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# Boxing injuries by anatomical location: a systematic review

Michael Loosemore<sup>1</sup>, Joseph Lightfoot<sup>1</sup>, Chris Beardsley<sup>2</sup> <sup>1</sup>Institute of Sport Exercise and Health, University College London, UK <sup>2</sup> Strength and Conditioning Research Limited, UK

Abstract. Background. Boxing is commonly associated with injury in the head region. However, injury to the head region encapsulates a wide range of injury types, ranging from facial lacerations to concussion. It is therefore unclear whether a high incidence of injury to the head region is also reflective of a high incidence of concussions or cerebral injury. Additionally, given the historic focus on head injury concussions in boxing, the proportions of injury that are associated with the upper extremity, lower extremity and trunk are unclear. Aim. The objective of this review was to assess the proportion of injuries that occur in each anatomical location during either boxing competition or training, as reported in observational studies performed in both professional and amateur boxers. Method. A systematic review was performed according to preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines of all observational studies of either professional or amateur boxing athletes that reported the proportion of injury by anatomical location as a result of either boxing competition or training. The PubMed database was systematically searched. Results. Fifteen eligible articles were identified, describing 5.020 injuries. Four studies were prospective cohort trials and the remainder were cross-sectional studies. There was substantial between-study variability in the proportion of injuries reported across all regions. The head region appeared to be injured most often (range: 9 - 96%), followed by the upper extremity (range: 2 - 55%). However, concussion accounted for far fewer injuries than the head region overall. Conclusion. Studies report substantial variability regarding the proportion of injuries sustained across different regions of the body in boxing. This variability may have arisen for several reasons, including a lack of consistency in respect of injury definitions, boxing conditions (type of headgear worn), and whether the athletes were amateur or professional.

Key words: boxing, sports injury, head injury, concussion.

#### Introduction

Boxing is commonly associated with injury in the head region. The literature supports this viewpoint, with many studies reporting a large proportion of injuries in this region (1-10). It is less clear whether this high incidence of injury in the head region is reflective of a similarly high incidence of concussions or cerebral injury.

While some studies have reported both a large number of injuries in the head region and also a great many concussions (6-8), other studies reporting large numbers of injuries in the head region have identified no concussions whatsoever (1, 4).

The reasons for this high degree of variability between studies is currently unclear. Given the historic focus on head injury concussions in boxing, the proportions of injury that are associated with the upper extremity, lower extremity and trunk are less well known. Since the incidence of injuries by anatomical location is most often reported by reference to a proportion of total injuries, variability in respect of injuries in the head region has important ramifications for injuries in the other anatomical locations.

Therefore, it was the purpose of this systematic review to assess the proportion of injuries that occur in each anatomical location during either boxing competition or training, as reported in observational studies of boxing injuries across all anatomical locations in both professional and amateur boxers.

# Material and Method

This review was conducted in accordance with the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines for systematic reviews (11).

The PubMed peer-reviewed database was systematically searched from the first available record for observational studies of either professional or amateur boxing athletes that reported the proportion of injury across all anatomical locations as a result of either boxing competition or training. The search terms were (1) boxing AND (2) injury OR injuries, subject to a date limit of 31 July 2015 and a requirement for studies to be performed in humans.

No other key terms, Boolean operators or limits were used. In addition to this database search, the reference lists of obtained full-texts were examined to identify studies that may have been missed by the database searches. Following the initial database searches, duplicates were removed to form an initial summary list. The abstracts of articles on this list were screened and potentially relevant articles identified. The full texts of these studies were obtained. Contact was not made with any of the authors in order to identify other potentially relevant articles. After reviewing the full texts of all those articles obtained and assessing them for eligibility in line with the inclusion and exclusion criteria, non-eligible articles were excluded, leaving only those to be included in the systematic review.

The inclusion criteria were: (1) an observational study design, (2) a population of boxing athletes, (3) record provided of injuries by anatomical location, (4) and any publication date. The exclusion criteria were: (1) non-English language article, (2) duplicates, (3), injuries reported that did not occur in either boxing competition or boxing training, (4) injuries not reported across whole body.

After finalizing the studies for incorporation into the review, data were extracted from each study by a single author. The data extracted were tabulated in rows on a spreadsheet using Microsoft Excel (Microsoft Corp., Redmond, WA), with each row containing a single trial.

The data extracted included the title, main author, study design, duration, training status of the population (amateur or professional), type of activity (training, competition, or both), number of subjects, total number of injuries, number of injuries in major anatomical region (head, upper extremity, lower extremity, trunk and other), specific anatomical location within the head region (face and scalp, nose, eye and eyebrow, mouth, jaw, ear, throat/neck, cerebral/neural /concussion, and non-specified), specific anatomical location within the upper extremity region (hand, shoulder, thumb, fingers, wrist, elbow, forearm, upper arm, clavicle), specific anatomical location within the lower extremity (knee, ankle, thigh, lower limb, foot, hip or groin, toes, non-specified), specific anatomical location within the trunk and other region (lumbo-pelvic, chest and ribs, neck, thorax, abdomen, other spine, non-specified or other).

Risk of bias of individual studies was not assessed as no statistical information was extracted from the individual studies that would permit any such analysis to be performed. Additionally, no assessment of study quality was performed.

The outcomes considered in this systematic review were (1) the proportion of injuries in each major region, and (2) the proportion of injuries in each anatomical location within each major region. These outcomes were calculated as percentages using the data extracted from each study and reported as ranges.

#### Results

*Search results*. After following the search process, 15 articles were finally identified as being eligible for review (1-10, 12-16). Four of these articles (Porter and O'Brien, 1996 (8), Zazryn et al. 2006 (9), Siewe et al. 2015 (15), Loosemore et al. 2015 (16)) were prospective cohort trials and the remainder were cross-sectional studies and therefore retrospective by design.

A total of 5.020 injuries were reported across all 15 studies. Substantial variability between studies was observed in respect of the time period studied (from 8 days to 15 years), the status of the boxers (amateur, elite amateur, and professional), injury definitions, descriptions of the individual injury locations, and the details provided regarding the nature of the injury.

*Injuries by region*. Overall, the most common injury region in boxing appeared to be the head, accounting for the greater part of injuries by region (range: 9 - 96%) (Table I).

The range of results was large, with some studies reporting almost exclusively head injuries (2, 3, 6) and other studies reporting relatively few (1, 13, 16). This high level of variability was reflected in the proportions of injuries in the other regions, as follows: upper extremity range: 2 - 55%, lower extremity range: 0 - 24%; and trunk and other injury range: 0 - 16%.

These differences were partly explained by amateur or professional status. In professionals, the large majority of all injuries was routinely sustained in the head region (range: 74 - 96%), with a small minority in the upper extremity (range: 0 - 22%) and virtually none in the lower extremity region (range: 0 - 2%) and trunk/other region (range: 2 - 5%). In contrast, in amateurs, while the proportions were still weighted towards the head (range: 9 - 75%) there was a greater proportion in the upper extremity region (range: 14 - 55%), as well as in the lower extremity region (range: 4 - 24%) and trunk/other region (range: 0 - 16%).

Table	Ι.	Injuries	by	region	

Study	Trial type	Training status	Training or competition	Period (years)	Total	Head	Upper extremity	Lower extremity	Trunk and other
Timm et al, 1993	R	Am	T&C	15	1,219	28%	36%	22%	14%
Zazryn et al, 2003	R	Pr	С	16	107	90%	7%	-	3%
Zazryn et al, 2009	R	Pr	С	8.5	214	86%	8%	1%	5%
Bledsoe et al, 2005	R	Pr	С	1.5	191	74%	22%	2%	2%
Bianco et al, 2005	R	Am	С	1.75	20	75%	20%	5%	-
Welch et al, 1986	R	Am (army)	Т	2	294	48%	46%	4%	2%
Jordan&Campbell, 1989	R	Pr	С	2	376	93%	2%	-	4%
Jordan et al, 1990	R	Am	С	10	447	27%	33%	24%	16%
Estwanik et al, 1984	R	Am	С	8	52	48%	44%	4%	4%
McCown, 1959	R	Pr	С	7	1,089	96%	4%	0%	-
Oelman et al, 1983	R	Am (army)	Т	12	437	68%	14%	5%	14%
Porter&O'Brien, 1996	Р	Am	С	0.41	64	72%	23%	5%	-
Zazryn et al. 2006	Р	Am⪻	T&C	1	21	71%	24%	-	5%
Siewe et al. 2015	Р	Am	T&C	1	192	46%	24%	16%	14%
Loosemore et al. 2015	Р	Am	T&C	5	297	9%	55%	22%	13%
Total / range					5,020	9 – 96%	2-55%	0 - 24%	0 - 16%

\*R= Retrospective; P= Prospective; Am= Amateur; Pr= Professional; T=Training; C=Competition

*Head Injury*. The most common injury location in boxing within the head region appeared to be the face/scalp, being reported to account for a large proportion of injuries by anatomical location (range: 0 - 96%), albeit with great variability between studies (Table II). Concussions were also often found to comprise a large proportion of head injuries (range: 0 - 75%), again with great variability between studies. It is noteworthy that one third of the studies reported no concussions or neural/cerebral injury of any kind (1, 4, 10, 12, 14). The variability between studies was not entirely explained by amateur or professional status, as face and scalp injuries appeared to be the most common location of injury within the head region in both amateur (range: 0 - 93%) and professional (range: 12 - 96%) cohorts.

Table II. Boxing head injuries by location										
Study	Total	Face	Nose	Eye	Mouth	Jaw	Ear	Throat/	Cerebral/	Non-
	injuries	and		and				neck	neural/	specified
		scalp		eyebrow					concussion	
Timm et al. 1993	344	42%	21%	13%	9%	8%	6%	1%	-	-
Zazryn et al. 2003	96	26%	-	51%	-	2%	-	-	21%	-
Zazryn et al. 2009	184	12%	4%	63%	3%	2%	2%	1%	14%	-
Bledsoe et al. 2005	142	68%	7%	19%	1%	2%	2%	-	-	-
Bianco et al. 2005	15	93%	-	7%	-	-	-	-	-	-
Welch et al. 1986	142	-	80%	-	-	4%	-	-	15%	-
Jordan&Campbell,	351	19%	1%	4%	-	1%	0%	-	75%	-
1989										
Jordan et al. 1990	121	7%	28%	19%	11%	6%	4%	-	26%	-
Estwanik et al. 1984	25	56%	12%	12%	8%	-	12%	-	-	-
McCown, 1959	1,049	96%	2%	2%	-	0%	-	-	-	-
Oelman et al. 1983	296	34%	-	-	-	-	-	-	62%	4%
Porter&O'Brien, 1996	46	9%	11%	7%	-	-	2%	-	72%	-
Zazryn et al. 2006	15	-	27%	27%	-	-	-	-	47%	-
Siewe et al. 2015	88	7%	25%	39%	13%	5%	2%	1%	9%	-
Loosemore et al. 2015	28	7%	7%	4%	7%	-	4%	36%	18%	18%
Total/range	2.942	7–	0–	0 - 63%	0 -	0-	012%	0-36%	0 - 75%	0 - 18%
		96%	80%		13%	8%				

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Upper Extremity Injury. The most common injury location in boxing within the major category of the upper extremity appeared to be the hand, accounting for the largest proportion of injuries by anatomical location (range: 7 - 100%), albeit with great variability between studies (Table III). It is noteworthy that all 15 studies found some instance of hand injury and 6 studies reported that hand injury comprised >75% of upper extremity injuries (2-4, 6, 10, 14). This variability was partially explained by amateur versus professional status, as hand, shoulder and wrist injuries all appeared to be substantially more common in amateur (ranges: 7 - 100%; 13 - 49%; 9 - 49%) than professional (range: 79 - 89%: 6 - 14%; 0 - 0%) cohorts.

Study	Total number	Hand	Shoulder	Thumb	Fingers	Wrist	Elbow	Forearm	Upper	Clavicle
Timm et al. 1993	441	24%	20%	14%	13%	10%	10%	4%	4%	2%
Zazryn et al. 2003	8	88%	-	-	-	-	-	-	13%	-
Zazryn et al. 2009	17	87%	6%	-	-	-	-	-	6%	-
Bledsoe et al. 2005	42	79%	14%	-	-	-	7%	-	-	-
Bianco et al. 2005	4	100%	-	-	-	-	-	-	-	-
Welch et al. 1986	134	7%	49%	10%	5%	19%	10%	-	-	-
Jordan& Campbell,	9	89%	11%	-	-	-	-	-	-	-
1989										
Jordan et al. 1990	147	24%	22%	12%	18%	9%	11%	2%	3%	-
Estwanik et al. 1984	23	57%	-	30%	-	9%	-	-	-	4%
McCown, 1959	39	82%	10%	-	8%	-	-	-	-	-
Oelman et al. 1983	59	47%	-	-	-	-	-	8%	2%	42%
Porter& O'Brien, 1996	15	53%	-	13%	-	20%	13%	-	-	-
Zazryn et al. 2006	5	20%	20%	-	-	20%	20%	-	20%	-
Siewe et al. 2015	47	11%	19%	-	4%	49%	2%	4%	11%	-
Loosemore et al. 2015	164	42%	13%	-	-	19%	14%	1%	12%	-
Total / range	1,154	7-100%	0-49%	0-30%	0-18%	0-20%	0-20%	0-8%	0-20%	0-42%

**Table** III. Boxing upper extremity injuries by location

*Lower Extremity Injury*. The most common injury locations in boxing within the major category of the lower extremity appeared to be the ankle and thigh, which each were found to account for the largest proportion of injuries by anatomical location (range: 0 - 100%), albeit with substantial variability between studies (Table IV). The total number of injuries in this category was very low in comparison with the head and the upper extremity.

Table IV. Boxing lower extremity injuries by location											
Study	Total number of injuries	Knee	Ankle	Thigh	Lower limb	Foot	Hip or groin	Toes	Non- specified		
	injunes										
Timm et al. 1993	267	29%	25%	15%	11%	9%	6%	4%	-		
Zazryn et al. 2003	-	-	-	-	-	-	-	-	-		
Zazryn et al. 2009	3	-	64%	-	36%	-	-	-	-		
Bledsoe et al. 2005	3	-	67%	-	-	33%	-	-	-		
Bianco et al. 2005	1	-	-	100%	-	-	-	-	-		
Welch et al. 1986	12	25%	67%	8%	-	-	-	-	-		
Jordan& Campbell, 1989	-	-	-	-	-	-	-	-	-		
Jordan et al. 1990	107	34%	25%	6%	18%	11%	7%	-	-		
Estwanik et al. 1984	2	50%	50%	-	-	-	-	-	-		
McCown, 1959	1	-	100%	-	-	-	-	-	-		
Oelman et al. 1983	21	48%	-	-	14%	-	-	-	38%		
Porter&O'Brien, 1996	3	33%	33%	-	33%	-	-	-	-		
Zazryn et al. 2006	-	-	-	-	-	-	-	-	-		
Siewe et al. 2015	30	-	17%	47%	37%	-	-	-	-		
Loosemore et al. 2015	65	15%	32%	18%	28%	6%	-	-	-		
Total / range	515	0-50%	0-00%	0-100%	0-36%	0-33%	0 - 7%	0-4%	0-38%		