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# Sport-related major trauma incidence in young people and adults in England and Wales: a national registry-based study

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## ABSTRACT

**Objectives** Data on sport and physical activity (PA) injury risk can guide intervention and prevention efforts. However, there are limited national-level data, and no estimates for England or Wales. This study sought to estimate sport and PA-related major trauma incidence in England and Wales.

**Methods** Nationwide, hospital registry-based cohort study between January 2012 and December 2017. Following Trauma Audit and Research Network Registry Research Committee approval, data were extracted in April 2018 for people  $\geq 16$  years of age, admitted following sport or PA-related injury in England and Wales. The population-based Active Lives Survey was used to estimate national sport and PA participation (ie, running, cycling, fitness activities). The cumulative injury incidence rate was estimated for each activity. Injury severity was described by Injury Severity Score (ISS)  $> 15$ .

**Results** 11 702 trauma incidents occurred (mean age  $41.2 \pm 16.2$  years, 59.0% male), with an ISS  $> 15$  for 28.0% of cases, and 1.3% were fatal. The overall annual injury incidence rate was 5.40 injuries per 100 000 participants. The incidence rate was higher in men (6.44 per 100 000) than women (3.34 per 100 000), and for sporting activities (9.88 per 100 000) than cycling (2.81 per 100 000), fitness (0.21 per 100 000) or walking (0.03 per 100 000). The highest annual incidence rate activities were motorsports (532.31 per 100 000), equestrian (235.28 per 100 000) and gliding (190.81 per 100 000).

**Conclusion** Injury incidence was higher in motorsports, equestrian activity and gliding. Targeted prevention in high-risk activities may reduce admissions and their associated burden, facilitating safer sport and PA participation.

## INTRODUCTION

Sporting activities and physical activities (PA) have health benefits, including lowering morbidity and mortality risks, improving pain, quality of life and mental health.<sup>1–4</sup> However, there is also an innate risk of injury. This central risk<sup>5</sup> can result in removal from activity and limit further participation, but can also predispose participants to disability,<sup>6,7</sup> and have financial consequences for individuals and society.<sup>8</sup> The financial sequelae of injury warrant international investment in preventative measures to reduce immediate and chronic societal burden.<sup>9</sup>

A major trauma and mortality rate of 12.2 per 100 000 participants has been identified in Australia

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Prior to this study, there were no national data on sport and physical activity (PA)-related trauma risks in the UK to inform prevention or reduction initiatives.

## WHAT THIS STUDY ADDS

⇒ Injury incidence data are presented for 61 sporting and physical activities. The national trauma incidence across all sport and PA in England and Wales was 5.4 injuries per 100 000 participants. The incidence was higher for male (6.4 injuries per 100 000 participants) than female participants (3.3 per 100 000 participants). Motorsport, equestrian and gliding activities had the highest annual injury incidence rate.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Comparatively at-risk groups have been identified, which can be targeted with injury reduction initiatives. This study also takes steps towards establishing the feasibility of a national register for serious sporting injuries, as recommended in the UK governmental Duty of Care in Sport Review.

(2847 injuries over 10 years to 2015), with an 8% increase in non-fatal trauma, notably equestrian activity, motorsports and cycling.<sup>10</sup> A national study in the Netherlands found that sports injury emergency department episodes had the third highest annual direct healthcare cost (€168 million), after home/leisure (€1334 million) and traffic injuries (€373 million).<sup>9</sup> In the context of nationalised, publicly funded healthcare such as the UK National Health Service (NHS), characterising injuries and identifying mechanism has clinical service implications, for reducing resource consumption, and facilitating PA health benefits with fewer detriments.

High-quality population-level data need to support prevention policies.<sup>11</sup> However, there are limited national sport-related data sources, and no such data in England and Wales. This limits prevention opportunities,<sup>11</sup> and the burden reduction of largely characterisable and preventable injuries. Since the 2012 introduction of regional trauma networks, and establishment of major trauma centres (regional specialist hospitals for trauma care provision) to provide increased specialised care for

trauma patients in England,<sup>12</sup> the Trauma Audit and Research Network (TARN) Registry has underpinned service evaluations, comparative patient outcome, characteristics and mortality to support more consistent and evidence-based major trauma care.<sup>13–16</sup> Metrics include Injury Severity Score (ISS), an individual's person-level summary of injury, commonly used to define major trauma (>15).<sup>17</sup>

This Registry also provides an opportunity to establish the number of severe sport and PA injuries nationally, and alongside population-based national participation data such as Sport England's Active Lives Survey (ALS), to derive injury incidence nationally and identify reduction opportunities.

Therefore, this study's objectives were:

- ▶ To identify NHS-treated sport-related or PA-related adult major trauma injuries in England and Wales between 2012 and 2017.
- ▶ To determine the cumulative incidence rate of adult major trauma injury in activities with highest national participation.
- ▶ To describe the cumulative incidence rate of adult major trauma injury annually from 2012 to 2017.
- ▶ To determine the proportion of fatal sport-related adult major trauma injuries, and the proportion classified with an ISS >15.

## METHODS

### Study design and setting

Registry-based cohort study of adults and young people (≥16 years), with severe injuries treated in NHS hospitals in England and Wales, from January 2012 to December 2017. The TARN Registry receives data from hospitals for patients who: (1) stay in hospital for ≥3 days, (2) become fatalities after admission or (3) have high dependency care admission.<sup>18</sup> All major trauma units and hospitals are members, with Health Research Authority approval for data collection without patient consent, in the absence of an individual national data opt-out.

Registry data include admission date and time, incident date, location and description, intent, sex, date of birth, ISS,<sup>19</sup> length of stay, length of stay in critical care, outcome at discharge and readmission. The categorical 'intent' field describes the rationale (ie, sport, non-intentional, intentional or self-harm). Outcome at discharge includes death after reaching hospital. Readmission is defined as ≤30 days of and related to the initial incident. Ethnicity data were not available.

Hospital-level case attainment is measured against Hospital Episode Statistics.

### Patient and public involvement

Patients or the public were involved in the design, conduct and dissemination plans through active involvement in the project's steering group. Categorisation for cases, definitions, study progress and outputs were all discussed, and decisions made jointly, informed by patient perspectives.

### Defining sport-related trauma cases

Injuries meeting the inclusion criteria, occurring in 'sport' (intent field) or including sporting phraseology in injury description (online supplemental file 1) were extracted.<sup>18</sup> Sporting injuries were defined as occurring in bowling, gymnastics, or team, roller, adventure, racket, water, leisure, combat or winter sports. PA definition included occurring during running, gym attendance, fitness or exercise classes, cycling or walking. Key sporting phrases were identified with Sport England, the study steering group and a literature review.

### Sport and PA exposure: ALS

ALS contacts households to examine sporting involvement, habits and spectatorship. Predetermined target responses per local authority are set throughout the survey year for national generalisability.<sup>19 20</sup> Only people aged ≥16 are included, with children's data collected elsewhere. There were 376 382 respondents to ALS in Year 2 (Y2; 2016/2017) and Year 3 (Y3; 2017/2018) surveys, with an 18.9% response rate in Y2 and Y3.<sup>19 20</sup>

Before ALS, the Active People Survey collected sports participation data in England. However, this landline telephone survey ran largely unchanged between its introduction in 2005 and 2015, thus becoming increasingly outdated and less generalisable. In discussion with Sport England, the second and third years of the new ALS were decided to be the most reliable national sporting exposure.

### Variables

Using Stata V.13.1 and V.16.1 SE (StataCorp, Texas), data were checked for accuracy and outliers. Queries regarding the definition of sports participation and sporting exposure were identified during data checking and escalated to a quarterly steering group for discussion and collaborative decision-making.

### Data cleaning and management

A sporting indicator variable was generated for each activity. Key phrases, likely typographic errors, alternate spelling or common derivations (ie, 'rugby', 'playing ruby', 'rygby') were identified. The *foreach* command was used to flag potential cases. Cases were reviewed, and any non-sport-related cases (eg, 'attended Rugby St Cross' hospital) excluded. The list of non-cases (ie, 'attended Rugby St Cross', 'way back from watching rugby') was reviewed again.

Cases with unclear sporting contexts (ie, tackled by a sibling at home; struck by hockey stick; triathlon inclusion as 'leg' of activity or overarching activity; moving goals and posts) were escalated for collective steering group decision-making on inclusion (n=61). This included one example (ie, struck by hockey stick) bought for every scenario it may happen (ie, struck by hockey stick, cricket bat, tennis racket). Cases with no evidence of sporting involvement, or alcohol consumption but no sporting mechanism (ie, 'fell over clothes horse', 'on Boxing Day'), were identified, a non-sports indicator generated using the string match (*strmatch*) command, and then reviewed. Incidents with special characters were excluded separately with the string position command *strpos*. Incidents occurring during rehabilitation of another injury ('rehab', 'physio class', 'physio exercises') were excluded. Data for prespecified sports were extracted, and remaining uncategorised cases reviewed. This case-by-case review process resulted in either: (1) the incident categorised as non-sport for exclusion, (2) the extraction terms being revised and rerun or (3) a novel sporting category generated. All exclusion cases were then reviewed again.

### Defining person-time at risk

Twice-monthly sports participation data from ALS Y2 and Y3 formed the 'person-time at risk' denominator across the study period. Respondents were asked about their broad activity participation (i.e., walking, cycling, dance, fitness or sporting activities) and selected each individual sport or activity they participated in from a list of 77 activities (online supplemental file 2). The ALS sampling strategy extrapolates responses to a population level using Office for National Statistics (ONS) data. The number of

sports participants at risk was derived from an ONS-weighted Y2 and Y3 ALS participation estimate, to produce a population-weighted mean Y2-Y3 estimate, for England and Wales.

Participation data were derived for:

- ▶ Any twice-monthly (28 days) participation.
- ▶ Twice-monthly broad activity participation (walking, cycling, creative or artistic dance, fitness activities, sporting activities).
- ▶ Each of 84 individually collected specific activities (online supplemental file 1).

Injury data could not be consistently differentiated between PA or travel incidents for walking and cycling. Therefore, broad activity groupings of (1) any walking or (2) any cycling in ALS (including commuting, off-road cycling or tricycles) were used. It is acknowledged that this may increase the denominator data. However, commuting trauma cases would be collected for walking or cycling injuries as for sport.

### Statistical methods

Descriptive statistics were estimated for demographic, incident, location type, treatment and derived sporting activity fields. Any trauma cases or participation data, either overall or by sex which reported a count of less than 5, were suppressed for the purpose of disclosure control. The crude cumulative incidence proportion for specific activities was estimated by dividing the total number of injuries by the sum of annual population-weighted participation data. Not every activity corresponded to a broad activity grouping in ALS (ie, motorsport was not included in sporting or fitness activities in ALS). All cases are presented for their specific activity.

The annual crude cumulative incidence rate was derived by dividing the number of injuries per specific activity by the annual population-weighted participation per sport. Annual incidence rate for all sport or activity participation, that is, any participation in one or more sport or PA activities twice in the last 28 days, was derived per year. This was also derived for broad activity groupings, and then for each individual sport or activity in ALS. The proportion of ISS >15 injuries was derived,<sup>17</sup> and the proportion fatal once reaching hospital. Cumulative injury incidence rate was reported per 100 000 participants/year, unless otherwise stated (ie, for specific year). Poisson CIs assessed the influence of injury risk factors (sex) on injury incidence. Incidence figures were produced in RStudio (1.2.1335). Subgroups of the number and proportion of injuries by sex for each age group were undertaken as sensitivity analyses.

## RESULTS

### Sport and PA-related severe sports injury: 2012–2017

Data for 18 343 incidents were received, of which 'sport' was the only search field would have captured 73.6% of cases (table 1). After excluding paediatric ( $\leq 16$  years,  $n=2191$ ), rehabilitation ( $n=5$ ), non-sports incidents ( $n=2549$ ), incidents with no description ( $n=164$ ) and incidents with sporting terminology but not occurring in sport ( $n=1732$ ), there were 11 702 incidents between January 2012 and December 2017. Most cases were men ( $n=6909$ ; 59.0%), with a mean age of 41.2 (16.2) years. The highest reported age category was 45–54 (21.3%), followed by 16–24 (21.2%). The mean length of stay was 9.4 days, 3278 incidents (28.0%) were ISS >15 and 148 (1.3%) were fatal (table 1).

**Table 1** Participant characteristics for those with eligible Trauma Audit and Research Network (TARN) Registry incidents, and reporting twice-monthly sports participation in Sport England's Active Lives Survey

	TARN incident participants (n=11 702)	Active Lives Survey Year 2 and Year 3 respondents with twice-monthly participation (n=376 382)	
		Respondents (n)	
Age (years)			
Mean age (SD) - years	41.2 (16.2)	373 174	–
Categories (%)			
16–24	2476 (21.2)	23 629 (6.3)	
25–34	2225 (19.0)	46 933 (12.6)	
35–44	1984 (17.0)	58 508 (15.7)	
45–54	2489 (21.3)	64 132 (17.2)	
55–64	1654 (14.1)	71 397 (19.1)	
65–74	630 (5.4)	71 446 (19.1)	
75–84	205 (1.8)	29 700 (8.0)	
85+	39 (0.33)	7429 (2.0)	
Male sex (%)	6909 (59.0)	166 086 (44.2)	
Ethnicity (%)			
White British	–	362 510	
White other	–	313 419 (86.5)	
South Asian	–	19 860 (5.5)	
Black	–	14 959 (4.1)	
Chinese	–	5490 (1.5)	
Mixed	–	1952 (0.5)	
Other ethnic group	–	4080 (1.1)	
Major trauma centre treated, n (%)	5812 (49.7)	–	–
Mode of arrival (n=8657)			
Helicopter	1334 (15.4%)	–	–
Ambulance	6164 (71.2%)	–	–
Car/personal vehicle	625 (7.2%)	–	–
Aircraft	21 (0.2%)	–	–
Walking	114 (1.3%)	–	–
Ambulance and helicopter	142 (1.6%)	–	–
Not applicable	195 (2.3%)	–	–
With police, by ambulance car or other	62 (0.7%)	–	–
Intent (n=11 702)			
Alleged assault	29 (0.2%)	–	–
Intent inconclusive	18 (0.2%)	–	–
Non-intentional	2999 (25.6%)	–	–
Sport	8608 (73.6%)	–	–
Suspected high-risk behaviour or self-harm	48 (0.4%)	–	–
Radiograph	8862 (75.7%)	–	–
CT scan	7869 (67.2%)	–	–
Length of stay (days)	9.4 (16.2)	–	–
Readmission	476 (4.1%)	–	–
Injury Severity Score >15	3278 (28.0%)	–	–
Death	148 (1.3%)	–	–

Data are reported as n (%) unless otherwise indicated.

**Table 2** The number of cases, length of stay and proportion of Injury Severity Score >15 for Trauma Audit and Research Network (TARN) Registry injuries by broad activity

	TARN cases (n)			Length of stay Days (SD)	Injury Severity Score >15 n (%)	Overall injury incidence (per 100 000 participants/year)	Male injury incidence (per 100 000 participants/year)	Female injury incidence (per 100 000 participants/year)
	Overall	Male	Female					
All adults physically active (aged 16+)	11 702	6909	4793	9.4 (16.2)	3278 (28.0)	5.39 (5.29 to 5.49)	6.44 (6.29 to 6.59)	3.34 (3.25 to 3.44)
Broad activity cases (n=11 208)								
Sporting activities	9623	5209	4414	9.3 (15.9)	2671 (27.8)	9.88 (9.68 to 10.08)	9.36 (9.11 to 9.62)	10.56 (10.25 to 10.88)
Cycling*	1339	559	86	9.9 (16.7)	206 (31.9)	2.81 (2.66 to 2.96)	4.04 (3.82 to 4.27)	0.71 (0.60 to 0.85)
Fitness activities	177	85	92	9.5 (9.1)	40 (22.6)	0.21 (0.18 to 0.24)	0.23 (0.19 to 0.28)	0.20 (0.16 to 0.25)
Walking*	49	32	17	12.4 (11.9)	23 (46.9)	0.03 (0.02 to 0.04)	0.04 (0.03 to 0.06)	0.02 (0.01 to 0.03)
Creative or artistic dance	20	†	†	12.4 (16.7)	2 (10.0)	0.35 (0.23 to 0.54)	†	†

Results are ordered by case number.

\*Walking and cycling are separated into the following activity groups in the Active Lives Survey: (1) walking for leisure and (2) walking for travel; and (1) cycling for leisure and sport and (2) cycling for travel. We are unable to correctly classify TARN incidents by these descriptions, and therefore they are not reported separately.

†Cells for which less than 5 cases have been suppressed for disclosure control.

### Sport and PA exposure

Most ALS respondents were active twice monthly (77.2% and 77.5% for ALS Y2 and Y3). When weighted by population estimates, this resulted in 77.3% active twice in 28 days (online supplemental file 3). Participation was highest in walking (59.1%), sport (34.7%) and fitness activities (29.7%). By individual activity, participation was highest in running (15.3%), fitness classes (14.3%) and gym sessions (12.8%). This equated to a 6-year total population at risk of 42.9 million for running, 40.2 million for fitness classes and 35.8 million for gym sessions (online supplemental file 2). Full participation data are provided (online supplemental files 2–4).

### Injury incidence and incidence by participation rankings

#### Overall injury incidence

With 11 702 trauma incidents, and 77.3% of the population active twice monthly, there was a cumulative injury incidence of 5.4 injuries per 100 000 participants/year. The overall cumulative incidence for male participants was 6.4 injuries per 100 000 participants/year, and 3.3 injuries per 100 000 for female participants/year (table 2). The incidence was highest for 16–24 year-olds (6.25 injuries per 100 000 participants/year), followed by 45–54 year-olds (figure 1).

By age group, the proportion of injuries was higher for men at all age groups aside from or those aged 55–64 years and 85+, where female participants accounted for 55.1% and 53.8% of trauma cases, respectively (figure 2).

#### Injury frequency and incidence by broad activity

The number of cases was highest for equestrian activity (n=4303), followed by cycling (n=1339), football (n=876), motorsports (n=597) and rugby (n=490). Injury severity was highest in boxing (71.6%), followed by abseiling (55.6%), surfing sports (51.1%) and gliding sports (online supplemental file 5).

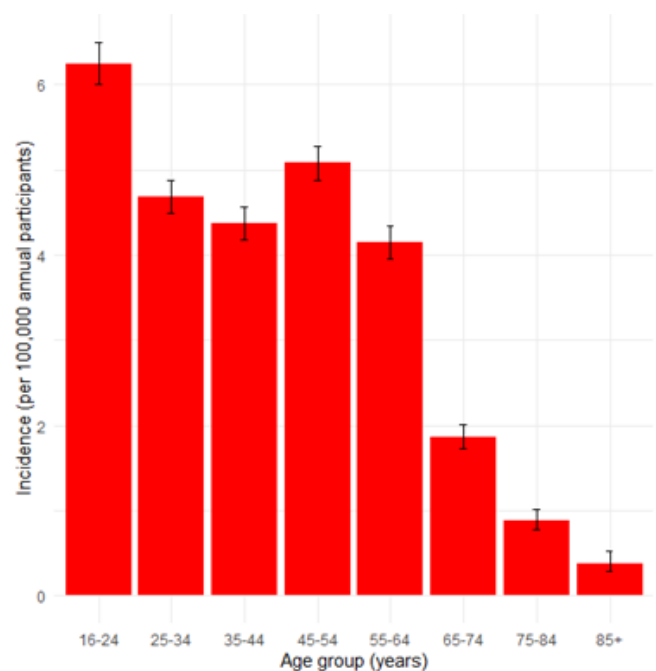
Of the 95.8% of incidents which corresponded to a broad activity grouping, 9623 (85.9%) were in sport, followed by 1339 in cycling (11.9%). The incidence was highest for sporting activities (9.9 injuries per 100 000 participants/year).

### Incidence of injury by national participation

Participation was highest in running, with an injury incidence of 0.70 per 100 000 participants/years (table 3). Of high participation sports, football had the highest injury incidence (6.56 per 100 000 participants/year).

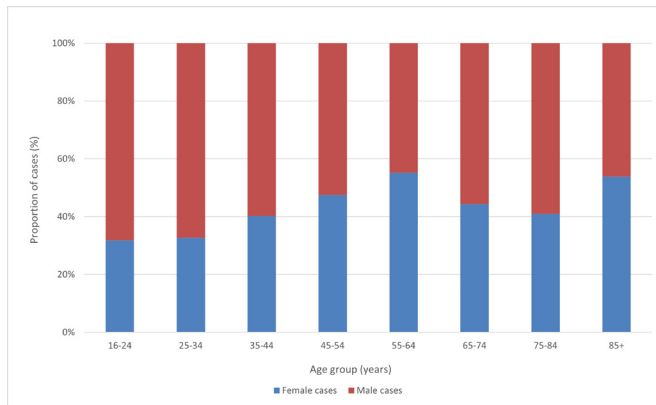
### Incidence of injury for specific activities

Motorsports had the highest incidence, with 532.3 injuries per 100 000 participants/year. This was followed by equestrian-related sports, with 235.3 injuries per 100 000 participants/year. The third highest sporting activity was gliding, paragliding or



**Figure 1** The overall annual incidence of severe sport-related injury (per 100 000 participants) by age group across the study period. Error bars represent 95% CIs.





**Figure 2** The proportion of severe sport-related injury cases, by age group and sex.

hang gliding, with 190.8 injuries per 100 000 participants/year (table 4). All sledding, luge and tobogganing incidents ranked 10th. However, excluding any incidents with ‘hill’ or ‘park’ (ie, discounting unorganised, seasonal recreation), this category was 14th (table 4). Full incidence data for all activities have been provided (online supplemental file 5).

### Annual cumulative injury incidence over time

The injury incidence appeared to increase over time (table 5), with the highest incidence in 2015, but data from 2016 and 2017 remaining higher than the incidences seen for 2012–2014. Sporting activities consistently had the highest incidence (7.75 per 100 000 participants (95% CI 7.33 to 8.20) in 2012 and 10.83 (95% CI 10.34 to 11.34) in 2017), followed by cycling (1.87 (95% CI 1.59 to 2.20) in 2012 and 2.92 (95% CI 2.57 to 3.32) in 2017). In sporting activities, there were an additional 3.08 injuries per 100 000 participants/year in 2017, compared with 2012, and injuries in fitness activities were more than twice the incidence in 2012 by 2017 (table 5).

## DISCUSSION

### Principal findings

Between 2012 and 2017, there were 11 702 trauma injuries and an injury incidence of 5.4 per 100 000 participants/year. Male incidence (6.4 injuries/100 000) was higher than female incidence (3.3 injuries/100 000)/participants/year. Among sports with the highest participation, football had the highest injury incidence rate (6.56 injuries/100 000 participants/year (95% CI 6.14 to 7.01)), followed by golf (1.25/100 000 participants/year (95% CI 1.00 to 1.57)) and badminton (1.9%; 0.82/100 000 participants/year (95% CI 0.61 to 1.10)). For fitness activities, running had the highest participation (0.70 injuries per 100 000 participants/year (95% CI 0.63 to 0.78)), followed by fitness classes (0.10 per 100 000 participants/year (95% CI 0.08 to 0.14)) and gym sessions (0.23 per 100 000 participants/year (95% CI 0.18 to 0.28)). All fitness activities had a lower incidence than the overall sport and PA incidence. This is the first time comparable sport-specific national data have been described for England and Wales.

### Interpretation and generalisability

Sporting activities had a higher injury incidence than cycling, walking, fitness or dance. A population-based survey in Finland similarly reported the injury incidence in ‘commuting and lifestyle activities’ (walking, rowing, gardening, home repair, cycling, hunting or fishing) as lower than in recreational and competitive sports.<sup>21</sup> The highest incidence activity was motorsports. In the UK, data from one regional trauma and spine unit identified an almost 500% increase in 5 years to 2015.<sup>22 23</sup> Motorsport’s prominence in our study may indicate its consistently higher risk profile over recent years, and that this risk is not localised.

Equestrian-related injuries had the second highest incidence. An observational study in the USA reported one in five equestrians (21%) seriously injured during horse riding, a finding which in 2007 prompted calls for injury prevention attention, particularly for novices.<sup>24</sup> The high proportion of UK road-related equine incidents and risk factors such as passing distance and speed have been discussed.<sup>25</sup> These more mechanistic data

**Table 3** The overall injury incidence and incidence by sex for the 15 highest participation sports and physical activities in individuals aged 16 and above

Activities	Participation (%)	Overall		Male		Female	
		Cases	Incidence	Cases	Incidence	Cases	Incidence
Walking	59.05	49	0.02 (0.02 to 0.03)	32	0.04 (0.03 to 0.06)	17	0.02 (0.01 to 0.03)
Cycling	16.98	1339	2.81 (2.67 to 2.97)	1215	4.04 (3.82 to 4.23)	124	0.71 (0.59 to 0.84)
Running	15.32	301	0.70 (0.63 to 0.78)	187	0.80 (0.70 to 0.93)	114	0.58 (0.48 to 0.69)
Fitness class	14.33	42	0.10 (0.08 to 0.14)	8	0.08 (0.04 to 0.15)	34	0.11 (0.08 to 0.16)
Gym session	12.76	81	0.23 (0.18 to 0.28)	40	0.21 (0.15 to 0.28)	41	0.25 (0.18 to 0.34)
Swimming	10.37	192	0.66 (0.57 to 0.76)	133	1.04 (0.88 to 1.24)	59	0.36 (0.28 to 0.47)
Exercise machines	8.59	27	0.11 (0.08 to 0.16)	17	0.13 (0.08 to 0.22)	10	0.09 (0.05 to 0.16)
Weights session	5.13	27	0.19 (0.13 to 0.27)	20	0.23 (0.15 to 0.36)	7	0.12 (0.06 to 0.25)
Football	4.76	876	6.56 (6.14 to 7.01)	839	6.92 (6.47 to 7.41)	37	2.98 (2.16 to 4.12)
Golf	2.14	75	1.25 (1.00 to 1.57)	64	1.26 (0.99 to 1.61)	11	1.18 (0.65 to 2.13)
Badminton	1.92	44	0.82 (0.61 to 1.10)	20	0.61 (0.39 to 0.95)	24	1.13 (0.76 to 1.69)
Tennis	1.83	73	1.42 (1.13 to 1.79)	37	1.19 (0.86 to 1.65)	36	1.77 (1.27 to 2.45)
Boxing (includes boxing fitness classes)	1.65	74	1.59 (1.27 to 2.00)		*		*
Rowing (includes indoor rowing)	1.48		*		*		*
Table tennis	0.95	34	1.28 (0.91 to 1.79)	15	0.8 (0.48 to 1.32)	19	2.41 (1.53 to 3.77)

Please note the Active Lives Survey broad activity groupings of walking and cycling have been included for completeness.

\*Result by sport or sex is not provided in the interests of non-disclosure (results are <5 cases).

**Table 4** Annual participation, overall injury incidence and injury incidence for the 6-year study period by sex for the 15 highest overall incidence sports and physical activities for individuals aged 16 and over

Activities (6-year participation estimate)	Overall		Male		Female	
	Cases	Incidence	Cases	Incidence	Cases	Incidence
Motorsports (n=112 153)	597	532.31 (491.28 to 576.77)	555	506.30 (465.88 to 550.22)	42	*
Equestrian (n=1 828 913)	4303	235.28 (228.35 to 242.41)	768	292.79 (272.80 to 314.25)	3535	223.87 (216.61 to 231.37)
Gliding, paragliding or hang gliding (n=56 077)	107	190.81 (157.87 to 230.62)	97	*	10	*
Skateboarding (n=400 121)	168	41.99 (36.09 to 48.84)	148	48.10 (40.94 to 56.51)	20	19.69 (12.70 to 30.52)
Ice skating (n=355 983)	113	31.74 (26.40 to 38.17)	52	34.93 (26.62 to 45.84)	61	29.32 (22.81 to 37.68)
Rugby union and league (n=1 959 355)	490	25.01 (22.89 to 27.32)	462	28.14 (25.68 to 30.82)	28	8.88 (6.13 to 12.86)
Water-skiing (n=94 560)	21	22.21 (14.48 to 34.06)	15	*	6	*
Roller-skating, inline skating, rollerblading (n=266 885)	59	22.11 (17.13 to 28.53)	30	26.78 (18.72 to 38.30)	29	16.37 (11.38 to 23.56)
Snowsport (n=1 542 641)	339	21.98 (19.76 to 24.44)	221	23.71 (20.78 to 27.05)	14	2.30 (1.36 to 3.88)
Sledding, luge, tobogganing (all) (n=140 191)	28	19.97 (13.79 to 28.93)	13	*	15	14.95 (9.01 to 24.79)
Abseiling (n=56 077)	9	16.05 (8.35 to 30.85)		†		†
Gymnastics (including all trampolining) (n=1 830 547)	273	14.91 (13.25 to 16.47)	179	25.87 (18.72 to 38.30)	94	8.24 (6.73 to 10.08)
Climbing and bouldering (n=1 962 678)	288	14.67 (13.07 to 16.47)	227	17.44 (15.31 to 19.86)	61	9.25 (7.20 to 11.89)
Sledding, luge, tobogganing (excluding hills and parks) (n=140 191)	19	13.59 (8.67 to 21.30)	10	*	9	*
Obstacle course (eg, Tough Mudder) (n=99 827)	12	12.02 (6.83 to 21.17)		†		†

\*Denominator data are not available in Active Lives Survey (ALS). This is predominantly due to insufficient data (ie, too few participant responses by sex) to report an ALS result. †Result by sex is not provided in the interests of non-disclosure (results for one sex are <5 cases).

may be able to support intervention, given increased awareness of aetiology and national burden. The incidence was broadly similar between male and female equestrians (292.79 injuries per 100 000 participants/year (95% CI 272.80 to 314.25) for males and 223.87 injuries per 100 000 participants/year (95% CI 216.61 to 231.37) for females), despite there being a higher case load of female incidents (n=3535), which constitutes 73.8% of the female in cases in this dataset. This may be indicative of a clear intervention opportunity for a well-phenotyped group of female sports and leisure participants, which also constitutes a high clinical trauma burden.

The third highest incidence activity was gliding or paragliding. Previous research has sought to establish the rate of gliding incidents in the UK by comparing a survey of paraglider pilots to an incident database.<sup>26</sup> This study proposed risk factors of control or error decisions above equipment failure, however quantified participation as per 100 000 hours of flight time, which prevents comparison to this study's population methodology.<sup>26</sup> These three prominent activities together accounted for 5007 incidents

(42.8% of cases), and therefore may be candidates for further prevention efforts.

The highest incidence age group was 16–24, followed by 45–54. A higher incidence for younger people emphasises the importance of injury management during the acute phase, as well as managing and mitigating longer term implications. Sensitivity analyses by sex demonstrated that the proportion of injuries was higher for males aside from two time points of 45–54 years and 85 years or more. Further investigation of the incident category responsible for this peak identified that almost half of the cases for the 45–54 age group were horse related. The proportion of injury by sex changing from predominantly male injuries (68.1%, 67.2% and 59.7% for 16–24, 25–34 and 35–44 years, respectively) to 55.1% female for 55–64 years of age and 53.8% for 85 years and older may be indicative of different life stages relating to the type of activity undertaken and relative risk of injury, encouraging individualised prevention approaches for at-risk groups.

**Table 5** Incidence by year of admission for the five broad activity groupings for injuries in individuals aged 16 and over

Activity	Year of admission					
	2012	2013	2014	2015	2016	2017
Any activity (cases, n=11 586)	1504	1739	1927	2178	2096	2142
Any activity (incidence)	4.24 (4.03 to 4.46)	4.87 (4.65 to 5.10)	5.35 (5.12 to 5.60)	6.00 (5.76 to 6.26)	5.73 (5.49 to 5.98)	5.83 (5.58 to 6.08)
Broad activities						
Walking	0.04 (0.02 to 0.07)	0.03 (0.2 to 0.06)	0.04 (0.02 to 0.07)	0.02 (0.01 to 0.05)	0.04 (0.02 to 0.07)	0.01 (0.00 to 0.03)
Cycling	1.87 (1.59 to 2.20)	2.32 (2.01 to 2.68)	2.76 (2.42 to 3.15)	3.97 (3.39 to 4.24)	3.00 (2.65 to 3.41)	2.92 (2.57 to 3.32)
Creative or artistic dance	0.11 (0.02 to 0.76)	*	0.53 (0.22 to 1.26)	0.42 (0.16 to 1.11)	0.41 (0.16 to 1.10)	0.62 (0.28 to 1.37)
Fitness activities	0.13 (0.08 to 0.21)	0.12 (0.08 to 0.20)	0.22 (0.15 to 0.31)	0.24 (0.17 to 0.33)	0.26 (0.19 to 0.36)	0.28 (0.20 to 0.38)
Sporting activities	7.75 (7.33 to 8.20)	9.08 (8.62 to 9.56)	9.71 (9.24 to 10.21)	10.71 (10.22 to 11.22)	10.55 (10.07 to 11.06)	10.83 (10.34 to 11.34)

\*No creative or artistic dance cases were reported in 2013.

Injury risks are increasing internationally.<sup>27</sup> In the Netherlands, the injury incidence of fitness injuries increased from 1.3 to 1.8 injuries per 1000 hours of participation between 2010 and 2014.<sup>28</sup> In Victoria, Australia, the annual rate of hospital-treated sports injury increased by 24% between 2004 and 2010,<sup>7</sup> with an incidence of sport-related major trauma or death of 12.2 per 100 000 participants/year.<sup>10</sup> This incidence in Victoria is higher than in our study; however, there were differences in the inclusion criteria for the Victorian State Trauma Registry which are: death after injury, an ISS >12 or intensive care unit admission for 24 hours.<sup>10</sup>

### Strengths and limitations

Study strengths include national registry data, collected at the point of treatment and with ascertainment evaluation. As the first sporting analysis using this data source, the data extraction process involved extracting 'sport' incidents (intent field), but also identifying and extracting those featuring any of 62 keywords. This meticulous approach is a strength, as only 73.6% of our cases were captured with the intent field, suggesting that 26.5% cases would have been missed without this approach. However, this is time intensive and resulted in a vast amount of meta-data generation. This can also support improvements in future data recording and extraction.

ALS data covered the latter period of the study, but were agreed as the best available denominator. Data for 2 years were used to reduce any year-on-year variation. For sports where one may not participate twice a month all year (ie, obstacle courses such as Tough Mudder, motorsport, paragliding), a twice-monthly participation may overestimate incidence, compared with less seasonal or more organised sports. Limitations of the denominator data for this purpose also include response rate (18.9% in Y2) and data availability for lower participation sports, particularly by sex. The sampling strategy for ALS does, however, weight responses to population-level data representative of national demographics, which may improve generalisability outside of this sample, and mitigate response bias. These data are also the best available nationally, which governmental decision-making and sport funding is partly based on.

A limitation of TARN data for our study is its fatality definition. Other data sources were sought for all fatalities irrespective of admission, but there is currently no established reporting for this purpose. While all 'sport' mechanism cases and free-text sport-related cases were extracted, differentiation between activities for sport and travel in TARN was harder for some activities (walking or cycling) than for other sports where terminology is clearer. Where there is genuine competitive sports participation in branches of these activities (ie, BMX/off-road, road cycling, track cycling or hiking, fell walking, orienteering), establishing incidence through registries may not be the most reliable true estimate of severe injury. This differentiation difficulty lead us to use 'any' definition for participation and injury these categories (ie, 'any walking' and 'any cycling'), in order to describe a comparable incidence across all forms of sporting and physical activity. We acknowledge this may be of limited value to individual competitive sports in these areas to inform prevention initiatives. However, some of these (ie, BMX) can also be interrogated further within the category, which while not providing comparative incidence may support the identification of injury mechanism. Data were extracted in 2018 before the SARS-CoV-2 pandemic, and we cannot infer current incidence, or changes to sports participation or trauma presentation after pandemic. A final consideration while facilitating this research

opportunity, representing severe clinical burden and ensuring reliable and consistent historic reporting, the severity of TARN inclusion criteria will exclude hospital episodes of 1–2 days, and any outpatient or brief inpatient interventions, which are relevant to fully identify the contribution of sports injury to patients and health services.

Most sport and recreation injuries may be considered preventable,<sup>27</sup> and major trauma is the third leading cause of avoidable mortality in the UK.<sup>29</sup> Modification to risk-taking behaviours, legislation, supervision and terrain may all provide opportunities to decrease these ~2000 annual incidents for patients, their families and the healthcare system. Multiple audits in emergency departments in the UK have highlighted these prominent sport-related injuries on a local level and demonstrate clinical eagerness to emphasise the burden of sports injury.<sup>22 30–32</sup> However, the sustained and higher incidence of sport-related major trauma in the UK in recent years is indicative of the absence of coordinated reduction efforts.

### CONCLUSION

This study derived a national incidence for major trauma in sport and PA. The highest injury incidence was for sporting injuries, and individual activities of motorsports, equestrian, and gliding, paragliding or hang gliding. To date, there have been no coordinated efforts to reduce this participant, clinical and economic burden in England and Wales. Identifying these higher incidence activities and populations may provide intervention opportunities to reduce risk, and safeguard shorter and longer term participant and population health.

**Contributors** SW, KAS and CM conceived the study, which was designed by all authors. Data were acquired by TL, SW, MD and AE. MD and SW were responsible for analysing the data. KAS, CM, FEL and AE acted as scientific advisors. All authors contributed to managing the study and interpreting the data. MD drafted the manuscript, which was critically revised and approved for publication by all authors. MD acts as guarantor for this work, with full responsibility for the work, conduct and access to the study's data.

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**Patient and public involvement** Patients with previous experience of sport-related trauma were members of the study steering group, responsible for contributing to its design, methodology, and decision-making.

**Patient consent for publication** Not applicable.

**Ethics approval** Institutional research ethics approval was granted for this study by the University of Bath Research Ethics Committee for Health (EP 17/18 08) and the TARN Research Committee.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data may be obtained from a third party and are not publicly available. No data were generated for this study. Active Lives Survey data are publicly available and retrievable from the Sport England website. Data used were obtained under agreement from the Trauma Audit and Research Network Registry and Sport England.

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Supplementary File 1: Key search terms and phrases associated with participation in sport and physical activity

## Free-text search for specific popular participation sports in England and Wales: TARN



- Rugby
- Rugby union
- Rugby league
- Gymnastics
- Trampoline
- Trampolining
- Horse riding
- Horse racing
- Equestrian
- Jockey
- American football
- Wrestling
- Boxing
- Fencing
- Judo
- Taekwondo
- Martial arts
- Karate
- Gaelic
- Football
- Netball
- Tennis
- Squash
- Basketball
- Wheelchair basketball
- Wheelchair rugby
- Lacrosse
- Field hockey
- Ice hockey
- Roller derby
- Roller skating
- Skate boarding
- Skating
- Ice skating
- Rowing
- Sailing
- Canoe
- Kayak
- Swimming
- Athletics
- Running
- Triathlon
- Obstacle course
- Tough Mudder
- Spartan Run
- Rat Race
- Weight

Free-text search for specific popular participation sports in England and Wales: TARN



- Weight training
- Weight lifting
- Olympic lifting
- Tournament
- Competition
- Class
- Training
- Exercise
- Gym
- Badminton
- Cricket
- Cheerleading
- Golf
  
- Climbing
- Bouldering
- Skiing
- Snowsports
- Karting
- Gokarting
- Motocross

Supplementary File 2 - Full national participation data by all Specific Activities in Active Lives Survey Years 2 and 3.

Activities	November 2016-17 (ALS 2)	November 2017-18 (ALS 3)	ONS MYE-weighted	Annual population estimates for England and Wales						6-year total population at risk
	Rate (%)	Rate (%)	Rate (%)	2012	2013	2014	2015	2016	2017	
Running	15.40%	15.20%	15.32%	7026986	7073363	7129484	7186880	7243553	7282198	42942464
Fitness class	14.60%	14.10%	14.33%	6576041	6619442	6671962	6725675	6778710	6814876	40186707
Gym session	12.00%	13.50%	12.76%	5854110	5892746	5939500	5987316	6034529	6066724	35774925
Swimming	10.20%	10.50%	10.37%	4756421	4787813	4825800	4864650	4903011	4929169	29066865
Exercise machines	8.40%	8.80%	8.59%	3940559	3966566	3998037	4030223	4062004	4083675	24081064
Hill and mountain walking	**	6.30%	6.25%	2867564	2886489	2909391	2932813	2955940	2971710	17523907
Weights session	4.60%	5.60%	5.13%	2355853	2371402	2390217	2409459	2428459	2441415	14396805
Interval sessions	5.40%	4.70%	5.10%	2338867	2354303	2372983	2392086	2410949	2423812	14292999
Football	5.00%	4.50%	4.76%	2183745	2198157	2215598	2233435	2251046	2263056	13345038
Generic fitness training	4.40%	4.20%	4.29%	1968897	1981892	1997616	2013698	2029577	2040405	12032086
Golf	2.20%	2.10%	2.14%	981864	988344	996186	1004206	1012125	1017524	6000250
Badminton	2.00%	1.90%	1.92%	881734	887553	894595	901797	908908	913757	5388343
Tennis	1.90%	1.70%	1.83%	839447	844987	851691	858548	865318	869935	5129927
Boxing (inclusive of boxing fitness classes)	1.70%	1.70%	1.65%	759328	764340	770404	776606	782730	786906	4640314
Rowing (inclusive of indoor rowing)	1.60%	1.40%	1.48%	680907	685401	690839	696401	701892	705637	4161076
Table Tennis	1.00%	0.90%	0.95%	435916	438793	442274	445835	449351	451748	2663917
Squash	0.80%	0.80%	0.77%	351139	353456	356261	359129	361961	363892	2145838
Bowls	0.80%	0.70%	0.75%	341830	344086	346816	349608	352365	354245	2088948
Climbing and bouldering	**	0.70%	0.70%	321167	323287	325852	328475	331065	332832	1962678
Basketball	0.70%	0.70%	0.67%	307403	309432	311887	314398	316877	318567	1878563
Cricket	0.70%	0.70%	0.66%	302879	304878	307297	309771	312213	313879	1850916
Equestrian	0.70%	0.60%	0.65%	299278	301253	303644	306088	308502	310148	1828913
Gymnastics (excluding trampolining)	0.70%	0.60%	0.65%	299546	301523	303915	306362	308777	310425	1830547
Gymnastics (inclusive of all trampolining)			0.65%	299546	301523	303915	302003	308777	310425	1830547
Gymnastics (inclusive of institutional (i.e., non-home based) trampolining)			0.65%	299546	301523	303915	302003	308777	310425	1830547

Netball	0.60%	0.60%	0.62%	284523	286401	288673	290997	293292	294857	1738744
Fell running	0.50%	0.70%	0.62%	286309	288199	290485	292824	295133	296707	1749657
Snowsport	0.50%	0.60%	0.55%	252434	254100	256116	258178	260213	261602	1542641
Rugby Union	0.60%	0.50%	0.53%	243522	245129	247074	249063	251027	252366	1488180
Martial Arts	0.50%	0.60%	0.52%	239940	241523	243439	245399	247334	248654	1466289
Track and field athletics	0.50%	0.40%	0.50%	227164	228663	230477	232333	234165	235414	1388216
Garden trampolining	0.40%	0.50%	0.46%	209460	210843	212516	214226	215916	217068	1280028
Canoeing	0.30%	0.40%	0.35%	161109	162172	163459	164775	166074	166960	984548
Surfing, board surfing, body boarding, kite surfing	0.20%	0.30%	0.30%	137043	137948	139042	140161	141267	142020	837481
Sailing	0.30%	0.30%	0.28%	129796	130652	131689	132749	133796	134510	793192
Hockey	0.20%	0.20%	0.24%	110114	110841	111721	112620	113508	114114	672918
Angling	0.20%	0.20%	0.24%	107863	108575	109436	110317	111187	111780	659158
Parkour or free running	0.20%	0.20%	0.22%	100938	101604	102411	103235	104049	104604	616842
Tai Chi	0.20%	0.20%	0.21%	97298	97941	98718	99512	100297	100832	594598
Shooting	0.20%	0.20%	0.20%	91762	92368	93101	93850	94590	95095	560765
Rounders	0.20%	0.20%	0.18%	80395	80925	81567	82224	82872	83315	491298
Rugby League	0.20%	0.10%	0.17%	77102	77611	78226	78856	79478	79902	471175
Volleyball	0.20%	0.20%	0.17%	75798	76298	76903	77522	78134	78551	463205
Frisbee or ultimate frisbee	0.10%	0.20%	0.14%	62694	63108	63609	64121	64626	64971	383129
Skateboarding	0.10%	0.20%	0.14%	65475	65907	66430	66964	67492	67853	400121
Dodgeball	0.10%	0.10%	0.13%	57462	57841	58300	58769	59232	59548	351152
Ice skating	0.10%	0.10%	0.13%	58252	58637	59102	59578	60047	60368	355983
Scuba diving or snorkelling	0.10%	0.10%	0.12%	53491	53844	54272	54709	55140	55434	326890
Orienteering	0.10%	0.10%	0.10%	43733	44021	44371	44728	45081	45321	267254
Roller-skating, inline skating, rollerblading	0.10%	0.10%	0.10%	43672	43961	44309	44666	45018	45258	266885
Taekwondo	0.10%	0.10%	0.09%	43298	43584	43930	44284	44633	44871	264600
Archery	0.10%	0.10%	0.08%	35856	36093	36379	36672	36961	37158	219120
Handball	0.10%	0.10%	0.06%	25253	25420	25621	25828	26031	26170	154324
Life-saving	0.10%	0.10%	0.06%	27529	27710	27930	28155	28377	28528	168230
Snooker	0.10%	0.10%	0.06%	25330	25497	25699	25906	26110	26250	154792
Judo	0.10%	0.00%	0.06%	26860	27037	27251	27471	27688	27835	164142



Wrestling	0.10%	0.10%	0.06%	27529	27710	27930	28155	28377	28528	168230
Baseball or Softball	0.10%	0.00%	0.05%	20819	20957	21123	21293	21461	21576	127230
Fencing	0.10%	0.00%	0.05%	23917	24075	24266	24461	24654	24785	146157
Sledding, luge, tobogganing	*	0.10%	0.05%	22941	23092	23275	23463	23648	23774	140191
Sledding, luge, tobogganing (excluding hill or park-based activities)			0.05%	22941	23092	23275	23129	23648	23774	139857
Triathlon	0.10%	0.10%	0.05%	22941	23092	23275	23463	23648	23774	140191
Cheerleading	0.00%	0.10%	0.05%	20960	21098	21265	21436	21605	21721	128085
Lacrosse	*	0.00%	0.04%	18352	18474	18620	18770	18918	19019	112153
Croquet	0.00%	0.10%	0.04%	19674	19803	19961	20121	20280	20388	120227
Obstacle course	0.00%	0.00%	0.04%	16335	16443	16574	16707	16839	16929	99827
Motor sports	0.00%	0.00%	0.04%	18352	18474	18620	18770	18918	19019	112153
Water-skiing	0.00%	0.00%	0.03%	15474	15576	15699	15826	15950	16036	94560
Ten-pin bowling	0.00%	0.00%	0.03%	13764	13855	13965	14078	14189	14264	84115
Pool	0.00%	0.00%	0.03%	12041	12121	12217	12315	12412	12479	73585
Darts	0.00%	0.00%	0.03%	11860	11938	12033	12130	12225	12291	72476
Ice hockey	0.00%	0.00%	0.03%	11830	11908	12002	12099	12194	12259	72291
Caving or pot holing	0.00%	0.00%	0.02%	9176	9237	9310	9385	9459	9509	56077
Abseiling	*	0.00%	0.02%	9176	9237	9310	9385	9459	9509	56077
Gliding, paragliding or hang gliding	0.00%	*	0.02%	9176	9237	9310	9385	9459	9509	56077
Skittles	0.00%	0.00%	0.02%	7283	7331	7389	7448	7507	7547	44505
Boules, petanque, deck bowls	0.00%	0.00%	0.02%	9176	9237	9310	9385	9459	9509	56077
Wheelchair Rugby	*	*								
Wheelchair Basketball	*	*								
Goalball	*	*								
High ropes	*	*								
Modern Pentathlon	*	*								
Boccia	*	*								

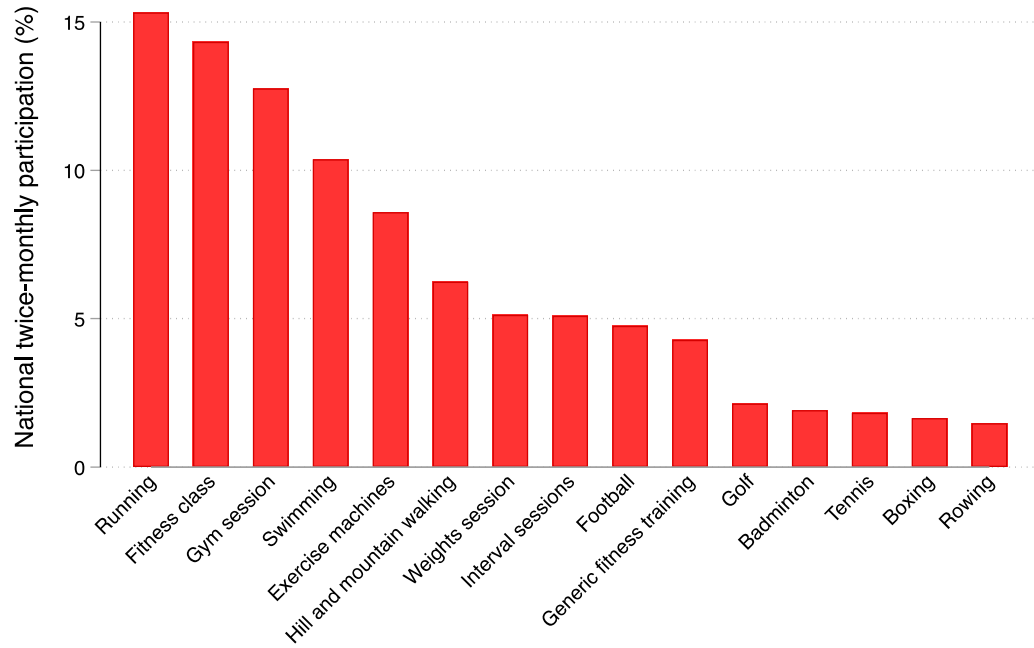
\* Result by sex is not provided in the interests of non-disclosure (results for one sex are <5 cases)

\*\* Denominator data are not available in Active Lives Survey (ALS). This is predominantly due to insufficient data (i.e., too few participant responses by sex), to report an ALS result.

Supplementary File 3. Active Lives Survey responses to twice-monthly sport or physical activity participation, applied to Office for National Statistics mid-year population estimates of adults (16 years+), in England and Wales to produce a 6-year estimate of population at risk of severe sport-related injury overall, by Broad Activity.

	November 2016-17 (ALS 2)	November 2017-18 (ALS 3)	ONS MYE- weighted ALS Y2 & 3	Annual population estimates						6-year total population at risk
	Rate (%)	Rate (%)	Rate (%)	2012	2013	2014	2015	2016	2017	
ONS England and Wales 16+ population				45,881,018	46,183,826	46,550,257	46,925,010	47,295,038	47,547,364	
All adults physically active twice monthly (aged 16+)	77.2%	77.5%	77.3%	35477863	35712012	35995357	36285138	36571265	36766378	216808013
Broad Activities										
Walking	58.2%	59.8%	59.1%	27093032	27271842	27488222	27709516	27928020	28077020	165567654
Cycling	17.3%	16.6%	17.08%	7790201	7841615	7903832	7967462	8030289	8073132	47606531
Creative or artistic dance	2.1%	2.0%	2.1%	938474	944668	952163	959828	967397	972558	5735089
Fitness activities	29.5%	29.9%	29.7%	13627523	13717462	13826299	13937608	14047513	14122459	83278863
Sporting activities	34.7%	34.7%	34.7%	15932206	16037356	16164599	16294732	16423225	16510845	97362963

Supplementary File 4 – Most frequently reported twice-monthly participation by individual activity for Active Lives Surveys. Boxing is inclusive of boxing fitness classes, and rowing is inclusive of indoor rowing. Combined and population-weighted estimates for Active Lives Surveys 2016-17 and 2017-18.



Supplementary File 5 – The incidence and severity (Injury Severity Score &gt;15) of all individual activities overall and incidence for male and female participants

Activities	Overall		Male		Female		Severity
	Cases	Incidence (95% CI)	Cases	Incidence	Cases	Incidence	
Abseiling	9	16.05 (8.35 to 30.85)		*		*	5 (55.6%)
Angling	*	*		*		*	*
Badminton	44	0.82 (0.61 to 1.10)	20	3.67 (2.37 to 5.69)	24	1.13 (0.76 to 1.69)	8 (18.2%)
Baseball or Softball	*	*		*		*	*
Basketball	29	1.54 (1.07 to 2.22)		*		*	5 (17.2%)
Bowls	9	0.43 (0.22 to 0.83)		*		*	*
Boxing (inclusive of boxing fitness classes)	74	1.59 (1.27 to 2.00)		*		*	53 (71.6%)
Canoeing	21	2.13 (1.39 to 3.27)	15	2.46 (2.48 to 4.08)	6	1.57 (0.71 to 3.49)	8 (38.1%)
Cheerleading	*	*		*		*	*
Climbing and bouldering	288	14.67 (13.07 to 16.47)	227	17.4 (15.28 to 19.82)	61	9.25 (7.20 to 11.89)	82 (28.5%)
Cricket	48	2.59 (1.95 to 3.44)		*		*	12 (25.0%)
Cycling	1339	2.81 (2.66 to 2.96)	1215	4.04 (3.82 to 4.27)	124	0.71 (0.60 to 0.85)	415 (31.0%)
Dodgeball	*	*		*		*	0
Equestrian	4303	235.28 (228.35 to 242.42)	768	292.79 (272.80 to 314.25)	3535	223.87 (216.61 to 231.37)	1229 (28.6%)
Exercise machines	27	0.11 (0.08 to 0.16)	17	0.13 (0.08 to 0.21)	10	0.09 (0.05 to 0.17)	8 (28.6%)
Fitness class	42	0.10 (0.07 to 0.14)	8	0.08 (0.04 to 0.16)	34	0.11 (0.08 to 0.15)	6 (14.3%)
Football	876	6.56 (6.14 to 7.01)	839	6.92 (6.47 to 7.40)	37	2.98 (2.16 to 4.11)	174 (19.9%)
Frisbee or ultimate frisbee	*	*		*		*	0
Garden trampolining	81	6.33 (5.09 to 7.87)	51	9.99 (7.59 to 13.14)	36	4.77 (3.44 to 6.61)	6 (7.4%)
Gliding, paragliding or hang gliding	107	190.81 (157.87 to 230.62)	97	**	10	**	53 (49.5%)
Golf	75	1.25 (1.00 to 1.57)	64	1.26 (0.99 to 1.61)	11	1.18 (0.65 to 2.13)	18 (24.0%)
Gym session	81	0.23 (0.18 to 0.29)	40	0.21 (0.15 to 0.29)	41	0.25 (0.18 to 0.34)	20 (24.7%)
Gymnastics excluding trampolining	21	1.15 (0.75 to 1.76)	12	1.73 (0.98 to 3.05)	9	0.79 (0.41 to 1.52)	*
Gymnastics inclusive of all trampolining	273	14.91 (13.24 to 16.79)	179	25.87 (22.34 to 29.95)	94	8.24 (6.73 to 10.09)	18 (6.6%)
Gymnastics inclusive of institutional (i.e., non-home based) trampolining	32	1.75 (1.24 to 2.47)		*		*	
Handball	*	*		*		*	*



Hockey	31	4.61 (3.24 to 6.56)	26	6.47 (4.41 to 9.50)	5	1.71 (0.71 to 4.11)	14 (45.2%)
Ice hockey	5	6.92 (2.88 to 16.63)		*		*	
Ice skating	113	31.74 (26.40 to 38.17)	52	34.93 (26.62 to 45.84)	61	29.32 (22.81 to 37.68)	15 (13.3%)
Judo	9	5.48 (2.85 to 10.53)		*		*	*
Lacrosse	5	4.46 (1.86 to 10.72)	5	**	0	**	*
Martial Arts	31	2.11 (1.48 to 3.00)	31	2.91 (2.05 to 4.14)	0	0	6 (19.4%)
Motor sports	597	532.31 (491.28 to 576.77)	555	506.30 (465.88 to 550.22)	42	**	254 (42.6%)
Netball	14	0.81 (0.48 to 1.37)		*		*	1 (7.1%)
Obstacle course	12	12.02 (6.83 to 21.17)		*		*	*
Parkour or free running	14	2.27 (1.34 to 3.83)		*		*	*
Roller skating, inline skating, rollerblading	59	22.11 (17.13 to 28.54)	30	26.78 (18.72 to 38.30)	29	16.37 (11.38 to 23.56)	*
Rounders	5	1.02 (0.42 to 2.45)		*		*	0
Rowing (inclusive of indoor rowing)	*	*		*		*	*
Rugby	490	25.01 (22.89 to 27.33)	462	28.14 (25.69 to 30.83)	28	8.88 (6.13 to 12.86)	88 (18.0%)
Running	301	0.7 (0.63 to 0.78)	187	0.80 (0.69 to 0.92)	114	0.58 (0.48 to 0.70)	65 (21.6%)
Sailing	15	1.89 (1.14 to 3.14)		*		*	7 (46.7%)
Scuba diving or snorkelling	*	*		*		*	*
Skateboarding	168	41.99 (36.10 to 48.84)	148	48.10 (40.94 to 56.51)	20	19.69 (12.70 to 30.52)	50 (29.8%)
Sledding, luge, tobogganing	28	19.97 (13.79 to 28.92)	13	-	15	14.95 (9.01 to 24.80)	*
Sledding, luge, tobogganing (excluding hill or park-based activities)	19	13.59 (8.67 to 21.31)		**		**	*
Snowsport	339	21.98 (19.76 to 24.45)	221	23.71 (20.78 to 27.05)	14	2.30 (1.36 to 3.88)	95 (28.0%)
Squash	8	0.37 (0.19 to 0.74)		*		*	*
Surfing, board surfing, body boarding, kite surfing	47	5.61 (4.22 to 7.47)		*		*	24 (51.1%)
Swimming	192	0.66 (0.57 to 0.76)	133	1.04 (0.88 to 1.23)	59	0.36 (0.28 to 0.46)	72 (37.5%)
Table Tennis	34	1.28 (0.91 to 1.79)	15	0.80 (0.48 to 1.33)	19	2.41 (1.54 to 3.78)	8 (23.5%)
Taekwondo	*	*		*		*	*
Tai Chi	*	*		*		*	*
Tennis	73	1.42 (1.13 to 1.79)	37	1.19 (0.86 to 1.64)	36	1.77 (1.28 to 2.45)	20 (27.4%)
Ten-pin bowling	5	5.94 (2.47 to 14.27)		*		*	
Track and field athletics	6	0.43 (0.19 to 0.96)		*		*	*

Triathlon	12	8.56 (4.86 to 15.07)		*		*	*
Volleyball	*	*		*		*	0
Walking	49	0.02 (0.02 to 0.03)	32	0.04 (0.03 to 0.06)	17	0.02 (0.01 to 0.03)	23 (46.9%)
Water-skiing	21	22.21 (14.48 to 34.06)	15	**	6	**	9 (42.9%)
Weights session	27	0.19 (0.13 to 0.28)	20	0.23 (0.15 to 0.36)	7	0.12 (0.06 to 0.25)	6 22.2%)
Wrestling	5	2.97 (1.24 to 7.14)		*		*	*