

Research Articles

Incidence of Video Game-Related Upper Extremity Injuries in the United States

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Objectives

Video game use is becoming increasingly popular and is projected to continue to rise for the foreseeable future. Gamers are at risk for unique upper extremity injuries related to overuse or trauma when playing interactive gaming systems. The purpose of this study was to characterize gaming-related upper extremity injuries in patients presenting to emergency departments across the United States over the past twenty years.

Methods

Data from the National Electronic Injury Surveillance System (NEISS) was queried for all upper extremity injuries related to using computer equipment and electronic games between 2001 and 2020. Narrative descriptions containing the keywords “game,” “gaming,” and “play” were isolated and then reviewed to identify injuries related to gaming. Demographic information, location of injury, and type of injury were collected.

Results

A total of 1,269 injuries were reported during the 20-year study period, with an extrapolated national incidence of 41,939. Most injuries occurred in males (66.9%) and those aged 10-19 (29.5%). The most common body parts injured were the finger (23.1%), followed by the hand (metacarpal) (21.3%) and wrist (19.0%). The most common injury types were strains and sprains (28.0%), followed by contusions and abrasions (17.0%).

Conclusion

Video game-related injuries represent a potentially modifiable or preventable cause of upper extremity injury. With the increased use and modernization of gaming systems, physicians should proactively educate patients and parents about this type of injury.

INTRODUCTION

Video game use is rapidly increasing worldwide, both in the number of gamers and the amount of gaming by individuals. Previously contained to a handful of platforms, gaming has expanded to include computers, traditional consoles, handheld consoles, tablets, and mobile devices. Globally, there were nearly two billion gamers in 2015, a number which is projected to increase to over three billion by 2023.¹ Gamers in the United States reported playing 7.7 hours weekly in 2021, an increase of 14% from 2020.² Nearly

ten percent reported playing over 20 hours weekly.² Binge gaming is common, with 42% of gamers reporting they played for at least five hours consecutively and ten percent having played more than 15 hours consecutively.² Repetitive strain injury, muscle-tendon syndrome, focal dystonia, hypermobility syndrome, and compressive neuropathy have been previously reported in musicians.^{3,4} Due to overlapping biomechanics of repetitive motion, musicians and gamers are vulnerable to similar pathologies.

Newer gaming systems, such as the Nintendo Wii and Xbox Kinect, have functionality that allows players to use

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either a remote or their body movements in place of a traditional controller. For the Nintendo Wii, the top-selling game throughout its lifetime is *Wii Sports*, with over 80 million copies sold.⁵ In this game, players can play tennis, baseball, bowling, golf, or boxing, using their remote to mimic sporting equipment. For example, in *Wii tennis*, players swing the remote like a tennis racket to hit the tennis ball as it comes toward them on the screen. Games with similar concepts are sold across different platforms. These games are typically played at home, where the environment is not ideally suited for the activity. Low ceilings, nearby walls, coffee tables, ceiling fans, and couches are all hazards that players can accidentally hit, causing traumatic injury.

While current literature offers anecdotal evidence of musculoskeletal injury related to gaming, there are limited studies on the incidence of these injuries nationally.⁶ This study aims to quantify the incidence of upper extremity injury related to gaming presenting to emergency rooms in the United States.

METHODS

The National Electronic Injury Surveillance System (NEISS) is a database managed by the Consumer Product Safety Commission (CPSC) in partnership with the Center for Disease Control and Prevention (CDC). Data are collected from roughly 100 hospitals with 24-hour emergency departments and at least six inpatient hospital beds. Selected hospitals are chosen to represent all other hospitals of their size and unique characteristics; together, they are a representative sample of over 5,000 hospitals nationwide. Its injury classification system has shown strong comparability with the International Classification of Diseases, Ninth Edition (ICD-9) codes, and it is considered the most comprehensive surveillance of injuries treated in emergency departments in the United States.^{7,8} It has been studied extensively across a wide range of topics.⁹⁻¹⁵ A population-based algorithm is used to assign weights to each sample, which are used to extrapolate national estimates.¹⁶

The NEISS records injuries related to specific consumer products and recreational activities. We queried the database for all injuries related to computer equipment and electronic games (code 557) between 2001 and 2020. Only injuries associated with the upper extremity were included: shoulder (code 30), elbow (code 32), lower arm (code 33), wrist (code 34), upper arm (code 80), hand (code 82), and finger (code 92). To isolate injuries specifically related to gaming, we searched database narrative descriptions for the keywords “game,” “gaming,” and “play.” Then, we read each of the remaining narratives to determine the final inclusion or exclusion of the record in the study.

Data for demographics, body parts, and injury type were extracted. Injury diagnoses classified by the database as “Other” were individually reviewed and further classified into “Tendonitis/Tenosynovitis” or “Other.” Ages were categorized into ten-year increments (0-9, 10-19, 20-29, 30-39, 40-49, and ≥ 50). A secondary analysis was performed comparing injured body parts to injury diagnosis. In

this analysis, the body part was grouped into finger/hand/wrist, lower arm/elbow, and upper arm/shoulder, as the injuries within each group were expected to have similar patterns.

Data analysis was performed using R statistical software, version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria). National estimates and confidence intervals were calculated using the survey package in R using weights, primary sampling units, and strata provided in the NEISS database to account for the complex survey design. Descriptive analyses were performed to describe patterns of injury based on patient demographics, injury location, and injury type. The CPSC considers national estimates unstable if there are less than 20 records, a national estimate less than 1,200, or a coefficient of variation greater than 33%. Therefore, confidence intervals for these estimates were not calculated.

This study was retrospective and based on de-identified records; therefore, it was exempt from Institutional Review Board approval.

RESULTS

During the study period, 1,269 injuries related to video game use were reported in the NEISS database. The extrapolated national incidence during this period was 41,939 (95% confidence interval (95% CI) 34,350 – 49,528), amounting to an average annual incidence of 2,477. Among all injuries, 67% occurred in males [28,065; 95% CI, 22,609 – 33,522]. The most commonly injured age groups were 10-19 [12,364 (30%); 95% CI, 9,835 – 14,893] and 20-29 [10,807 (26%); 95% CI, 8,589 – 13,025]. Demographics of injuries are shown in [Table 1](#).

Injuries most frequently occurred in the distal upper extremity, with 23% occurring in the finger [9,675; 95% CI, 7,315 – 12,035], 21% in the hand (metacarpals) [8,936; 95% CI, 6,782 – 11,090], and 19% in the wrist [7,974; 95% CI, 5,618 – 10,330] [Table 2](#). The most common injury diagnoses were strain or sprain [11,641 (28%); 95% CI, 9,224 – 14,059], followed by contusions and abrasions [6,969 (17%); 95% CI, 5,138 – 8,799] [Table 3](#).

In the secondary analysis, the most common injuries in the finger/hand/wrist group were strain/sprain (21.3%), contusion/abrasion (18.1%), fracture (17.2%), and laceration (17.2%). The most common injuries in the lower arm/elbow group were strain/sprain (22.6%) and contusion/abrasion (19.0%). The most common injuries in the upper arm/shoulder group were strain/sprain (54.5%), foreign body (12.9%), and contusion/abrasion (9.4%) [Table 4](#).

From a low of 440 in 2005, injuries increased to a high of 4,478 in 2010, a change of 918% [Table 5](#). From its peak, annual cases declined by 60% over the next five years, reaching 1,812 in 2015. Annual cases then steadily increased over the following five years, reaching 2,639 in 2020, a 46% increase from 2015.

Table 1. Demographic Distribution of Video Game-Related Injuries, 2001-2020

Characteristic	Number	(%)	CI ^a Lower	CI ^a Upper
Total	41,939	(100.0%)	34,350	49,528
Sex				
Male	28,065	(66.9%)	22,609	33,522
Female	13,873	(33.1%)	11,074	16,673
Age Group				
0-9	6,777	(16.2%)	4,986	8,569
10-19	12,364	(29.5%)	9,835	14,893
20-29	10,807	(25.8%)	8,589	13,025
30-39	6,466	(15.4%)	4,892	8,040
40-49	2,628	(6.3%)	1,662	3,594
50+	2,896	(6.9%)	1,697	4,095
Race				
White	21,515	(51.3%)	16,950	26,079
Black/African American	5,810	(13.9%)	3,499	8,121
Asian	159	b		
American Indian/Alaska Native	5	b		
Native Hawaiian/Pacific Islander	78	b		
Other	1,987	b		
Not Stated	12,385	(29.5%)	6,865	17,905
Injury Location				
Home	26,499	(63.2%)	20,595	32,403
Street or highway	142	b		
Other public property	2,371	(5.7%)	1,376	3,365
School	136	b		
Place of recreation or sports	1,520	(3.6%)	855	2,184
Not recorded	11,272	(26.9%)	7,468	15,076
Disposition				
Released	41,257	(98.4%)	33,685	48,829
Transferred	19	b		
Admitted	340	b		
Left without being seen	323	b		

^a Confidence interval.^b Unstable estimate. Confidence interval excluded.**Table 2. Incidence of Video Game-Related Injuries by Injured Body Part, 2001-2020**

Injured Body Part	Number	(%)	CI ^a Lower	CI ^a Upper
Finger	9,675	(23.1%)	7,315	12,035
Hand (Metacarpal)	8,936	(21.3%)	6,782	11,090
Wrist	7,974	(19.0%)	5,618	10,330
Lower Arm	3,990	(9.5%)	2,599	5,382
Elbow	3,499	(8.3%)	2,216	4,782
Upper Arm	1,270	(3.0%)	746	1,795
Shoulder	6,594	(15.7%)	5,100	8,088

^a Confidence interval.

Table 3. Incidence of Video Game-Related Injuries by Diagnosis, 2001-2020

Injury Diagnosis	Number	(%)	CI ^a Lower	CI ^a Upper
Avulsion	79	b		
Contusion/Abrasion	6,969	(17%)	5,138	8,799
Crushing	93	b		
Dislocation	1,834	(4%)	921	2,747
Foreign Body	114	b		
Fracture	6,044	(14%)	4,211	7,878
Hematoma	91	b		
Laceration	5,435	(13%)	4,097	6,772
Nerve Damage	3,417	(8%)	1,882	4,952
Strain/Sprain	11,641	(28%)	9,224	14,059
Other	6,222	(15%)	4,057	8,387
Other - Tendonitis/Tenosynovitis	2,646	(6%)	1,727	3,565
Other - Other	3,576	(9%)	1,737	5,414

^a Confidence interval.

^b Unstable estimate. Confidence interval excluded.

Table 4. Video Game-Related Injuries – Diagnosis vs. Body Part, 2001-2020

Injury Diagnosis	Finger/Hand/Wrist	Lower Arm/Elbow	Upper Arm/Shoulder
Avulsion	0.0%	1.1%	0.0%
Contusion/Abrasion	18.1%	19.0%	9.4%
Crushing	0.4%	0.0%	0.0%
Dislocation	0.4%	0.0%	0.0%
Foreign Body	1.2%	6.7%	12.9%
Fracture	17.2%	11.8%	7.4%
Hematoma	0.1%	0.7%	0.0%
Laceration	17.2%	10.5%	1.1%
Nerve Damage	10.1%	7.9%	1.8%
Strain/Sprain	21.3%	22.6%	54.5%
Tendonitis/Tenosynovitis	6.8%	6.8%	4.2%
Other	7.2%	13.0%	8.8%
Total	100%	100%	100%

DISCUSSION

Video game use is expanding in both the number of people playing and the length of time played.² The goal of our study was to describe the types of injuries related to video game use seen across the United States and to describe the demographics at the highest risk of injury. Our data show that males aged 10-29 are among the highest-risk demographic, and the nature of these injuries has evolved with the modernization of gaming systems.

Video game-related injuries have been documented for over 30 years. The first report dates back to 1987 when two cases of trigger finger related to joystick use in children were reported. At that time, the injury was termed “Joystick digit”.¹⁷ Additional case reports were published in the early 1990’s. One case documented a 35-year-old woman who

played a Nintendo video game she received for Christmas for five hours straight. She later experienced pain in the area of the right thumb extensor tendon; the injury was creatively coined “Nintendinitis”.¹⁸ Additional cases of “Nintendinitis” were subsequently reported, attributing injury to repeated motions while handling a controller.¹⁹⁻²¹

Strains, sprains, tendonitis, tenosynovitis, and non-specified pain account for nearly half of all injury diagnoses in our study, with almost two-thirds of injuries occurring in the finger, hand, or wrist. Narrative descriptions in these cases often included reports of excessive gaming prior to the injury, such as “32 YO M pt was playing video games for the past 14 hours and now c/o wrist pain”; “patient with arm numbness, play handheld video game x4 hours a day”; and “pt with thumb pain and swelling after *** playing.” While gaming systems have evolved since the initial re-

Table 5. Incidence of Video Game-Related Injuries by Year, 2001-2020

Year	Number	CI ^a Lower	CI ^a Upper
2001	1,057	b	
2002	800	b	
2003	931	b	
2004	673	b	
2005	440	b	
2006	906	b	
2007	1,520	895	2,145
2008	2,307	1,617	2,997
2009	3,672	2,666	4,678
2010	4,478	3,409	5,548
2011	3,859	2,819	4,899
2012	3,355	2,351	4,359
2013	2,567	1,514	3,621
2014	1,800	1,067	2,533
2015	1,812	922	2,703
2016	2,269	1,326	3,212
2017	1,638	725	2,552
2018	2,615	1,730	3,499
2019	2,600	1,543	3,656
2020	2,639	1,679	3,599

^a Confidence interval.

^b Unstable estimate. Confidence interval excluded.

ports of “Nintendinitis,” many continue to use a basic controller design with buttons and joysticks manipulated by the thumb and fingers. Our results suggest that overuse injury in gamers may be more widespread than case reports have previously suggested.

Gaming systems have evolved since initial reports of “Nintendinitis,” and the interactive nature of modern systems leaves players more vulnerable to injury. Interactive sports games require similar movements to the sport being played; however, gamers are often amateurs with little experience playing that sport. Poor mechanics and improper warm-up can leave players susceptible to soft tissue injury. Interestingly, our secondary analysis showed strains and sprains as the most common injuries in all body part groups. However, while these made approximately one-fifth of injuries in the finger/hand/wrist and lower arm/elbow groups, these were nearly half of the injuries in the upper arm/shoulder group. Multiple studies have described upper arm and shoulder muscular injuries and complaints related to gaming. A study by Bonis *et al.*²² described a 29-year-old male who suffered infraspinatus tendonitis after playing tennis on his Nintendo Wii for the first time, coining the term “Wii-itis.” Others have reported reports of shoulder pain after excessive time spent on the Nintendo Wii, leading to the coining of the term “Wii-shoulder.”^{23,24} A study by Nett *et al.*²⁵ used MRI to demonstrate changes to the posterior deltoid, teres minor, triceps, and latissimus dorsi muscles in an individual after aggressively playing a

bowling game on his Nintendo Wii. These studies have not been limited to the upper arm and shoulder. One 19-year-old woman suffered acute carpal tunnel syndrome after playing her Nintendo Wii for 6-8 hours per day for ten days.²⁶ Vibrating controllers were first introduced by Nintendo in 1997 with the Rumble Pak and are now widely used across the industry.²⁷ These controllers have been anecdotally linked to hand-vibration syndrome, where prolonged exposure to vibration causes the hands to become white and swollen when exposed to cold and red and painful on warming.²⁸ Excessive vibration has also been linked to carpal tunnel syndrome in other applications.²⁹

Injuries from modern gaming systems are not limited to soft tissue injury. Consoles are typically connected to a television, which may be close to low ceilings, nearby walls, coffee tables, ceiling fans, couches, or other hazards obstructing player movement. Our secondary analysis found fractures, lacerations, and contusions more common in the distal limb than in the proximal limb. These findings are supported by multiple published case studies and case series. A review of 39 self-reported Wii-related injuries found hand lacerations as the most common injury, with almost half of all injuries occurring while playing Wii Tennis.³⁰ One case report described a Rolando fracture sustained after hitting a coffee table while bowling on a Nintendo Wii.³¹ Another case report described a rupture of the extensor pollicis longus tendon after hitting a wall with a backhand while playing tennis on a Nintendo Wii.³²

We found 44% of injury diagnoses were contusions, abrasions, lacerations, and fractures. Narrative descriptions suggest direct trauma from the gaming system or poor anger management. Examples include “contusion (R) shoulder, pt fell from the sofa while playing video games, c/o pain,” “hand ct - hand hit a ceiling fan while playing the *** game at home,” and “14 yo male punched a wall because he was mad at a video game. dx finger fx”. Our study also shows the peak incidence of injury trailed the peak Nintendo Wii sales by one year. While determining a causal relationship is not within the scope of this study, further studies are warranted to understand better the association between gamer injury and the emergence of interactive gaming systems.

While most gamers play casually and can recover with simple pain control and rest, these injuries can have real financial implications for certain people. One professional Call of Duty eSport athlete with nearly \$400,000 of career earnings was forced to retire due to a chronic wrist and thumb injury.³³ Relief pitcher Joel Zumaya missed games in the 2006 Major League Baseball playoffs after injuring his throwing arm while playing excessive amounts of Guitar Hero.³⁴

With video game-related injuries on the rise, patient and parent education is more important than ever. Gamers appear engaged in their health; YouTube videos posted by an orthopaedic surgeon describing hand, wrist, and forearm exercises targeted to gamers have several million views, although it is unclear whether these videos have decreased injury incidence.³⁵ Physicians should capitalize on this level of engagement to raise awareness of video game-related injuries to modify or prevent injuries.

Our study has several limitations. First, NEISS data only represents injuries presented to emergency departments. In many cases, particularly with overuse injuries, patients may either self-diagnose or present to an outpatient office rather than the emergency room. As such, relying on the NEISS database for extrapolating national estimates may limit accuracy; the database may not fully capture all video game-related injuries, potentiating underreporting or overestimating the national incidence. For example, a significant number of patients (7,609 cases) over the study period presented with “unspecified pain” as the main complaint or cause for emergency room visits. As such, there is a potential underestimation of more specific conditions.

Furthermore, the absence of routine outpatient visits and the inclusion of exclusively emergency room visits skews our study toward more severe injuries. Second, narrative descriptions may only imply video games as a cause of injury. Further testing to more accurately diagnose the condition is beyond the scope of an emergency department visit. As a result, diagnoses are based on the treating physician’s judgment. Third, the NEISS database is dependent on

accurate and consistent data entry. Entries may have been miscoded or may have missed the keywords “game,” “gaming,” or “play”. Ultimately, our descriptive analysis is only as accurate as the data entered into the registry. Last, additional information that could make our analysis more robust, such as diagnostic testing results, specifics of which gaming system was used, more detail about the setting in which the injuries were sustained, and injury specifics, such as fracture patterns, were unavailable in this database.

CONCLUSION

Video game-related injuries represent a preventable cause of upper extremity injury. Our study describes demographic factors associated with injury, with adolescent males among the highest-risk group. With the increased use and modernization of gaming systems, physicians should proactively educate patients and parents to help prevent injury, particularly in the adolescent population.

DECLARATION OF CONFLICT OF INTEREST

Dr. Michael M. Vosbikian, MD receives honorarium for content authorship from *The Journal of Bone and Joint Surgery Clinical Classroom – Hand and Wrist* and is an editorial board member for *ePlasty* and *SurgiColl*. We otherwise do NOT have any other potential conflicts of interest for this manuscript.

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

As this study was retrospective in nature and based on deidentified records, it was exempt from the local Institutional Review Board approval.

DECLARATION OF INFORMED CONSENT

There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

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