 6 demonstrates findings compared across three separate age groups within the sport cohort. Mechanism of injury, ICU and hospital LOS, and in-hospital mortality were not different by age group. Discharge disposition was significantly different by age group, characterized by a decreased ability to discharge home with increasing age.

In the sport group, 73 patients had a comorbid condition. When compared to the remaining 453 in the sport group without identified comorbidities, these patients did not experience increased ICU ($p = 0.52$) or hospital LOS ($p = 0.67$), or a difference in discharge disposition including in-hospital mortality ($p = 0.90$). Further analysis assessing the impact of preinjury anticoagulant use revealed similar findings.

Discussion

In this study we identified a steady increase in both the overall number of admitted trauma patients ≥65 years of age, as well as those injured while participating in recreational activities. This trend in patients admitted for a sport-related injury was most evident in those aged 65–74 compared to older age groups, which is similar to what other series have observed.[8–10] The impact of underlying physical fitness on geriatric patient outcomes after traumatic injury has not been previously explored. Our study found that compared to a non-sport group of hospitalized elderly trauma patients, the active elderly are younger, healthier with fewer comorbid medical conditions, and more severely injured without experiencing a difference in hospital LOS. Furthermore, the ability to engage in sports was significantly associated with a favorable discharge disposition to home regardless of age, number of comorbidities, and ISS. In contrast, in-hospital mortality was associated with older age, number of comorbidities, and ISS, but not preinjury fitness. Older age has previously been identified as an independent risk factor for increased mortality after trauma,[11–13] but not consistently other adverse outcomes.[14,15] Emerging data suggest that frailty, or the state of low functional and physiologic capacity, is as common as 44% among elderly trauma patients, and independently predicts adverse discharge disposition, post injury functional status and mortality at 6- and 12-months regardless of age.[15,16] Our results suggest that preinjury physical health, as evidenced by participation in sport, may positively impact geriatric outcomes after trauma. Although this concept is not well studied or validated, it may perhaps be thought of as the “opposite” of frailty, and warrants further exploration.

It is imperative that trauma providers are aware of common injury patterns in the active elderly population, so as to best anticipate their workup and management. In the sport study population as a whole, lower extremity injuries were found to be the most common body area injured. Skiers also were most likely to experience lower extremity injuries, contrary to what has been published on younger injured skiers in whom traumatic brain injury is the prevailing injury.[17] This may be linked to lower rates of helmet use observed in younger skiers,[18] or simply the higher level of aggression with which young people ski. When comparing the sport and non-sport cohorts, however, leg injury was more common and severe in non-sport patients, which may be a result of decreased bone health associated with inactive lifestyles.[2,19] Head injury was equally common between both groups, but more severe in the non-sport cohort. We speculate this could be a result of helmet use in the sport group given that the most common sports mechanisms generally utilize helmets. More prevalent anticoagulation use in the non-sport group may also be a contributing

Table 4
Injury patterns by AIS compared between the sport and non-sport groups.

AIS Category	Sport N = 526		Non-Sport N = 9171		Significance	
	Incidence N (%)	Severity Mean (SD)	Incidence N (%)	Severity Mean (SD)	Incidence p-value	Severity p-value
Abdomen	35 (7%)	2.1 (0.9)	272 (3%)	2.4 (1.2)	<0.001	0.12
Chest	172 (33%)	2.8 (0.9)	1487 (16%)	2.6 (0.9)	<0.001	0.004
Cervical Spine	64 (12%)	2.8 (1.1)	813 (9%)	2.4 (0.8)	0.013	0.007
Face	47 (9%)	1.6 (0.6)	816 (9%)	1.5 (0.6)	1.00	0.36
Head	166 (32%)	2.8 (1.2)	2824 (31%)	3.2 (1.3)	0.75	<0.001
Lower extremity	195 (37%)	2.5 (0.8)	3977 (43%)	2.6 (0.6)	0.005	0.05
Lumbar Spine	40 (8%)	2.1 (0.3)	726 (8%)	2.3 (0.6)	0.86	<0.001
Thoracic Spine	49 (9%)	2.4 (0.6)	717 (8%)	2.4 (0.6)	0.25	0.71
Upper extremity	127 (24%)	2.0 (0.5)	1614 (18%)	2.0 (0.6)	<0.001	0.44

Note: For each AIS category we report the percentage of encounters that has the area injured ("Incidence"), and the central tendency of the AIS ("Severity") among those who had the area injured.
AIS – Abbreviated Injury Scale.

Table 5
Subgroup analysis evaluating injuries by common mechanisms.

AIS Category; n (%)	Ski (N = 187)	OV (n = 108)	Bike (N = 86)	Animal (N = 83)
Abdomen	9 (5%)	9 (8%)	5 (6%)	11 (13%)
Chest	48 (26%)	48 (44%)	32 (37%)	36 (43%)
Cervical Spine	24 (13%)	14 (13%)	9 (10%)	11 (13%)
Face	12 (6%)	10 (9%)	10 (12%)	10 (12%)
Head	57 (30%)	27 (25%)	38 (44%)	29 (35%)
Lower extremity	63 (34%)	40 (37%)	37 (43%)	29 (35%)
Lumbar Spine	8 (4%)	14 (13%)	4 (5%)	9 (11%)
Thoracic Spine	12 (6%)	17 (16%)	5 (6%)	10 (12%)
Upper extremity	32 (17%)	36 (33%)	28 (33%)	20 (24%)

AIS – Abbreviated Injury Scale.

Table 6
Subgroup analysis on sport group assessing outcomes by age group.

Outcome	Age 65–74	Age 75–84	Age 85+	p-value
	N = 365 (69%)	N = 140 (27%)	N = 21 (4%)	
Mechanism of Injury; n (%)				0.11
Animal	57 (16%)	22 (16%)	4 (19%)	
Bike	60 (16%)	22 (16%)	4 (19%)	
Fall	23 (6%)	14 (10%)	5 (24%)	
OV	83 (23%)	21 (15%)	4 (19%)	
Ski	131 (36%)	53 (38%)	3 (14%)	
Sport	7 (2%)	6 (4%)	1 (5%)	
Other	4 (1%)	2 (1%)	0 (0%)	
Discharge Disposition; n (%)				<0.001
Home	288 (79%)	87 (62%)	10 (48%)	<0.001
Extended Care Facility	40 (11%)	27 (19%)	6 (28%)	0.02
Hospice	0 (0%)	0 (0%)	1 (5%)	0.07
Rehab/Psych	20 (5%)	14 (10%)	3 (14%)	0.07
Other	6 (2%)	1 (1%)	0 (0%)	0.76
ICU LOS (days); median (IQR)	2 (1–4)	2 (1–5)	3 (2–5)	0.27
Hospital LOS (days); median (IQR)	4 (2–6)	4 (2–6)	4 (2–4)	0.58
Mortality; n (%)	9 (2%)	8 (6%)	1 (5%)	0.12

Note: 2 patients in the 65–74 age group and 3 in the 75–84 age group had a missing discharge disposition.
LOS – Length of Stay.

factor. Elderly cyclists most commonly suffer traumatic brain injury, which is consistent with observations previously made regarding cycling injuries.[20–22]

Not surprisingly given Utah's ski industry, and similar to a group who published an epidemiologic study on sport-related injuries in the elderly from Innsbruck, Austria,[8] we identified alpine skiing as the most common mechanism. Bicycling was responsible for 16% of the injuries in our study, and has gained popularity with older adults. Bicycling is one of the most prevalent mechanisms causing injury in the active aging population across all geographies, and accidents resulting in injury are more likely to occur with increasing age.[23,24] Utah's varied climate catering to ATV and snow mobile use creates a unique group of elderly who constitute a significant percentage of injured patients in this study. Similarly, other groups have identified the elderly as representing a rising proportion of ATV drivers, and at higher risk of injury and poorer outcomes compared to younger ATV recreationalists.[25] While not a sport in the purest sense, off-road vehicle riding is an activity that requires significant baseline strength and coordination. Further, these activities in our region occur on rugged terrain, where the need for physical fitness to control and maneuver such powerful machines is even more pronounced.

Data suggest the use of preinjury anticoagulation is an independent risk factor for worse outcomes including mortality after

traumatic injury,[26,27] and the prevalence of ambulatory oral anticoagulant use continues to grow significantly.[28] In this study, 12% of elderly persons participating in sport were anticoagulated at baseline, but this increased bleeding risk did not affect ICU or hospital LOS, discharge disposition or in-hospital mortality. DeBoard et al. compared 294 elderly patients injured during sport who were anticoagulated at baseline to a control cohort of 3929 elderly sport patients who were not anticoagulated. They found that the groups had a similar mortality rate, but the anticoagulated patients experienced significantly longer hospital LOS, increased blood product transfusion and rates of acute VTE. They concluded that active elderly patients taking blood thinning medications should be more thoroughly counseled as to the potential for adverse outcomes.[29]

Our study contained several limitations. The design was retrospective in nature, and is limited by the inherent constraints of the trauma registry design. Our data is collected from a single center, which may inhibit its applicability to other geographic settings. The total number of elderly patients injured from sport is underestimated, given that we only described those with injuries severe enough to require hospital admission to the trauma service; however, our report does capture those patients who are more severely injured. We did not follow outcomes beyond hospital discharge, and therefore cannot generalize our findings to long-term or functional outcomes. Our sample size in the sport cohort was much smaller than the non-sport group, increasing the risk of a type II error when comparing outcomes.

Conclusion

This epidemiologic study describes a growing elderly population that continues to be involved in recreation and thus susceptible to injury. Recognizing common injury patterns and risk factors may improve patient care and facilitate preventive measures to reduce incidence and morbidity. Our findings suggest that the ability to participate in recreational activity may have a favorable impact on recovery after injury, demonstrated by an improved ability to discharge home despite being more severely injured. Studies looking at long-term outcomes are necessary to fully characterize the extent of the differences in this patient population compared to their non-sport peers.

Conflicts of interest

None of the authors have anything to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.11.030.

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