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Carpal Tunnel syndrome symptoms in Esports players

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Abstract
The thesis study was conducted to identify the risk factors for Esports players when it comes to developing Carpal Tunnel syndrome, how prevalent the symptoms are, and what preventative measures can be taken based on current research and available treatment methods.

Methods
An overview was provided on the Esports industry and differences between playing computer games vs. traditional office work, and a literature review was conducted on Carpal tunnel syndrome definition, testing, risk factors and treatment.
For the practical implementation, measurements were recorded in collaboration with 6 players from Tikka eSports and 2 independent players. For 7 days, the players filled a symptom and performance diary with attached software recording of mouse movement.

Results
Within the sample group was found that longer play time is not a risk factor for some of the Carpal tunnel syndrome symptoms. However, symptoms of burning in the mouse hand wrist increased proportionally to mouse distance travelled, and in addition there was found a decrease in self-reported performance. All in combination show that there may be a higher risk for players who need to use lower mouse sensitivity and therefore have increased travel area.

Conclusion
What the gathered data has shown is an example of physical wrist stress and potential Carpal Tunnel syndrome risk factors an Esports player could have. For any of the conclusions to be industry-relevant, a much larger size of players and longer-term measurements are needed. This study is the first of its kind and while the sample group is small, it opens the conversation about importance of conducting research and implementing preventative practices within the Esports industry.

Key words: carpal tunnel syndrome, physiotherapy, Esports, electronic sports, video games, gamers, questionnaire, injury prevention

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1 INTRODUCTION

Playing video games is often a negatively perceived hobby in majority of the Western world – waste of time, a sign for inactive lifestyle, lack of social skills, addiction and activity frequently connected to criminally violent behaviour. (Duggan, 2015; Website of WHO, 2018)

At the same time, video games are one of the most popular entertainment choices of our age, with different genres and accessibility options to offer something for everyone. (Merwin, Sugiyama & Mubayi, 2018) Most recently, in the wake of the worldwide covid-19 pandemic, WHO's Ray Chambers recommended video games as a way to stay socially connected and boost morale in times of social distancing and self-isolation with the campaign #PlayApartTogether as well as charity events such as the "Game for 19 Hours for the British Red Cross" campaign. (Canales, 2020; Website of British Red Cross, 2020) In June 2020, the U.S. Food and Drug Administration also approved the first game-based therapy for treatment of ADHD in 8-12 years old children with inattentive or combined type of the condition. (Website of FDA, 2020)

From the first organized game event of Space Invaders in 1972 at Stanford University, there has been the drive to play games competitively and build a skill, not only for casual fun. (Li, 2016, 10) Electronic sports or "Esports" is the modern unification of people who want to play competitively, structured teams who compete together, and most importantly people who watch them. It is a rapidly growing industry that has engagement and finances on par with traditional sports, and yet is not very well known to majority of the population. (Jenny, Manning & Keiper, 2016; Taylor, 2016, 115-130) The gap between the Esports industry and everyone else is real, the concern towards people who decide to follow that career path is also valid. Through scientific research and data, we can create a bridge of understanding, so that people who are skilled can pursue and develop that ability, while the others understand and support their growth as they would every other venture.

Physiotherapists and other healthcare professionals worldwide aim to promote being active and participating the chosen activities of daily living to all people, and in competitive areas such as sports and Esports - that also means to be able to practice and develop skills safely and progressively. (Website of WCPT, 2017)

In its final form, the thesis will serve as an educational guide to both healthcare and Esports industry professionals, to help in choosing appropriate care for players.
It will touch upon what it means to play video games professionally, what the specific differences and risks are (compared to traditional computer work), what Carpal Tunnel syndrome is and why it's worth applying preventive measures to ensure the wellbeing and performance of players.

Vocabulary

CTS – Carpal Tunnel syndrome

Esports/e-sports – electronic sports. The activity of playing computer games against other people on the internet, often for money, and often watched by other people using the internet, sometimes at special organized events (Website of Cambridge Dictionary, 2020)

Gamer – for the purpose of this thesis, the term will only describe a person who plays video games, not the broad meaning including tabletop, board and card game players.

PC – personal computer

FPS – first person shooter. A video game genre in which the player views the action through the eyes of a character (Website of Oxford Learner's dictionaries, 2020)

2 AIM AND OBJECTIVES

Aim of this thesis is to offer a beginning to the conversation about physical stress and health of professional Esports players and suggest evidence-based prevention methods for the risk of developing Carpal Tunnel syndrome, within the context of the rapidly developing field of competitive Esports.

Objectives of this thesis are to provide an overview of the industry of competitive computer video games through literature review, present the latest research on Carpal tunnel syndrome, and to find out specific risk factors and prevalence of symptoms for professional Esports players through a symptom diary matched with recording of mouse movement of Esports players from the Finnish team Tikka eSports and two independent players. Time frame for the study is from Spring 2019 to Winter 2020. (Appendix 1)

3 THE INDUSTRY OF COMPETITIVE COMPUTER VIDEO GAMES

The nature of games is such that while they can be a great recreational activity, there is always going to be someone who wants to do better at the given task. Whether it's developing an individual's skill, multiple people in a team working together, or teams against each other - there will be competition. (Duggan, 2016)

People strive for development and progression on a personal and social level. That involves freedom over choices, mastery over skills and to belong in a community. While games can't replace reality, they've become very good at fulfilling these social needs. (Eyal, 2018)

Competitive gaming is extremely accessible – both in participation and as an entertainment medium, and while in recent years it has been significantly growing as an industry, playing video games is not a new hobby - the first worldwide televised tournaments were Nintendo and Sega championships in the late 80s – early 90s, which brought console gaming to most people's living rooms. (Jenny, Manning & Keiper, 2016; Kane, 2017)

In 2020 the gaming industry is valued at USD 150+ billion, with Esports leading the way with USD 1.1 billion, in developing revenue structure of sponsorships, advertising, media rights, event tickets, betting, team and player investments, brand collaborations and merchandise etc. resembling every other traditional sport. (Marinkovic, 2020; Merwin, Sugiyama & Mubayi, 2018; Taylor, 2016, 115-130; Website of Louis Vuitton, 2020; Website of Reuters, 2020)

Part of the growth during 2020 is due to the exceptional role of Esports in the global pandemic due to covid-19, with movement restrictions, complete halt of social gathering and country-wide lockdowns. With traditional sports and live events cancelled, and many transitioning to their equivalent video game – Formula 1, FIFA, NHL etc. video games and Esports served as a way for people to maintain their mental wellbeing through social connection and participation, and in some cases as a revenue from streaming, while being in social distancing situation at home. (Canales, 2020; Marinkovic, 2020; Website of F1, 2020; Website of FIFAe 2020; Website of NHL, 2020; Winkie, 2020)

The typical stereotype of a gamer is very far from the image of an athlete, but it does not mean professional gamers do not demonstrate high-level performance capabilities and mastery over the tools of their trade – mouse, keyboard and monitor, with a clear gap between the elite performers vs. non-competitive gamers. (Hemphill, 2005, 195-207)

During play (both practice hours and competitive), cognitive skills, eyes-to-hands co-ordination, teamwork, bodily signs of exertion such as MET (metabolic equivalents of task fitness test), VO2 (oxygen uptake), heart rate, perspiration, ability to perform under stress and public attention and perceived exertion based on Borg RPE scale (rating of perceived exertion) are all found to increase. (Stroud, 2010, 643-649; Li, 2016, 10-30) As games continuously change/add game mechanics that alter the way players interact, professional gamers must constantly adapt to changes – roughly once every 3 months when a new patch or season is available. (Pluss, Bennett & Novak, 2019) This is not something traditional sports athletes have to deal with, as it would be equivalent to a football player having to kick a different shape, size and weight ball while using two different types of shoes on a different terrain every match, while sometimes also playing as a goalie or a medic.

In an increasing number of countries such as US, professional gamers can obtain athlete-type visa and scholarships, and in South Korea (KeSPA) and Finland (SEUL) the Esports associations are recognized as part of the Olympic committee. (Kane, 2017)

4 CARPAL TUNNEL SYNDROME

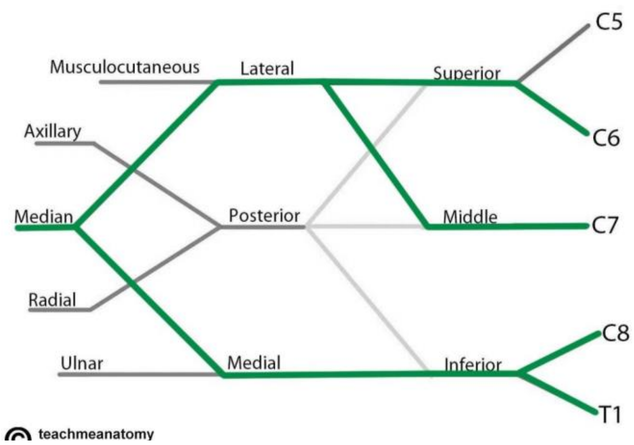
Carpal Tunnel syndrome (CTS) is one of the most common neurological conditions and most common neuropathic entrapment of the upper extremity, with high prevalence in the general working-age population.

Typical symptoms such as burning, pain, numbness, “electric shock”-like sensations and tingling in the hand and arm, often bilaterally. More severe cases may include sleep disturbance, pain sensation to travel from the thumb towards the shoulder, weakness, and clumsiness in hand, causing loss of proprioception, dropping things, limitation in use of technology and fine motor skills. As symptoms begin without a clear trauma, early diagnosis and conservative treatment are key in preventing social and physical limitations, reduction of workability, increase of medical costs and - as the symptoms worsen with time, leading to neural damage and increasing the need for surgical intervention with prolonged further rehabilitation. (Atroshi, Gummesson & Johnsson 1999, 153-158)

4.1 Anatomy related to Carpal Tunnel syndrome

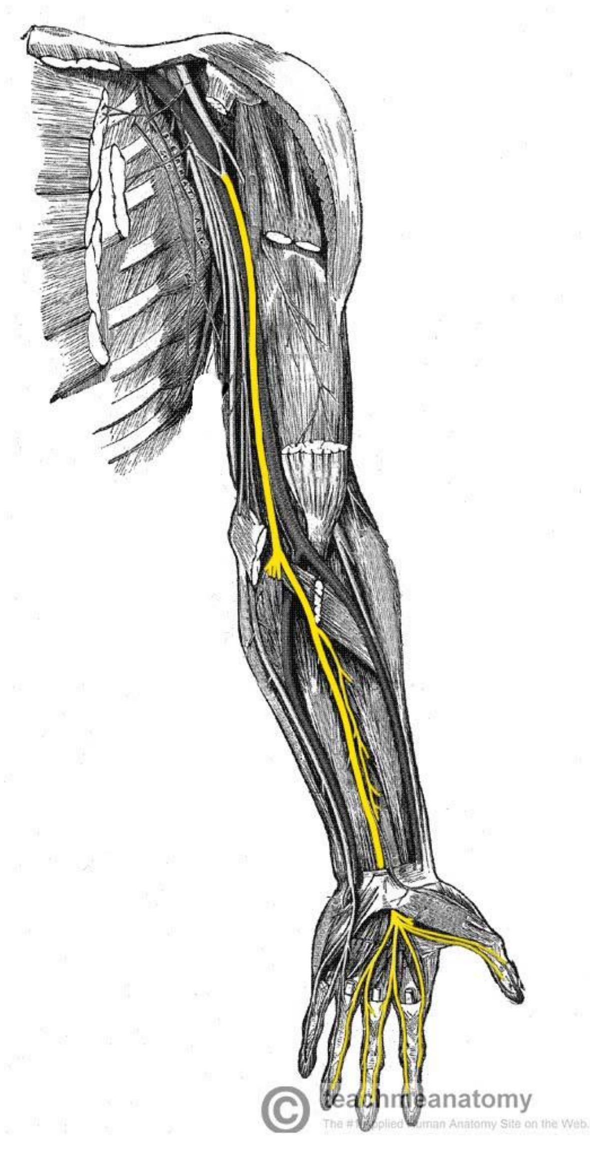
The Brachial plexus is located in the Cervical spine, starting from C5 to the first Thoracic spine vertebrae or T1. It is the origin place for all upper limb nerves (shown in Picture 1)

Carpal Tunnel syndrome is caused by compression of the Median nerve, which is one of the major upper limb nerves (Agur & Dalley, 2016, 71-75)



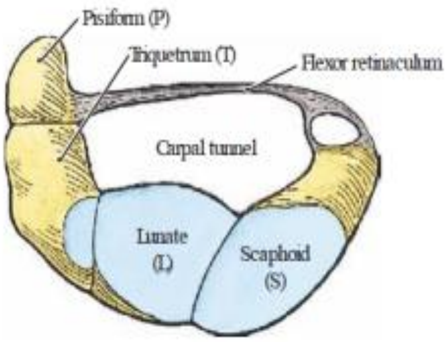
Picture 1 The brachial plexus (Jones, 2020)

The Median nerve runs through the entire upper limb, innervating muscles in the anterior forearm through Anterior interosseous nerve branch to allow for pronation of the forearm and flexion of the wrist. (Picture 2) It follows to the hand through Palmar cutaneous nerve branch innervating the skin of the lateral palm, Recurrent branch innervating the thenar muscles and Palmar digital branch innervating the palmar surface and fingertips of the lateral three and a half fingers, all allowing for flexion of the fingers of the hand. The areas innervated by the Median nerve are also where the typical CTS symptoms are reported. (Agur & Dalley, 2016, 71-75)



Picture 2 Median nerve (Jones, 2020)

The carpal tunnel serves as a protective "tube" for the Median nerve. At the top, or inner side of the wrist, is the transverse carpal ligament, followed by the carpal bones Hamate, Capitate, Trapezoid and Trapezium illustrated in Picture 3. The ligament serves as a flexible connection between the end carpal bones Hamate and Trapezium, allowing for movement and flexibility of the wrist. (Hulkkonen, 2019)



Picture 3 The carpal tunnel (Agur & Dalley, 2016, 187)

4.2 Testing and differentiation

A thorough review of medical history, symptom frequency and intensity, followed by physical examination of visual inspection and palpation to check for thenar muscle atrophy, and ultrasound imaging in combination, is how a clinician can get the most accurate way to diagnose CTS. (Henry, Zwinczewska & Roy, 2015)

Physical tests are commonly used in clinical setting; however, they cannot be used as a standalone diagnostic method due to high sensitivity and weak clinical value in relation to CTS. (Valdes & La Stayo, 2013, 32-42, Almasi-Doghaee, Boostani & Saeed 2016, 173-174)

Full spectrum testing is needed, in order to achieve differentiation from the wide variety of conditions that affect the same area and may present similar symptoms. Some of the more common being Carpometacarpal arthritis of the thumb or wrist arthritis (not common in younger ages), Peripheral neuropathy (especially in history of diabetes), and Pronator syndrome with median nerve compression at the elbow. (Wipperman & Goerl 2016, 993-999)

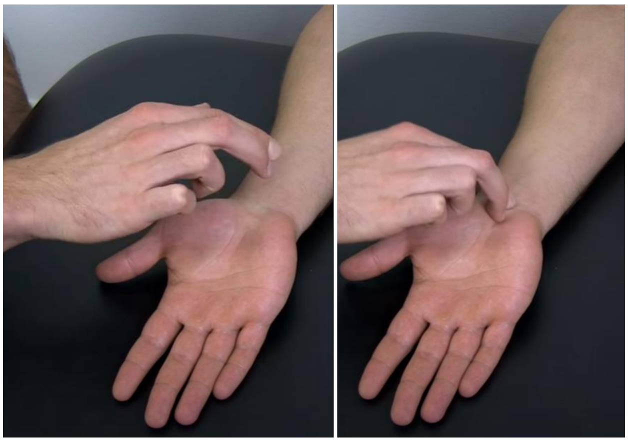
Carpal Tunnel Compression test is performed by putting pressure over the carpal tunnel for 30 seconds, typically by using a finger, while the hand of the client is flat on a surface. (Picture 4) Positive results are symptoms of dull pain or paresthesia along the Median nerve within the compression time. Discomfort must be addressed with the client as this is a provoking test. (Almasi-Doghaee,Boostani & Saeed 2016, 173-174; Franko, 2020)

Picture 4 Screenshot of Carpal Tunnel compression test (Website of Physiotutors Youtube channel, 2020)

Phalen’s test is performed in standing or sitting, flexing both wrists together in elevated position for 1 minute. (Picture 5) Positive sign is reproduction of symptoms along the Median nerve. It has to be differentiated between CTS symptoms and general muscle weakness. (Brüske, Bednarski, & Grzelec 2002, 141-145, Almasi-Doghaee,Boostani & Saeed 2016, 173-174)

Picture 5 Screenshot of Phalen's test (Website of Physiotutors Youtube channel, 2020)

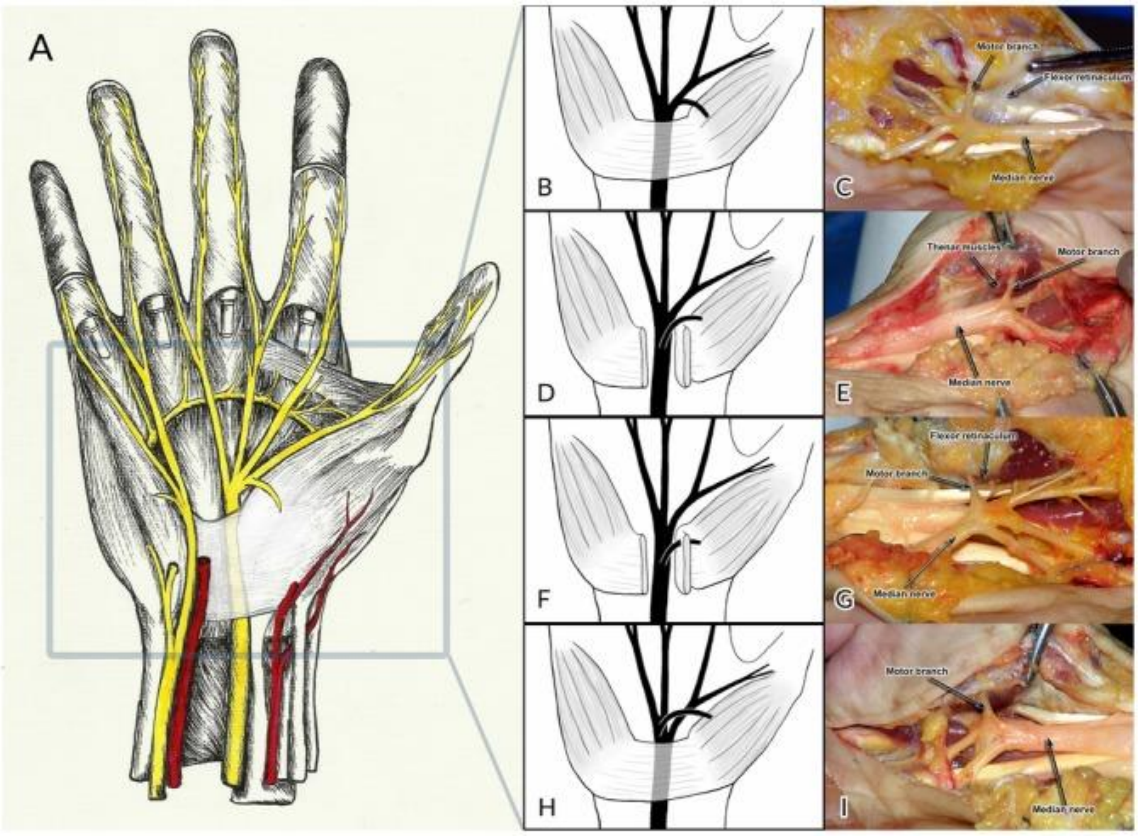
Hoffmann - Tinel’s sign test is performed by tapping on the median nerve over the carpal tunnel as shown in Picture 6. The goal is to provoke symptoms along the Median nerve. Positive signs are sharp pain and shock-like sensations. As with the Carpal compression test, discomfort must be addressed with the client. (Brüske, Bednarski, & Grzelec 2002, 141-145, Almasi-Doghaee,Boostani & Saeed 2016, 173-174)



Picture 6 Screenshot of Hoffmann-Tinel's sign (Website of Physiotutors Youtube channel, 2015)

4.3 Anatomical risk factors

Anatomical differences can be a contributing hereditary factor, varied by geographic location, which can affect the success rate of conservative and surgical interventions. Variation of the Median nerve and its accessory branches, as well as musculoskeletal narrowness of the Carpal tunnel, wrist shape, hand size in some individuals can be a reason for difference in CTS symptom severity in both hands due to lack of anatomical symmetry. (Picture 7) It needs to be considered for its influence on outcomes from median nerve decompression surgery with added risk of functional deficits of the thumb such as thenar weakness, loss of opposition and iatrogenic nerve injury, particularly in cases with hypertrophic thenar muscles. (Henry, Zwinczewska & Roy, 2015)



Picture 7 extraligamentous type TMB with radial side of branching (B, C), subligamentous type TMB (D, E), transliga-mentous type TMB (F, G), extraligamentous type TMB with ulnar side of branching (Henry, Zwinczewska & Roy, 2015)

4.4 Individual risk factors

Ageing has been identified as one of the major individual factors that increases incidence of CTS, peak being 45-55, but also in the 60+ category, which can be attributed to natural physiological changes of ageing, particularly due to musculoskeletal conditions such as rheumatoid arthritis, bone mass degeneration, increase risk of falls and recovery time, decrease in the function of the vascular system and microvasculature affecting the soft tissues. (National Research Council, 1999, Scioli, Bielli & Arcuri 2014)

Both Type 1 and 2 Diabetes have been linked to an increased risk of neuropathy, which for CTS goes from 10% lifetime risk up to 84% after age 54, particularly in those who had later onset of diabetes. (Singh, Gamble & Cundy, 2005, 625-630) In addition - overweight, obesity and smoking have been noted as minor contributing factors that lead to increased intracarpal pressure and lower peripheral circulation. (Pourmemari, Shiri & Falah-Hassani, 2015, 1094-1104)

Female gender is commonly considered a risk factor as CTS is more commonly diagnosed in women and underlying reasons for it were found to be pregnancy and hormonal factors, difference in wrist shape and size, and the distribution of adipose tissue in comparison to men. (Atroshi 1999, Hulkkonen, 2019) However, men are more likely to be involved in industries which carry higher occupational risk and therefore more gender-adjusted research is needed for a more definitive opinion to be made. (National Research Council, 1999)

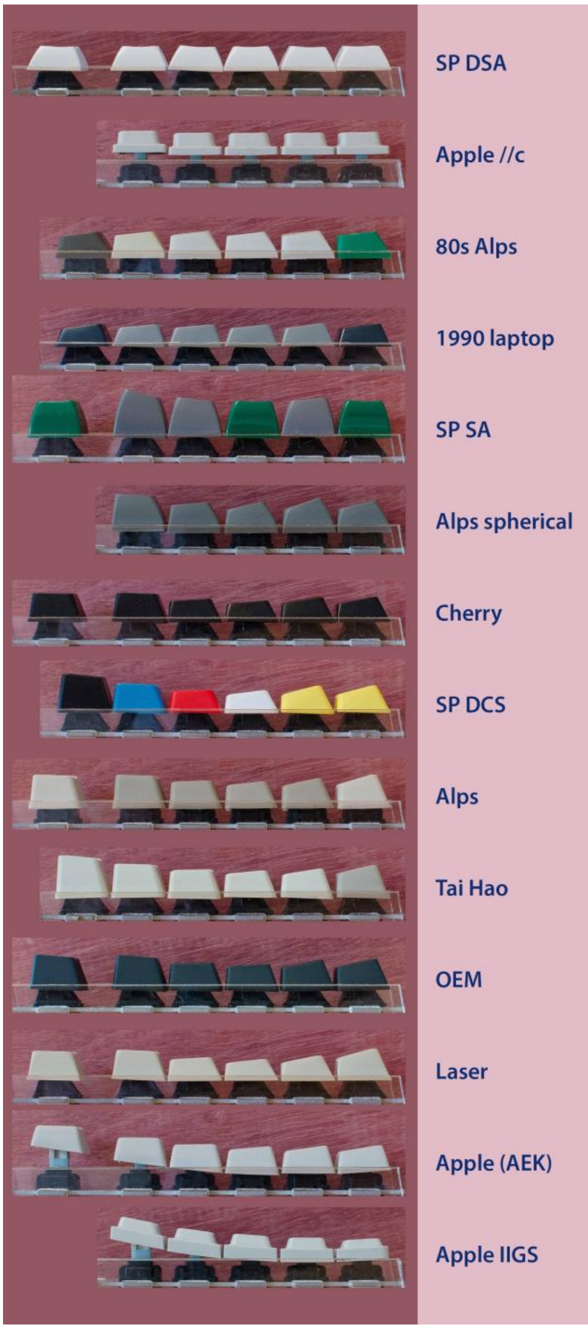
4.5 Occupational risk factors

For the working-age adults, the risk is more closely related to the field of work and its associated environmental risk factors such as occupation, work tasks, task repetition, work tools and ergonomics. The highest incidence of CTS is in occupations within food processing, line assembly work and jobs involving use of power tools. Attributing factors are when the tasks are done within a prolonged period of time such as over half of the work hours, and/or in combination with arm elevation, wrist flexion and extension, high force and repetitiveness of quick cycle times of <10s. (Rijn, Huisstede & Koes, 2009, 19-36) While there has been no significant association between computer work and CTS, it is still considered a low risk occupation. (Kozak, Schedlbauer, & Wirth, 2015)

4.5.1 Keyboard

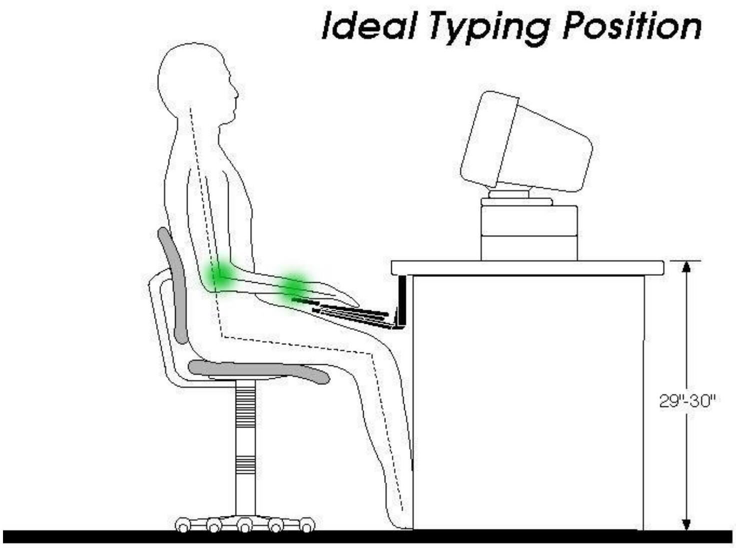
Office keyboards typically feature a flat profile which puts the hands at a relatively parallel to the desk level, often with possibility for wrist support – either built-in or separate that is compatible, and can be used with roller mouse attachment to further reduce desk reaching and less mouse usage in general. (Website of Contour Design, 2020) They have membrane, dome or scissor style key switches, like a standard laptop keyboard, with a low profile and little to nontactile feedback or click when the keys are fully pressed. (Website of Ergopedia, 2020)

Gaming keyboards are generally larger and feature keys with mechanical switches (most common being OEM and Cherry shown comparison in Picture 8), making their overall height taller than standard non-mechanical keyboards. (Website of Mechanical-keyboard, 2020) The added height, shape of the mechanical switches and lack of wrist support places the wrist at an extended angle. (Website of Mechlab, 2020)



Picture 8 Types of keycaps. Copyright by Jacob Rus, used with permission

Having wrist support and a negative slope style keyboard as shown in Picture 9 can be beneficial in levelling the wrist position, but it’s not always offered with gaming peripherals.



Picture 9 Cornell University ergonomics suggestion for ideal typing position (Website of Cornell University, 2020)

Alternative ergonomic keyboard layouts with split design, neutral or negative inclination are a very costly niche and limited when it comes to compatibility with gaming, non-applicable to professional competitive gaming where switching between keyboard designs can hinder performance at a competition where peripherals are usually uniformly provided to all players. (Website of Mechlab, 2020)

4.5.2 Mouse

To generalize, there are three major types of grip styles for playing computer games shown in Picture 10. Palm grip being the most common among all computer mouse users. It involves the entire palm resting on the mouse surface. Fingertip and Claw grips allow for faster clicking and faster flick, which is an important factor in first person shooter games such as Counter Strike: Global offensive. Claw grip is the overall preferred style for many professional players, despite it putting the hand position in the most stress. (Website of 1-hp, 2020)

Picture 10 Mouse grip styles. Copyright by Matthew Hwu of 1-HP, image used with permission

4.5.3 Ergonomics

Ergonomics is a multidisciplinary way of designing environments such as corporate, commercial, industrial, public or home spaces, product use and interaction with digital systems – all in consideration with the people who use them. The main goal is to improve interaction, risk prevention and increase productivity. That is achieved through cooperation between professionals in areas such as engineering and craftsmanship, art and design, psychology, anthropology and physiology.

Office environments are designed with occupational ergonomics in mind, to improve productivity and minimize work stress on the worker's body. For office spaces that includes desk reaching area, monitor positioning, desk height and chair adjustment for optimal posture during the workday. (Website of Dohrmann consulting, 2020)

Where Esports differs is that the players are typically at their private home, with environment built based on preference by the players themselves. For professional players, sponsorship deals affect choices when it comes to equipment, and in the case of “team house” environments, the gaming areas are designed by someone else, but it doesn’t necessarily include ergonomics assessment, nor individual adjustment. (Nambiema, Bertrais & Bodin, 2020, 456, Website of 1-hp, 2020)
In both cases of keyboard use – office and gaming, the ergonomics adjustment has moved towards optimizing the environment, but not the user. There are recommendations on different angles at the elbow and knees, distance of feet while sitting, back posture etc. but they’re not realistic since people don’t sit in the same position for 8h/day. (Website of Dohrmann consulting, 2020; Website of 1-hp, 2020) Having proper training on typing technique and the posture required for reducing wrist stress and back problems are unfortunately a thing of the past, when typewriters were the beginning of the keyboard work, but although outdated as an idea, there are good points on training the person, not adjusting the environment and hoping an ergonomic piece of furniture will fix their posture automatically. (Website of Periscope Film LLC Youtube archives, 2020)

4.6 Treatment of Carpal Tunnel syndrome

While CTS is common among the general population, there is a severe lack of quality research on non-invasive and non-surgical treatments and their effectiveness in prevention and management of symptoms. (Website of Orthoinfo, 2018)

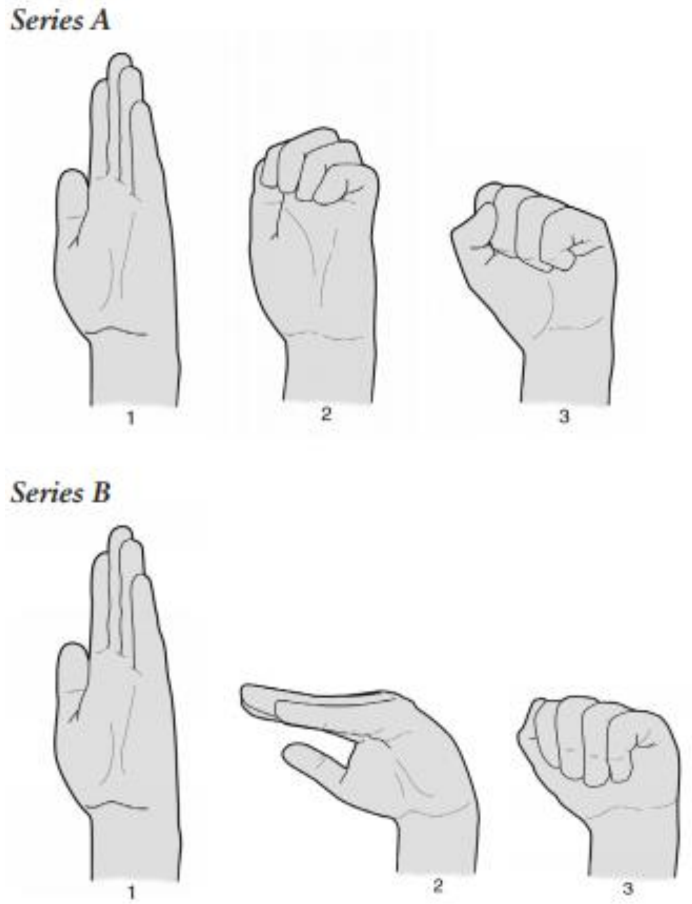
4.6.1 Conservative methods for treatment and prevention

Conservative treatment is considered a valid preventive measure to avoid diagnosis entirely, or to treat early stage cases of CTS. Main goals are to relieve pain and improve functional ability, however there is no consensus on which method is the most effective, with no evidence to show improvements by using a single method and slightly better results documented from using a combination of treatments. (del Barrio, Gracia & García, 2018, 590-601) Below are outlined some of the methods with highest quality research, and while there are other options available, there is not enough current evidence to support the effects.

Splinting is by far the most recommended and prescribed method for mild to medium symptoms, typically in combination with pharmaceuticals. It provides support to the wrist and limits the flexion/extension significantly, thus reducing compression within the carpal tunnel. It can be used during the day or only at night with similar results, typically over the course of 4-6 weeks. While it is effective on its own, better results come from using splinting in combination with other treatments. (Gerritsen, de Vet & Scholten, 2002, 1245-1251; Wipperman & Goerl, 2016, 993-999; del Barrio, Gracia & García, 2018, 590-601)

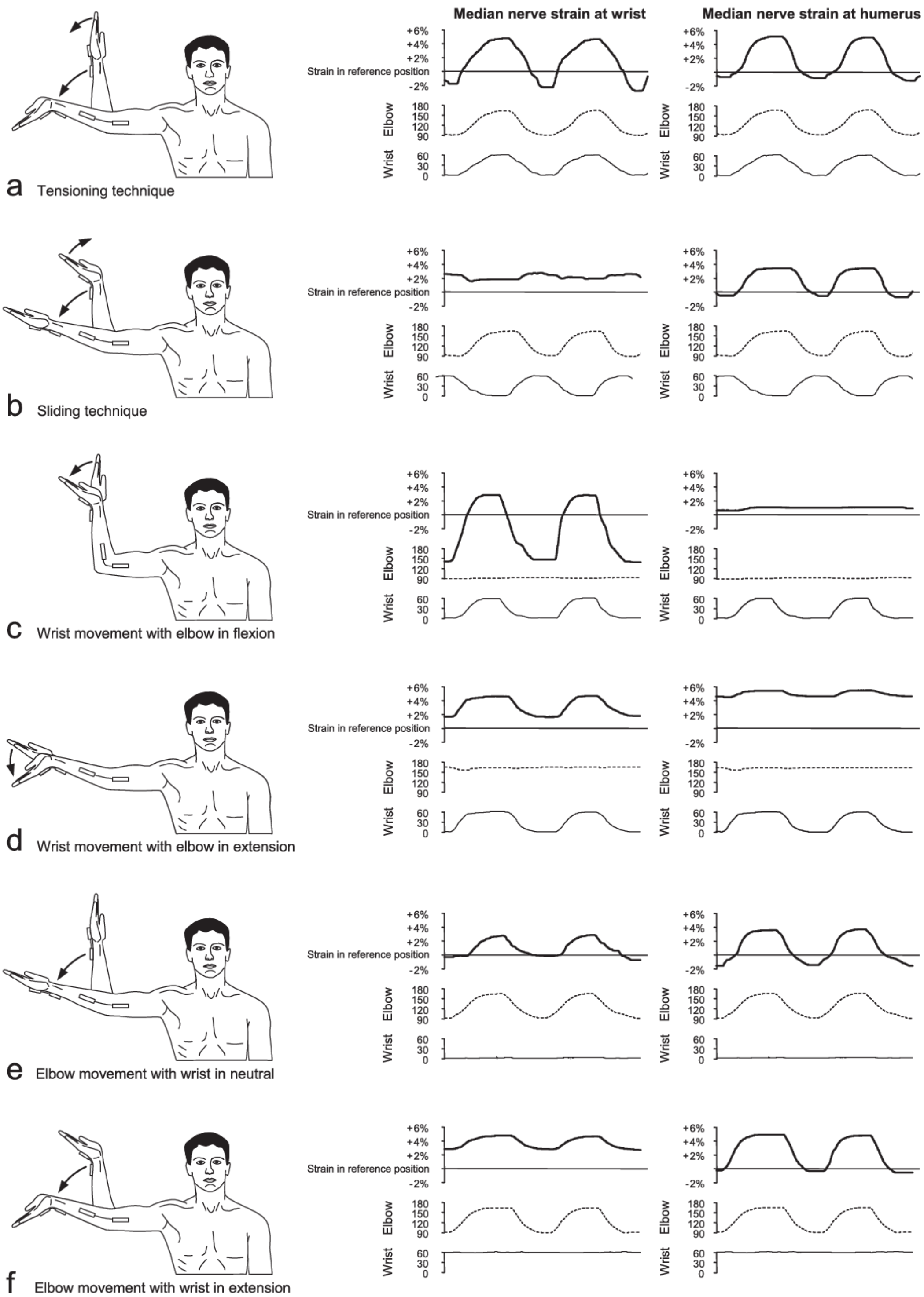
Therapeutic exercise role in CTS treatment is as a supportive treatment, with some clinical evidence in prevention and in early stages of developing symptoms. It is more effective if used in combination with other treatments such as splinting, kinesiotaping and manual therapy. (del Barrio, Gracia & García, 2018, 590-601))
Neuromobilization techniques such as sliders and tensioners for the Median nerve are the most typical form of therapeutic exercise related to CTS rehabilitation (also used in the diagnostic testing process). The aim is to help with functional performance, reduce symptom severity of pain, numbness and tingling sensations, as well as improve grip strength. (Coppieters & Butler, 2008, 213-221; Wipperman & Goerl, 2016, 993-999; Lim, Chee & Girdler, 2017, 397-406; del Barrio, Gracia & García, 2018, 590-601)

They can be done actively, at the level of the hand, as part of a home exercise program as shown in Picture 11 – the nerve glides help in mobilizing the Median nerve at the distal end in the hand. (Website of Orthoinfo, 2018)



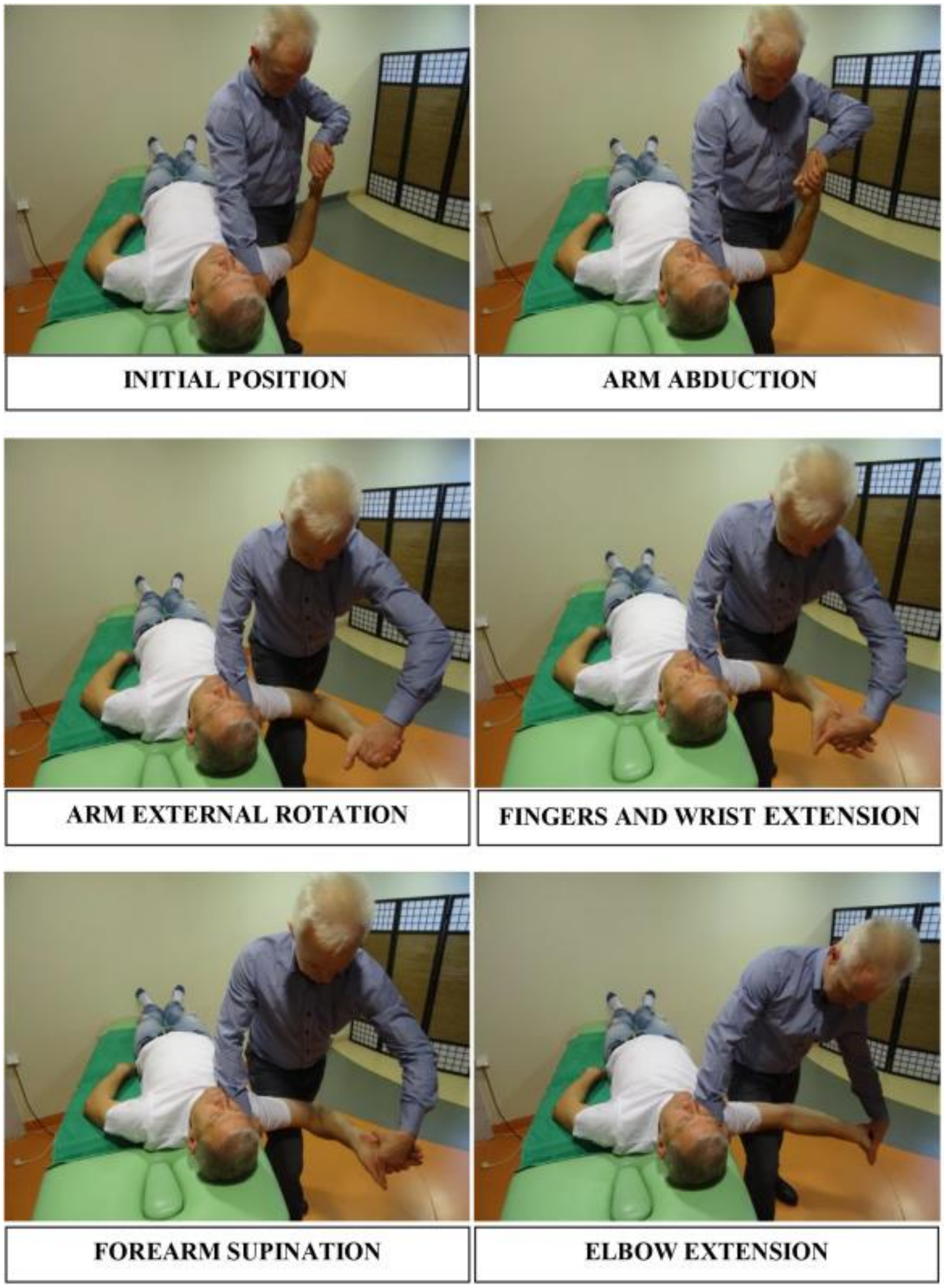
Picture 11 Median nerve glides (Website of Orthoinfo, 2016)

Or including the entire upper limb with tensioning and sliding techniques, also used for diagnostics. Picture 12 Shows how the Median nerve is strained at the wrist and at the elbow during the exercises, which helps selecting appropriate technique, based on the symptoms and the areas to be improved through physiotherapy. (Coppieters & Butler, 2008, 213-221)



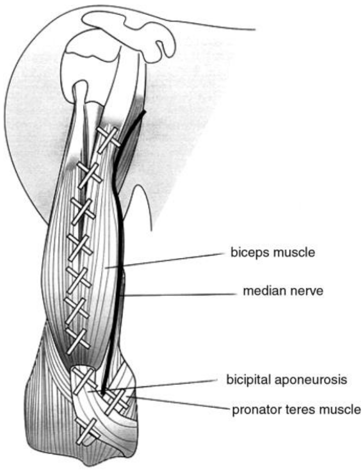
Picture 12 Active Median nerve mobilization techniques Coppieters & Butler, 2008, 213-221)

Neuromobilization can also be done as treatment by a physiotherapist as part of manual therapy session, as shown in Picture 13. There is no significant difference in effectiveness between active and passive treatment. (Wolny, Saulicz & Linek, 2017, 263-272; Wolny & Linek, 2018, 843-854)



Picture 13 Passive neuromobilization done by a physiotherapist (Wolny & Linek, 2018, 843-854)

Another promising manual therapy technique was to perform ischemic compression or trigger point therapy. (Picture 14) While the trial included chronic CTS participants, the technique is worth including in the early stages of symptoms, as well as a preventive measure. (Hains, Descarreaux & Lamy, 2010, 155-163)



Picture 14 Trigger points for CTS (Hains, Descarreaux & Lamy, 2010, 155-163)

In addition to exercise and manual therapy, kinesiotaping can further support the rehabilitation process, however the findings of its effectiveness are also inconclusive. Three techniques were identified as somewhat effective.

Using the first technique shown in Picture 15 - in ultrasonographic evaluation for treatment of CTS, there were no significant improvements in the group that used taping method in addition to gliding exercises, but it is still recommended as worth using if available for short-term mild to moderate symptoms. (Yıldırım, Dilek & Şahin, 2018, 925-932

Picture 15 Taping method 1: left placebo, right intervention (Yıldırım, Dilek & Şahin, 2018, 925-932)

The second method shown in Picture 16 found similar results, with the addition that grip strength was improved when using splinting + kinesiotape. (Külcü, Bursali & Aktaş 1042-4049)

Picture 16 Taping method 2: left intervention, right placebo (Külcü, Bursali & Aktaş 1042-4049)

The third method, shown in Picture 17, was used in combination with splinting and paraffin baths in a single-blind randomized controlled study. The results found were relieving for symptoms when used at night in combination with splinting. (Kaplan, Akyuz & Kokar, 2018, 297-304)

Picture 17 Taping method 3 (Kaplan, Akyuz & Kokar, 2018, 297-304)

4.6.2 Surgical intervention

Decompression surgery called Carpal Tunnel release is by far the most effective treatment for CTS, and the only option for moderate to severe cases. It is followed up by conservative treatment for strengthening and stabilizing, to achieve a symptom-free long-term result. During the surgery, typically the carpal ligament is cut to release pressure within the Carpal tunnel, however complications can occur as with any other invasive procedure. (Henry, Zwinczewska & Roy, 2015; del Barrio, Gracia & García, 2018, 590-601; Huisstede, Brink & Randsdorp, 2018, 1660-1680; Klokkari & Mamais, 2018, 91-114)

5 THESIS METHODS

The thesis method is a quantitative study, with theoretical literature review (Chapters 1 to 4), a questionnaire and practical measurements through software. The method is based on collecting and analysing numerical data in order to find correlation between values and does not require players to be physically connected or in the same space, which fits the nature of the Esports industry and the gaming practices of players who are at their private homes for the most part.

6 DATA COLLECTION METHODS

The practical implementation of this study consists in measuring the physical stress of an Esports player’s mouse hand, combined with a questionnaire of symptoms and perceived performance decrease or increase. This serves as a first look into how much physical stress are the players under, when it comes to mouse movement and how we can use the data to design preventive programs and ensure players’ wellbeing.

6 players from TIKKA eSports and 2 independent players were asked to complete an Excel spreadsheet diary with daily screenshots of Mousotron software for 7 days during July/August 2020. (Table 2 and 3) (Mousotron, 2020)

The selection of players was done on a voluntary basis by Henri Luhtanen, CEO of Tikka eSports, Finland and for the independent players – by Matthiew Manavit of Esports Gaming school in Bordeaux, France. They also handled the collection and upload to Onedrive of the consent forms and diaries filled by the players. (Appendix 2) The only condition set by the author was that the players are 18+ years old and compete in Esports from Beginner to High level.

The players chose their own nickname for the Player diaries, in addition to never meeting with the author. (Table 1) This was done to ensure blind analysis and eliminate any factors that may cause bias towards the data.

	How to mark symptoms:
	0 = no symptoms
Player nickname:	*1 - 5 = symptoms from mild to severe*
Competence Level:	**Levels: Beginner, Semi-pro, Pro**
Left or right handed:	***How to mark performance:***
Mouse/grip style:	*0 = no changes*
Keyboard:	*1 - 5 = worse to better*

Table 1 Player instructions

		Symptoms										
		Numbness		Burning/Tingling		Pain			**Most played games**			
Date	**Playtime/h**	mouse hand	keyboard hand	mouse hand	keyboard hand	mouse hand	keyboard hand	el-bow	1	2	**Per-for-mance**	**Symptoms el-sewhere?**

Table 2 Symptom diary

Example of Mousotron measurements recording for a day:

days	hr	min	sec	km	m	cm	keystrokes	left button	right button	middle button	extra button 1	extra button 2
0	12	44	1	3	302	26	47287	3345	2738	64	5	13

double clicks	mousewheel	speed (km/hr)	X coord	Y coord	idle	hr	min	sec
1356	4077	0.00	-323	866	0	1	6	50

Table 3 Screenshot from Mousotron measurements

In Table 2 are shown the fields players had to fill as part of their symptom diary self-report.

Play time was the player’s reported hours of play during each day of the weekly recording. It both gives an idea of average “working hours” of a professional Esports player, as well as being a factor of whether longer hours are linked to increase risk.

The symptoms from which players could choose from were the most common symptoms associated with CTS – numbness, burning and pain in either mouse hand, keyboard hand or both. It serves as a differentiator between CTS – which is bilateral, or repetitive stress on the mouse hand wrist.

Performance is the player’s perceived result at the end of a day. It gives an idea of what factors can interact with a player’s performance in game – whether longer time or symptoms can be linked to decreased success in games, or if there is no correlation.

In table 3 is shown the last metric - recording from Mousotron software, showing the distance travelled by the mouse hand within the course of a day. It is the first insight in how much more movement an Esports player performs with their mouse hand, compared to any other standard use of computer.

7 RESULTS

Multivariate regression analysis was done with RStudio on the following fields in Table 4 with relevance to the research question.

Playtime	Numb	numb_mc	numb_key	burning	burning_n	burning_k	pain	pain_mou	pain_keyb	pain_elbo	Performar	distance_t
5.1	1	1	1	1	0	1	1	0	1	1	2.571429	1.771429
4	0	0	0	0	0	0	0	0	0	0	3.428571	0.41
4.142857	0	0	0	0	0	0	1	1	1	1	3.857143	0.514286
5.328571	1	1	1	1	1	1	1	1	1	1	0	2.357143
10.57143	0	0	0	0	0	0	1	0	1	0	0	1.865714
5	1	1	0	0	0	0	1	0	1	0	4.857143	0.657143
3.714286	1	1	1	1	1	1	1	1	1	0	4.571429	0.428571
4.714286	1	1	0	1	1	0	0	0	0	0	0	2.671429

Table 4 Descriptive characteristics of playing, symptoms occurred and performance factor. Data are provided as averages and symptom occurrences over 7 days follow up period

Within the sample group, there is no significant association between time played and distance travelled with pain and numbness symptoms, as tested by multiple regression analysis and ANOVA.
However, there is a nearly significant p = 0.051* correlation between burning sensation and distance travelled. (Table 5)

Variable	Estimate	Std. error	t-value	Pr(>|t|)
Intercept	0.68975	0.39771	1.734	0.143
Play time	-0.14816	0.07469	-1.984	0.104
distance	0.44863	0.17562	2.555	0.051*

Table 5 symptoms vs play time and distance

In terms of player performance (self-reported) - playing computer games for longer, doesn't reduce the performance with p = 0.6517, however, player performance is significantly dependent on the distance travelled with p = 0.001179**, showing decrease in performance as the mouse travel distance increases, which can affect players who compete in games that require more mouse movement. (Table 6)
The model approximation is significant p = 0.002 with R2 = 0.2, R=0.21 and t-value for distance is -3.289.

Variable	Estimate	Std. error	t-value	Pr(>|t|)
Intercept	3.15418	0.39886	7.908	1.57e-10 *
Play time	0.03029	0.06672	0.454	0.65170
distance	-0.67792	0.20612	-3.289	0.00179 **

Table 6 performance vs play time and distance

8 CONCLUSION

Within the sample group of players was found that longer play time is not a risk factor for some of the Carpal tunnel syndrome symptoms. However, symptoms of burning in the mouse hand wrist increased proportionally to mouse distance travelled, and in addition there was found a decrease in self-reported performance. According to the study, the results show that there may be a higher risk for players who need to use lower mouse sensitivity and therefore have increased travel area.

What the gathered data has shown is an example of physical wrist stress and potential Carpal Tunnel syndrome risk factors an Esports player could have. For any of the conclusions to be industry-relevant, a much larger size of players and longer-term measurements are needed. While the sample group is small, it opens the conversation about importance of conducting research and implementing preventative practices within the Esports industry.

9 DISCUSSION

This study is the first of its kind and is only within the scope of an independent bachelor's thesis in Physiotherapy. It is to serve as a beginning of a much longer conversation, about the importance of healthcare professionals and preventative practices as a much-needed implementation within the Esports professional scene.

For any real statistical significance and from a healthcare injury prevention and diagnostics point of view, a much bigger sample of players is needed, playing the same game, recording symptoms and mouse measurements for a month - all repeated for as many different games or game genres as possible, as different games have different mouse usage and sensitivity requirements.
Only after gathering more data, there can be a prevention program specific to the needs of Esports players. For the time being, the existing exercise programs described in this thesis are the best evidence-based approach.

As the world of Esports opens to the mainstream and looking towards entering the Olympic games or as an equivalent worldwide event, there is an urgent need for a deeper understanding of the physical stress involved in playing computer games.
This thesis offers input on differentiation between playing computer games and general office work involving a computer. However, more research is needed in areas of

cardiovascular and respiratory systems of an Esports player, muscle tone and potential atrophy from prolonged sitting, low back pain, eye strain, as well as beneficial cognitive skills and hand-eye coordination acquired through playing at a top level.

The more research is published, the better preventive measures can be designed by healthcare and performance professionals, ensuring the health and wellbeing of the players. As a positive consequence, there will be ways of improving the longevity of their careers and reducing stress from constant team roster rotations.

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Henri Luhtanen (CEO Tikka eSports) and Matthiew Manavit for caring about players and their well-being, and for trusting in me to have the gamers' best interest in my research.
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Tomas Cervinka (ScD Tech, BSc PT) for making statistical analysis seem easy.
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11 CONFLICT OF INTEREST

The author has no financial affiliation nor personal involvement with any of the games, health conditions, services mentioned, nor other relationship that may present a conflict of interest over the submitted work.

The client had no influence over the choice of hardware, methods of data collection or interpretation.

The software used for the physical measurements was selected due to the ease of use and providing the data needed at the time of writing. Costs related to the licensing were funded through an independent Gofundme campaign (May 2020).

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APPENDIX 1

PLANNED SCHEDULE – Violeta Ivanova

	Months		
Process stage	Planning	Data acquisition	Writing
Topic - selection - definition	Spring - Summer 2019	Autumn 2019	Autumn 2019
Planning of content - thematic plan - research plan - roadmap	Autumn 2019	Winter 2019	Winter 2019
Literature - availability - reading	Winter 2019 – Spring 2020	Winter 2019 – Spring 2020	Winter 2019 – Spring 2020
Specification of the research or development task	Autumn 2019	Autumn 2019	Autumn 2019
Compilation of the theoretical background/framework/background material	Spring 2020	Spring 2020	Spring 2020
Data acquisition - Permits OP07B - Collection o *Questionnaire/Log* o *Heatmap*	- Dec 2019 - *Summer 2020*	- Dec 2019 - *Summer 2020*	- Dec 2019 - *Summer 2020*
Methods - studying - selection - application – exercise prevention program	Summer – Autumn 2020	Summer – Autumn 2020	Summer – Autumn 2020
Results or development proposals etc. - classification - conclusions	Autumn 2020	Autumn 2020	Autumn 2020
Writing	Autumn 2019 – Autumn 2020	Autumn 2019 – Autumn 2020	Autumn 2019 – Autumn 2020
Evaluation - proofreading - pre-examination - submittal of the thesis	November 2020	November 2020	November 2020

Source: Hakala, J. T. 2004. Opinnäyteopas ammattikorkeakouluille. Helsinki: Gaudeamus.

APPENDIX 2

Informed Consent form

Title of the research: Physiotherapy for prevention of Carpal Tunnel syndrome in PC Esports players
Author: Violeta Ivanova, Physiotherapy student at Satakunta University of Applied Sciences, Finland
Research Supervisor: Mari Törne, Senior lecturer of Physiotherapy at Satakunta Univesity of Applied Sciences, Finland

Data collection goals

This research aims to find out the physical stress in the wrist, elbow and shoulder experienced by an Esports player and how it relates to potential symptoms and performance level.

Data collection methods

For the purpose of this research, the collected data will be under anonymous nickname created by the player. There will be no collection of data related to exact age, gender, medical history or location. Personal information from the consent form will not be published and will be stored according to the Finnish law (information below).
The collected information will include a symptom diary Excel file that is filled by each player at the end of each day, for 7 days.
The diary includes logging of playtime hours, symptoms – numbness, burning/tingling, pain; 2 most played games, perceived personal performance and additional symptoms that are optional to disclose.

Consent

I declare that I am 18 years old or older.
I have received and read written information about the research mentioned above, which clarified the purpose of the study, as well as the nature of the research methods used. The bulletin explains the benefits of the study for the research subject as well as the possible risks and disadvantages. I have had the opportunity to ask researchers questions about research and participation, and to get answers to my questions.
It has been clarified to me that the material collected in the study will be stored digitally at Satakunta University of Applied Sciences and electronically on OneDrive which is protected by personal usernames and passwords. Access to anonymized material may be granted to other researchers upon request only for research purposes. The collected material may only be used for the purpose stated in the bulletin.
At no point in the publication of research results will my identity be revealed.

I have had enough time to consider participating in the study. I voluntarily agree to this study and, as described above, authorize researchers to collect, record, and use research-related information about me. I know that I may, at any time, withdraw my consent without giving any reason.

This consent form has been signed in duplicate, one for me and one for the researchers to file.

Consent:	Date:	Signature:
	First names:	Last names:
	Phone:	
Recipient of the consent form:	Date: 10.6.2020	Signature:
	Profession/status: Physiotherapy student	Name: Violeta Ivanova
	Phone:	Email: violeta.o.ivanova@student.samk.fi