

## Supplementary Table. Description and examples of data sources that include capture of sports related deaths

Data Source	Description	Example(s) cite
Surveillance system	<p><i>Systematic capture of deaths and timely dissemination of information</i></p> <ul style="list-style-type: none"> <li>Key attributes of surveillance include: routine and ongoing activity that emphasizes both—data collection, analysis, and interpretation (data in) and dissemination of results to stake holders (data out)—are emphasized to enable public health action or intervention <sup>1</sup></li> <li>Information generally considered accurate as the individuals recording information are trained and methods for recording are defined</li> <li>Single source or pooled from multiple sources</li> <li>Systems have high capture and can be both broad or narrowly focused. Level of detail varies from basic to highly detailed.</li> </ul>	<p><u>National Center for Catastrophic Sports Injury Research (NCCSIR):</u> Kucera, KL, Yau RK, Register-Mihalik J, et al.(2016). Traumatic Brain and Spinal Cord Fatalities Among High School and College Football Players - United States, 2005-2014. <i>MMWR</i>. 65(52): 1465-1469. <sup>2</sup></p> <p>Mueller F, Cantu R. Catastrophic injuries and fatalities in high school and college sports, fall 1982-spring 1988. <i>Medicine and Science in Sports and Exercise</i>. 1990 12;22(6):737-41. <sup>3</sup></p> <p><u>NCDETECT state-wide syndromic surveillance system (Pooled sources including ED, poison control center, etc.):</u> Kerr, Z. Y., et al. (2014). The Epidemiology of traumatic Brain injuries treated in emergency departments in North Carolina, 2010–2011. <i>North Carolina Medical Journal</i> 75(1): 8-14. <sup>4</sup></p> <p><u>Population-specific – National Football League:</u> Torg, J., et al. (1985). The National Football Head and Neck Injury Registry. 14-year report on cervical quadriplegia, 1971 through 1984. <i>JAMA</i> 254(24): 3439-3443. <sup>5</sup></p> <p><u>Trauma-registry – Victorian State Trauma Registry (VSTR):</u> Andrew, N. E., et al. (2012). Trends in sport and active recreation injuries resulting in major trauma or death in adults in Victoria, Australia, 2001-2007. <i>Injury</i> 43(9): 1527-1533. <sup>6</sup></p> <p><u>Sport-specific – Soccer/football</u> Scharhag, J., P. Bohm, J. Dvorak and T. Meyer (2015). F-MARC: the FIFA Sudden Death Registry (FIFA-SDR). <i>British Journal of Sports Medicine</i> 49(9): 563-565. <sup>7</sup></p> <p><u>Death Record Review:</u> Chappex, N., et al. (2015). Sudden cardiac death among general population and sport related population in forensic experience. <i>J Forensic Leg Med</i> 35: 62-68. <sup>8</sup></p> <p>Suárez-Mier MP1, Aguilera B, Mosquera RM, Sánchez-de-León MS. Pathology of sudden death during recreational sports in Spain. <i>Forensic Sci Int</i>. 2013 Mar 10;226(1-3):188-96. doi: 10.1016/j.forsciint.2013.01.016. <sup>9</sup></p> <p><u>Child death review team of autopsies:</u> Quan L, Pilkey D, Gomez A, Bennett E. Analysis of paediatric drowning deaths in Washington State using the child death review (CDR) for surveillance: what CDR does and does not tell us about lethal drowning injury. <i>Inj Prev</i>. 2011 Feb;17 Suppl 1:i28-33. doi: 10.1136/ip.2010.026849. <sup>10</sup></p> <p><u>Hospital emergency department network</u> Glass, T., R. M. Ruddy, E. R. Alpern, M. Gorelick, J. Callahan, L. Lee, M. Gerardi, K. Melville, M. Miskin, J. F. Holmes and N. Kuppermann (2015). Traumatic brain injuries and computed tomography use in pediatric sports participants. <i>The American Journal of Emergency Medicine</i> 33(10): 1458-1464. <sup>11</sup></p>
Registries	<p><i>Systematic recording of all deaths from defined capture area or group of people.</i></p> <ul style="list-style-type: none"> <li>Registries record all deaths in a defined population at risk. Can be specific to a population (e.g., youth sport participants), type of injury or condition (e.g., commotio cordis registry), or exposure (e.g., batted ball-related deaths).</li> <li>Information generally considered accurate as the individuals recording information are trained and methods for recording are previously defined</li> <li>Single source or pooled from multiple sources</li> <li>Registries tend to have high capture and be narrowly focused. Capture may be limited by where the data is collected (e.g., trauma registries include those transported to the hospital where the registrars are) and may exclude events where the individual was declared dead on scene.</li> </ul>	
Death records (coroner, Medical Examiner)	<p><i>Report filed by official at time of death (coroner, medical examiner, physician)</i></p> <ul style="list-style-type: none"> <li>Record of death or death certificate filed by a designated official such as a medical examiner, coroner, or other medical provider. Death records do not generally include specifics like the sport played, sponsoring school, club or organization, or medical services provided.</li> <li>Both accuracy and level of detail vary. If an autopsy is performed an extensive review of the death is conducted and data sources may include toxicology reports, law enforcement investigations, medical examiner/coroner report notes, and other items. In most jurisdictions, this will include some of event details, but the level of detail is not guaranteed.</li> <li>Death records data can be considerably delayed –1-2 years is not uncommon - because of the need to resolve death investigations. This source is best-suited to sport-related death estimates for a specific cause (e.g., drowning, blunt force trauma), condition (e.g., heat stroke, cardiac arrest), or age-group in situations where defining the specific sport, activity, sponsoring organization is not essential.</li> </ul>	
Hospital records	<p><i>Admissions to hospital or emergency department records of care provided prior to death</i></p> <ul style="list-style-type: none"> <li>Hospital and emergency department visit data used for administrative purposes. Information is considered administrative data gathered for medical treatment and insurance billing purposes. May or may not provide information on sport-related deaths.</li> <li>Data may comprise records from one hospital, a group or system of hospitals, or data pooled from several hospitals.</li> </ul>	

Insurance	<ul style="list-style-type: none"> <li>• Relevant details about the athlete, event and injury are often not recorded (sport, level of play, sponsoring organization). Deaths that are not transported to a hospital are not recorded here (e.g. death on the field of play).</li> <li>• Best for sport-related death estimates for a specific cause (e.g., drowning), specific condition (e.g., heat stroke), or age-group where defining the specific sport or sponsoring organization is not critical.</li> </ul>	
	<p><i>Claims filed to insurance company</i></p> <ul style="list-style-type: none"> <li>• Individuals covered by insurance plans, or their nominee, file claims to cover the costs of medical treatment, lost income and other costs incurred. Insurance coverage may be medical-related (e.g., health insurer), death benefits (e.g., life insurance), or catastrophic coverage for sport or venue (e.g., sports organization, state high school association or school based).</li> <li>• Claims are filed by the family or next-of-kin and the organization evaluates whether the claim will be covered. Data is only representative of the individuals who are eligible and actually file a claim.</li> <li>• Medical care claims, catastrophic insurance claim, death benefit claim</li> <li>• Data available include items related to the claim being processed and may include dates of event, treatment and/or death; diagnoses and service codes; type of event, etc.</li> <li>• Activity or sport may be missing for health or life insurance, but is typically available for catastrophic insurance</li> </ul>	<p><u>Venue insurance – Jockey injuries at insured race tracks:</u> Waller AE, Daniels JL, Weaver NL, Robinson P. Jockey injuries in the United States. JAMA. 2000 Mar 8;283(10):1326-8. <sup>12</sup></p> <p><u>National sport risk protection policy – Australian football</u> Fortington LV, Finch CF (2016) Death in community Australian football: a ten year national insurance claims report. PLoS ONE 11(7): e0159008. doi:10.1371/journal.pone.0159008 <sup>13</sup></p> <p><u>Organization insurance - state-level high school catastrophic insurance:</u> Maron, B., et al. (1998). Prevalence of sudden cardiac death during competitive sports activities in Minnesota high school athletes. Journal of the American College of Cardiology 32(7): 1881-1884. <sup>14</sup></p> <p><u>Membership insurance – Australia Jockey Association Claims:</u> Curry BA, Hitchens PL, Otahal P, Si L, Palmer AJ. Workplace injuries in thoroughbred racing: an analysis of insurance payments and injuries amongst jockeys in Australia from 2002 to 2010. Animals (Basel). 2015 Sep 8;5(3):897-909. doi: 10.3390/ani5030390. <sup>15</sup></p>
Workers' comp/cover	<p><i>Claims filed with employer</i></p> <ul style="list-style-type: none"> <li>• Workers' compensation or cover for players ("workers") who are employed by a sporting team, club, or organization. Insurers may be government sponsored or private. Generally, if the player is injured "on the job" they are eligible to file a claim for medical care, wage replacement, and disability. If they die, they may be eligible for death benefits.</li> <li>• Workers' compensation/cover information is recorded on health care visits including dates of treatment, diagnosis codes, treatment received, etc.</li> <li>• Greater level of detail available, but generalizable to the individuals covered by the plan and who file a claim.</li> <li>• Information is also available for the player (gender, age, etc.), sport (sport, organization, level of play), and the circumstances surrounding the event (event date, activity, and mechanism of injury). Workers' compensation data for professional sports may be difficult for outside researchers to access.</li> </ul>	
Emergency services	<p><i>Ambulance, air rescue, ski patrol, or surf lifesaving record of care provided prior to death</i></p> <ul style="list-style-type: none"> <li>• A catastrophic injury/death of a player will more than likely be attended by emergency service personnel including ambulance, emergency medical system (EMS), police, and/or fire services; search and rescue; lifeguard; etc.</li> <li>• Records are representative of the status of the athlete at the time of rescue and transfer and may or may not contain information about whether the athlete died (e.g., death).</li> <li>• Call-outs and/or services</li> <li>• Data from these sources includes basic information about the event (date, time, location, and witnesses), victim (age, gender), type of injury and symptom presentation, type of emergency services provided, and disposition (dead on arrival, transport to hospital, helicopter transfer, etc.).</li> </ul>	<p><u>Search and Rescue – recreational sport:</u> Pasquier M, Taffé P, Kottmann A, Mosimann U, Reisten O, Hugli O. Epidemiology and mortality of glacier crevasse accidents. Injury. 2014 Nov;45(11):1700-3. doi: 10.1016/j.injury.2014.07.001. <sup>16</sup></p> <p>Hohlrieder M, Kroesslhuber F, Voelckel W, Lutz M, Mair P. Experience with helicopter rescue missions for crevasse accidents. High Alt Med Biol. 2010 Winter;11(4):375-9. doi: 10.1089/ham.2010.1027. <sup>17</sup></p> <p><u>Lifeguard reports:</u> Harada SY, Goto RS, Nathanson AT. Analysis of lifeguard-recorded data at Hanauma Bay, Hawaii. Wilderness Environ Med. 2011 Mar;22(1):72-6. doi: 10.1016/j.wem.2010.10.012. <sup>18</sup></p> <p><u>Sport Organization:</u> Harmon KG, Drezner JA, Maleszewski JJ, Lopez-Anderson M, Owens D, Prutkin JM, Asif IM, Klossner D, Ackerman MJ. Pathogenesis of sudden cardiac death in National Collegiate Athletic Association athletes. Circ Arrhythm Electrophysiol. 2014 Apr;7(2):198-204. doi: 10.1161/CIRCEP.113.001376. <sup>19</sup></p> <p>Brown JC, Lambert M, Verhagen E, Readhead C, Van Mechelen</p>
Sport, club, or organization specific	<p><i>Deaths recorded for players in entire sport, club or organization</i></p> <ul style="list-style-type: none"> <li>• Sport teams, clubs, and organizations collect their own injury and mortality information for their participants.</li> <li>• Data are generally collected to monitor and inform the safety and health of their participants.</li> <li>• Athlete-status and sport are known, as is the activity at the time of the death. Not always available for research purposes.</li> <li>• Data from these organizations varies from basic reports about the injury/death to a very detailed account</li> </ul>	

	of the event, injury, medical care, and player details to detailed surveillance systems.	W, Viljoen W. The incidence of rugby-related catastrophic injuries (including cardiac events) in South Africa from 2008 to 2011: a cohort study. <i>BMJ Open</i> 2013;3:1-10. <sup>20</sup> <u>Global burden of disease estimates – WHO Injury Mortality Database:</u>
Government statistics	<p><i>Death reports gathered from multiple sources to produce national statistics</i></p> <ul style="list-style-type: none"> <li>• Governments' vital statistics for their citizens (births and deaths) come from different sources and vary by country of origin ranging from registering every death of every citizen (most developed nations) to no system at all (<a href="http://apps.who.int/iris/bitstream/10665/75351/1/9789241504072_eng.pdf">http://apps.who.int/iris/bitstream/10665/75351/1/9789241504072_eng.pdf</a>). <sup>21</sup></li> <li>• Vital registration for deaths come from death certificates completed by designated individuals in states, territories or regions. Death registrations are then gathered by the government agency.</li> <li>• Include all deaths recorded – those certified by a coroner or not. In the absence of formal registration, governments may provide verbal autopsies through community based data collection process whereby the representative interviews the family and other community members about the event. Mortuaries also provide important source of information on injury-related deaths.</li> <li>• Information is based on the ICD-10 codes and establishing athlete status or that the activity was sport-related may be difficult/impossible.</li> </ul>	<u>Global burden of disease estimates – WHO Injury Mortality Database:</u> Bhalla, K., J. Harrison, L. Fingerhut, S. Shahraz, J. Abraham and P. Hsiu-Yeh (2011). The global injury mortality data collection of the GBD-Injury Expert Group: a publicly accessible research tool. <i>International Journal of Injury Control and Safety Promotion</i> . 18 (3): 249-253. <sup>22</sup>
Publicly available sources	<p><i>Deaths gathered from news media reports, social media, online public databases, etc.</i></p> <ul style="list-style-type: none"> <li>• Death of an athlete or player will often be reported and/or discussed in the public domain. Consists of publicly available information including articles in news and print media available and other documents publicly available including court records after lawsuit settlement, web blogs, social media, Wikipedia, etc.</li> <li>• Useful for the initial notification that a player death has occurred. However, not all deaths are covered in the public domain and capture is not complete. Useful for deaths due to unusual or unique circumstances such as shallow water blackout drownings in swim training (<a href="http://www.shallowwaterblackoutprevention.org/">http://www.shallowwaterblackoutprevention.org/</a>).</li> <li>• Accuracy and validity of publicly available sources varies widely. Even reports published by professional journalists are subject to error. Unverified social media reports should be treated with a high level of caution. Caution is required, and additional efforts to verify accuracy may be required.</li> <li>• Sport-relatedness may or may not be accurate and determinable with information available.</li> <li>• Internet search engines; media search engines; paper clipping services; online databases; other</li> <li>• Data from these sources range from very basic to detailed accounts of the event that include interviews with family, school personnel, medical personnel, law enforcement, and results from autopsies.</li> </ul>	<p><u>Case descriptions from media:</u></p> <p>Kelly et al. Sports-related recurrent brain injuries United States. <i>MMWR</i>. 1997; 46: 224-227. <sup>23</sup></p> <p>Fortington LV, Bekker S, Finch CF. Online news media reporting of football-related fatalities in Australia: A matter of life and death. <i>Journal of Science &amp; Medicine in Sport</i> 2017; doi: 10.1016/j.jsams.2017.06.015. <sup>24</sup></p> <p><u>Cases gathered from media searches:</u></p> <p>Lemez, S., N. Wattie and J. Baker (2016). Early death in active professional athletes: Trends and causes. <i>Scandinavian Journal of Medicine &amp; Science in Sports</i> 26(5): 544-549. <sup>25</sup></p> <p>Pelletier AR, Gilchrist J. Fatalities in swimming pools with lifeguards: USA, 2000-2008. <i>Inj Prev</i>. 2011 Aug;17(4):250-3. doi: 10.1136/ip.2010.029751. <sup>26</sup></p>
Case report/series	<p><i>Medical based reports of one or a series of deaths</i></p> <ul style="list-style-type: none"> <li>• Published case reports and series provide detailed information about one or several deaths</li> <li>• Useful for identifying characteristics of new or unique injury or condition, exposure, or treatment that would be of interest to the sports and medical community as well as the public. Inform data collection systems and practices (new types of events to monitor, types of care provided, etc.).</li> <li>• Limited in scope. Do not provide any information on prevalence, incidence, or risk.</li> <li>• Level of detail is place or source of publication driven: player demographics and pertinent medical history, the circumstances of the event, the medical course of the injury or illness, medical care provided, and final disposition which can inform current and future medical practices.</li> </ul>	<p><u>Case studies:</u></p> <p>Cantu, R. C. and A. D. Gean (2010). Second-impact syndrome and a small subdural hematoma: an uncommon catastrophic result of repetitive head injury with a characteristic imaging appearance. <i>Journal of Neurotrauma</i> 27(9): 1557-1564. <sup>27</sup></p> <p>Allen SB, Cross KP. Out of the frying pan, into the fire: a case of heat shock and its fatal complications. <i>Pediatr Emerg Care</i>. 2014 Dec;30(12):904-10. doi: 10.1097/PEC.000000000000296. <sup>28</sup></p>
Observational studies	<p><i>Research based study of sport injury resulting in death (e.g., cohort, case-control)</i></p> <ul style="list-style-type: none"> <li>• Research studies provide information on sport-related deaths and largely depends on the purpose of the research.</li> <li>• More useful if the purpose is to specifically study death. If not specific to death, then the study may or may not capture deaths depending on when the study is conducted (e.g. rarity of deaths).</li> <li>• Include prospective cohort studies of sport participants, case-control and case-crossover studies, and cross-sectional studies.</li> </ul>	<p><u>Research study:</u></p> <p>Webner D, DuPrey KM, Drezner JA, Cronholm P, Roberts WO. Sudden cardiac arrest and death in United States marathons. <i>Med Sci Sports Exerc</i>. 2012 Oct;44(10):1843-5. doi: 10.1249/MSS.0b013e318258b59a. <sup>29</sup></p>

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