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REVIEW ARTICLE

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Pitfalls in a Gamer's Paradise--A systematic Review

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ABSTRACT

Video games and tenpin bowling are two things highly admired by everyone looking for active indoor recreation. Hence, the aim is to throw light on the type injuries related to these recreational sports and their prevention. Video games are gaining utmost popularity in the light of the current pandemic where people are forced to stay home and they (especially children and young adults) resort to Virtual Reality and other kinds of video games for entertainment. Hence,Video gaming injuries which were once upon a time considered as a novelty diagnosis, are becoming highly prevalent.These injuries are commonly regarded as eccentric injuries and can sometimes result in lasting limitations.

Bowler's thumb is a traumatic neuropathy of the ulnar nerve of the thumb seen in frequent tenpin bowlers. Given the popularity of bowling, it is important to keep this diagnosis in mind along with other sport injuries when a patient presents with paresthesias, hyperesthesia, numbness,changes in two-point discrimination sense, or a positive Tinel sign in the distribution of the involved digital nerve (thick and firm to palpation).

Sources of data used were peer-reviewed,English articles in Pubmed,Google scholar,CINAHL using certain keywords like 'Nintendo related thumb injuries','Gaming injuries','Wii injuries','Bowler's thumb','Tenpin bowling injury'.

Results from studies related to gaming injuries suggested that problems included neurological, psychological and surgical. Tendinitis of the extensor of the thumb was seen in traditional controllers with buttons. Palmar ulceration was seen with the joystick on the Nintendo controller and the motion sensitive Wii remote was associated with musculoskeletal problems and various traumas.

Results from various studies related to bowling injuries showed that pain was a predominant symptom, especially in wrist, ring and middle fingers, and thumb. Other repetitive injury-related disorders were also less common than in their non-playing limb and the general population than the affected limb. Hence, creating awareness among the normal population in order to ensure adequate preparation before undertaking virtual sports and tenpin bowling, is the key to prevention of these recreational injuries and happy gaming.

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Introduction

In the last few years,virtual reality has taken over the world and has given promising results while doing so. It is well known to create 'embodied cognition' .Some of the most common sectors using VR are healthcare-e.g surgery,psychiatry,aviation ,weather forecast and gaming. And since it is widely accepted and entertaining in nature, they are often used as a tool in rehabilitation.It is used to assesses balance ability with the pressure sensitive balance board and can help in training older people and patients with multiple sclerosis or Parkinson's disease. Also,basic laparoscopic skills can be improved using the motion sensitive Wii remote controller.'Exergames' are used for exercise in children with cystic fibrosis, weight loss,cardiovascular training,and postoperative rehabilitation.

Video games have become a must-have possession, especially the Nintendo Wii which is known not only for its gaming experience but also for enhancing a person's fitness.It creates an exceptional user interface that allows one to compete with others in an array of activities all at the comfort of being home. However, the increasing popularity is accompanied by a multitude of gaming injuries and although the activity is simulated, injuries are real.

Data also suggests that among those who presented with Wii-related injuries, only 1/10th were treated conservatively, whereas 9/10th underwent either surgical or interventional treatment. In tenpin bowling, a weighted ball is held using only the thumb, middle and ring fingers, is swung and launched at speed along an

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18m long alley, in an attempt to knock down as many of the pins as possible, thus accumulating as many points as possible. Such movements when performed repetitively, could result in overuse injuries of elbows, wrists and hands. The most common injuries were that of the fingers followed by the trunk and the wrist. Despite being a very popular sport and tremendous amount of research dedicated to the field of sports medicine, very little effort has been taken to investigate the bad effects of it on the musculoskeletal health of frequent players.

Literature Search

Secondary qualitative and quantitative data was referred to for this study.Peer-reviewed English articles were included from Pubmed,Google scholar,CINAHL using search words like 'Nintendo related thumb injuries','Gaming injuries','Wii injuries','Bowler's thumb','Tenpin bowling injury'.Inclusion criterias were Studies giving details about 1)Frequent players Exclusion criteria were studies referring to patients having pre-existing conditions--like de Quervain's tenosynovitis, tennis and golfer's elbow, carpal tunnel syndrome and trigger finger. AND Boolean operator was used to narrow down the article search. This search gave us 79 articles out of which we narrowed down to 9 relevant articles.

Results

The search gave us 79 articles out of which we narrowed down to 9 relevant articles.

Findings of various studies are shown in Table 1 & table 2. A variety of injuries have been reported which include Soft tissue injuries,Repetitive stress related injuries and specific types fractures(eg.ACL tear,Base of thumb fracture).Some reports suggested that hand lacerations or bruising were the most common injury with incidence rate of 50% of the total number of cases.

Quantitative Analysis:

Gaming:

FRACTURES	N (T=27)	%
Metatarsal fractures	5	18.5%
Other	3	11.0%
SOFT TISSUE INJURIES		
Tendon/ligament injury a)Upper limb b)Lower limb	 6 4	 22% 14.8%
Spine injury	3	11.0%
Nerve compression injury	1	3.7%
MISCELLANEOUS		
	5	18.5%

Bowling:

	n=45	%
WRIST SYMPTOMS	28	62.2
THUMB SYMPTOMS	10	22.2
INDEX FINGER SYMPTOMS	0	0
MIDDLE FINGER SYMPTOMS	14	31.0
RING FINGER SYMPTOMS	19	42.2
LITTLE FINGER SYMPTOMS	0	0
SPINE SYMPTOMS	5	11.0

Several types of injury can be related to this form of physical activity one of them being basal thumb fracture, a Rolando type of fracture similar to the one obtained while doing the actual activity mimicked in the game. Such injury can occur following an impact sustained by the individual not clearing enough space to undertake the game safely. The mechanism of Rolando fracture is similar to the injury in a fistfight wherein an axial blow occurs to partially flexed metacarpal. A T-shaped or Y-shaped fracture line is typically observed . The main dorsal fragment subluxes or dislocates dorsally and radially due to the unopposed pull of abductor pollicis longus whereas the volar fragment remains attached to the carpometacarpal joint. A similar axial load may be transmitted to patient's thumb while hitting nearby objects during gaming or bowling. Subsequently such patients have to undergo surgical treatment to regain functions.Such injuries are more frequently seen in real contact sports. However, there is always the possibility of such or even more severe injuries of the musculoskeletal system or any other part of the body during these console games activities.

Among the cutaneous manifestations of excessive video gaming, video gamer thumb or "playstation thumb" refers to the presence of hyperkeratosis, blisters, and petechiae on the tips of the thumbs. Multiple cutaneous disorders can arise from excessive use of electronic devices and a high index of suspicion is necessary to allow an early diagnosis. Ensuring a safe and spacious environment before undertaking sport is key to prevent injury and the same principles are needed when undertaking virtual sport.

Perineural fibrosis causing chronic digital neuropathy of the palmar nerve supplying the median aspect of the thumb is termed "Bowler's thumb". In some rare cases, a bowler's thumb lesion could be a traumatic neuroma caused by proliferation of fibrous tissues, both around and within the digital nerve. These phenomena are a result of adaptive changes in the thumb in response to frequent insertion and compression by the holes of the bowling ball. Similar injuries are also seen in baseball, by repetitive use injuries, and following finger surgery. The most common complaints are pain, neuropathy, and mass lesions. Rapidly paced bowlers are more predisposed.

The most common mechanisms of injury are due to tripping, falling, being hit by the bowling ball, and dropped ball injuries, which are less common in experienced athletes. Other mechanisms include repetitive strain in frequent players. Injuries can range from fractures (eg. Mallet finger seen in Baseball injuries) to soft tissue injuries and sprains or strains--finger sprains, muscle strain, thumb sprain, adductor muscle strain, adductor tendinopathy, carpal tunnel syndrome, de Quervain's

tenosynovitis, knee ligamentous injury, lumbar disc injuries, quadriceps and bowlers thumb. The exact pathophysiology is chronic repetitive suppression of the ulnar soft tissues of the thumb by the thumb hole of a bowling ball which is more likely when the bowler uses a smaller-than-required size of the bowl. Most common sites injured are the wrist, back, shoulder, hip and knee. It is important that the muscles, tendons, joints and ligaments in these areas function in accordance with each other so as to remain injury-free.

Despite being a non-contact, non-vigorous sport, the players who are engaged frequently, can sustain a certain number of painful injuries. Results of certains studies have shown that, symptoms of stiffness and swelling of these parts of the body were also seen. Wrist symptoms were found to be mainly due to de Quervain's tenosynovitis (80%) making it the commonest diagnosis on clinical examination. With an incidence of 54%,it was considerably higher than in the average population wherein only 0.49% of the population were reportedly affected by de Quervain's tenosynovitis (more routinely found in older age groups). Diagnosis of tennis and golfer's elbow, carpal tunnel syndrome and trigger finger were less prevalent but were still much more common when compared to the non-playing limb. The incidence of these disorders was also higher in comparison to the average population.

Diagnosis is often made by clinical examination, X-rays,USG and MRI. Most common complaint of bowler's thumb is hypesthesia, paresthesia, and numbness. On clinical examination, a usually mobile mass is detectable in almost all cases. Thickening of the digital nerve, callous formation, or skin atrophy may also be present. A positive Tinel's sign and Nerve conduction studies abnormalities is seen. USG can be a useful initial imaging modality for the evaluation of small peripheral nerves.

Since it is a clinical diagnosis, very few reports of MRI appearance of the bowler's thumb exist. MRI features of bowler's thumb are similar to Morton neuroma as both conditions are pathologically related to perineural fibrosis rather than to true neuromas. The perineural fibrosis in both entities is low to intermediate in signal on T1- and T2-weighted images. In fact, the signal on T2-weighted images is so low that the mass might not be identifiable on fat-suppressed imaging. It is helpful to do preoperative distinction between nodular neuroma and epineural fibrosis forms of the disease.

A good clinical history and recognition of enlargement of the digital nerve should permit accurate characterization of the perineural fibrosis of the bowler's thumb. The differential diagnosis may include peripheral-nerve-sheath tumor and giant-cell tumor of the tendon sheath. Peripheral-nerve-sheath tumor of a digital nerve is uncommon, and these lesions are characteristically higher in signal on T2-weighted images than they are in the case of perineural fibrosis. The masslike presentation and low T2 signal may cause confusion with the giant-cell tumor of the tendon sheath, but this process should not cause enlargement of the digital nerve.

Treatment may depend upon the kind of injury and it ranges from rest, non-steroidal anti-inflammatory drugs, injection corticosteroids and eventually surgery. Interventional IV thrombolysis and chiropractic intervention are also used sometimes. Treatment of bowler's thumb is usually conservative. Nonoperative interventions such as avoidance of bowling, beveled holes in the bowling ball, more distant placement of the ball thumbhole (so that only the distal phalanx can enter the ball), and thumb guards have been used with success. Operative interventions are reserved for individuals who fail conservative therapy. Neurolysis and transposition of the nerve are surgical options.

Porcine extracellular matrix nerve wrap can be placed in an attempt to prevent recurrence of neuroma, but long-term follow-up is necessary.

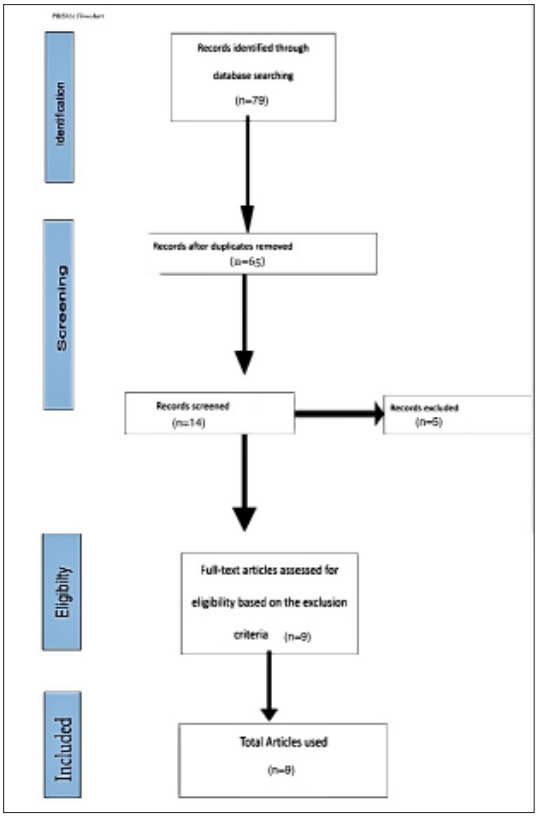
Discussion

While gaming, the participation of the whole body is comparable to real sports. The user is supposed to actively imitate mental and physical actions as though it was all happening in reality. Thus, intensities of some of the games are comparable or even more extensive to those of conventional sports and can result in injuries as severe as acute carotid dissection after 3 hours of Wii running or Wii tennis. It is unlikely that players prepare or warm up for extended Wii sport sessions. However, this kind of physical activity has a real risk of injury; severe injuries that may need interventional or surgical treatment. Among these are potentially life-threatening injuries (egacute strangulation of small bowel) and several injuries with potential long-lasting consequences such as a globe rupture leading to loss of vision, an osteochondral lesion of the knee, a meniscus tear, or an ACL rupture described by us. All of the 3 latter are known for an increased risk of posttraumatic osteoarthritis. Beside these, a number of overuse injuries could occur. Typical injuries in the elderly are a femoral neck fracture, head, neck and spine injury and shoulder dislocations.

When it comes to bowling, a few aspects of how the game is played can clearly attribute to the kinds of injuries and symptoms. In order to produce a greater impact on the pin that comes in contact and to generate a domino effect on the other bowling pins, players have to attempt to spin the bowling ball by hooking onto it with the thumb, middle and ring fingers. Hence, exclusive wrist action is required to release the ball which increases the work and hence repetitive strain around it. This technique where only the thumb, middle and ring fingers are fitted within the gripping holes of a ball, predisposes these areas to injury whereas the index and little fingers show no symptoms. Hence, a more ideal hypothetical method where the ball weight is distributed more equally should be researched on. Also, giving hand and wrist support along with the bowl should become mandatory. It is found that the use of a heavier bowling ball increases the risk of musculoskeletal afflictions due to the increase in force required to handle and launch them.

The kind and duration of training also plays an important role. High intensity,long duration training sessions of the athletes could also precipitate an injury and/or prevent its healing. It has been found that a good number of athletes continued bowling despite experiencing some kind of symptoms, some of which lasted longer than a year. The ultimate result of these musculoskeletal disorders is poorer performance and loss of days of work, long term morbidities or even end of careers if left untreated. It is therefore important that initiatives are taken to identify, diagnose and treat them at an early stage as these conditions are known to respond favourably to both nonoperative and operative

management. Awareness programmes, more personalised training schedules and modern training methods, an improvement in throwing technique, and the development of highly individualised equipment may help retard or deter their occurrence. The area of further research should be focused on assisting in the formulation of other preventive strategies.



TYPE OF INJURY	STUDY	GAMING OR BOWLING	CASE REPORT SUMMARY
FRACTURES			
	[1]	Gaming	A 38-year-old man sustained an acute C7 spinous process fracture after heavily swinging his Wii game console. After 3 months of conservative treatment, the posterior fracture fragment had to be resected due to persistent posterior neck pain.
	[1]	Gaming	Eley reported on a 14-year-old girl with a proximal fifth metatarsal fracture after falling of the Wii Fit balance board and sustaining an inversion injury. The fracture healed well after conservative treatment.
	[2]	Gaming	A 54-year-old teacher sustained a Rolando fracture of the first metacarpal base while playing Wii bowling and hitting his right hand against a glass coffee table. The fracture needed to be operatively reduced and internally fixed with a plate.
	[3]	Gaming	A 38 year old man fractured his spinous C7 process after swinging a Wii remote vigorously, and a girl who fell during a game of Wii Fit sustained a small fracture of the fifth metatarsal of her right hand. Another report described an intra-articular fracture of the first metacarpal bone in a patient who was playing a sports game.
NON-OSSEOUS			
	[3]	Gaming	A 16-year-old boy with lateral patella dislocation, osteochondral lesion of the lateral femur condyle, and complete rupture of the medial patella femoral ligament (MPFL) after twisting the knee while playing Wii. The patient underwent surgical fixation of the osteochondral fragment along with repair of the MPFL and progressed well postoperatively.
	[3]	Gaming	A 23-year-old woman who sustained a tear of her medial meniscus while playing Wii bowling. The patient underwent partial medial meniscectomy and recovered well afterward.
	[3]	Gaming	An acute rupture of the extensor pollicis longus tendon while playing tennis and hitting her hand to a wall requiring tendon surgery.

	[6]	Bowling	Two rare cases of bowler's thumb (traumatic neuropathy of the ulnar digital nerve of the thumb) were treated surgically with encouraging results. These had different types of lesion, involving nodular neuroma and epineural mass, which were distinguished by magnetic resonance imaging. The surgical outcome for active bowlers is unclear and postoperative protection from the repetitive trauma of throwing is important. Possible technical solutions include changing the size and weight of the ball, the spacing between holes, the fitting of thumb to ball, and the slope and size of thumb holes. It is important that both bowlers and clinicians are sufficiently aware of bowler's thumb to allow early diagnosis and treatment of this lesion.
	[8]	Bowling	A 68-year-old man with a history of avid bowling presented with a chief complaint of left thumb numbness and tingling for several months. Physical examination demonstrated a small tender mass along the ulnar surface of the left thumb with a positive Tinel's sign and diminished 2-point discrimination distal to the mass. The patient's symptoms did not improve with conservative measures. Here, we describe his surgical treatment and review the current literature.
	[5]	Bowling	A 27-year-old, left-hand-dominant man with a long history of avid bowling presented to the Orthopedic Surgery Clinic complaining of pain, numbness, and a thumb mass. On physical examination, a small, tender, mobile mass was identified at the ulnar aspect of the thumb at the level of the proximal phalanx. Steroid and anesthetic injection did not provide any relief. An MRI of the thumb was performed.
	[3]	Gaming	The first Wii related injury, dubbed “wiiitis,” was seen in a 29 year old man who experienced acute tendinitis of his right infraspinatus muscle after playing Wii Sports for several hours. Others also reported acute muscle pain in the upper extremities after playing the game.One report even described a case of arm swelling and a rise in creatine kinase, consistent with serious muscle injury. Magnetic resonance imaging in another case of upper extremity wiiitis showed increased signal intensity in various muscles of the upper extremities.Wiiitis can affect various muscles in the arm and shoulder, depending on the movements made during different games. All cases were treated with rest and non-steroidal anti-inflammatory drugs.
	[3]	Gaming	The patient was a 35 year old woman who experienced severe pain in her right thumb after playing her Nintendo uninterrupted for five hours.A similar case, which was termed nintendinitis—a form of tendinitis—was caused by repetitive microtrauma.The authors of similar case reports suggested that prophylactic hand care instructions should be given at school. Another report described a boy who developed eczema on both his thumbs after playing his Game Boy on a daily basis.
	[3]	Gaming	Four paediatric cases of wiiitis were reported; children presented not only with a painful arm, but also with a painful neck and postural deviations.
	[3]	Gaming	Another report described a case of carpal tunnel syndrome in a woman who played a bowling game for six to eight hours daily for 10 days.
	[3]	Gaming	There are also two reports of Achilles wiiitis—a (partial) tear of the Achilles tendon.
	[3]	Gaming	The term “Wii knee” encompasses all Wii related knee injuries. The first report was of a young woman who dislocated her left patella when she fell while serving a tennis ball in Wii Sports. In addition, a boy who twisted his knee while playing the Wii dislocated his patella and fractured his lateral femoral condyle,and another report mentions a medial meniscal tear in a woman who was playing a bowling game.
	[5]	Bowling	A case of bowler's thumb in a 21-year-old male recreational bowler who presented with a painful mass on the ulnar side of the right thumb. Magnetic resonance (MR) imaging of the hand was inconclusive. However, subsequent ultrasound (US) showed asymmetric enlargement of the ulnar digital nerve of the thumb with marked epineural thickening corresponding to the palpable mass, confirming the clinical diagnosis of bowler's thumb.
OVERUSE			
	[1]	Gaming	4 children aged 3 to 9 years presenting to a chiropractic clinic with spinal pain, spinal joint dysfunction (subluxation), and related extremity pain after excessive gaming. All children were successfully treated with chiropractic manipulations.
	[1]	Gaming	A case of overuse in a patient with acute arm swelling associated with a rise in serum creatine kinase to >8000 U/L after excessive Wii gaming. Conservative treatment and rest was initiated and the symptoms resolved soon.
OTHER			
	[3]	Gaming	A 55 year old woman sustained a massive haemothorax (>1250 mL) after falling on her sofa while playing tennis on her Wii.Another patient required resection of infarcted bowel when a pre-existing paraumbilical hernia strangulated while doing exercises with Wii Fit.Two patients were admitted with ischaemic stroke owing to an internal carotid artery dissection after playing the Wii.

	[3]	Gaming	A case of a 13 year old girl who experienced a generalised seizure after playing Super Mario Bros on her Nintendo entertainment system (1984) for almost three hours. This "Nintendo epilepsy" was attributed to a rapid change of on-screen patterns. A large multicentre study later showed that patients with a history of seizures when watching television were more sensitive to a game similar to Super Mario Bros than to a normal television programme.
	[3]	Gaming	In the early 1990s two cases of Nintendo related incontinence were published.One described a boy who developed episodes of faecal soiling, and the other reported three (related) boys who suddenly developed daytime enuresis. All children were so engrossed in Super Mario Bros that they ignored their urge to go to the toilet. All cases were successfully treated by explaining how to pause the game. One of the authors jokingly suggested that Nintendo should develop a wet sensor that aborts the game if a player loses bladder control.
	[3]	Gaming	In 1991, an author described how his son developed intense neck pain after playing his Game Boy—a portable system first marketed in 1989 with a small unlit display—for 30 minutes.His position while playing was reported as "hunched over, chin almost resting on his chest, elbows bent while he holds the small screen close to his face." The boy's problems, dubbed "Nintendo neck," were attributed to playing in this position.
	[3]	Gaming	Similarly, "Nintendo elbow" was diagnosed in a 12 year old boy who had pain in his right elbow after playing his Nintendo "a lot" for more than a month.Symptoms resolved with non-steroidal anti-inflammatory drugs and rest.
	[3]	Gaming	We also found a report of "Nintendo hallucinations." The patient, who had previously been diagnosed as having paranoid schizophrenia, had persistent auditory hallucinations of video game music.
	[3]	Gaming	A forehead laceration in a girl whose brother accidentally hit her with a Wii remote, and permanent loss of vision in a 7 year old boy after he accidentally struck his left eye while playing Wii Sports. Finally, a woman experienced rupture of the extensor pollicis longus after hitting a wall while playing tennis.
	[3]	Gaming	A 47-year-old woman and a 14-year-old boy with an acute ischemic stroke due to an internal carotid dissection after 3 hours of Wii tennis and Wii running, respectively. Being in good health before, both patients presented with acute onset of headache followed by hemiplegia. Both were treated by an intravenous thrombolysis. The boy recovered `completely, whereas the woman was still dependent after 3 months.
	[3]	Gaming	While playing tennis, a 7-year-old boy struck his left eye with the controller in his right hand and suffered a globe rupture and nearly complete loss of vision. The same day the prolapsed uvea was repositioned and the corneal-scleral laceration repaired. The case was complicated by a total hyphema and later by a central corneal scar and a cataract. Ten months after injury, vision remained impaired and an ultrasound revealed a detached retina. However, the parents refused any further surgery.
	[3]	Gaming	The first abdominal trauma after Wii sports. A patient with a preexisting paraumbilical hernia presented with acute strangulation of her small bowel after completing her aerobic exercises on Wii Fit. The patient required emergency laparotomy including small bowel resection of the infarcted part.
	[3]	Gaming	An otherwise healthy 9-year-old boy presented with itching and painful lesions on both thumbs of 5 months' evolution. He had received treatment with high-potency topical corticosteroids with partial improvement. Physical examination showed erythema, lichenification and fissures on the tips of both thumbs. Patch testing was performed, with negative results. After exhaustive questioning, the parents stated that the child usually spent several hours per day playing video games. The boy also admitted to being "addicted to PlayStation games." A diagnosis of frictional dermatitis was made. The lesions completely resolved following 2 weeks of forced abstinence from video gaming.
	[3]	Gaming	In addition, one case of wiiitis presented as a massive venous thrombosis of the gluteal veins that reached as far as the inferior vena cava.

Conclusion

These kind of gaming injuries are completely uninvited and easily avoidable if necessary easy precautions are taken. Hence, Staying away from alcohol, Wearing your wrist-strap/thumb and wrist support correctly, properly estimating the space required to undertake the gaming activities and prepare the surrounding environment appropriately. Not being used to sports may also lead to people injuring themselves. Hence,it is important to be aware of these possibilities and working accordingly to avoid lifetime disabilities [1-9].

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