

Review Article

Integrated analysis of health dynamics in esports: injury profiles, intervention strategies, and health optimization protocols

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ABSTRACT

The rapidly expanding realm of Electronic Sports (eSports) has captivated global attention, blurring the lines between virtual entertainment and traditional athletics. As participation in eSports continues to rise, these competitive gaming platforms are increasingly recognized as legitimate sports. However, with this surge in participation, there's a simultaneous increase in the susceptibility to health hazards, spanning both physical and psychological domains. Musculoskeletal injuries, caused by extended sedentary postures and repetitive motions, afflict eSports athletes, resulting in discomfort in the wrists and hands, alongside back and neck problems. The prolonged exposure to screens predisposes participants to vision-related concerns, highlighting the imperative of addressing ocular health within the eSports community. Simultaneously, the intense cognitive demands and competitive pressures exacerbate mental health challenges, resulting in depression and anxiety among players. Similar to traditional athletes, eSports competitors need appropriate protocols to minimize injury risks, alongside access to medical intervention to manage potential health hazards. This review comprehensively analyses the health dynamics of eSports, elucidating injury profiles, intervention strategies, and health optimization protocols essential for safeguarding the well-being of eSports athletes and enhancing awareness within the eSports community.

Keywords: Electronic sports, Sports injury, Ergonomic, Sports physiotherapy, Mental health, E-athletes

INTRODUCTION

The electronic sports (eSports) that encapsulate the excitement are commercialized through a computer video gaming tournament with audiences to speculate, to create an experience that simulates traditional sports. Gamers or e-athletes indulge in these games as teams in multiplayer or individual mode. With the immense support of streaming services like Twitch and YouTube, the popularity has spread amongst the masses to witness and celebrate these tournaments. The audience treats them as professional sports players. Common electronic sports games to mention are League of Legends, Call of Duty,

Counter-Strike, Call of Duty, Dota 2, Fortnite, Madden NFL, and Overwatch. The competition and the recognition of the event as a sport with grades of achievement increases the impulse for the e-athletes to engage more in the sport which serves as a drive for this industry to thrive and prosper! Though eSports have become common for the past few years, it does not imply a recent development. This sporting domain has roots that are hinged to the beginning of competitive computer gaming and retro-competitive online games. Though the eSports industry has gained interest in this decade, it was formally institutionalized at the beginning of the new millennium as its origin dates back to the 1980s. In fact,

in 1958, hundreds of students lined up for an analog computer at the Brookhaven National Laboratory. Over the next three days, thousands would play the world's first-ever game designed for entertainment purposes only, Tennis for Two.¹ Esports traces its origins back to 1972 when home consoles first became common. The first esports event happened in 1972 at Stanford University, where students competed in the video game Space War. Esports origin relies heavily on launching the World Wide Web in 1989 and the early 1990s software and hardware technologies with network and multiplayer functions.² Game journalist Tristan Donovan points to the Intergalactic Space Warfare Olympics held in 1972 at the Massachusetts Institute of Technology (MIT) as the first electronic gaming competition in history. At the end of the 70s of the last centuries, the combination of the first computers, recreational pleasure, and the vision of aspiring entrepreneurs laid the foundation for today's thriving electronic entertainment industry.

Time magazine's 1981 interview of teenager Steve Juraszek for his record in a 16-hour game, Life magazine's feature on the Twin Galaxies arcade and its star players, and the inclusion of the best player of the year in the 1985 Guinness Sports Record are examples of the contribution of the media toward the professionalization of eSports and its players, in addition to its appeal to the public and the interest of other industries in the entertainment industry.³ History has led its way with events that implicitly witness the appreciation of eSports way ahead of time that is expected. These events bookmark the growing interest of eSports in the audience as well as emphasize the importance of media in the evolution of eSports. Esports have been parallelly evolving with the evolution of computers and the amusement of online games. With the facilitation of technology and exploration of features that mold electronic games to emerge as an enriching experience, gamers also become professional over time, gathering their group of audiences and promoting the gaming sport to reach a point where Esports is competing in the gaming market rendering excitement the equal excitement that the traditional sports brought in! An exponential growth of the eSports industry, along with potential business opportunities, has been witnessed in recent times.⁴

In 2023, 31.6 million esports viewers were accounted for, according to Insider Intelligence's forecast.⁵ According to the Esports Federation of India, eSports is expected to have a 1.9 billion global market with 532 million international fans and 152 countries engaging in eSports.⁶ The numbers promise an enormous amount of support and participation from gamers and fans of gamers all around the world to witness this competitive electronic sport. Esports is being broadcasted through live-streaming platforms with a hundred million players participating. According to the recently presented data by Josh Howarth, the gaming market has a current valuation of 282 billion and is expected to raise its bars to 363 billion.

According to the latest data, there are around 3.32 billion active gamers worldwide.⁷ The sporting qualities of competitive computer gaming are still questioned amongst public health domain members and media. The definition of sport has been rethought with the arrival of eSports into our lives. The health benefits we obtain from traditional sports are argued with the health implications due to prolonged engagement with computer gaming and eSports encouragement. Sports are regarded as a virtue, whereas computer gaming is viewed as a vice.⁸ Strong arguments have been raised against the consideration of esports under the domain of sports, and it is implicitly referred to as a misnomer. The most convincing reason is that esports are not inadequately human: they lack physicality, they fail to employ decisive whole-body control and whole-body skill, and cannot contribute to the development of the whole human.⁹ The sole purpose of this review is to emphasize the health implications, potential injuries, and managing the impacts of eSports amongst professional gamers, viewers, and global audiences.

HEALTH IMPLICATION OF E-SPORTS

Sedentary lifestyle and its consequences on physical health

Sedentary lifestyle and its consequences: Engaging in activities while seated before a screen is identified as sedentary behaviour.¹⁰ Research indicates a higher prevalence of metabolic syndrome, increased risk of obesity, cancer, type 2 diabetes, and greater overall mortality among individuals who dedicate prolonged periods to sedentary pursuits like watching television, videos, or using a computer.¹¹⁻¹⁵ However, Wijndaele et al conducted a cross-sectional analysis revealing a positive correlation between time spent in sedentary activities and the occurrence of metabolic syndrome and its components.¹⁶ While active video gaming allows both children and adults to expend more calories compared to sedentary video games, the substitution of video games for actual sports or unstructured play requires further examination.¹⁷

Vandewater et al identified a connection between weight status and the duration of time spent engaging in video games.¹⁸ Activities that require energy expenditure in the range of 1.0-1.5 metabolic equivalent units (METs) are considered sedentary.¹⁹ Research has indicated a negative correlation between metabolic syndrome and physical activity participation.²⁰⁻²⁵ The World Health Organisation (WHO) and other international bodies' recommended levels of physical activity for elite esports athletes were met by the 115 participants in the research, which involved 5.3 hours of training per day, including 1.1 hours of physical exercise.²⁶⁻²⁸ Elevated levels of physical activity have been found by Ekelund et al. to potentially attenuate the negative effects of television viewing and act as a protective factor against the development of metabolic syndrome.²⁹

Musculoskeletal Issues

Extended periods of sitting coupled with poor posture and repetitive movements associated with gamepad, mouse, and keyboard use are identified as significant contributors to musculoskeletal hazards in the realm of eSports.³⁰ According to multiple studies, wrist and hand pain is the most common complaint among e-athletes, closely followed by back and neck pain.³¹ Early research on hand and upper limb injuries coined the term “Nintendinitis”.^{32,33} Typical e-athletes might experience head flexion, repetitive or prolonged wrist bending, and described twisting or thrusting motions of the thumb as they adopt a hand-held mobile gaming position and maintain a prolonged inferior viewing angle.³⁴ Esports athletes face an elevated risk of wrist and hand injuries due to their engagement in a high volume of actions, reaching up to 500-600 actions per minute (APMs) involving keyboards, mice, or gamepads.^{31,35,36}

Table 1: Musculoskeletal issues in Esports can be categorized into two main factors.

Cause	Injuries
Prolonged Suboptimal Posture	Neck pain, low back pain, cervical radiculopathy, thoracic outlet syndrome, cervicogenic headache. ⁴²⁻⁴⁴
Repetitive Movements	Shoulder overuse tendinopathy, cubital tunnel syndrome, olecranon bursitis, lateral epicondylitis, carpal tunnel syndrome, De Quervain's syndrome, finger tendinopathies. ⁴²⁻⁴⁴

The most prevalent symptoms among athletes who play video games pertain to the neck (42%), back (42%), wrist (36%), and hands (32%), based on the prevalence rates of symptoms.³¹ A common ailment among e-athletes is "Gamer's Neck," often referred to as the "Nintendo Neck".³⁷ This condition is caused by persisting to sustain incorrect posture and is defined by spinal flexion and axial pain that travels from the cervical to the lumbar area.³⁸ A study conducted by Sekiguchi et al looked at how 200 baseball players were impacted by playing video games.³⁹ Based on their study, there is a strong link between playing video games for three hours or longer every day and suffering severe elbow or shoulder pain.³⁹ According to Di Francisco Donoghue et al., wrist, hand, and neck/back injuries account for 42%, 36%, and 32% of all reported injuries.³¹ The most commonly injured regions during esports, according to Lindberg et al., are the shoulder (11%), neck (11%), and back (31%).⁴⁰ A different study revealed that the wrist and hand joints [66%] are most afflicted in esports followed by other body parts such as the shoulder (18%), neck (6%), lower back (5%), and mid back (2%).⁴¹

Mental health

Esports, unlike traditional sports, have their demerits in the aspect of maintaining sound mental health whilst

investing a lot of time on screen, encouraging addictive behaviour and leading a sedentary lifestyle, which has its own physical and psychological health effects the World Health Organization lists ‘Gaming Disorder’ as a Mental Disorder.⁴⁵ The prevalence of esports and the popularity of competitive computer gaming elements amongst gamers and viewers over a prolonged period could determine the physiological and psychological effects. Measures have to be taken to protect against some health risks and are of paramount importance to be noted. Awareness should be spread amongst the gamers, and the viewers indulged in esports by healthcare practitioners and policymakers.

Cognitive effects

It is established from the collection of studies tabulated in the review article that Video Gaming and Internet Gaming Disorder. Internet gaming disorders are defined by continuous and repeated involvement with video games, often leading to significant daily work and educational disruptions and has been suggested by American Psychiatric Association (APA) as a tentative psychiatric disorder, have a negative impact on the brain structures and specific neural alterations.^{46,47} The massive scale of participation, controlled environments, structured skill rating, pervasive social nature and large data repositories could be an optimal set-up for research on the neuroscience of athletes' cognitive abilities. Understanding neurological changes as expertise develops is a central topic in cognitive psychology and cognitive neuroscience. This facilitation could pave the way for understanding the positive/negative effects of gaming on neurocognition.⁴⁷

Psychological wellbeing

Some of the ill-effects would include Psychological and Physiological Anxiety and Stress, Identity Transformation and Mental Well-being development process of esports professionals, Addiction and musculoskeletal pain.⁴⁸⁻⁵² It is established from the collection of studies tabulated in the review article that Active Video Gaming and Internet Gaming Disorder have a negative impact on: Personality and Psychological Well-being, Mental disorders and Sleep, Psychological Distress and Reward Seeking, Leading to Depression, Leading to Anxiety, Sleep.⁵³⁻⁵⁸ Long hours of online gaming were associated with the presence of the following mental health implications such as depression, social phobia, obsession-compulsion, interpersonal sensitivity, hostility, phobic anxiety, paranoid ideation, psychoticism, ADHD, gaming addiction.⁵⁹ Esports, when accompanied by numerous negative mental health implications, becomes a matter of concern, especially amongst the younger generation who are entering the zone of competitive computer gaming without knowing the limits and being unaware of the consequences of their extensive gaming in their routine lives.

COMMON INJURIES IN ESPORTS

Carpal tunnel syndrome

Carpal tunnel syndrome (CTS) stands out as the most frequently identified entrapment syndrome affecting peripheral nerves in the upper extremity.⁶⁰ According to a published article, a robust correlation exists between the occurrence of carpal tunnel syndrome and repetitive hand movements.⁶¹ Thomsen et al determined that biomechanical elements, including forceful actions, repetitive motions, and uncomfortable postures, elevate the likelihood of developing CTS.⁶²

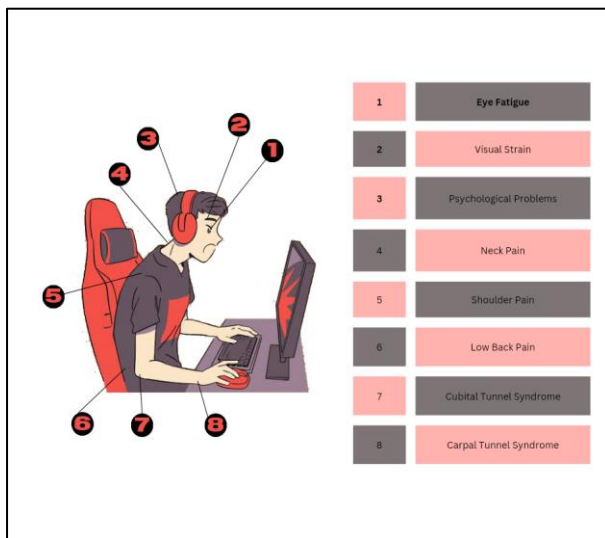


Figure 1: Major injuries associated with eSports.

A study identified that an awkward typing stance poses a risk for the onset of CTS symptoms, particularly with increased degrees of ulnar deviation in wrist posture, deviating from a neutral flexion/extension position.^{63,64} Epidemiological data indicates that occupational factors contribute to the onset of CTS, with increased risk linked to professions involving extended periods of repetitive and forceful movements, uncomfortable or fixed postures, localized mechanical pressure, and exposure to vibration.⁶⁵⁻⁶⁹ Additionally, a bibliometric investigation by Ram et al affirmed a prevalent association between CTS and prolonged engagement with computers and keyboards.⁷⁰ Liu et al conducted a study involving clinical examinations and median nerve conduction tests on symptomatic office workers spending more than 6 hours per day working on computers. The research revealed a significant positive correlation between a larger wrist angle (less than 20 degrees of extension) during keyboard use and an elevated risk of developing CTS.⁷¹ Ali et al presented evidence indicating that computer professionals working over 12 hours daily for eight years face a heightened susceptibility to CTS.⁷² Additionally, Di-Franciso-Donghee et al observed that esports athletes practicing 3-10 hours daily frequently experienced hand and wrist pain, among other complaints.³¹

In an experimental investigation, the average carpal tunnel pressure (CTP) exhibited an increase from 5 mmHg during resting before placing the hand on the mouse to 17-19 mmHg after the hand was positioned on the mouse, escalating further to 29-33 mmHg during the act of dragging the mouse.⁷³ Factors influencing CTP encompass wrist pressure, forearm posture, finger posture, and fingertip force.⁷⁴ CTP elevation is associated with forearm rotation beyond 45 degrees of pronation and wrist deviation from a neutral position, particularly in wrist extension.⁷⁵⁻⁷⁷ An extension of the wrist angle beyond 20 degrees poses a potential risk for the development of CTS.⁷⁸ The observed U-shaped relationship between wrist posture and CTP during typing aligns with findings from other studies measuring CTP at static wrist postures or with simple wrist motions.⁷⁴ Prolonged elevation in intracarpal pressure can lead to intraneural edema, ultimately resulting in median nerve demyelination.⁷⁹ Greening et al proposed that pathological changes in the sub-synovial connective tissue, such as noninflammatory fibrosis and thickening, may also contribute to CTS.⁸⁰ New onset CTS often manifests as pain and paraesthesia in the lateral three digits and lateral half of the ring finger.⁸¹ Advanced cases may involve tingling sensations in these digits.⁸² In a survey of frequent computer users, 29.6% reported hand paraesthesia, and 10.5% met clinical criteria for CTS.⁸³ Over time, symptoms may progress to a weakened grip and difficulty in holding heavy objects.⁸⁴ The reported prevalence of CTS in the general population varies from 0.7% to 9.2% among women and from 0.4% to 2.1% among men.⁸⁵ A study on gamers found symptoms of CTS in over 60% of participants, with more than 50% reporting functional impairment.⁸⁶ A recent systematic review and meta-analysis by Mediouni et al investigated the potential association between CTS and computer-related work.⁸⁷ Reducing the duration, frequency, or intensity of exposure to forceful repetitive work, extreme wrist postures, and the vibration is likely to contribute to a decrease in the incidence or severity of CTS in the working population.⁸⁸

Lateral epicondylitis

Lateral epicondylitis, commonly known as tennis elbow, is referred to as "Mouse Elbow" in the esports community, as it is prevalent among gamers who engage in repetitive wrist extension and forearm pronation while using computers.⁸⁹ This condition primarily involves the exaggerated condition of the common extensor tendon of the elbow, specifically the extension carpi radialis brevis (ECRB).⁹⁰ Prolonged exposure to repetitive movements during computer use is associated with a poor long-term prognosis for individuals with lateral epicondylitis.⁹¹ High-quality evidence that a large amount of repetitive movement exposure raises the chance of acquiring this syndrome was provided by a meta-analysis based on two studies.⁹²⁻⁹³

Table 2: common musculoskeletal injuries and their physiotherapeutic management.

Injury	Management	Therapeutic Techniques	References
Carpal tunnel syndrome	Electrotherapy	Laser	159-160
		Ultrasound	159,161
		Paraffin wax therapy	162
		ESWT	163-164
		Iontophoresis with galantamine	165
	Physical therapy	Neural mobilization	166
		Tendon gliding	167
		Cupping therapy	168
Lateral epicondylitis	Electrotherapy	Pulsed ultrasound	169
		TENS	170
		Pulsed electromagnetic therapy	171-172
		Shock wave therapy	173
		Phonophoresis	174
		ESWT	175
		LLLT	176
	Physical therapy	Deep transverse friction massage+ mill's manipulation	177
		Elbow manipulation	178
		Strengthening exercise	179-180
		Stretching exercise	179,181
		Eccentric-concentric exercise	180-181
		Cyriax physical technique	182
De-Quervain's disease	Electrotherapy	Mulligan manipulation	182
		KT	183
		Tens	184
		Laser	185
		Therapeutic ultrasound with paraffin wax bath	183
		ESWT	185,187
		Radiotherapy	187-188
	Physical therapy	Electron-beam therapy	187,189
		Phonophoresis	190
		Infrared therapy	190
		Mobilization with movement	191
		Eccentric strengthening	192
Neck pain	Electrotherapy	KT	193
		Laser therapy	194-195
		TENS	196-197
	Physical therapy	Spinal stabilization	198
		Cervical stabilization	199
		Maitland mobilization	200
		Strength and endurance training	201
		Thoracic manipulation	202
		Mixed exercise (submaximal training, stretching, and aerobic endurance)	203
		Postural exercises	204
		Kinaesthetic muscle exercises	204
		Low-load exercises for neck and scapular muscles.	204
Shoulder pain	Electrotherapy	TENS	205
		IFT	206
		Ultrasound	206
		Low-frequency current	206
	Physical therapy	Mobilization and manipulation	207
Low back pain	Electrotherapy	Hot water fomentation	

Continued.

Injury	Management	Therapeutic Techniques	References
	Physical therapy	Stretching and strengthening exercises.	208
		Mackenzie approach	209
		Lumbar stabilization	210-212
		Reflex therapy	213-214
		Manual therapy	215-217
		KT	218-220
		Core stabilization exercises	221
		Spinal stabilization programme	222
		Proper posture maintains	223-224

ESWT= Extracorporeal Shock Therapy, TENS= Transcutaneous Electrical Nerve Stimulation, LLLT= Low-Level Laser Therapy, KT= Kinesio taping, IFT= Interferential Therapy, ROM= Range of Motion, SWD= Shortwave Diathermy.

Patients report pain as their main symptom, with clinical symptoms including pain that is localized around the lateral epicondyle and occasionally radiates to the forearm.⁹⁴ Studies have shown that a substantial number of patients with lateral epicondylitis remain to have discomfort and functional loss even two years following treatment, including a decrease in handgrip strength.⁹⁵⁻⁹⁷ Lateral epicondylitis may progress into an ongoing medical condition. While the precise cause of lateral epicondylitis is not fully understood, it is believed to result from a degenerative process involving vascular proliferation and hyalin degeneration of the ECRB and extensor digitorum communis at the lateral epicondyle. This degeneration is attributed to factors such as overuse, repetitive forceful movements, poor circulation, strength deficits, or muscle imbalance.⁹⁷⁻⁹⁹ Histopathologic examination reveals a degenerative, noninflammatory process characterized by disorganized collagen, immature fibroblasts, and neovascularization, termed Angio fibroblastic tendinosis.¹⁰⁰ Esports players, engaging in 10 hours or more of gaming activity per day, are at an increased risk of developing lateral epicondylitis, potentially impacting their physical performance.⁸⁹ In a detailed examination of predominantly computer-using injured workers, 7% were identified with radial tunnel syndrome, and 33% were diagnosed with lateral epicondylitis.¹⁰¹ Lateral epicondylitis is the most commonly diagnosed elbow condition, affecting 1% to 3% of the general population annually, with workplace activities contributing to 35% to 64% of all cases.^{97,102,103}

Neck pain and low back pain

A study found that neck and back pain are experienced by about 35% of collegiate esports athletes when they play. Neck pain (NP) is a prevalent issue among individuals who spend an excessive amount of time in front of computers.¹⁰⁴⁻¹⁰⁶ Sedentary behavior, prolonged use of computers, low-intensity activities, increased tension, strain on the upper back and neck, and improper posture are the primary root causes of this problem.¹⁰⁷⁻¹⁰⁹ There is evidence in the scientific literature to support the claim that neck pain is mainly brought on by static loading and repetitive neck muscle movements, with a beneficial relationship seen between neck flexion and neck pain.¹¹⁰ Research investigating posture during gaming suggests that players' capacity to remain centred and erect during

the first half hour of play decreases, which contributes to forward head posture.¹¹¹⁻¹¹² The cervical extensor muscles endure a further 10 pounds of torque force for every inch as the head moves forward.¹¹¹ According to Jung-Ho and Groszek, the upper cross syndrome may be exacerbated by extended positioning when combined with severe neck bending.^{113,114} The micro-lengthening of posterior cervical structures as a result of persistent submaximal stretching may be explained through biomechanical parameters like creep, which may also trigger persistent muscular spasms and microstructural disintegration. This is particularly apparent in the levator scapulae, sternocleidomastoid, and upper trapezius muscles, which surround the cervical spine.^{112,115-117} Janda's patterns of muscle imbalance indicate that reciprocal inhibition of tight structures promotes weakness in deep neck muscles, including serratus anterior, lower trapezius, and rhomboids, which in turn contributes to postural neck syndrome.¹¹⁸⁻¹²⁰ Asymmetrical tension of the cervical joints caused by prolonged maintenance of high cervical angles might cause displacement from the typical lordotic neutral alignment.^{117,120} Research shows that those with symptoms flex their necks around five degrees more than controls lacking symptoms do, and this difference holds even when the pain gets exacerbated during continuous typing sessions.¹²⁰ According to Holte and Westgaard and Mork and Westgaard, people who suffer chronic pain might develop altered patterns of muscular activation as a coping mechanism.¹²¹⁻¹²² According to Hogg-Johnson et al the incidence of neck pain in the general population ranges from 15.5 to 213 per 1000 person-years, demonstrating the pain's broad impact.¹²³ Furthermore, people who use computers and video display devices have been found to have a higher incidence of musculoskeletal problems.^{124,125}

Low back pain

Leading a sedentary lifestyle is commonly recognized as a significant contributor to the risk for low back pain (LBP), and numerous researchers have pointed out the possible long-term effects of exerting too much strain on these anatomical systems.^{114,126} Prolonged and repetitive over-rotation or flexion of the trunk of the body may contribute to non-specific LBP, especially when people must rotate their trunk around to face a computer monitor that is not in front of them.¹²⁷⁻¹²⁹ An additional

investigation revealed a favourable association between the length of time spent in the vicinity of a screen and the probability of experiencing spinal column pain.¹³⁰ Adopting a slumping posture in the lower back increases pressure on the intervertebral discs, potentially leading to herniations.¹³¹

Backward-leaning seats flatten the lumbar lordosis, enhance the potential hazards of kyphotic posture, and contribute to posterior pelvic tilt.¹³² Reduced activation of the multifidus and erector spinae (longissimus) muscles, as well as weakening in the transverse abdominis and buttock muscles, are the results of an increased posterior pelvic tilt.¹³² The relationship between low transverse abdominis muscle activation and a slumped posture is corroborated by Rasouli's research.¹³³ Research shows that women are more likely than men to experience environmental risk factors, which may contribute to the higher prevalence of LBP. More specifically, rates of 44.8% in the upper back and 56.1% in the lower back have been recorded documented.^{134,135}

Shoulder pain

Shoulder and neck pain are the most widespread type of pain encountered by esports athletes; research suggests that these symptoms occur more frequently than other upper extremity problems among computer users.¹³⁶ Bernard analyzed more than 20 epidemiological research and found that prolonged shoulder postures (over 60 degrees of flexion or abduction) and repetitive motions are linked to shoulder pain.¹³⁷

Prolonged static positions are associated with musculoskeletal conditions in office workers, and prolonged static muscular activity and repetitive tasks tend to exacerbate pain symptoms.¹³⁸⁻¹³⁹ Numerous research investigations have identified potential risk factors for shoulder pain, such as reiterated tasks, workplace design, and physical exposure from static body postures.¹⁴⁰ Studies in clinical settings have confirmed that the most prevalent type of shoulder discomfort among computer users is associated with muscular fatigue, particularly in the trapezius muscle.¹⁴¹ According to a study by Hedge et al, the risk of musculoskeletal disorders is dramatically increased while using computers for more than four hours a day.¹⁴² In a prior investigation, office workers at KhonKaen University reported a three-month prevalence of shoulder pain, with the right shoulder reporting higher frequency (51.1%) compared to the left (41.1%).¹⁴³ Furthermore, the research revealed that female employees experienced more instances of shoulder pain in comparison to their male colleagues.¹⁴³

Other injuries

De Quervain's tenosynovitis, ulnar neuropathy, trigger finger, cubital tunnel syndrome, and medial epicondylitis are also found in the case of esports athletes.¹⁴⁴⁻¹⁴⁷

Vision-related issues

Prolonged exposure to computer screen time has deteriorating effects on the visual and ocular systems in the human body. To understand the irreversible defects in their vision and the functioning of their ocular system, strong awareness has to be raised amongst computer gamers, especially those engaged in esports, which demand more screen time and attention to the eyes.

Computer vision syndrome

Computers, being a part of our daily lives, primarily as a medium for electronic sports to be conducted, could present themselves with various ocular symptoms due to their prolonged usage. These symptoms include eye strain, tired eyes, irritation, redness, blurred vision and double vision and the syndrome is referred to as computer vision syndrome.

Many esports' athletes have computer vision syndrome, characterised by symptoms including blurry vision, low back pain, and tension headaches. This condition is found in 90 per cent of individuals using a computer for more than 3 hours per day.¹⁴⁸ Lack of contrast and definition in pixel-generated computer images increases strain on the eye. Consequently, saccadic movements, accommodation, and convergence increase while the blink rate decreases, which fatigues the oculomotor system.¹⁴⁹

Eye-strain and fatigue

Since eSports also demand practice, there is a heavy load on the eyes of esports athletes, and the most commonly reported complaint is eye fatigue. More than 25% of collegiate esports athletes practise more than 5 hours daily. This sport solely demands hand-eye coordination with a heavy focus on the screen for extended periods, which is not optimal and healthy for the eyes. When routinely done by eSports athletes, this practice would result in Computer vision syndrome, discussed in the previous section.

MANAGEMENT AND PREVENTION STRATEGY

Physiotherapeutic interventions

Esports competitors need to warm up adequately to avoid musculoskeletal injuries, much like conventional athletes do.¹⁵⁰ Despite warming up is frequently linked to enhanced performance as well as potential benefits for minimizing injuries, its application in upper extremity processes has not yet been established beyond a reasonable doubt.^{150,151} Stretching should be done for three to five minutes as part of warm-up activities, and then again for five minutes every two hours.¹⁵² The warm-up may also involve aerobic activities like walking or running.^{150,153}

Professional esports players run the danger of suffering injuries that could end their careers,³¹ which are mostly caused by extended bad postures and repetitive motions of the upper extremities that can cause musculoskeletal problems.¹⁵⁴⁻¹⁵⁵ To reduce these risks, physiotherapists advocate the initiation of core stabilization exercises, as the core muscles play a crucial role in maintaining proper body positioning.¹⁵⁶ Furthermore, it is recommended that esports athletes take regular breaks, such as a 5-10-minute break every hour or 20-minute break every 3 hours, to alleviate the axial load on the lumbar spine.^{157,158}

Ergonomics Intervention

When designing computers, ergonomic concepts must be considered because ill-conceived systems can greatly exacerbate musculoskeletal issues.²²⁵ Maintaining a repetitive and incorrect posture may result in musculoskeletal problems, whereas changing posture can lead to better clinical outcomes, according to Cramer et al.²²⁶ Poor shoulder position has been related in studies to musculoskeletal problems in the upper limbs and neck.²²⁷⁻²²⁸ Awkward postures have been connected to low back pain, according to Lis et al.²²⁹ Nevertheless, a recent, encouraging study discovered no connection between non-neutral shoulder postures and disorders or symptoms related to the hands, arms, or neck.²³⁰

It is suggested that esports athletes utilize controllers and keyboards with the appropriate sensitivity to avoid putting excessive pressure on their fingertips repeatedly.²³¹ Increased keystrokes and mouse use can result from time constraints and the introduction of new software, which increases physical burden.²³²⁻²³³ Maintaining a neutral spine position where the head, chest, and hips are in alignment—as additionally assuring that the knees are horizontally positioned about the floor and that the upper extremities are in line with the torso are the most important factors to consider.²³¹ Six suggested actions include choosing the ideal keyboard and mouse configurations, sitting in a suitable display position, adjusting lifestyle and customary behaviours, and choosing the appropriate desk height to improve the gaming position and alleviate stress on athletes.²³² Furthermore, certain ergonomic measures are necessary to reduce visual problems. These include positioning the monitor's centre 5 to 6 inches below a straight vision line at a distance of 20 to 28 inches, modifying lighting to reduce glare, correcting refractive errors, accommodating astigmatism, engaging in eye exercises, and, most significantly, adhering to the "20-20-20" rule, which requires looking 20 feet away for 20 seconds every 20 minutes.²³⁴

Psychological intervention

A study conducted on stress and coping in electronic sports athletes informs us that there is some overlap between mental toughness (MT) and stress-coping processes in high-performing traditional sports and

competitive esports athletes.²³⁵ This research result implies that psychological interventions (for instance, imagery intervention) successfully practiced by traditional athletes could also be translated to esports athletes to reduce stress and anxiety while playing in tournaments. Imagery Interventions are a type of sports psychology intervention.

Imagery is also called Visualisation or mental rehearsal. It means using your senses (e.g., seeing, feeling, hearing, taste, smell) to rehearse your sport in your mind.²³⁶ Imagery and Visualisation involve a mental rehearsal through imagery aids in familiarising players with potential scenarios, sharpening reactions, and boosting confidence. As imagery interventions have been proven to be beneficial for traditional athletes, it could be an efficient intervention strategy to manage anxiety in competitive situations such as esports tournaments as recent research successfully implies imagery intervention on League of Legends video game players to reduce stress and optimize their performance.²³⁷

The most common techniques besides 'Imagery Interventions' are 'Goal Setting' and 'Self-Talk and Positive Reinforcement'. Goal setting establishes clear, achievable goals and helps in guiding focus and motivation. It aids in breaking down larger objectives into manageable steps, enhancing performance. Self-talk and Positive Reinforcement cultivate a positive inner dialogue that can significantly impact performance. Encouraging self-talk and affirmations bolster confidence and resilience.²³⁸

CONCLUSION

Likewise, with conventional sports, engaging in esports exposes participants to an array of risks that are associated with their musculoskeletal system, eyesight, and psychological well-being. Musculoskeletal issues such as overuse tendinopathies and dysfunction in the cervical and lumbar spine, are more common in esports athletes owing to sedentary lifestyles, inadequate ergonomic support, and repetitive upper extremity motions during gameplay. Additionally, extended gaming sessions and light-emitting diode monitors have increased vision-related issues such as computer vision syndrome, eye strain, and fatigue. Finally, the quantity of time spent playing online games can affect the development of mental health conditions such as depression, anxiety, apathy, and sleeplessness. This study provides the framework for addressing the awareness and mitigation of health hazards faced by esports athletes. Also, it provides a strategy that is intended for coaches, trainers, and sports medicine specialists to improve their health and well-being and ultimately assist overall performance optimization. In summary, the necessity for interdisciplinary research to enhance awareness and establish uniform protocols for addressing health hazards in eSports is undeniable.

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REFERENCES

- Migliore L. What Is Esports? The Past, Present, and Future of Competitive Gaming. *Esports Med*. 2021.
- de la Maza AJ. Possible Worlds in Video Games: From Classic Narrative to Meaningful Actions. Lulu. 2017.
- De-Santis A, Morante LF. ESports in the Entertainment Industry: Overview. *Esports Med*. 2022.
- Scholz TM. A Short History of eSports and Management. *eSports Bus*. 2019.
- Insider Intelligence. Available at: <https://www.insiderintelligence.com/insights/esports-ecosystem-market-report/>. Accessed on 20 November 2023.
- Esportsfederation.in. Available at: <https://esportsfederation.in/>. Accessed on 20 November 2023.
- Howarth J. How Many Gamers Are There? Available at: <https://explodingtopics.com/blog/number-of-gamers>. Accessed on 20 November 2023.
- Jonasson K, Thiborg J. Electronic sport and its impact on future sport. *Sport in Society*. 2010;13(2): 287-99.
- Parry J. ESports are Not Sports. *Sport Ethics Philos*. 2018;13(1):3-18.
- Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, et al. Sedentary behavior research network (SBRN)-terminology consensus project process and outcome. *IJBMPA*. 2017;14:1-7.
- Dunstan DW, Salmon J, Owen N. Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. *Diabetologia*. 2005; 48:2254-61.
- Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003;289(14):1785-91.
- Gierach GL, Chang SC, Brinton LA, Lacey JV, Hollenbeck AR, Schatzkin A, et al. Physical activity, sedentary behavior, and endometrial cancer risk in the NIH-AARP Diet and Health Study. *Int J Cancer*. 2009;124(9):2139-47.
- Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci*. 2009; 41(5):998-1005.
- Ford ES, Kohl III HW, Mokdad AH, Ajani UA. Sedentary behavior, physical activity, and the metabolic syndrome among US adults. *Obesity Res*. 2005;13(3):608-14.
- Wijndaele K, Duvigneaud N, Matton L. Sedentary behaviour, physical activity and a continuous metabolic syndrome risk score in adults. *Eur J Clin Nutr*. 2009;63(3):421-9.
- Lanningham-Foster L, Foster RC, McCrady SK, Jensen TB, Mitre N, Levine JA. Activity-promoting video games and increased energy expenditure. *J Pediatr*. 2009;154(6):819-23.
- Vandewater EA, Shim MS, Caplovitz AG. Linking obesity and activity level with children's television and video game use. *J Adolesc*. 2004;27(1):71-85.
- Pate RR, O'Neill JR, Lobelo F. The evolving definition of "sedentary". *Exer Sport Sci Rev*. 2008; 36(4):173-8.
- Laaksonen DE, Lakka HM, Salonen JT. Low levels of leisure-time physical activity and cardiorespiratory fitness predict development of the metabolic syndrome. *Diabetes Care*. 2002;25(9): 1612-8.
- Gustat J, Srinivasan SR, Elkasabany A, Berenson GS. Relation of self-rated measures of physical activity to multiple risk factors of insulin resistance syndrome in young adults: the Bogalusa Heart Study. *J Clin Epidemiol*. 2002;55(10):997-1006.
- Irwin ML, Ainsworth BE, Mayer-Davis EJ, Addy CL, Pate RR, Durstine JL. Physical activity and the metabolic syndrome in a tri-ethnic sample of women. *Obesity Res*. 2002;10(10):1030-7.
- Kullo IJ, Hensrud DD, Allison TG. Relation of low cardiorespiratory fitness to the metabolic syndrome in middle-aged men. *Am J Cardiol*. 2002;90(7):795-7.
- Lakka TA, Laaksonen DE, Lakka HM, Männikkö NI, Niskanen LK, Rauramaa RA. Sedentary lifestyle, poor cardiorespiratory fitness, and the metabolic syndrome. *Med Sci Sport Exer*. 2003; 35(8):1279-86.
- Rennie KL, McCarthy N, Yazdgerdi S, Marmot M, Brunner E. Association of the metabolic syndrome with both vigorous and moderate physical activity. *Int J Epidemiol*. 2003;32(4):600-6.
- Kari T, Karhulahti VM. Do e-athletes move?: a study on training and physical exercise in elite eSports. *IJGCMS*. 2016;8(4):5366.
- Global recommendations on physical activity for health. Available at: <https://www.who.int/>. Accessed on 20 November 2023.
- Wattanapisit A. A Review of the Current International Physical Activity Guidelines for Various Age Groups to Prevent and Control Noncommunicable Diseases. *Songklanagarind Med J*. 2016;34(1):39-49.
- Ekelund U, Tarp J, Steene-Johannessen J, Hansen BH, Jefferis B. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: systematic review and harmonised meta-analysis. *BMJ*. 2019; 21:366.
- Louw S, Makwela S, Manas L, Meyer L, Terblanche D, Brink Y. Effectiveness of exercise in office workers with neck pain: A systematic review and meta-analysis. *South Afr J Physiother*. 2017;73(1): 23-9.

31. DiFrancisco-Donoghue J, Balentine J, Schmidt G, Zwibel H. Managing the health of the eSport athlete: an integrated health management model. *BMJ Sport Exerc Med*. 2019;5:e000467.
32. Eley KA. A Wii fracture. *New Emg J Med*. 2010; 362(5):473-4.
33. Koh TG. Ulcerative “nintendinitis”: a new kind of repetitive strain injury. *Med J Australia*. 2000; 173(12):671.
34. Ma T, Song L, Ning S, Wang H, Zhang G, Wu Z. Relationship between the incidence of de Quervain’s disease among teenagers and mobile gaming. *Int Orthopaed*. 2019;43:2587-92.
35. Lewis J, Trinh P, Kirsh D. A corpus analysis of strategy video game play in starcraft: Brood war. *Int Orthopaed*. 2011.
36. Szeto GP, Straker LM, O’Sullivan PB. The effects of speed and force of keyboard operation on neck–shoulder muscle activities in symptomatic and asymptomatic office workers. *Int J Indus Ergon*. 2005;35(5):429-44.
37. Miller DL. Nintendo neck. *CMAJ*. 1991;145(10): 1202.
38. Zwibel H, DiFrancisco-Donoghue J, DeFeo A, Yao S. An osteopathic physician's approach to the Esports athlete. *J Osteopath Med*. 2019;119(11): 756-62.
39. Sekiguchi T, Hagiwara Y, Yabe Y. Playing video games for more than 3 hours a day is associated with shoulder and elbow pain in elite young male baseball players. *J Shoulder Elbow Surg*. 2018;27(9): 1629-35.
40. Lindberg L, Nielsen SB, Damgaard M, Sloth OR, Rathleff MS, Straszek CL. Musculoskeletal pain is common in competitive gaming: a cross-sectional study among Danish esports athletes. *BMJ*. 2020; 6(1):799.
41. McGee C, Hwu M, Nicholson LL, Ho KK. More than a game: musculoskeletal injuries and a key role for the physical therapist in Esports. *J Ortho Sports Physical Ther*. 2021;51(9):415-7.
42. Schary DP, Jenny SE, Koshy A. Levelling up esports health: Current status and call to action. *International J Esports*. 2022;3(3):8.
43. Kelly S, Leung J. The New Frontier of Esports and gaming: A scoping meta-review of Health Impacts and Research Agenda. *Front Sports Active Liv*. 2021;3:640.
44. Burleigh TL, Griffiths MD, Sumich A, Stavropoulos V, Kuss DJ. A systematic review of the co-occurrence of Gaming Disorder and other potentially addictive behaviours. *Curr Addict Rep*. 2019;6:383-401.
45. Mortality and Morbidity Statistic. Available at: <https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/1448597234>. Accessed on 20 November 2023.
46. Medical Practice and Review Impact of Computer Technology on health: Computer Vision Syndrome. Available at: <https://academicjournals.org/journal/MPR/article-full-text-pdf/0905F9948599>. Accessed on 20 November 2023.
47. Kelly S, Leung J. The New Frontier of Esports and Gaming: A Scoping Meta-Review of Health Impacts and Research Agenda. *Fronti Sports Active Liv*. 2021.
48. Urukovičová N. Psychological and Physiological Anxiety and Stress in Competitive ESports Settings. *Megatrendy*. 2021;8(1):607-17.
49. Zhao Y, Zhu Y. Identity transformation, stigma power, and mental wellbeing of Chinese eSports professional players. *Int J Cultural Stud*. 2020; 24(3):485-503.
50. Chung T, Sum S, Chan M, Lai E, Cheng N. Will esports result in a higher prevalence of problematic gaming? A review of the global situation. *J Behav Addict*. 2019;8(3):384-94.
51. Lindberg L, Nielsen SB, Damgaard M, Sloth OR, Rathleff MS, Straszek CL. Musculoskeletal pain is common in competitive gaming: a cross-sectional study among Danish esports athletes. *BMJ*. 2020; 6(1):799.
52. Toth AJ, Ramsbottom N, Kowal M, Campbell MJ. Converging Evidence Supporting the Cognitive Link between Exercise and Esport Performance: A Dual Systematic Review. *Brain Sci*. 2020;10(11): 859.
53. Kocadağ M. Investigating Psychological Well-Being Levels of Teenagers Interested in Esport Career. *Res Edu Psychol*. 2019;3(1):1-10.
54. Bonnar D, Lee S, Roane BM, Blum DJ. Evaluation of a brief sleep intervention designed to improve the sleep, mood, and cognitive performance of esports athletes. *Int J Environ Res Public Health*. 2022; 19(7):4146.
55. Palanichamy T, Sharma MK, Sahu M, Kanchana DM. Influence of Esports on stress: A systematic review. *Indus Psychiatr J*. 2020;29(2):191-9.
56. Monteiro Pereira A, Costa JA, Verhagen E, Figueiredo P, Brito J. Associations between esports participation and health: a scoping review. *Sports Med*. 2022;52(9):2039-60.
57. Mendoza G, Clemente-Suárez VJ, Alvero-Cruz JR. The role of experience, perceived match importance, and anxiety on cortisol response in an official esports competition. *Int J Environ Res Public Health*. 2021;18(6):2893.
58. Bonnar D, Lee S, Gradisar M, Suh S. Risk factors and sleep intervention considerations in esports: A review and practical guide. *Sleep Med Res*. 2019; 10(2):59-66.
59. Nasution FA, Effendy E, Amin MM. Internet Gaming Disorder (IGD): A Case Report of Social Anxiety. *Macedonian J Med Sci*. 2019;7(16):2664-6.
60. Burton CL, Chen Y, Chesterton LS, van der Windt DA. Trends in the prevalence, incidence and surgical management of carpal tunnel syndrome between 1993 and 2013: an observational analysis

- of UK primary care records. *BMJ*. 2018;8(6): e020166.
61. Woo EH, White P, Lai CW. Morphological changes of the median nerve within the carpal tunnel during various finger and wrist positions: an analysis of intensive and nonintensive electronic device users. *J Hand Surg*. 2019;44(7):610.
62. Thomsen JF, Gerr F, Atroshi I. Carpal tunnel syndrome and the use of computer mouse and keyboard: a systematic review. *BMC*. 2008;9(1):1-9.
63. Hunting W. Postural and visual loads at VDT workplaces. *Ergonomics* 1981;24:917-31.
64. Simoneau GG, Marklin RW. Effect of computer keyboard slope and height on wrist extension angle. *Human Factors*. 2001;43(2):287-98.
65. Palmer KT, Harris EC, Coggon D. Carpal tunnel syndrome and its relation to occupation: a systematic literature review. *Occup Med*. 2007; 57(1):57-66.
66. Punnett L. Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. *J. Electromyogr*. 2004;14:13-23.
67. Roquelaure Y, Mechali S, Dano C, Fanello S, Benetti F, Bureau D, et al. Occupational and personal risk factors for carpal tunnel syndrome in industrial workers. *Scand J Work Environ Health*. 1997;2:364-9.
68. Silverstein BA, Fine LJ, Armstrong TJ. Occupational factors and carpal tunnel syndrome. *Am J Ind Med*. 1987;11(3):343-58.
69. Van Rijn RM, Huisstede BM, Koes BW, Burdorf A. Associations between work-related factors and the carpal tunnel syndrome a systematic review. *Scand J Work Environ Health*. 2009;19-36.
70. Ram S. Carpal tunnel syndrome: A bibliometric study of 35 years of research. *Neurology India*. 2019;67(7):55.
71. Liu CW, Chen CH, Lee CL, Huang MH, Chen TW, Wang MC. Relationship between carpal tunnel syndrome and wrist angle in computer workers. *Kaohsiung J Med Sci*. 2003;19(12):617-22.
72. Ali KM, Sathiyasekaran BW. Computer professionals and carpal tunnel syndrome (CTS). *Int J Occup Safety Ergonom*. 2006;12(3):319-25.
73. Keir PJ, Bach JM, Rempel D. Effects of computer mouse design and task on carpal tunnel pressure. *Ergonomics*. 1999;42(10):1350-60.
74. Rempel DM, Keir PJ, Bach JM. Effect of wrist posture on carpal tunnel pressure while typing. *J orthoped Res*. 2008;26(9):1269-73.
75. Keir PJ, Bach JM, Hudes M, Rempel DM. Guidelines for wrist posture based on carpal tunnel pressure thresholds. *Human Factors*. 2007;49(1):88-99.
76. Rempel D, Bach JM, Gordon L, So Y. Effects of forearm pronation/supination on carpal tunnel pressure. *J Hand Surg*. 1998;23(1):38-42.
77. Keir PJ, Bach JM, Rempel DM. Effects of finger posture on carpal tunnel pressure during wrist motion. *J Hand Surg*. 1998;23(6):1004-9.
78. Liu CW, Chen CH, Lee CL, Huang MH, Chen TW, Wang MC. Relationship between carpal tunnel syndrome and wrist angle in computer workers. *Kaohsiung J Med Sci*. 2003;19(12):617-22.
79. Lundborg G, Gelberman RH, Minter-Convery M, Lee YF, Hargens AR. Median nerve compression in the carpal tunnel functional response to experimentally induced controlled pressure. *J Hand Surg*. 1982;7(3):252-9.
80. Greening J, Lynn B, Leary R, Warren L, O'higgins P, Hall-Craggs M. The use of ultrasound imaging to demonstrate reduced movement of the median nerve during wrist flexion in patients with non-specific arm pain. *J Hand Surg*. 2001;26(5):401-6.
81. Newington L, Harris EC, Walker-Bone K. Carpal tunnel syndrome and work. *Clin Rheumatol*. 2015; 29(3):440-53.
82. Shiri R, Falah-Hassani K. Computer use and carpal tunnel syndrome: a meta-analysis. *J Neurol Sci*. 2015;349(1-2):15-9.
83. Clarke Stevens J, Witt JC, Smith BE, Weaver AL. The frequency of carpal tunnel syndrome in computer users at a medical facility. *Neurology*. 2001;56(11):1568-70.
84. Basuodan RM, Aljebreen AW, Sobih HA, Majrashi KA, Almutairi NH, Alhaqbani SS, et al. the impact of electronic gaming on upper limb neuropathies among esports athlete. *Medycyna Prac*. 2023;74(4): 279-87.
85. Andersen JH, Thomsen JF, Overgaard E, Lassen CF, Brandt LP, Vilstrup I, et al. Computer use and carpal tunnel syndrome: a 1-year follow-up study. *JAMA*. 2003;289(22):2963-9.
86. Zain NH, Jaafar A, Abdul razak FH. Severity scoring of symptoms associated with carpal tunnel syndrome based on recall of computer game playing experiences. *J Theor Applied Inform Technol*. 2014;63(1):23.
87. Mediouni Z, de Roquemaurel A, Dumontier C, Becour B, Garrabe H, Roquelaure Y, Descatha A. Is Carpal Tunnel Syndrome Related to Computer Exposure at Work?. *J Occup Environ Med*. 2014; 56(2):204-8.
88. Viikari-Juntura E, Silverstein B. Role of physical load factors in carpal tunnel syndrome. *Scandinavian J Occup Environ Med*. 1999;10:163-85.
89. Sant K, Stafrace KM. Upper Limb Injuries secondary to Overuse in the Esports community. Is this a rising epidemic? *Int J Esports*. 2021;2(2):29-32.
90. Kryger AI, Lassen CF, Andersen JH. The role of physical examinations in studies of musculoskeletal disorders of the elbow. *Occup Environ Med*. 2007; 64(11):776-81.
91. Waugh EJ, Jaglal SB, Davis AM. Computer use associated with poor long-term prognosis of conservatively managed lateral epicondylalgia. *J Orthopaed Sports Physical Ther*. 2004;34(12):770-

92. Descatha A, Dale AM, Jaegers L, Herquelot E, Evanoff B. Self-reported physical exposure association with medial and lateral epicondylitis incidence in a large longitudinal study. *Occup Environ Med*. 2013;70(9):670-3.
93. Fan ZJ, Silverstein BA, Bao S, Bonauto DK, Howard NL, Smith CK. The association between combination of hand force and forearm posture and incidence of lateral epicondylitis in a working population. *Human Factors*. 2014;56(1):151-65.
94. Assendelft W, Green S, Buchbinder R, Struijs P, Smidt N. Tennis elbow. *BMJ*. 2003;327(7410):329.
95. Nilsson P, Baigi A, Swärd L, Möller M, Månsson J. Lateral epicondylalgia: a structured programme better than corticosteroids and NSAID. *Scand J Occup Ther*. 2012;19(5):404-10.
96. Dilek B, Batmaz I, Sanyıldız MA, Sahin E, Ilter L, Gulbahar S, Cevik R, Nas K. Kinesio taping in patients with lateral epicondylitis. *J Back Musculoskelet Rehab*. 2016;29(4):853-8.
97. Nirschl RP. Elbow tendinosis/tennis elbow. *Clin Sports Med*. 1992;11(4):851-70.
98. Bongers PM, Kremer AM, Laak JT. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist? A review of the epidemiological literature. *Am J Indust Med*. 2002;41(5):315-42.
99. Kamien M. A rational management of tennis elbow. *Sports Med*. 1990;9:173-91.
100. Ajimsha MS, Chithra S, Thulasyammal RP. Effectiveness of myofascial release in the management of lateral epicondylitis in computer professionals. *Arch Physical Med Rehab*. 2012; 93(4):604-9.
101. Hough PA, Nel M. Postural risks and musculoskeletal discomfort of three preferred positions during laptop use amongst students. *South Afr Occup Ther*. 2017;47(1):3-8.
102. Dimberg L. The prevalence and causation of tennis elbow (lateral humeral epicondylitis) in a population of workers in an engineering industry. *Ergonomics*. 1987;30(3):573-9.
103. Verhaar JA. Tennis elbow: anatomical, epidemiological and therapeutic aspects. *Int Orthopaed*. 1994;21:263-7.
104. DiFrancisco-Donoghue J, Balentine JR. Collegiate eSport: Where do we fit in?. *Curr Sports Med Rep*. 2018;17(4):117-8.
105. Cagnie B, Danneels L, Van Tiggelen D, De Loose V, Cambier D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. *Eur Spine J*. 2007;16:679-86.
106. Stupar M, Shearer H, Cote P, Van der Velde G, Cassidy JD, Carroll LJ. Prevalence and factors associated with neck pain in office workers. *Curr Sports Med Rep*. 2008.
107. Binder AI. Cervical spondylosis and neck pain. *BMJ*. 2007;334(7592):527-31.
108. Andersson GB. Epidemiological features of chronic low-back pain. *Lancet*. 1999;354(9178):581-5.
109. Auvinen J, Tammelin T, Taimela S, Zitting P, Karppinen J. Neck and shoulder pains in relation to physical activity and sedentary activities in adolescence. *Spine*. 2007;32(9):1038-44.
110. Khan AS, Faizan M. Neck pain in computer users. *Panacea J Med Sci*. 2016;6(2):88-91.
111. Gugliotti M. Contribution of aberrant postures to neck pain and headaches in esports athletes. *Spine*. 2018;19(12):1307-9.
112. Franks RR, King D, Bodine W, Chisari E, Heller A, Jamal IVF, et al. AOASM position statement on esports, active video gaming, and the role of the sports medicine physician. *Clin J Sport Med*. 2022; 32(3):e221.
113. Kang JH, Park RY, Lee SJ, Kim JY, Yoon SR, Jung KI. The effect of the forward head posture on postural balance in long time computer based worker. *Ann Rehab Med*. 2012;36(1):98-104.
114. Groszek M, Babula G, Nagraba Ł, Stolarczyk A, Mitek T. Zagrożenia powstające w wyniku niewłaściwej postawy siedzącej. *Artroskopia Chirurgia Stawów*. 2011;7(3-4):50-61.
115. Levangie PK, Norkin CC. Joint structure and function: a comprehensive analysis. *Curr Sports Med Rep*. 2011.
116. Shin G, Mirka GA. An in vivo assessment of the low back response to prolonged flexion: Interplay between active and passive tissues. *Clin Biomech*. 2007;22(9):965-71.
117. Kumar S. Theories of musculoskeletal injury causation. *Ergonomics*. 2001;44(1):17-47.
118. Page P, Frank CC, Lardner R. Assessment and treatment of muscle imbalance. *Ergonomics*. 2010.
119. Norkin CC. The influence of different sitting postures on head/neck posture and muscle activity. *Man Ther*. 2010;15:5-60.
120. Shikdar AA, Al-Kindi MA. Office ergonomics: deficiencies in computer workstation design. *Int J Occup Safety Ergonomics*. 2007;13(2):215-23.
121. Holte KA, Westgaard RH. Daytime trapezius muscle activity and shoulder-neck pain of service workers with work stress and low biomechanical exposure. *Am J Indust Med*. 2002;41(5):393-405.
122. Mork PJ, Westgaard RH. The association between nocturnal trapezius muscle activity and shoulder and neck pain. *Eur J Applied Physiol*. 2004;92:18-25.
123. Hogg-Johnson S, van der Velde G, Carroll LJ, Holm LW, Cassidy JD, Guzman J, et al. The burden and determinants of neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Eur Spine J*. 2008;17:39-51.
124. Aarås A, Horgen G, Bjørset HH, Ro O, Thoresen M. Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. *Applied Ergonomics*. 1998;29(5):335-54.
125. Fredriksson K, Alfredsson L, Ahlberg G, Josephson M, Kilbom Å, Hjelm EW, et al. Work environment and neck and shoulder pain: the influence of

- exposure time. Results from a population based case-control study. *Occup Environ Med*. 2002; 59(3):182-8.
126. Leavitt SB. Sitting smarter. *Health Facilities Manag*. 1995;8(6):22-8.
 127. Ambusam S, Baharudin O, Roslizawati N, Leonard J. Position of document holder and work related risk factors for neck pain among computer users: a narrative review. *La Clinica terapeutica*. 2015; 166(6):256-61.
 128. Hoogendoorn WE, Bongers PM, De Vet HC, Douwes M, Koes BW, Miedema MC, et al. Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. *Spine*. 2000;25(23):3087-92.
 129. Ye S, Jing Q, Wei C, Lu J. Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study. *BMJ*. 2017;7(4):e014914.
 130. Torsheim T, Eriksson L, Schnohr CW, Hansen F, Bjarnason T, Välimaa R. Screen-based activities and physical complaints among adolescents from the Nordic countries. *BMC Public Health*. 2010;10(1): 1-8.
 131. Szczygieł E, Zielonka K, Mętel S, Golec J. Musculo-skeletal and pulmonary effects of sitting position-a systematic review. *Ann Agricult Environ Med*. 2017;24(1):23-9.
 132. Mörl F, Bradl I. Lumbar posture and muscular activity while sitting during office work. *J Electromyograph Kinesiol*. 2013;23(2):362-8.
 133. Rasouli O, Arab AM, Amiri M, Jaberzadeh S. Ultrasound measurement of deep abdominal muscle activity in sitting positions with different stability levels in subjects with and without chronic low back pain. *Manual Ther*. 2011;16(4):388-93.
 134. Ye S, Jing Q, Wei C, Lu J. Risk factors of non-specific neck pain and low back pain in computer-using office workers in China: a cross-sectional study. *BMJ*. 2017;7(4):e014914.
 135. Kaliniene G, Ustinaviciene R, Skemiene L, Vaiciulis V, Vasilavicius P. Associations between musculoskeletal pain and work-related factors among public service sector computer workers in Kaunas County, Lithuania. *BMC*. 2016;17:1-2.
 136. Eltayeb S, Staal JB, Kennes J, Lamberts PH, de Bie RA. Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire. *BMC*. 2007;8:1-1.
 137. Bpin B. Musculoskeletal disorders and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. *Manual Ther*. 1997;13:12-6.
 138. Van Der Windt DA, Thomas E, Pope DP, De Winter AF, Macfarlane GJ, et al. Occupational risk factors for shoulder pain: a systematic review. *Occup Environ Med*. 2000;57(7):433-42.
 139. Brandt M, Sundstrup E, Jakobsen MD, Jay K, Colado JC, Wang Y, et al. Association between neck/shoulder pain and trapezius muscle tenderness in office workers. *Pain Res Treat*. 2014;2014.
 140. Ranasinghe P, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, Rajapakse S, et al. Work related complaints of neck, shoulder and arm among computer office workers: a cross-sectional evaluation of prevalence and risk factors in a developing country. *Environment Health*. 2011; 10(1):1-9.
 141. Juul-Kristensen B, Kadefors R, Hansen K, Byström P, Sandsjö L, Sjøgaard G. Clinical signs and physical function in neck and upper extremities among elderly female computer users: the new study. *Eur J App Physiol*. 2006;96:136-45.
 142. Hedge A, Ruder M. Dynamic sitting how much do we move when working at a computer?. *Environment Health*. 2003.
 143. Krusun M, Chaiklieng S. Prevalence of neck, shoulder and back discomfort among university office workers who used desktop computers more than 4 hours per day. *KKUJ*. 2014.
 144. Gigante MR, Martinotti I, Cirila PE. Computer work and De Quervain's tenosynovitis: an evidence-based approach. *Giornale Ital Medicina Lavoro Ergon*. 2012;34(3):116-8.
 145. Andersen JH, Frost P, Fuglsang-Frederiksen A, Johnson B, Wulff Svendsen S. Computer use and ulnar neuropathy: results from a case-referent study. *Work*. 2012;41(1):2434.
 146. De la Parra-Márquez ML, Tamez-Cavazos R, Zertuche-Cedillo L, Martínez-Pérez JJ, Velasco-Rodríguez V, Cisneros-Pérez V. Factores de riesgo asociados a tenosinovitis estenosante. Estudio de casos y controles. *Cirugía Cirujanos*. 2008;76(4): 323-7.
 147. Pascarelli EF, Hsu YP. Understanding work-related upper extremity disorders: clinical findings in 485 computer users, musicians, and others. *J Occup Rehab*. 2001;11:1-21.
 148. Blehm C, Vishnu S, Khatkhat A, Mitra S, Yee RW. Computer Vision Syndrome: A Review. *Surv Ophthalmol*. 2005;50(3):253-62.
 149. Poulos D, Coulter TJ, Trotter MG, Polman R. Stress and coping in esports and the influence of mental toughness. *Front Psychol*. 2020;11(628).
 150. Myburgh GK, Pfeifer CE, Hecht CJ. Warm-ups for youth athletes: making the first 15-minutes count. *Strength Conditioning J*. 2020;42(6):45-53.
 151. McCrary JM. A systematic review of the effects of upper body. *Surv Ophthalmol*. 2007;51(2):153-62.
 152. Emara AK, Ng MK, Cruickshank JA, Kampert MW, Piuzzi NS, Schaffer JL, et al. Gamer's health guide: optimizing performance, recognizing hazards, and promoting wellness in esports. *Curr Sports Med Rep*. 2020;19(12):537-45.
 153. Fradkin AJ, Zazryn TR, Smoliga JM. Effects of warming-up on physical performance: a systematic

- review with meta-analysis. *J Strength Condition Res*. 2010;24(1):140-8.
154. Franks RR, King D, Bodine W, Chisari E, Heller A, Jamal IV et al. AOASM position statement on esports, active video gaming, and the role of the sports medicine physician. *Clin J Sport Med*. 2022; 32(3):e221.
155. Geoghegan L, Wormald JC. Sport-related hand injury: a new perspective of eSports. *J Hand Surg*. 2018;20:44(2).
156. Chang WD, Lin HY, Lai PT. Core strength training for patients with chronic low back pain. *J Physical Ther Sci*. 2015;27(3):619-22.
157. Emara AK, Ng MK, Cruickshank JA, Kampert MW, Piuze NS, Schaffer JL, King D. Gamer's health guide: optimizing performance, recognizing hazards, and promoting wellness in esports. *Curr Sports Med Rep*. 2020;19(12):537-45.
158. Rempel DM, Krause N, Goldberg R, Benner D, Hudes M, Goldner GU. A randomised controlled trial evaluating the effects of two workstation interventions on upper body pain and incident musculoskeletal disorders among computer operators. *Occup Environ Med*. 2006;63(5):300.
159. Bakhtiary AH, Rashidy-Pour A. Ultrasound and laser therapy in the treatment of carpal tunnel syndrome. *Aust J Physiother*. 2004;50(3):147-51.
160. Yagci I, Elmas O, Akcan E, Ustun I, Gunduz OH, Guven Z. Comparison of splinting and splinting plus low-level laser therapy in idiopathic carpal tunnel syndrome. *Clin Rheumatol*. 2009;28:1059-65.
161. Oztas O, Turan B, Bora I, Karakaya MK. Ultrasound therapy effect in carpal tunnel syndrome. *Arch Physical Med Rehab*. 1998;79(12):1540-4.
162. Chang YW, Hsieh SF, Horng YS, Chen HL, Lee KC, Horng YS. Comparative effectiveness of ultrasound and paraffin therapy in patients with carpal tunnel syndrome: a randomized trial. *BMC*. 2014;15:1-7.
163. Vahdatpour B, Kiyani A, Dehghan F. Effect of extracorporeal shock wave therapy on the treatment of patients with carpal tunnel syndrome. *Adv Biomed Res*. 2016;5:21-8.
164. Seok H, Kim SH. The effectiveness of extracorporeal shock wave therapy vs. local steroid injection for management of carpal tunnel syndrome: a randomized controlled trial. *Arch Physical Med Rehab*. 2013;92(4):327-34.
165. Vladeva E. The role of physical factors in the conservative treatment of carpal canal syndrome. *Arch Physical Med Rehab*. 2012;91(2):129-34.
166. Akalin E, El Ö, Peker Ö, Senocak Ö, Tamci S, Gülbahar S, Çakmur R, Öncel S. Treatment of carpal tunnel syndrome with nerve and tendon gliding exercises. *Am J Physical Med Rehab*. 2002; 81(2):108-13.
167. Rozmaryn LM, Dovel S, Rothman ER, Gorman K, Olvey KM, Bartko JJ. Nerve and tendon gliding exercises and the conservative management of carpal tunnel syndrome. *J Hand Ther*. 1998;11(3): 171-9.
168. Al-Bedah AM, Elsubai IS, Qureshi NA, Aboushanab TS, Ali GI, El-Olemy AT, et al. The medical perspective of cupping therapy: Effects and mechanisms of action. *J Tradition Complement Med*. 2019;9(2):90-7.
169. Smidt N, Van Der Windt DA, Assendelft WJ, Devillé WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. *Lancet*. 2002; 359(9307):657-62.
170. Halle JS, Franklin RJ, Karalfa BL. Comparison of four treatment approaches for lateral epicondylitis of the elbow. *J Orthopaed Sports Physical Ther*. 1986; 8(2):62-9.
171. Chard MD, Hazleman BL. Pulsed electromagnetic field treatment of chronic lateral humeral epicondylitis. *Clin Experiment Rheumatol*. 1988; 6(3):330-2.
172. Uzunca K, Birtane M, Taştekin N. Effectiveness of pulsed electromagnetic field therapy in lateral epicondylitis. *Clin Rheumatol*. 2007;26:69-74.
173. Landesa-Piñeiro L, Leiros-Rodriguez R. Physiotherapy treatment of lateral epicondylitis: A systematic review. *J Back Musculoskelet Rehab*. 2022;35(3):463-77.
174. Teitz CC, Garrett Jr WE, Miniaci A, Lee MH, Mann RA. Instructional course lectures, JBJS. 1997; 79(1):138-52.
175. Buchbinder R, Green SE, Struijs PA. Tennis elbow. *BMJ*. 2008.
176. Bjordal JM, Lopes-Martins RA, Joensen J, Couppe C, Ljunggren AE, Stergioulas A, Johnson MI. A systematic review with procedural assessments and meta-analysis of low-level laser therapy in lateral elbow tendinopathy (tennis elbow). *BMC*. 2008;9:1-5.
177. Cyriax JH, Cyriax P. Cyriax's illustrated manual of orthopaedic medicine. JBJS. 1993.
178. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ*. 2006; 333(7575):939.
179. Houck J, Neville C, Tome J, Flemister A. Randomized controlled trial comparing orthosis augmented by either stretching or stretching and strengthening for stage II tibialis posterior tendon dysfunction. *Foot Ankle Int*. 2015;36(9):1006-16.
180. Giray E, Karali-Bingul D, Akyuz G. The effectiveness of Kinesiotaping, sham taping or exercises only in lateral epicondylitis treatment: a randomized controlled study. *BMC*. 2019;11(7): 681-93.
181. Olaussen M, Holmedal Ø, Mdala I, Brage S, Lindbæk M. Corticosteroid or placebo injection combined with deep transverse friction massage, Mills manipulation, stretching and eccentric exercise

- for acute lateral epicondylitis: a randomised, controlled trial. *BMC*. 2015;16(1):1-3.
182. Eraslan L, Yuce D, Erbilici A, Baltaci G. Does Kinesiotaping improve pain and functionality in patients with newly diagnosed lateral epicondylitis?. *Knee Surg Sport Traumatol Arthrosc*. 2018;26:938-45.
183. Nowotny J, El-Zayat B, Goronzy J, Biewener A, Bausenhart F, Greiner S, Kasten P. Prospective randomized controlled trial in the treatment of lateral epicondylitis with a new dynamic wrist orthosis. *Eur J Med Res*. 2018;23:1-7.
184. Hoogvliet P, Randsdorp MS, Dingemanse R, Koes BW, Huisstede BM. Does effectiveness of exercise therapy and mobilisation techniques offer guidance for the treatment of lateral and medial epicondylitis? A systematic review. *Br J Sports Med*. 2013.
185. Homayouni K, Zeynali L, Mianehsaz E. Comparison between Kinesio taping and physiotherapy in the treatment of de Quervain's disease. *J Musculoskelet Res*. 2013;16(4): 135.
186. Mahdinasab S, Alemohammad S. Methylprednisolone acetate injection plus casting versus casting alone for the treatment of de Quervain's tenosynovitis. *J Musculoskelet Res*. 2013.
187. Huisstede BM, Coert JH, Fridén J, Hoogvliet P. Consensus on a multidisciplinary treatment guideline for de Quervain disease: results from the European Handguide study. *Physical Ther*. 2014; 94(8):1095-110.
188. Fleisch SB, Spindler KP, Lee DH. Corticosteroid injections in the treatment of trigger finger: a level I and II systematic review. *JAAOS*. 2007;15(3):166-71.
189. Ball C, Izadi D, Verjee LS, Chan J, Nanchahal J. Systematic review of non-surgical treatments for early Dupuytren's disease. *BMC*. 2016;17:1-7.
190. Elerian AE, Ewida MM, Elbehary NA, Mohamed GI, Abdel-Aal NM, Elmakaky AM, et al. Effect Of Anodyne Therapy Versus Traditional Physiotherapy In Treating De Quervain Tenosynovitis. *Biosci Res*. 2018;15(4):3254-61.
191. Ferrara PE, Codazza S, Cerulli S, Maccauro G, Ferriero G, Ronconi G. Physical modalities for the conservative treatment of wrist and hand's tenosynovitis: A systematic review. *Biosci Res*. 2017.
192. Mulligan BR. Manual therapy. *JAAOS*. 1999;1:45-9.
193. Rabin A, Israeli T, Kozol Z. Physiotherapy Management of People Diagnosed with de Quervain's Disease: A Case Series. *Physiother Canada*. 2015;67(3):263-7.
194. Kahanov L. Kinesio Taping®, part 1: an overview of its use in athletes. *Int J Athletic Ther Training*. 2007;12(3):17-8.
195. Kroeling P, Gross A, Graham N, Burnie SJ, Szeto G, Goldsmith CH, et al. Electrotherapy for neck pain. *JAAOS*. 2013;8:123-9.
196. Chow RT, Heller GZ, Barnsley L. The effect of 300 mW, 830 nm laser on chronic neck pain: a double-blind, randomized, placebo-controlled study. *Pain*. 2006;124(1-2):201-10.
197. Chiu TT, Hui-Chan CW, Cheing G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. *Clin Rehab*. 2005;19(8):850-60.
198. Moffett J, McLean S. The role of physiotherapy in the management of non-specific back pain and neck pain. *Rheumatology*. 2006;45(4):371-8.
199. Jull G, Trott P, Potter H, Zito G, Niere K, Shirley D, Emberson J, Marschner I, Richardson C. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. *JAAOS*. 2010;12:123-9.
200. Snodgrass SJ, Rivett DA, Robertson VJ. Manual forces applied during cervical mobilization. *J Manipulat Physiologic Therap*. 2007;30(1):17-25.
201. Ylinen J, Takala EP, Nykänen M. Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial. *JAMA*. 2003;289(19):2509-16.
202. Lau HM, Chiu TT, Lam TH. The effectiveness of thoracic manipulation on patients with chronic mechanical neck pain—a randomized controlled trial. *Manual Ther*. 2011;16(2):141-7.
203. Stewart MJ, Maher CG, Refshauge KM, Herbert RD, Bogduk N, Nicholas M. Randomized controlled trial of exercise for chronic whiplash-associated disorders. *Pain*. 2007;128(1-2):59-68.
204. Jull G, Sterling M, Kenardy J, Beller E. Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? A preliminary RCT. *Pain*. 2007; 129(1):28-34.
205. Kroeling P, Gross A, Graham N, Burnie SJ, Szeto G, Goldsmith CH, Haines T, Forget M. Electrotherapy for neck pain. *Cochrane Database System Rev*. 2013;12:13-9.
206. Bains BS, Askari SS. The Role of Physiotherapy in the Rehabilitation of Chronic Neck Pain and Shoulder Pain; Single Subject Case Study. *Int J Aging Health Move*. 2022;4(1):24-8.
207. Ganesh GS, Mohanty P, Pattnaik M, Mishra C. Effectiveness of mobilization therapy and exercises in mechanical neck pain. *Physiother Theory Pract*. 2015;31(2):99-106.
208. Hayden JA, Van Tulder MW, Tomlinson G. Systematic review: strategies for using exercise therapy to improve outcomes in chronic low back pain. *Ann Int Med*. 2005;142(9):776-85.
209. Clare HA, Adams R, Maher CG. A systematic review of efficacy of McKenzie therapy for spinal pain. *Aus J Physiother*. 2004;50(4):209-16.
210. Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine*. 2001;26(11):e243-8.
211. Gross AR, Kay T, Hondras M, Goldsmith C, Haines T, Peloso PE, Kennedy C, Hoving J. Manual therapy

- for mechanical neck disorders: a systematic review. *Manual Ther*. 2002;7(3):131-49.
212. Gross AR, Kay T, Hondras M. Manual therapy for mechanical neck disorders: a systematic review. *Man Ther*. 2002;7:131-49.
213. Dalal K, Elanchezhian D, Das R. Noninvasive characterisation of foot reflexology areas by swept source-optical coherence tomography in patients with low back pain. *Evid Based Complement Alt Med*. 2013.
214. McCullough JE, Liddle SD, Sinclair M, Close C, Hughes CM. The physiological and biochemical outcomes associated with a reflexology treatment: a systematic review. *Evid Based Complement Alt Med*. 2014.
215. Hu X, Chen N, Yang G, Chai Q, Trevelyn E, Lorenc A, et al. Integrated treatment for low back pain: a systematic review. *Eur J Integrat Med*. 2013;6(5): 572.
216. Ferreira ML, Ferreira PH, Latimer J. Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: a randomized trial. *Pain*. 2007;131(1-2):31-7.
217. Ulger O, Demirel A, Oz M, Tamer S. The effect of manual therapy and exercise in patients with chronic lowback pain: double blind randomized controlled trial. *J Back Musculoskelet Rehab*. 2017;30(6): 1303-9.
218. Ramírez-Vélez R, Hormazábal-Aguayo I, Izquierdo M, González-Ruiz K, Correa-Bautista JE, García-Hermoso A. Effects of kinesio taping alone versus sham taping in individuals with musculoskeletal conditions after intervention for at least one week: A systematic review and meta-analysis. *Physiotherapy*. 2019;105(4):412-20.
219. Castro-Sánchez AM, Lara-Palomo IC, Matarán-Peñarocha GA, Fernández-Sánchez M, Sánchez-Labraca N, Arroyo-Morales M. Kinesio Taping reduces disability and pain slightly in chronic non-specific low back pain: a randomised trial. *J Physiother*. 2012;58(2):89-95.
220. Kim CH, Kim AR, Kim MI, Kim SH, Yoo HJ, Lee SH. The efficacy of Kinesio taping in patients with a low back pain. *J Korean Acad Family Med*. 2002; 23(2):197-204.
221. Hodges PW. Core stability exercise in chronic low back pain. *Orthoped Clin*. 2003;34(2):245-54.
222. Koldaş Doğan Ş, Sonel Tur B, Kurtaiş Y, Atay MB. Comparison of three different approaches in the treatment of chronic low back pain. *Clin Rheumatol*. 2008;27:873-81.
223. Marshall PW, Murphy BA. Core stability exercises on and off a Swiss ball. *Arch Physical Med Rehab*. 2005;86(2):242-9.
224. Jull GA, Richardson CA. Motor control problems in patients with spinal pain: a new direction for therapeutic exercise. *J Manipulat Physiol Therap*. 2000;23(2):115-7.
225. Borhany T, Shahid E, Siddique WA, Ali H. Musculoskeletal problems in frequent computer and internet users. *Journal Family Med Primary Care*. 2018;7(2):337.
226. Cramer H, Mehling WE, Saha FJ, Dobos G, Lauche R. Postural awareness and its relation to pain: validation of an innovative instrument measuring awareness of body posture in patients with chronic pain. *BMC*. 2018;19(1):1-0.
227. Punnett L, Bergqvist U. Visual display unit work and upper extremity musculoskeletal disorders. *Evid Based Complement Alt Med*. 2007.
228. Tittiranonda P, Burastero S, Rempel D. Risk factors for musculoskeletal disorders among computer users. *Occup Med*. 1999;14(1):17.
229. Lis AM, Black KM, Korn H, Nordin M. Association between sitting and occupational LBP. *Eur Spine J*. 2007;16(2):283-98.
230. Marcus M, Gerr F, Monteilh C, Ortiz DJ, Gentry E, Cohen S, Edwards A, Ensor C, Kleinbaum D. A prospective study of computer users: II. Postural risk factors for musculoskeletal symptoms and disorders. *Am J Indus Med*. 2002;41(4):236-49.
231. Emara AK, Ng MK, Cruickshank JA, Kampert MW, Piuzzi NS, Schaffer JL, King D. Gamer's health guide: optimizing performance, recognizing hazards, and promoting wellness in esports. *Curr Sports Med Rep*. 2020;19(12):537-45.
232. Feuerstein M, Armstrong T, Hickey P, Lincoln A. Computer keyboard force and upper extremity symptoms. *J Occup Environ Med*. 1997;32:1144-53.
233. Johnson PW. The development, characterization and implementation of a technique to measure muscle fatigue during computer use. *Evid Based Complement Alt Med*. 2005;12:320-9.
234. Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer Vision Syndrome: A Review. *Surv Ophthalmology*. 2005;50(3):253-62.
235. Poulus D, Coulter TJ, Trotter MG, Polman R. Stress and coping in esports and the influence of mental toughness. *Front Psychol*. 2020;11(628):123-8.
236. Cumming J. Sport Imagery Training. Available at: <https://appliedsportpsych.org/resources/resources-for-athletes/sport-imagery-training/>. Accessed on 20 November 2023.
237. Munroe-Chandler KJ, Loughhead TM, Zuluiev EG, Ely FO. An imagery-based intervention for managing anxiety in esports. *J Image Res Sport Physical Activity*. 2023;3.
238. The role of esports psychology. Available at: <https://universidadeuropea.com/en/blog/esportspsychology/#examples-esports-psychology>. Accessed on 20 November 2023.

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