

Background

Second Impact Syndrome (SIS) is described as a phenomenon that occurs when an individual suffers a second head injury while symptoms from initial head injury are still present. SIS has been associated with a unique set of characteristics. Despite the attention and curiosity regarding SIS as a diagnosis, there are no existing World Health Organization (WHO) criteria associated with the syndrome.

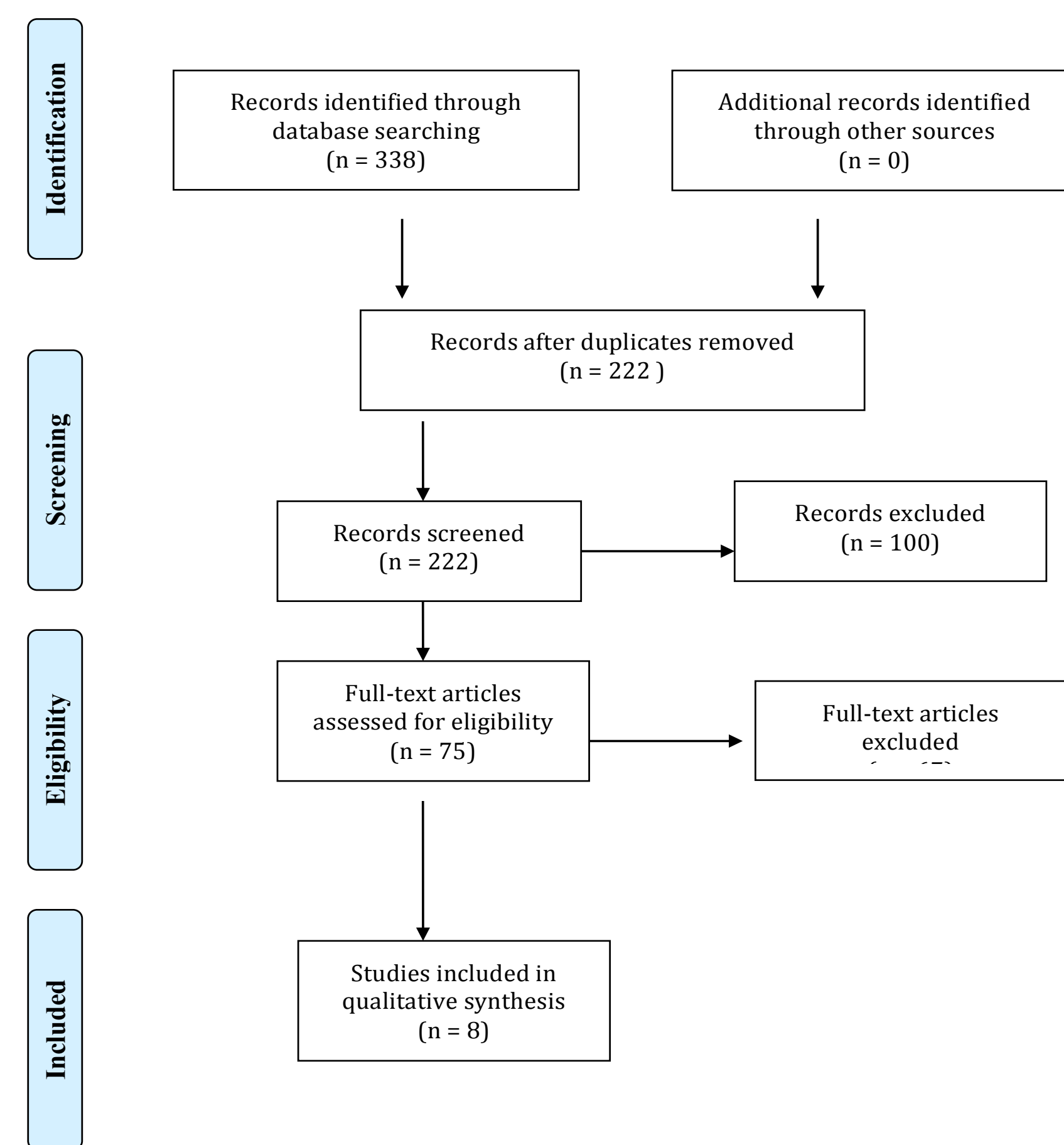
Purpose

The purpose of the review was to examine current literature to determine whether or not existing evidence is adequate to support a WHO recognized, ICD-10 case definition for SIS.

Methods

A sensitive search strategy was developed to include all relevant literature. Data were extracted and placed into a diagnostic framework constructed based upon previously accepted ICD-10 diagnoses. The quality of included studies was assessed using a checklist developed specifically for case reports.

Figure 1: PRISMA flow diagram - Search strategy



Results

We identified 222 unique citations of which 75 articles were assessed for full-text eligibility. Five case studies and 3 case series were determined appropriate for inclusion. The majority of these cases are suspected, not confirmed episodes of SIS. Young, physically active males, particularly those participating in sports such as American football, boxing and rugby, are at highest risk for SIS.

Results (cont.)

Table 1. PEOT (Population, Exposure, Outcome, and Study Type): Description of included articles

	Population	Exposure	Outcome	Study Type
Cantu (1998)	Teen and young male <i>Sport: Boxing</i>	Second head injury	Vomiting, fixed and dilated pupils, subdural hematoma, brain herniation, comatose	Case Study
Cantu (2003)	Male Adolescents <i>Sports: rugby, football</i>	Second head injury	Comatose, diffuse cerebral swelling; violent headache, brain herniation, vomiting, tingling sensation in legs, seizure	Case Study
Cantu (2010)	Adolescent males 10 year-old female participating in pee-wee football	Second head injury	Comatose, fixed and dilated pupils, labored respiration, vomiting, change in vision, absent gag reflex, subdural hematoma, brain herniation	Case Series
CDC (1997)	Teenage male football players	Second head injury	Coma, subdural hematoma, brain herniation	Case Series
Logan (2001)	18 year-old male football player	Second head injury	Decreased level of consciousness, seizure, incontinence, acute subdural hematoma	Case Study
Mori (2006)	Male adolescents or young adults <i>Sports: American football, boxing, karate, skiing</i>	Second head injury	Subdural hematoma, extensive cerebral swelling	Case Series
Saunders (1984)	19 year-old male football player	Second head injury	Collapsed, unresponsive, dilated pupils, ataxic respiration, cerebral swelling, intraparenchymal hematoma	Case Study
Weinstein (2013)	17 year-old male football player	Second head injury	Headache, dizziness, loss of consciousness, generalized seizure activity, brain herniation, bilateral subdural hematoma	Case Study

Table 2: Quality assessment of included case studies (Key: Y=Yes; N=No; CT= Cannot tell)

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Cantu ⁵ (1998)	Y	Y	Y	N	N	CT	N	Y	Y	Y
Cantu ²⁷ (2003)	Y	Y	Y	N	Y	N	N	Y	Y	Y
Cantu ¹⁷ (2010)	Y	Y	Y	N	Y	Y	N	Y	Y	Y
CDC ¹⁸ (1997)	N	N	Y	N	Y	N	N	Y	Y	Y
Logan ²³ (2001)	Y	Y	Y	N	Y	N	N	Y	Y	Y
Mori ⁹ (2006)	Y	Y	Y	N	Y	N	N	N	Y	N
Saunders ⁶ (1984)	Y	Y	Y	N	Y	N	N	Y	Y	Y
Weinstein ²² (2013)	Y	Y	Y	N	Y	Y	N	Y	Y	Y

Item 1: Did the study address a clearly focused question/issue?
 Item 2: Is the research method (study design) appropriate for answering the research question?
 Item 3: Are both the setting and the subjects representative with regard to the population to which the findings will be referred?
 Item 4: Is the researcher's perspective clearly described and taken into account?
 Item 5: Are the methods for collecting data clearly described?
 Item 6: Are the methods for analyzing the data likely to be valid and reliable? Are quality control measures used?
 Item 7: Was the analysis repeated by more than one researcher to ensure reliability?
 Item 8: Are the results credible, and if so, are they relevant for practice?
 Item 9: Are the conclusions drawn justified by the results?
 Item 10: Are the findings of the study transferable to other settings?

Results (cont.)

Table 3: World Health Organization framework for an ICD-10 case definition – evidence in current literature

1) Signs and symptoms of SIS	Present	Absent	Mixed
<i>Suspected case (in the field):</i>			
Generalized seizure ^{5,22,23}	X		
Comatose ^{5,17,27}	X		
Fixed, dilated pupils ^{5,6,17}	X		
Labored respiration ^{6,17}	X		
Headache ^{22,27}	X		
Vomiting ^{5,17,27}	X		
<i>Probable case (once admitted to a medical facility):</i>			
Rapid cerebral edema ⁹	X		
***absence of structural damage ²⁰			X
***Presence of a subdural hematoma along with vascular engorgement while still symptomatic from an initial impact ¹⁷			X
<i>Confirmed case:</i>			
		X	
2) Diagnostic Guidelines for SIS			
<i>Laboratory work up (imaging, blood work):</i>			
Cerebral swelling ^{9,17,23,27}			X
<i>Required signs and symptoms for SIS diagnosis:</i>			
		X	
3) Differential Diagnosis (consider the possibility of one of the following occurring as a result of head injury):			
Consider the possibility of one of the following diagnoses related to head injury: concussion, post-concussion syndrome, epidural hematoma and/or malignant brain edema	X		
Consider the timing of brain injury and the possibility of a previous and related head injury	X		
4) Populations at risk or with confirmed cases of SIS:			
Male adolescents or young adults ⁹	X		
Young adult male boxers ⁵	X		
Teen and young adult American football players ^{6,22,23}	X		

Conclusions

At present, there is not sufficient evidence to satisfy a standardized WHO, ICD-10 case definition for SIS as a unique diagnosis. Future studies are needed to better understand and define at risk populations, diagnostic signs and symptoms, and the multisystem consequences of SIS.

Clinical Relevance

Based on the inability to standardize an ICD-10 case definition of SIS, health care providers should exercise caution when assigning SIS as a strict diagnosis. On-the-field health care providers should be proactive and diligent in documenting head injuries, regardless of perceived impact severity. This will help prevent retrospective/ anecdotal reporting of head-related injuries by athletes, coaches and training and medical staff. Proactive documentation of head injury, regardless of severity, can also help decrease the risk of premature return to play in athletes, and decrease the incidence of more severe outcomes.

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