TEXT MESSAGING & THE UPPER EXTREMITY

BRINGING AWARENESS TO THE OVERUSE INJURIES RELATED TO TEXT MESSAGING

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Dr. Grace M. Golden

Text messaging (texting) has become an increasingly and a more noticeably popular communication method within our society. Due to the potentially high volume and repetitive nature of mechanical loading and distinct positions required for texting, a health issue awareness has surfaced related to the potential impact texting has on the upper extremity. Despite its wide spread health implications, there is no prevalent published research addressing these potential texting related overuse injuries. A cross-sectional questionnaire-based study was created and conducted on the University of Oregon (UO) campus through online means, which was used to explore whether or not there was a relationship between texting habits and the signs and symptoms of overuse injuries. A twenty-four-item survey was used to investigate text messaging habits, musculoskeletal symptoms of injury in addition to participants past injury history. Other confounding factors that were considered to have the potential to contribute to musculoskeletal symptoms, (such as typing on a computer or what type of phone display they used) were also explored in the questionnaire. Of the three hundred respondents, data from 251 participants (age: 22.62 ± 3.57) was used for cross tabulation analysis. One hundred and

eighty-nine participants (75%) were female, 62 (25%) were male and 74% were current UO students. The main findings were: i) fifty-four respondents (22%) reported they had signs and symptoms with texting, ii) the most common single symptom and location of texting discomfort was stiffness in the thumbs, iii) the most popular interface was the vertically-oriented QWERTY keyboard, and iv) students mainly texted with the thumbs of both hands at the same time. Although some participants reported experiencing signs and symptoms with texting, there was no single analyzed factor which significantly contributed to an association between texting and overuse injury. An overwhelming majority of individuals who did have symptoms with texting (96%) did not seek medical attention, which suggests there is still a lack of awareness of the need to care for injuries which are related to text messaging behavior. Further research, aimed at investigating other age groups or population, along with the participation in other cell phone tasks (such as e-mailing or surfing the web), may lead to a better understanding of texting habits and potential for influence of upper extremity injury.

Key words: Text messaging; texting habits; Overuse injuries; Repetitive stress motions; Recurring mechanical loading; Musculoskeletal system; Upper extremity; Thumb pain; University of Oregon

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Chapter I:
INTRODUCTION

1.1. Preface

Text messaging has become an accepted and heavily used form of communication in today's society, and its convenience and efficiency is increasing its popularity. On a university campus sidewalk it is becoming quite common to see a pedestrian's head bent over their phone sending a text message. The nationwide popularity of texting is also evident. According to the Cellular Telecommunications and Internet Association (CTIA), annualized yearly text messages sent in the United States increased from 81 billion in 2005 to 2.1 trillion in 2010 (CTIA Consumer Info, 2011). However, the popularity of texting has created a backlash of concern, especially around the dangers of texting and driving. Thirty states, including California, Oregon and Washington, have banned text messaging for all drivers (Insurance Institute for Highway Safety – Highway Loss Data Institute, 2011). Aside from the potential dangers of being distracted when using this communication method while walking or driving, there is an existing concern for other potential health-related risks associated with text messaging. The repetitive act of operating a miniature keyboard stresses the body, and conditions lightly referred to as "Blackberry thumb" are now evolving into more serious complications such as "carpal tunnel syndrome".

1.2. Purpose

The various shortcomings associated with texting have included the dangers of texting while driving, losing more personal methods of communication, distracting kids

and young adults during school, and the increasing incorporation of texting vocabulary and jargon into our daily lexicon. While most shortcomings are social drawbacks, most research studies have examined the physical dangers of driving and texting (Texting-while-driving.org, 2010). However, there is also increasing research about another potential physical risk: the effect of text messaging on the musculoskeletal system in the upper body and neck, which includes areas such as the hands, wrists and shoulders. Musculoskeletal disorders are generally associated with risk factors such as repeated loading, mechanical pressure and force exertion; but may also include awkward postures and duration of loading when it comes to cell phone use (Chany et al., 2007), where the most reported upper extremity musculoskeletal symptom is muscle pain (Buckle & Devereux, 2002). Texting requires recurring mechanical loading on the hands and fingers, and involves distinct postures of the hands, wrists and neck; and as occurs with any repetitive motion, when the duration of loading is increased, texting may lead to an overuse injury. Overuse injuries, often termed repetitive stress injuries, are generally associated with the pathology of repetitive microtrauma to the musculo-tendinous unit (Keifhaber and Stern, 1992). Overuse injury will be the term mainly used in this manuscript to refer to text messaging syndrome as this thesis will include a technical review of this physiological injury.

To date there is minimal peer-reviewed literature with a main focus that has related text messaging to overuse injury. Therefore another purpose of this thesis is to increase the awareness of the potential correlation. Several sources of information have related overuse injuries to typing on a computer keyboard (Peçina et al., 2004), playing video games (Nett et al., 2008) or participating in sports (Renström et al., 1985), but very few have directly studied the effects of text messaging. A large amount of freelance online

information (meaning non-peer-reviewed) suggests a negative impact on the musculoskeletal system due to texting, but without the proper justification from peer-reviewed literature, it is difficult to be able to conclude there is evidence of a direct correlation. Therefore the lack of significant research relative to text messaging and musculoskeletal injuries warrants additional research. Swedish ergonomist Ewa Gustafsson affirmed the necessity to consider, "how much we use the small mobile phone keypads, [and why] it is important that we learn how they affect our bodies. We need to identify factors related to mobile phone usage that may affect our health and ability to work" (University of Gothenburg, 2009). It is essential to become aware of any potential dangers associated with texting in order to minimize the risks so as to ensure the maintenance of a healthy lifestyle in all aspects of our lives, especially with newfound technology and newly formed habits. In addition, Judith E. Gold, an ergonomist and epidemiologist at Temple University, reported a potential increase in risk of discomfort in the shoulder or neck due to texting, but suggested that further research needs to be done to validate those findings (Gold et al., 2009).

As the researcher was a science-major and research student (fostering an interest in medicine while channeling the goal of scientific research), the main intentions of this thesis were to, 1) explore whether text messaging is associated with self-reported upper extremity pain or injury; and, in light of the increasing popularity of texting, 2) raise the awareness of this potential health-injury, thereby triggering further research. Findings and conclusions of this study could be used by the cell phone industries potentially influencing the type of cell phones manufactured and commercialized or by parents who may be interested in learning about the musculoskeletal impacts of texting on their children, as they are acquiring cell phones at younger ages (Pew Research Center, 2010).

The expectations for the general population and medical community to consider the potential effects of texting on themselves or others are high, so those that hear about the study are encouraged to reflect upon their own texting habits and consider any potential risks related to overuse injury.

1.3. Hypothesis

Evidence of the relationship between the musculoskeletal injury and text messaging is limited to-date; however, available information suggests a possible correlation exists. Based on this information, this study was intended to investigate the potential relationship between self-reported musculoskeletal symptoms in the upper extremity and text messaging. We anticipated those individuals who participated in a large frequency and volume of texting would be at greater risk of musculoskeletal pain or discomfort; with confounding variables being 1) the type of cell phone keypad utilized, 2) previous injury in the upper extremity and neck and 3) participation in other tasks (such as typing on a computer or playing video games).

Chapter 2:
BACKGROUND AND REVIEW OF LITERATURE

2.1. What is text messaging?

Text messaging, originally known as Short Message Service (SMS), is creating a revolution in terms of communication methods utilized in this decade. Texting is a way to converse by sending and receiving short plain messages using a cell phone. It is necessary to know the other user's cell phone number in order to address the message properly. The 160-character-limit text-only message is sent through the wireless service provider's network, routed and delivered much like a voice call (CTIA – Business Resources). Text messaging may also include sending and receiving messages through the Multimedia Message Service, or MMS, where messages include not only text but also sounds, images and video (GSM World, 2010) where it is also possible to send messages to an e-mail address.

2.1.1. The popularity of SMS

According to English language author and researcher David Crystal, the Global System for Mobile Communications (GSM) began discussions of a short message service in the mid-1980s but it wasn't commercially developed until the early nineties (*Txtng: The Gr8 Db8*). The first ever text message was sent in 1992 (GSM World, 2010), and while many cell phone and service developments occurred since then, it wasn't until 2000 when the number of text messages sent in one month hit a count of five billion. The delay between the invention of texting almost 20 years ago and the reliance we place on it today as a primary means of communication was due to companies' difficulty in determining

appropriate pricing plans. Once these companies were able to frame realistic prices for the consumer, the popularity of texting increased to the rate and magnitude that we observe now. Additionally, Crystal reported world figures started out at 17 billion text messages sent in 2000 which increased to 250 billion in just one year. The same author suggests industry analysts have predicted a world figure of 2.4 trillion texts sent by the year by 2010. The number should be much higher than predicted since the United States alone has already reached 2.1 trillion [Table 1].

Table 1

Topic	Dec-10	Dec-05	Dec-00	Dec-95
Monthly SMS Messages	187.7B*	9.8B	14.4M	N/A
Annualized Yearly SMS Messages	2.1T	81B	N/A	N/A

"U.S. Wireless Quick Facts." *CTIA Consumer Info.* CTIA - The Wireless Association, December 2010.

*B = billion, T = trillion

In addition, the CTIA reports, "text messaging continues to be enormously popular, with more than 822 billion text messages sent and received on carriers' networks during the last half of 2009 — amounting to almost 5 billion messages per day at the end of the year," (2010).

2.1.2. Texting habits

It is important to examine which populations are sending out the most text messages as well as why texting is so popular. Using a logging tool on participants' phones, Battestini (2009) found student subjects (ages 17 to 26 years) communicated with a large number of contacts for extended periods of time, carrying on simultaneous conversations with as many as 9 contacts, and using texting as a way to switch between communication mediums, such as from chatting online to texting. Texting fits seamlessly into teen and young adult lives because, unlike phone calls, text messaging can be quietly

carried out unaware to parents, teachers or other authority figures; and unlike instant message chat on a computer, it can be done almost anywhere (Whitcomb, 2010). The Pew Research Center finds daily text messaging has increased rapidly from 2008, at which time 38% of teens were daily texters, whereas 54% were texting in September 2009. Of the 75% of teens who own cell phones, 87% use text messaging at least occasionally. Pew researcher Amanda Lenhart attributes the rise in texting in part to payment plans allowing for unlimited texting (Pew Internet Research, 2010). Because texting has become an essential and, at times, a preferred communication means, consideration must be made of the societal and health effects.

2.2. The upper body

Texting requires use of our upper limb and neck. The upper limb, upper extremity, or commonly referred to as the arm, extends from the deltoid region of the shoulder to the hand, including the arm, elbow, forearm, wrist and hand [Figure 1]. It is specialized for functions requiring great mobility such as grasping and manipulating (Dorlands, 2010). The bones in the upper limb are considered part of the appendicular skeleton helping anchor the limb to the axial skeleton. While the neck is considered a part of the latter, it is also involved with texting as it allows us to adjust our

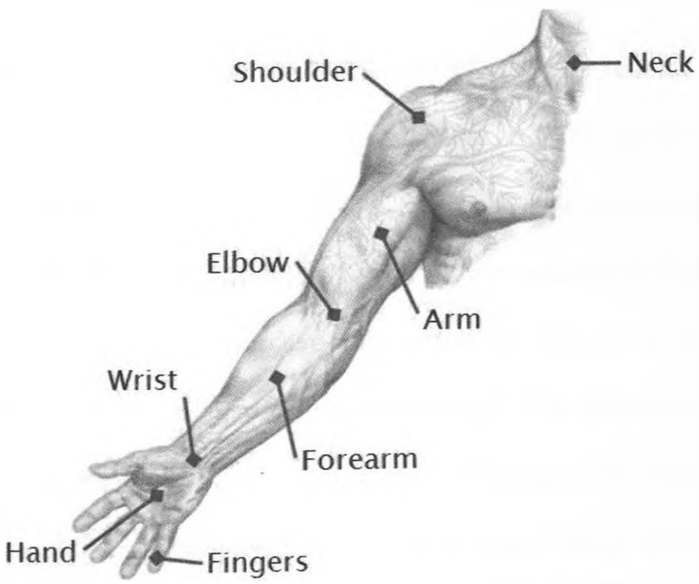
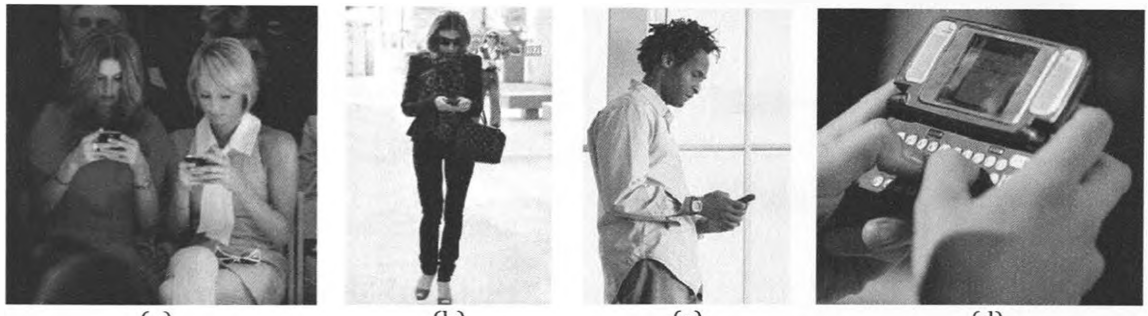


Figure 1. The surface anatomy of the upper limb and neck

gaze by flexing the head to look down on the phone, joining the shoulders in producing a commonly seen hunched position (University of Gothenberg, 2010) [Figure 2, a-c]. In this paper, the upper extremity and neck have been grouped under the term "upper extremity" when referring to overuse injuries. In order to further appreciate the potential for upper extremity posture to influence injury risk with texting, an understanding of the musculoskeletal anatomy of the upper extremity will be established.



(a) (b) (c) (d)

Figure 2. (a) Texting position while sitting down with head bent over phone. (b) Texting while walking with similar upper extremity position. (c) Standing position while texting, with neck and elbow positions seen more clearly. (d) Hand and thumb positions while texting.

2.2.1. The musculoskeletal system

The musculoskeletal system is one that can be directly affected by the repetitive motions of text messaging and the specific positions in which a cell phone needs to be held. The muscular system refers to the muscles in the body that help move the bones. The muscles involved are responsible for fine motor control of the fingers, in addition to supportive control of the hand and arm. The skeletal system is comprised of bones that help protect and support the body. They connect at joints and their ends are protected by cartilage, another type of connective tissue which helps reduce the friction when motions are made [Figure 3]. A body motion is made when a pulling force produced by a muscle is placed onto a bone, transmitting forces through a thick connective tissue called a tendon. Additionally, ligaments, which are another type of thick connective tissue, connect bones

to each other. These connective tissues along with nerves and various blood vessels work together in joints to move and support the body or parts of the body.

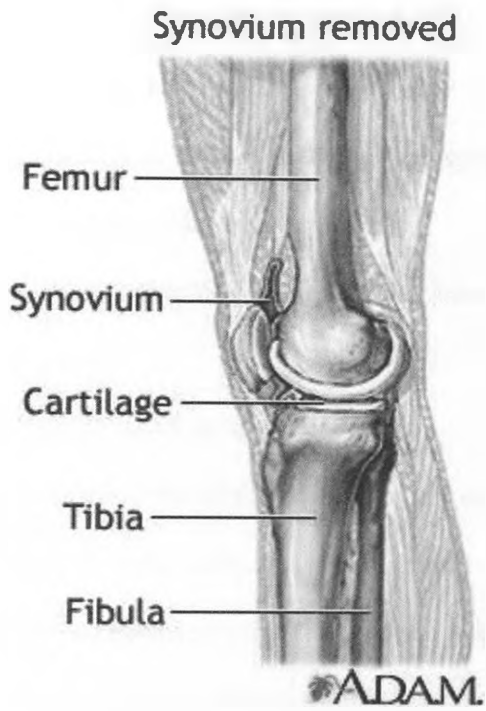


Figure 3. Cartilage at the knee joint.

2.2.2. The upper body anatomy

There are many joints found in the upper extremity that allow for movement and postural orientation of the body structure with respect to texting. The shoulder is quite immobile during texting while generally allowing for great mobility and gross placement of the arm in space during other daily activities (Starkey et al., 2010). Commonly referred to as the neck, the cervical region contains two of the most mobile vertebrae in the entire spinal column. The cervical vertebra, C1 or atlas, does not have a vertebral body and supports the weight of the skull through its two concave facet surfaces articulating with the occipital condyles of the skull and permits flexion and extension of the head (as done in order for the person to look down to their phone, [Figure 2, a-b]). The second cervical vertebra, the axis, has a process called the dens on which the atlas rotates allowing rotation of the head [Figure 4]. Due to

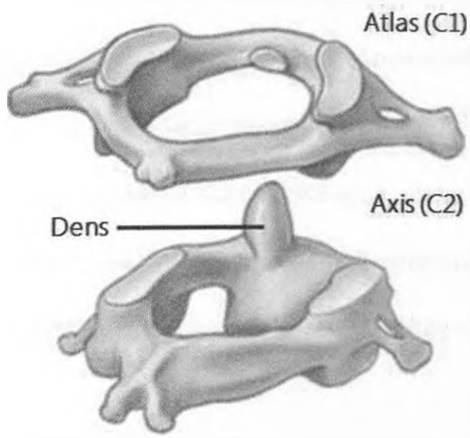


Figure 4. The atlas and the axis. "Skeleton Flash Cards." *The Biology Corner*.

the great mobility of the neck, the ligaments serving to support and strengthen this atloaxoid joint are called the capsular, anterior and posterior atloaxial, and transverse ligaments. Another ligament, the ligamentum nuchae, restricts flexion in the cervical spine and is a broad area for muscle attachment such as the trapezius and splenius capitis. Respectively, the muscles attach to the spine of the scapula (shoulder blade) and the base of the skull, both allowing for support of the arm and neck.

The elbow serves as an important link between the gross movements of the shoulder and fine motor control of the hand (Starkey, 2010). The elbow joint depends on its bone structure and soft tissues to maintain its stability as the joint allows flexion and extension to occur where the humerus contacts with the radius and ulna. The three bones are held together by major ligaments such as the radial and ulnar collateral ligaments as well as the annular ligament, which connect the radius and ulna. These elbow connections permit pronation and supination of the forearm where the hand is able to be palm up or palm down.

The more mobile joints during texting in the upper extremity are in the areas of the wrist, hand and fingers (Gustafsson, 2009). These joints allow strength and precision (Starkey, 2010) and fine motor skills, or the coordination of small muscle movements. The distal portions of the ulna and radius make the distal radioulnar joint also allowing for pronation and supination of the forearm, in addition to the elbow. The radius articulates with the eight carpal bones and makes up the radiocarpal joint permitting flexion and extension of the wrist. These two joints make up what is commonly known as the wrist joint.

The carpal bones articulate with the five metacarpal bones (at the carpometa-carpal (CMC) joints) that in turn join with the phalanges at the metacarpophalangeal (MP)

joints which are the base of the fingers. The fingers are made up of the proximal, middle and distal phalanges [Figure 5]. The phalanges are joined at the interphalangeal (IP) joints allowing for flexion and extension whereas the MP joints are condyloid joints allowing flexion/extension and adduction/abduction. The index (II) to ring finger (IV) CMC joints only allow flexion/extension as the first (thumb) and fifth (pinky) CMC joints have two degrees of freedom permitting abduction/ adduction in addition to occur. The first CMC joint has its own synovial cavity, separate of the others, and allows for opposition of the thumb, meaning it can touch each of the other four fingers.

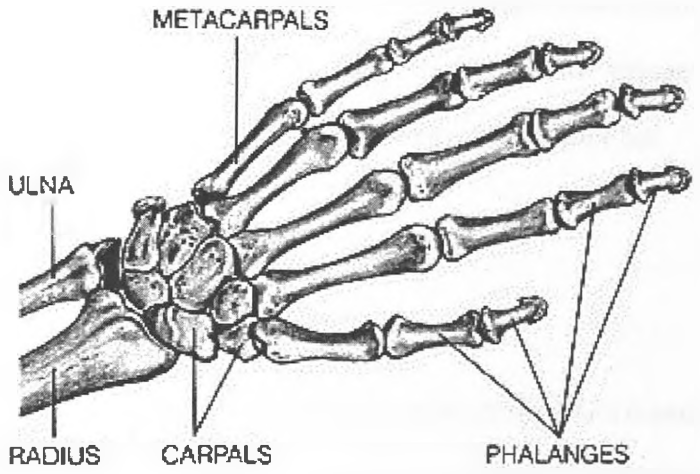


Figure 5. Bones of the hand. Phalanges – proximal, middle and distal (from left to right), with exception in the thumb that only has the proximal and distal. *Sydney Physiotherapist Clinic.*

All motions that are produced by the wrist, hand and fingers require the coordination of many joints. The various articulations are reinforced by numerous ligaments and sheaths which promote stabilization in addition to proper motions at each joint. The muscles of the wrist and hand allow for strong grip actions as well as fine motor movements. Each is innervated by the branches of the ulnar, median and radial nerves that provide motor and sensory input to each area.

2.3. *Pathologies of the upper body*

As the musculoskeletal system and related structures are susceptible to external injury or internal malfunctioning such inflammation or degenerative changes (also known as orthopedic injury) it is important to understand how the body responds to the stresses and forces placed upon the body and what happens when healthy adaptation does not occur.

2.3.1. *Tissue response to stress*

Stress is not only a psychological and emotional construct that affects one's mental state, but is also a term that is used to describe the physical forces or loads placed on one's body, directly affecting tissues. Stress is needed for soft tissue and bone to maintain homeostasis (Starkey, 2010) because otherwise, tissues may succumb to atrophy – an undesirable state where the tissues have less mass and strength than normal ones, such as in prolonged bed-rest or spending time in a cast. There is also the state of hypertrophy where the tissues may begin to grown in mass and strength in a healthy way over time due to the increase in stresses such as weight lifting or exercising. However, when the demands of activity result in stresses being applied too rapidly and the body's

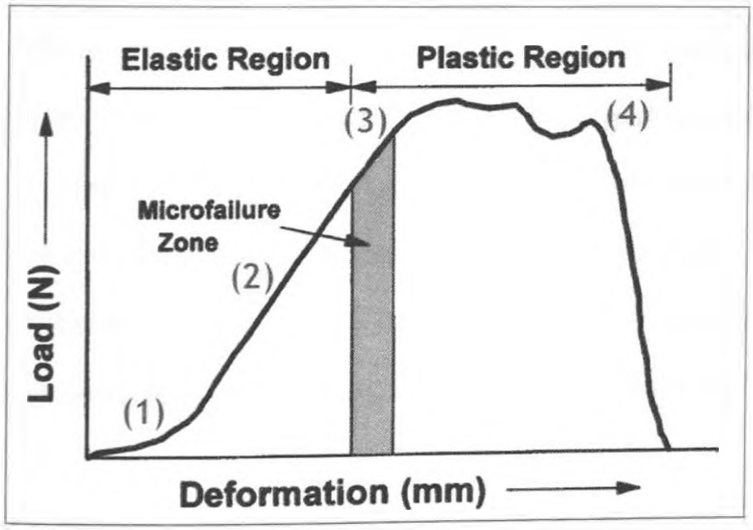


Figure 6. "Load-deformation curve."(1)Non-linear region, (2)linear region, (3)microfailure zone, and (4)failure point. *Ian Griffiths Sports Podiatry.*

tissues cannot adequately respond to them, injury or cell death may occur. Strain represents deformation of the sampled tissue and is dependent on the stress (load) applied. A stress-strain curve demonstrates the amount of tensile load some tissues may be able to handle before injury occurs [Figure 6]. For example, the deformation for a tendon is at first non-linear (1) with the load because the small stresses simply straighten out some initially-crimped fibers resulting in a disproportional strain. Once the load begins to stretch the fibers, the tissue enters a linear region (2) where the stress placed on the tissue causes a proportional strain, or deformation. The two areas are in the elastic region where if the load is taken away, with time the tissue eventually reverts to its original state, a phenomenon known as hysteresis. When the load placed on the tissue becomes too great and once removed does not allow the tissue to revert to its original state, the permanent changes in the tissue is understood to be characteristic of the plastic region. The microfailure zone (3) indicates where the potential for tendinopathy (or damages) exists, and pathology begins to manifest (Griffiths Sports Podiatry, 2010). However, the tissue is still able to adapt. When the load is further increased, the tissue reaches its ultimate failure point (4) meaning it is partially or completely damaged or deformed. At this point, the tissue has failed to adapt and can no longer function normally.

2.3.2. Mechanisms of injury

There are two different types of trauma that can lead the tissue to reach its failure point. The first is macrotrauma, which results when a single force leads to injury. The second type is termed microtrauma, where the tissue is subjected to repeated sub-maximal forces over time and when joined with insufficient rest periods it may lead to tendon abrasion (Starkey, 2010). The most common forms of acute musculoskeletal

trauma are usually due to tensile, compression, shear or torsion forces that can lead to tissue fatigue. Soft tissue pathology is the most common form of orthopedic injury which includes damage to muscles, their tendons, the skin, joint capsules, ligaments, nerves and bursae (Starkey). These injuries usually limit the motions of a joint or decrease the amount of force a muscle can produce. The most common soft tissue pathologies are strains and inflammations, along with dislocations or contusions.

2.3.3. Pain and inflammation

The signs and symptoms of chronic microtrauma tend to progressively worsen over time and with continued stresses may include pain and tenderness (Fry, 2008). In addition to tingling or numbness, pain and inflammation are important because the reporting of subjective information from the patient is non-invasive and allows clinicians to assess the significance of the injury for the individual. When loads are applied to tissues faster than the body can adapt to the stresses, a healing process called inflammation begins. This is a complex biological response of vascular (or blood conducting), chemical and cellular systems to harmful stimuli such as pathogens, damaged cells or other irritants (Ferrero-Miliani et al., 2007). It is a response which allows the body to attempt removal of the pathogenic stimuli in order to heal itself. Inflammation can be classified as acute or chronic. Acute inflammation is an initial response that stimulates plasma and leukocytes (white blood cells) to the area(s) of injury and may last a couple minutes to a few hours. Inflammation is considered chronic when it has been prolonged and tissues are constantly and simultaneously destroyed and healed (Cotran et al., 1998). The signs of acute inflammation are redness, heat, swelling, pain and loss of function. These are also seen in chronic inflammation, but may also involve other areas of

the body causing greater and a wider variety of symptoms. The redness and heat stem from the increased blood flow to the area. Swelling is from an accumulation of fluid in the tissue space; and pain is caused by the chemical stimulation of free nerve endings and noxious (pain) receptors. The resulting loss of function, often seen when tissues are inflamed, stems from a multitude of causes, including inhibition of muscle function and pain. This process signals something is wrong and whatever is causing the discomfort should be stopped. However, because overuse injuries sometimes may have a slow onset time, many people do not pay attention to the signs and symptoms until the damage appears chronic and may become permanent.

2.3.4. Overuse injuries

The syndrome related to excessive text messaging[1] has been identified by several names: overuse injury, repetitive stress injury (RSI), repetitive motion injury (RMI) or repetitive stress disorder (RSD). An overuse injury is a condition that develops because of recurring microscopic tears in the soft tissues, in this case, the musculoskeletal system and its related structures, and can be combined with effects on the microvasculature. Tissues are quite capable of healing when responding to triggers such as pain or inflammation due to acute or chronic trauma. However, an injury can occur when the rate of trauma overcomes the rate of the healing process, without necessarily causing a complete loss of function (Pitner, 1990). The events leading to the injury, as well as the level of stress required to incite them – whether due to time, volume or frequency – depend on the tissue and the individual. Physical signs in overuse injury consist of tenderness and pain in muscles, tendons and joint ligaments whose biological tolerance has been exceeded. Such

[1] By the various sources throughout this paper

signs in the intrinsic muscles of the hand and ligaments of the wrist joint and carpometacarpal joint of the thumb are virtually diagnostic of overuse injury (Fry, 2008). In a cross-sectional study of the relationship between repetitive work and the prevalence of upper limb musculoskeletal disorders, results indicate that repetitive work is related to upper limb discomfort, tendinitis, and carpal tunnel syndrome in workers (Latko et al., 1999). Texting may not be a seemingly stressful motion, but with the volume of the repetitiveness and increasing frequency of performing the task, it may cause harm to the body. The following includes a list of common overuse injuries that pertain to the upper extremity.

2.3.5. Tendinosis

Tendinopathy is the best generic descriptive term for the clinical conditions in and around tendons arising from overuse (Sharma et al., 2005). Most experts now use this term when the exact state of tendon pathology is unknown as it may include active inflammation (tendinitis) as well as microscopic tears (tendinosis). Tendinosis is the degeneration of a tendon from repetitive microtrauma without inflammation or collagen degeneration – usually seen in tendinitis (Starkey et al., 2006). Tendinitis is a tendon injury resulting from repetitive mechanical load with a subsequent inflammatory response (Almekinders et al., 1988), whereas bursitis is the inflammation of the bursa. The bursa is a fluid-filled sac that surrounds and lubricates a particular joint, decreasing the amount of friction and irritation that comes from normal movement of a joint. Bursae are found in areas of the body where excessive friction are common, such as under the patella, under acromion process of the shoulder, or around the greater trochanter of the femur; but rarely in the hand or wrist. Both of these injuries can occur from a sudden

severe impact, but are affected by minor repetitive motions leading to inflammation or degeneration. The main symptom of an overuse injury is pain; however there can be swelling or redness. On physical examination with tendinosis, there is often tenderness along the involved tendon or its sheath (outer covering), [Figure 7] or at one particular point within the tendon and pain when the muscle to which the tendon is attached is worked against resistance. As tendons age, they become less able to deal with stresses put on them because they become less elastic and easier to tear (Almekinders, 1988). Therefore tendinitis is more common in adults over 40 years of age which can be due to the average stresses they have put on their tendons throughout their lives or simply because of their age. However, if due to pathology, today's young adults may see tendinopathy become apparent earlier in our lives because of the excessive and unusual amount of stress we are putting on our tendons due to texting.

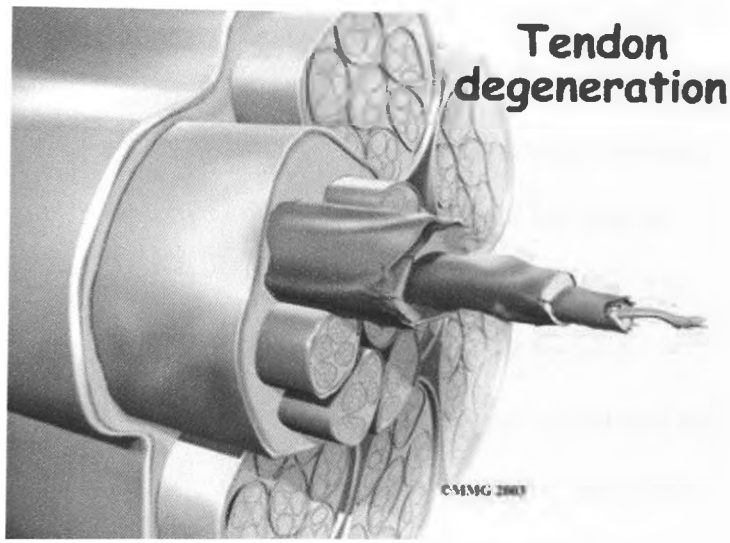


Figure 7. Inflammation of the tendon.

2.3.6. De Quervain's disease

A common tendinitis condition of the thumb is called de Quervain's disease. This is an inflammation of the sheath that surrounds the two tendons controlling movement of the thumb; the extensor pollicis brevis and the abductor pollicis longus [Figure 8]. The

inflammation of the tendons can cause pain and tenderness along the thumb side of the wrist, which is more noticeable when forming a fist, grasping or gripping things, or when turning the wrist (American Academy of Orthopaedic Surgeons, 2010). The cause of de Quervain's remains idiopathic, but may be caused by overuse. It is sometimes found in inflammatory arthritis and is most commonly seen in middle-aged women. De Quervain's has been associated with texting, however minimally, and has been newly termed as "texting tenosynovitis". In a New Zealand medical journal, Storr et al. (2007) reported of a 20-year old who had increasing pain and tenderness on the radial side of her right wrist and proximal thumb over a three-month period, consistent with de Quervain's. The subject had been sending 2500 texts a month with about 150 characters each using her right thumb. Once instructing the subject to begin texting with the left thumb as well, the original symptoms of the right hand developed in the left. Storr (2007) reports that while there are only two other known cases (that were treated with corticosteroid injections or topical naproxen and rest), texting tenosynovitis may be seen more frequently than we think.

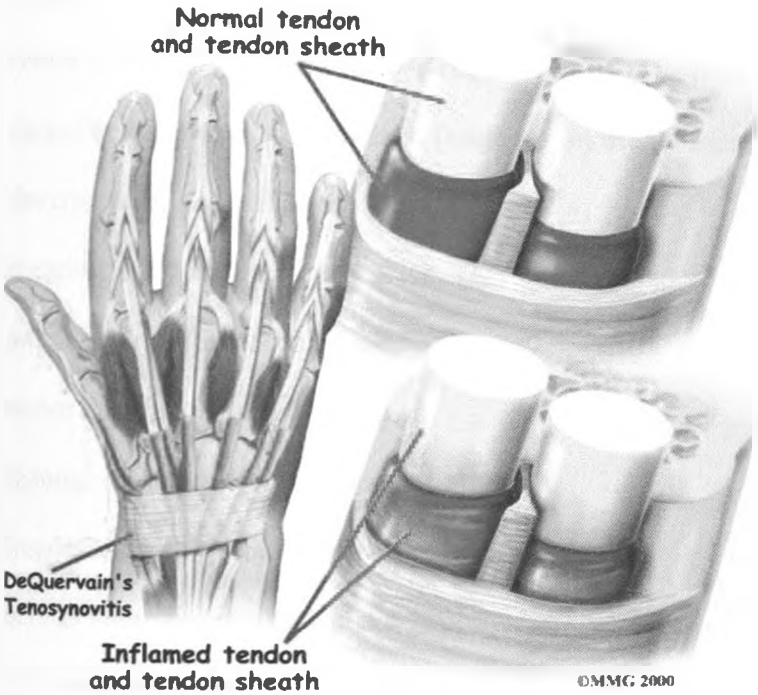


Figure 8. De Quervain's tenosynovitis.

2.3.7. Carpal tunnel syndrome

Carpal tunnel syndrome is another overuse injury, where the cause of it is similar to texting, in that it requires repetitive hand and wrist motions. The term "carpal tunnel" refers to a passageway in the wrist located at the base of the palm. It is made up of the carpal bones oriented in an arch (concave on the palmar side) and connected anteriorly by the transverse carpal ligament, creating the "tunnel" in the wrist. This passageway allows for the median nerve and flexor tendons to pass through connecting the forearm to the fingers. Carpal tunnel syndrome occurs when the median nerve becomes compressed (pinched) in this passageway due to a swelling of the actual nerve or the tendons that allow flexion at the wrist [Figure 9]. When this nerve is compressed, it affects the sensation to the palm side of the thumb, index and middle fingers as well as decreasing the force of the thumb muscles. This compression also creates a tingling feeling, along with pain that can spread to the forearm and fingers. Carpal tunnel has been associated with tasks including awkward hand motions and mechanical stresses on the palm; or as Silverstein et al. (2007) have found, with high force-high repetitive jobs. These may include computer use or typing, machine operation, heavy lifting and



Figure 9. Carpal tunnel syndrome. *The Internet Encyclopedia of Science*

assembly-line work. Carpal tunnel has also been associated with texting as a 16-year old was diagnosed with it from sending approximately 100 texts per day at her peak (ABCNews.com, 2010). The subject initially felt tingling and decreased sensation that eventually led to decreased strength to grasp everyday objects.

2.3.8. Basal joint arthritis

The word arthritis comes from its root words *arthro-* and *-itis*, meaning joint and inflammation, respectively; however, medically, the term arthritis encompasses a group of diseases and conditions affecting the joints of the body in a variety of different ways. Basal joint arthritis is more commonly known as CMC or thumb arthritis because it affects the carpometacarpal (CMC) joint of the thumb. A loosened ligament may cause abnormal rotation of the joint causing increased wear or arthritis (University of Washington Medicine Hand Center). It is a fairly common condition, especially in women, but treatment may range from splinting or reconstructive procedures to restore thumb motion and strength (Alton Barron et al., 2000). Basal joint arthritis has also been connected to text messaging by Ming et al. (2006) where the subject had swelling and pain at the base of their left thumb for about two years. The x-ray showed a subluxation (a partial dislocation) and arthritis of the first CMC joint of the left hand where they stated that excessive mobile use with active texting was the main cause of the problem.

2.4. Cell phone-related risks

The upper extremity is susceptible to a multitude of injuries and diseases, from the neck to the tips of fingers. As previously mentioned, pathologies may have connections to texting, or at least with cell phone use. The extended intensive use of mobile phones and

other devices for information and communication technology could expose the thumbs and fingers to operational stresses beyond their intended function which may generate pain and musculoskeletal disorders in the thumbs and associated joints (Jonsson, 2009). While the elbow is mainly immobile during cell phone use (meaning there are no gross movements done with the joint), this does not rule out elbow pathologies due to cell phone usage. Orthopedic specialists are reporting cases of "cell phone elbow," or cubital tunnel syndrome, in which patients may damage the ulnar nerve in their arm by bending their elbows too tightly for too long compressing such nerve (Darowish et al., 2009). The Hand and Upper Extremity Center physicians at the Cleveland Clinic observed tingling in the ring and small finger in a clinical setting that may be due to holding the cell phone close to the ear. As texting allows the elbow to be held at a lower position so as to see the electronic (thus causing less of a nerve compression), it may still increase the risk of injury.

2.4.1. Research

As there are few reported cases of texting-related syndromes or conditions, the research about how texting may affect the upper extremity has also been limited. Text messaging usually actively involves the use of the thumb of one hand to type on a phone keypad where the movement of the thumb covers motions in the planes of flexion-extension and abduction-adduction (Ong, 2009). The studies conducted by Gold et al. (2009) and Gustafsson et al. (2009) have attempted to directly connect texting to any musculoskeletal symptoms in the upper body. Gold's questionnaire-based study addressed whether or not there was an association seen in self-reported musculoskeletal discomfort and the number of text messages sent per day in college students. They

demonstrated that shoulder or neck discomfort may be affected by the number of daily text messages sent. Gustafsson reported that sitting and standing postures and the type of cell phone task affected muscle activity and thumb positions during cell phone use (2009). She also found that subjects with musculoskeletal symptoms in the wrist and hand tended to move their thumbs with a higher speed than those without symptoms. The higher velocity may partially explain why they have developed symptoms as high movement velocity has been found to be a risk factor for musculoskeletal disorders. That same symptomatic group also tended to text with fewer and shorter pauses, adding to the proof that high frequency movements may be a risk factor. More recently, Gustafsson et al. (2010) published another study that expanded on whether or not thumb postures, movements and muscle activity were affected while texting. They observed that females were found to have higher muscle activity in the extensor digitorum and abductor pollicis longus (APL) while texting than males. Females also had greater thumb abduction and higher movement velocities than males, along with fewer pauses in their thumb movements (Gustafsson, 2010). They also found that subjects with musculoskeletal symptoms had lower muscle activity in the APL but had higher thumb movement velocities and fewer pauses compared to the group without symptoms.

Per Jonsson (2009) used electrogoniometry (the measurement of joint angles) and electromyography (the measurement of electrical activity in a muscle) and observed that thumb movements worked near extreme ranges of motion while texting which had the potential for contributing to musculoskeletal disorders. Jonsson reported thumb posture was affected by the size of mobile phone used and that the thumb moved almost twice as fast during in abduction/adduction than during flexion/extension [Figure 10]. Another study also determined thumb motion as well as typing forces for texting on a cell phone,

however because these motions occur simultaneously it is difficult to completely isolate each movement of the thumb (Ong, 2009). Ong observed the IP and MCP joints to be responsible for thumb flexion/extension during texting while abduction/adduction was executed by the CMC joint. He also found the MCP and CMC joints experience more opposition movement (when the thumb reaches over in the direction of the other fingers) than abduction/adduction.

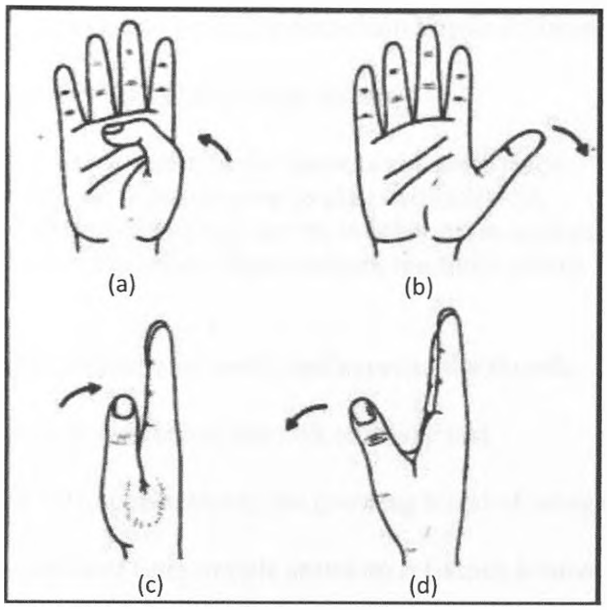


Figure 10. Movements of the thumb in two different axes. (a) Flexion, (b) extension, (c) adduction and, (d) abduction.

2.4.2. Awareness

Earliest reports of the association between pain or discomfort and cell phone use began in 2005 in unreliable sources such as USA Today (2006). However, reports of discomfort to mainly the thumb due to typing on a computer or playing video games were already found in other more credible literature. The American Society of Hand Therapists (ASHT) and The American Physical Therapy Association and other occupational organizations warned that improper use and overuse of handheld electronics, such as personal digital assistants (PDAs) such as Blackberries and iPods are more likely to develop symptoms ranging from swelling and hand throbbing to tendinopathy (ASHT, 2005; Business Credit, 2006). The concern comes from the workplace, where companies who require their employees to have PDAs could be liable if injuries came from using such

devices. In a similar article, Margot Miller, the president of the American Physical Therapy Association (APTA)'s Occupational Health Special Interest Group, states,

> The use of PDAs is no longer limited to the eight hours spent in the workplace. More and more, people are depending on these devices to stay in touch with friends and family before and after the workday and on the weekends, as well as having access to work when they leave the office. That is where the heart of the problem lies (US News, 2008).

Miller also adds, "Because the keyboard of the PDA is so small, and because the thumb, which is the least dexterous part of the hand, is overtaxed, the risk of injury just skyrockets" (APTA, 2006). Whereas the APTA began noticing the growing trend of using a hand held device and an increase in the amount of time people spent on it (which is now reflected in the CTIA consumer report about the increasing number of text messages), years later there are still only a few studies or reports to be found to substantiate the problem.

The overall purpose of this paper was to observe, through a self-reporting survey, if in fact texting could increase one's risk of musculoskeletal disorders in the upper body and whether it may add to the increasing awareness of such risk that is currently found on the Internet or through scientific studies.

Chapter 3:
METHODS

3.1.Study design

This thesis was comprised of an online survey created to provide additional qualitative information that would contribute in the discussion of the potential relationship between musculoskeletal injury and text messaging. A twenty-four item survey [Appendix A] was created using Qualtrics™, a web-based research software company in order to allow as many as 500 respondents once distributed. Questions ranged from obtaining the subjects' upper-musculoskeletal history and their texting profile, to identifying their participation in any additional hand-intensive activities such as playing a musical instrument or typing on a computer keyboard. The basis of these questions came from the Gold et al. study at Temple University whose questionnaire only included the volume of text messages sent per day and a body map to indicate areas of discomfort, with confounding variables of gender and age. Our intention was to build upon this study and ask more detailed questions. The online survey was intended to increase statistical analysis efficiency as well as allow for the most resourceful distribution possible. The survey and all distribution methods were approved by the University of Oregon Office for Protection of Human Subjects (OPHS).

3.2.Participants

The primary population of interest for this study was currently-enrolled students at the University of Oregon (UO) through the Spring 2010 term. However, respondents from other institutions or the surrounding community were also included. In order to

comply with the standards of the OPHS, participants electronically signed a consent form indicating they were at least eighteen years of age. The intention was to study average UO students for their texting profile and potentially extrapolate the results to learn the habits of a young-adult population in general. The primary methods of recruitment for these participants were via UO e-mail listservs and Facebook; the latter allowing for non-UO students to respond. In addition, a technique described as snowball sampling was also used – one where one respondent told other respondents about the survey and in turn those respondents told others, etc. The subjects required only their own internet access point to participate in the survey, and no subject was allowed to complete the survey more than once. Respondents were not penalized for not answering. Additionally all subjects had the chance to decline participation in the survey, withdraw from their initial consent to participate, as well as provide their e-mail address in order to receive feedback once the thesis project was completed.

3.3.Statistical analysis

The responses of the survey were collected by Qualtrics and were accessible by the researcher with username and password information. Reponses could be seen collectively or individually. Once the survey was completed, the data as a whole was extracted to a database spreadsheet (Microsoft Office Excel 2007) to be used for further analysis. After excluding any data that would have invalidated results, the responses were then categorized and analyzed using Predictive Analytics SoftWare (IMB Corporation, Somers, NY). The intent of the statistical analysis for the data obtained was to calculate observed frequencies as well as look for any relationship between two or more variables (e.g., type of cell phone interface used and the presence of musculoskeletal symptoms or in what

area of the upper extremity they show up in). The use of crosstabulation (or contingency table) analysis was useful in this case as it displayed the joint frequency distribution of two variables, one being the independent variable and the other the dependent variable. The independent and dependent variables were chosen based on the likelihood of which variable would most likely influence another. The joint frequency distribution was analyzed with the *chi-square* statistic (χ^2) to determine whether the variables were statistically independent or if they were associated. The a priori level of significance was set to $\alpha \leq 0.05$ for chi-square tests.

Chapter 4:
RESULTS

4.1.Subjects

Upon completion of the survey, there were 300 responses collected; of which 251 participants fully completed the 24-item questionnaire with usable responses that would not invalidate any results. The data excluded responses from participants that chose not to indicate their sex, chose responses that contradicted each other (i.e., did not indicate they experienced signs and symptoms, yet still indicated a location and severity of their discomfort), or did not complete the entire survey. Overall, nearly three-quarters (74%) of respondents were current Spring 2010 UO students, ages ranged from 18 to 52 years (21.62 ± 3.57) [Graph 1], with 189 females and 62 males responding. Among the 251 participants, 89% were right handed and 26% reported a significant past

Graph 1. Ages

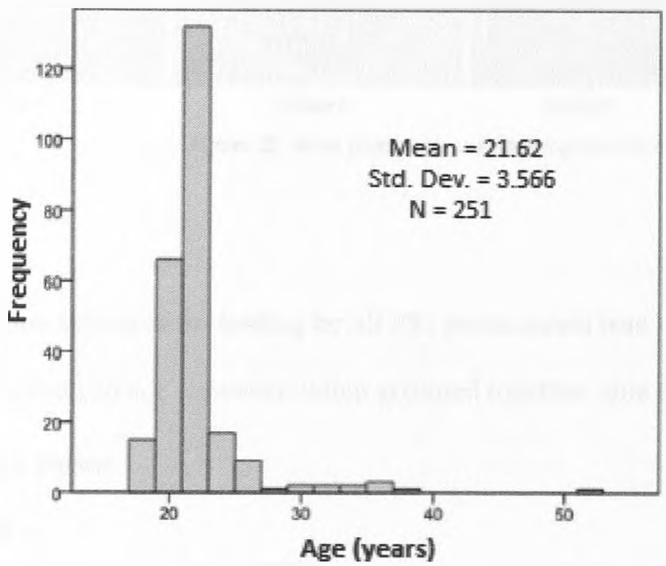
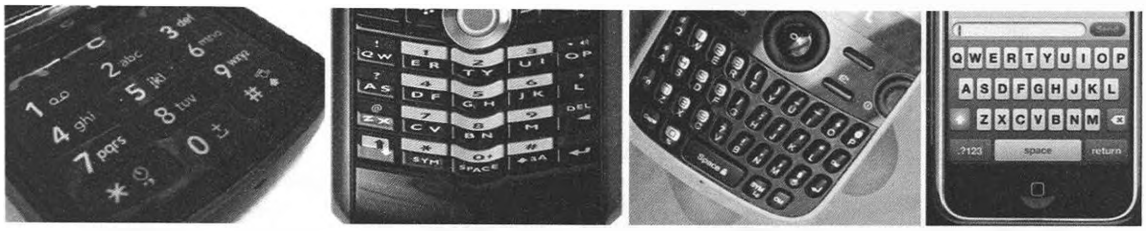


Table 2. Participant overview

		n	%
Status	**Total**	**251**	**100.0**
	UO Student	186	74.1
	UO Staff/Faculty	7	2.8
	Other	58	23.1
Sex	**Total**	**251**	**100.0**
	Female	189	75.3
	Male	62	24.7
Handedness	**Total**	**251**	**100.0**
	Ambidextrous	10	4.0
	Left-handed	17	6.8
	Right-handed	224	89.2
Past Injury	**Total**	**251**	**100.0**
	No	187	74.5
	Yes	64	25.5

injury to their upper extremity – injuries including a variety of bone breaks, dislocated shoulders, torn or sprained ligaments, and tendonitis [Table 2].



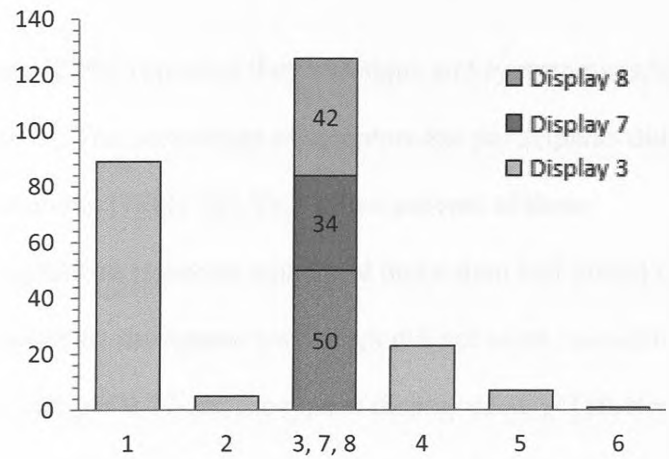
Display 1 Display 3 Display 7 Display 8

Figure 11. Most commonly used texting interfaces

4.2.Responses to texting profiles

The single most used cell phone interface for texting for all 251 participants was Display 1, the alphanumeric hard keypad (36%). However, when grouped together, due to their similar vertical orientation and QWERTY-style keyboards (Displays 3, 7 and 8, condensed hard keypad, full hard key pad and full touch screen, respectively; [Figure 11 & Appendix A]) the resulting interface made up half (50%) of the responses to which texting display is mainly used [Graph 2 & Table 3a]. Eighty-six percent of participants indicated they have an unlimited texting plan and 62% send zero to 40 texts per day, with another 27% sending 40 to 100 texts per day. The most common method used to text is with the thumbs (94%) while using both hands at the same time

Graph 2. Displays



(63%), [Table 3b]. Sex also played a difference in the appearance of signs and symptoms as more females reported experiencing them than males, χ^2 (2, N = 251) = 7.56, p = 0.02.

Table 3a.

	n	%
Display	**251**	**100.0**
1) Alphanumeric hard keypad	89	35.5
2) Alphanumeric touch screen	5	2.0
Vertical QWERTY	126	50.2
3) Condensed hard keypad	50	39.7
7) Full hard keypad	34	27.0
8) Full touch screen	42	33.3
4) Condensed QWERTY touch scrn	23	9.2
5) Horiz. QWERTY hard keypad	7	2.8
6) Horiz. QWERTY touch screen	1	0.4

Table 3b.

	n	%
Method to text	**251**	**100.0**
Thumbs	236	94.0
Index Finger	10	4.0
Pen	1	0.4
Other	4	1.6
Hand used to text	**251**	**100.0**
Right	63	25.1
Left	4	1.6
Switch hands	26	10.4
Both at same time	158	62.9

Table 4b. Experiencing signs & symptoms from texting

		n	%		n	%
Experience	**Total**	**251**	**100.0**	**UO students**	**186**	**100.0**
Symptomatic		54	21.5		44	23.7
Asymptomatic		120	47.8		89	47.8
Unrelated to texting		77	30.7		53	28.5

Of all respondents, 54 respondents (22%) reported they had signs and symptoms (s/s) with texting (44 female and 10 male). The percentage of symptomatic participants did not change with only observing UO students [Table 4b]. Thirty-two percent of these symptomatic participants cited significant previous injury and more than half (54%) used Displays 3, 7 and 8 [Figure 11]. However, the appearance of s/s did not seem related to previous injury, χ^2(2, N = 251) = 1.51, p = 0.47 nor the type of display used, χ^2 (10, N = 251) = 6.75, p = 0.75. The most common symptom in this cohort was stiffness (64%) while 26% reported experiencing two symptoms or more (the majority being pain in addition to stiffness). More than half (52%) indicated their symptoms were mainly located in their thumbs, while 37% indicated two locations or more (including the thumbs

and hands). Sixty-seven percent of these symptomatic participants indicated their level of discomfort was chiefly low (0 to 3 on a scale of 0 to 10; 0 being none, 10 being the worst possible pain, (Farrar et al., 2001)) but 17 people (32%) did report a moderate level of discomfort (4 to 6 on the same scale). Thirty-six of the 54 (67%) also indicated their usual treatment for their symptoms was to pause in their texting to rest or massage the area of discomfort while 32% just ignored their symptom(s) and continued texting. The treatment also differed by sex as the majority of females (75%) were more likely to attend to their s/s while the majority of males (60%) ignored the issue. However, nearly all of the symptomatic participants (96%), male or female, did not seek medical attention for their discomfort with texting [Table 5a].

Table 5a. Symptomatic cohort

	n	%
Symptoms	**54**	**100.0**
Pain	3	5.6
Numbness	1	1.9
Tingling	2	3.7
Stiffness	34	63.0
2 symptoms or more	14	25.9
Stiffness	12	85.7
Pain	11	78.6
	n	**%**
Location	**54**	**100.0**
Thumbs	28	51.9
Hands	3	5.6
Distal Limb	2	3.7
Proximal Limb	1	1.9
2 locations or more	20	37.0
Thumbs	18	90.0
Hands	12	60.0
Severity	**54**	**100.0**
Low (0-3)	36	66.7
Moderate (4-6)	17	31.5
Severe (7-10)	1	1.9
Treatment	**54**	**100.0**
Pause from texting	36	66.7
Switch hands to text	1	1.9
None	17	31.5
Medical Attention	**54**	**100.0**
Yes	2	3.7
None	52	96.3

Another cohort that included 31% of all participants reported they experienced s/s but indicated they believed their conditions were unrelated to texting. Twenty-two percent of these respondents indicated a previous injury to their upper extremity and half of them (53%) also used Displays 3, 7 and 8 (Appendix A). Forty-eight percent of respondents did not experience any s/s, also referred to as asymptomatic participants, and only a quarter (25%) of them reported a previous significant injury. Fifty-six of the 122 asymptomatic respondents also used Displays 3, 7 and 8.

Respondents were also asked to indicate if they participated in any hand-intensive activities, such as typing on a computer keyboard, playing video games, surfing the internet on their phone or playing a musical instrument. Additional activities were reported such as jewelry making or writing notes. Thirty-two percent reported only typing on a computer as another activity, while 67% participate in two activities or more – 99% indicated their other activities included typing on a computer and 38% indicating playing video games. Overall, nearly a quarter (26%) said they spent five to ten hours per week performing these activities while another quarter (26%) spent ten to twenty hours per week [Table 3c]. The relation between how many hours per week spent on other hand-intensive activities and the appearance of s/s due to texting mainly manifests when the use indicates using Display 1, χ^2 (14, N = 89) = 26.79, p = 0.02.

Table 3c.

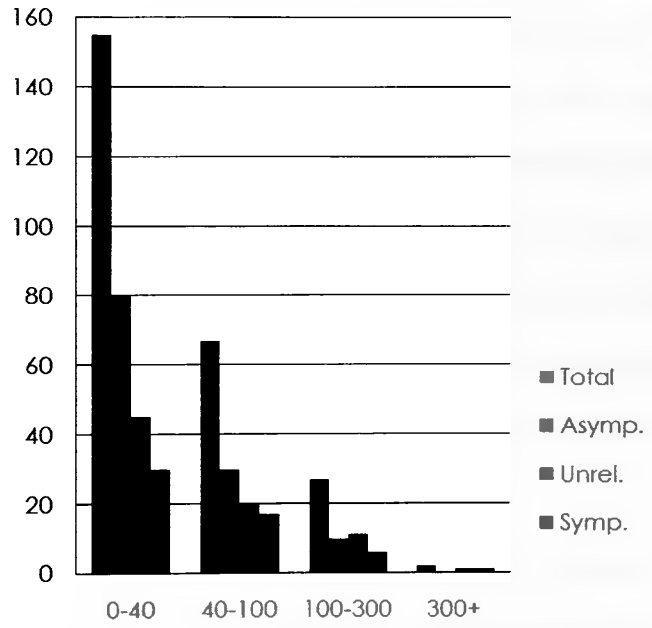
	n	%
Other activities	**251**	**100.0**
None	1	0.4
Type on a computer	80	31.9
Surf web on phone	1	0.4
Play music	1	0.4
2 activities or more	168	66.9
Type on computer	167	99.4
Play video games	64	38.1
Hrs/wk on other activities	**251**	**100.0**
0 - 5	36	14.3
5 to 10	66	26.3
10 to 20	64	25.5
20 - 30	39	15.5
30 - 40	25	10.0
40 - 50	9	3.6
50 - 100	8	3.2
100 or more	4	1.6

Table 6. Chi-square values from the crosstabulation (with a layer variable) between two variable "hours per week spent on hand-intensive activities" & "appearance of signs and symptoms". Layer variable is "display used".

Layer variable		Value	df	χ^2
Display 1	Pearson Chi-Square	26.793	14	0.020
	N of Valid Cases	89		
Display 2	Pearson Chi-Square	6.250	6	0.396
	N of Valid Cases	5		
Display 3, 7, 8	Pearson Chi-Square	19.771	14	0.138
	N of Valid Cases	126		
Display 4	Pearson Chi-Square	9.956	12	0.620
	N of Valid Cases	23		
Display 5	Pearson Chi-Square	9.800	8	0.279
	N of Valid Cases	7		
Display 6	Pearson Chi-Square	--	--	--
	N of Valid Cases	1		
Total	Pearson Chi-Square	19.563	14	0.145
	N of Valid Cases	251		

Overall, the appearance of symptoms (dependent variable) was not affected by the number of texts sent per day, χ^2 (6, N = 251) = 5.06, p = 0.54 [Graph 3]; the type of text messaging plan used, χ^2 (8, N = 251) = 8.95, p = 0.35; the average number of characters their average text message has, χ^2 (10, N = 251) = 7.90, p = 0.64; their method to text, χ^2 (6, N = 251) = 5.67, p = 0.46; nor which hand is mainly used to text, χ^2 (6, N = 251) = 8.54, p = 0.20. All frequency tables, crosstabulations and graphs are found in Appendix B.

Graph 3. Number of texts sent per day



Chapter 5:
DISCUSSION

5.1. Findings

Overall, the results failed to support the hypothesis of this study. There is no significant evidence texting leads to self-reported overuse injury as only 22% respondents of the survey indicated experiencing signs and symptoms (s/s) in their upper extremity and neck. In addition, there is also no strong evidence that college-age students are prone to symptoms with texting as only 24% of UO students reported feeling s/s. This is not to say that texting does not cause discomfort as 22 or 24 are still noteworthy percentages. However, it is determined that texting may not as risky as theorized, at least in the college-age range. There were no differences seen between symptomatic and asymptomatic participants when reporting which texting interface they most often used, how many texts per day they sent, or whether they used only one hand to text or both. Additionally there was no difference seen between both cohorts based on whether or not they had a past injury.

Observing all participants, the vertical QWERTY-keyboard interface (hard key pad or touch screen) was the most used; which explains why using the thumbs of both hands at the same time was the most reported means for texting. The use of the thumbs to text supports the findings of Gustafsson (2009) who found high velocity movements in this area with texting. Berolo et al. (2010) also observed pain in at least one body part and right hand pain was most common at the base of the thumb. However, this study found that the vertical QWERTY keyboard interface did not affect participants reporting signs and symptoms (s/s) due to texting. As the interface allows both hands to be used, there

may be a distribution of movements and forces between the two thumbs and may explain the lack of symptoms reported when used. In contrast, when comparing time spent engaging in other hand-intensive activities and the presence of s/s, the interface that did have a significant affect with texting was the alphanumeric hard keypad. Meaning, when the subject used Display 1 and spent large amounts of time participating in hand-intensive activities, s/s would surface. This might be explained by the size of the keyboard which may restrict the movements of the thumb and hand. As each key represents more than two or three characters, the thumb must repeat more of the same motions on a smaller surface area. As we have seen in the description of overuse injury, the volume and frequency of such movements are factors in its manifestation. Therefore, while only texting on an alphanumeric keypad may not initially make s/s appear, once other hand-intensive activities are performed in large amounts of time, they may. Returning to the vertical QWERTY interface, as the thumbs are allowed a wider range of movements due to the size of the mobile device and spread of its characters, this decreases the risk of injury.

The volume of texting itself did not affect experiencing s/s as 56% of the symptomatic cohort only sent 1 to 40 texts per day. However, this could be the result of the discomfort they feel with texting and chose to send fewer texts. This also may explain why 64% with a reported past injury also only sent 1 to 40 texts per day. It is interesting to note the two participants that reported sending more than 300 texts per day indicated they experienced s/s – one believing their s/s in their thumbs and hands to be from texting and the other believing their s/s were unrelated to texting – even though they also reported a past injuries to their hand. While this study did not find a relation between males and shoulder s/s like Gold et al. (2009), it cannot be ruled out that texting does not affect the upper musculoskeletal area. Additionally, in light of increasing the awareness of

texting and overuse injury, 90 of the 251 (36%) participants in the survey were interested in receiving the results of the study.

5.2.Study limitations and errors

The questionnaire was very helpful in categorizing answers and allowing for an easy collection of data. However, a few specific limitations should be addressed. First it may be the lack of evidence to link texting with overuse injuries as may happen with a limited subject age range. The elected focus on distribution of the survey to people over the age of 18 excludes adolescents, who may have a different text messaging profile with respect to phone type, volume and possible associated signs and symptoms. The number of females also greatly outnumbered the males which could have influenced the results. Nevertheless, this preliminary study is good foundation for further research to continue. Further studies should not only include adolescent participants, but allow respondents to explain why they send the number of texts per day they do – whether because of their past injury or because they feel s/s when they text.

Studies should also increase the focus on how many tasks each person performs on their mobile device, such as e-mailing, instant messaging, or surfing websites such as Facebook or Twitter as mobile phone technology is advancing and the "smart phone" is becoming increasingly popular. Smart phones include a variety of applications that increase the time a user might spend on their phone that may increase their typing time. This study only included texting and "other hand-intensive activities" but the former tasks may also be confounding factors in the appearance of musculoskeletal symptoms.

As an additional step to this type of project, it would be of value to interview the symptomatic cohort to find similarities in their texting profiles. Supplementary

information may lead to additional questions or further findings that could bring to light the factors that actually may increase the risk of experiencing signs and symptoms with texting.

Chapter 6:
CONCLUSION

6.1.Summary

The findings of this study show that there is no significant link between a texting variable and reports of discomfort or pain in the upper extremity. While there were participants who did report signs and symptoms, there was no single factor analyzed which greatly contributed to that fact other than a history of significant past injury to their upper extremity and neck. However, 22% of subjects were found to have signs and symptoms with texting. It was observed that the majority of participants use a QWERTY-keypad in the vertical orientation and was most likely to text with their thumbs on both hands at the same time. Of the subjects who did experience pain or discomfort, the majority did not seek medical attention indicating the lack of awareness and therefore lack of response by the medical community. Overall it cannot be completely ruled out that texting does not affect the upper extremity.

6.2. Applications

While this study did not show that texting led to overuse injury in UO students, it is still possible that other age groups may have a greater risk from texting. As many ages and populations were not able to be represented in this study, further studies must be done in order to find out how risky texting is. Coincidentally, this study may create a baseline of information for further studies.

Appendix A:

SURVEY

1. Introduction

You are invited to participate in a research study conducted by Martha E. La Rosa, an undergraduate student of the Department of Human Physiology at the University of Oregon (UO). The purpose of this research study is to find out more about an individual's texting habits. Pain or discomfort have been reported in the upper extremity and associated with texting or with other activities that require the same posture or repetition of movements. The information obtained in this study will be used to determine whether or not there is an association between text messaging habits and upper extremity injury. The information will then be used as material to write an Clark Honors College thesis.

If you decide to participate, you will be asked to fill out an online survey which should take no longer than 10 minutes to complete. You will be able to fill out this survey on any computer of your choice. There is no cost to you for participating in this survey. If you complete the survey, you will have the opportunity to enter your e-mail address if you would like feedback on the results of this project.

Your email address will not be linked to your survey in any way and it will not be possible (even for the researchers) to identify which survey is yours. However, were any information obtained in connection with this study to be identifiable with you, it would remain confidential and not be disclosed without your explicit permission.

Your participation is voluntary. Your decision whether or not to participate will not affect your relationship with the researchers or with the University of Oregon. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without penalty.

We encourage you to forward the link to this survey to other students or staff at the University of Oregon, or other adults you may know, as we hope to reach as many individuals as possible. Please note that the deadline for completing this survey is May 15, 2010.

2. Consent to Participate & Research Procedures

INFORMED CONSENT
Please read the following informed consent statement. Click the bubble below the statement if you understand the informed consent statement and agree to participate in the survey.

We encourage you to PRINT and keep a copy of this consent form for your records. Please note that you must be at least 18 years of age. If otherwise, your data will not be used.

RESEARCH PROCEDURES
This research is being conducted to discover the texting habits of adults. If you agree to participate, you will be asked to complete a 10 minute online survey with a series of demographic and open-ended items related to this topic.

RISKS
There are no foreseeable risks for participating in this research. Specifically, "the chance and magnitude of potential harm or discomfort during the course of the study is no greater than that encountered in everyday life". However, completing the survey may influence your behavior associated with text messaging.

BENEFITS
There are no specific benefits (monetary or otherwise) to you as a participant. Your participation may, however, further research into text messaging and overuse injuries.

CONFIDENTIALITY
The data in this study will be anonymous. Names and other identifiers will not be placed on surveys. Furthermore, the data will not be linked to email addresses or any other identifiers. In addition, while it is understood that no computer transmission can be perfectly secure, reasonable efforts will be made to protect the confidentiality of your transmission.

PARTICIPATION
Your participation is voluntary, and you may withdraw from the survey at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty to you. There are no costs to you or any other party associated with this survey.

CONTACT
This research is being conducted by Martha E. La Rosa, an undergraduate student of the Department of Human Physiology and Grace M. Golden of the Department of Human Physiology. Martha La Rosa can be contacted at mlarosa@uoregon.edu for questions or the reporting of a survey-related problem. You may also contact Grace Golden at graceg@uoregon.edu. You may contact the University of Oregon's Office for Protection of Human Subjects at (541) 346-2510 if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to the University of Oregon's procedures governing your participation in this research.

CONSENT
The University of Oregon's Office for Protection of Human Subjects has waived the requirement for a signature on this consent form. Checking the bubble below and proceeding with this survey indicates your consent. It also indicates that you are at least 18 years of age.

3. CONSENT

I have read and understand the informed consent statement. I am at least eighteen years of age and I agree to participate in the survey.

Disagree ○ Agree ○

Survey Powered By Qualtrics >>

What is your handedness?

Left ○ Right ○ Ambidextrous ○

Have you ever had significant injury to your hand, wrist, neck or shoulder?

Yes ○ No ○

Survey Powered By Qualtrics << >>

Have you ever felt any of the following due to text messaging? (Check all that apply)

- ☐ Pain
- ☐ Numbness
- ☐ Tingling
- ☐ Stiffness
- ☐ I have felt these symptoms, but not while I text
- ☐ I have not experienced these symptoms

Survey Powered By Qualtrics

<< >>

If so, where? (Check all that apply)

- ☐ Thumbs
- ☐ Other fingers
- ☐ Palm
- ☐ Back of hand
- ☐ Wrist
- ☐ Forearm
- ☐ Shoulder
- ☐ Neck
- ☐ Other:
- ☐ I have never experienced these symptoms anywhere due to text messaging

What is the severity of your pain or discomfort?

No pain					Moderate pain					Worst possible pain
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

How do you deal with the pain or discomfort?

- ○ Pause for less than one (1) minute
- ○ I have to put down my phone and massage my area of discomfort
- ○ I just keep text messaging and deal with it later
- ○ I have never felt pain while text messaging
- ○ Other:

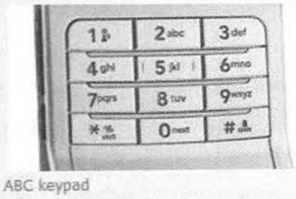
Have you ever sought medical attention for your pain or discomfort due to texting?

- ○ Yes, I went to the doctor
- ○ Yes, I searched on a medical website
- ○ No
- ○ Other: _____

Survey Powered By [redacted]

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Which texting display is most similar to the one you use the most?

○ 

ABC keypad

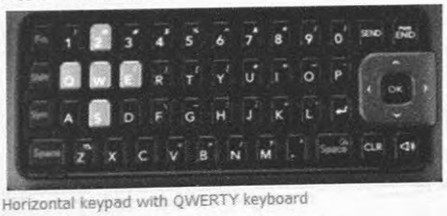
○ 

Touch screen ABC

○ 
Keypad with grouped letters

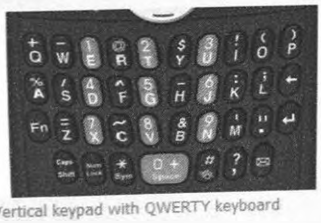
○ 

Touch screen with grouped letters

○ 
Horizontal keypad with QWERTY keyboard

○ 

Horizontal touch screen with QWERTY keyboard

○ 
Vertical keypad with QWERTY keyboard

○ 

Vertical touch screen with QWERTY keyboard

Which text messaging plan do you have?

- None
- At most 250
- At most 500
- Unlimited
- Other: _____

Approximately how many texts do you send per day? (Click on the range closest to your average)

- None
- 1-5
- 5-10
- 10-20
- 20-40
- 40-60
- 60-100
- 100-200
- 200-300
- 300+
- Other: _____

On average, how many characters does each message contain?

- 1-10
- 10-50
- 50-100
- 100-160
- 160+
- I don't know
- Other: _____

Do you let your phone automatically predict words for you (T9 function)?

- Yes
- No
- Yes, but I type in the letters anyway
- No, but I do let my phone auto-correct my spelling
- I don't' know
- Other: _____

Survey Powered By Qualtrics

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On average, how long does it take you to send a text message? (s = seconds)

- 1 - 5 s
- 6 - 10 s
- 11 - 20 s
- 20 - 30 s
- 31 - 60 s
- 60+ s
- I don't know
- Other: _____

How do you normally text?

- Thumbs
- Index Fingers
- Touch screen pen
- Other: _____

How do you normally text?

- Thumbs
- Index Fingers
- Touch screen pen
- Other: _____

Do you use both hands to text?

Mainly right hand	Mainly left hand	I switch between both	I use both hands at the same time
○	○	○	○

What other activities do you do? (Check all that apply)

- ☐ Play video games
- ☐ Typing on my computer
- ☐ Use a free-texting application on my iPod Touch
- ☐ Play a portable video game
- ☐ Surf the web on my phone
- ☐ Play an instrument
- ☐ Other: _____

On average, how many hours per week do you spend doing these activities?

- ○ 0 - 5 hours
- ○ 5 - 10 hours
- ○ 10 - 20 hours
- ○ 20 - 30 hours
- ○ 30 - 40 hours
- ○ 40 - 50 hours
- ○ 50 - 100 hours
- ○ 100 + hours
- ○ Other: _____

Gender:

Male	Female	Prefer not to answer
○	○	○

Age: _____

Status:

- ○ University of Oregon Student
- ○ University of Oregon Staff/Faculty
- ○ Other: _____

Survey Powered By Qualtrics

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Insert your email address if you are interested in finding out about the results of this survey. This is not required to do so.

Thank you for your participation. It is greatly appreciated.

Survey Powered By Qualtrics

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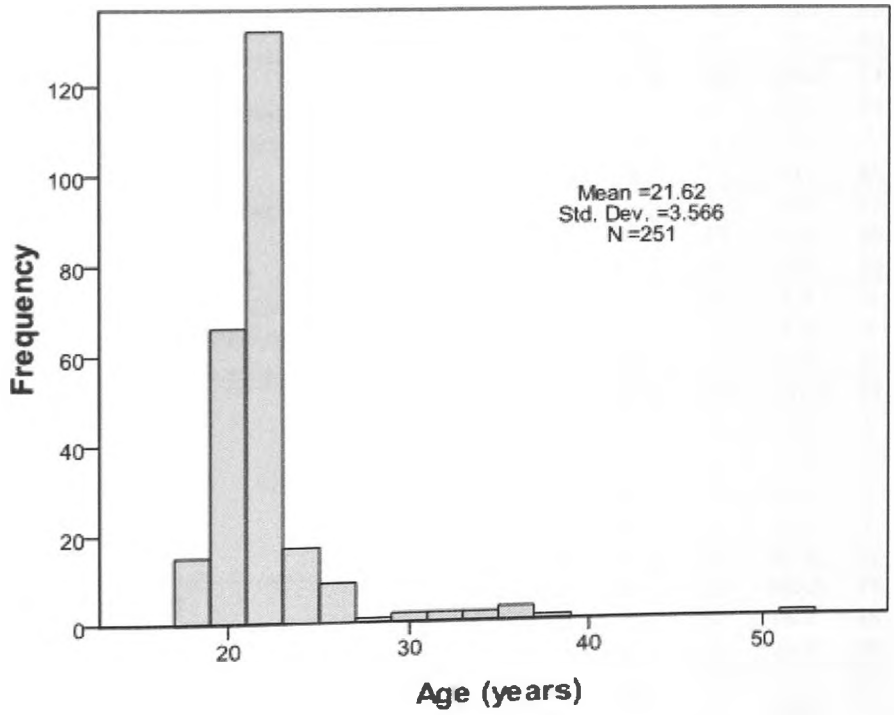
Appendix B:

FREQUENCY TABLES & CROSSTABULATIONS

Table 2. Participant overview

		n	%
Status	**Total**	**251**	**100.0**
	UO Student	186	74.1
	UO Staff/Faculty	7	2.8
	Other	58	23.1
Sex	**Total**	**251**	**100.0**
	Female	189	75.3
	Male	62	24.7
Handedness	**Total**	**251**	**100.0**
	Ambidextrous	10	4.0
	Left-handed	17	6.8
	Right-handed	224	89.2
Past Injury	**Total**	**251**	**100.0**
	No	187	74.5
	Yes	64	25.5

Graph 1. Ages



Graph 2. Displays used

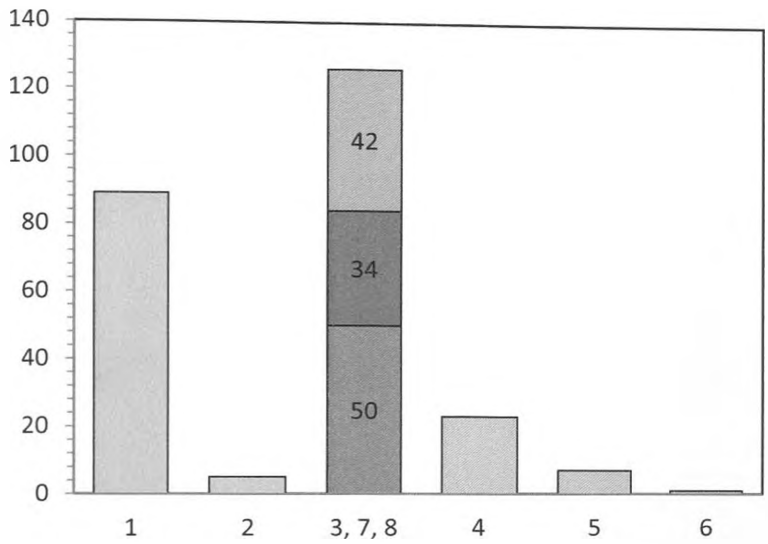


Table 3. Texting profile overview

	Total	%	Symp.	%	Asymp.	%	Unrel.	%	df	X^2	ρ
Sex	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**2**	**7.564**	**0.023**
Female	189	75.3	44	81.5	81	67.5	64	83.1			
Male	62	24.7	10	18.5	39	32.5	13	16.9			
Past Injury	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**2**	**1.508**	**0.471**
Yes	64	25.5	17	31.5	30	25.0	17	22.1			
No	187	74.5	37	68.5	90	75.0	60	77.9			
Display	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**10**	**6.751**	**0.749**
1) Alphanumeric hard keypad	89	35.5	18	33.3	47	39.2	24	31.2			
2) Alphanumeric touch screen	5	2.0	2	3.7	1	0.8	2	2.6			
Vertical QWERTY	126	50.2	29	53.7	56	46.7	41	53.2			
3) Condensed hard keypad	50	39.7	11	37.9	22	39.3	17	41.5			
7) Full hard keypad	34	27.0	6	20.7	18	32.1	10	24.4			
8) Full touch screen	42	33.3	12	41.4	16	28.6	14	34.1			
4) Condensed QWERTY touch scrn	23	9.2	4	7.4	10	8.3	9	11.7			
5) Horiz. QWERTY hard keypad	7	2.8	1	1.9	5	4.2	1	1.3			
6) Horiz. QWERTY touch screen	1	0.4	0	0.0	1	0.8	0	0.0			
Texting Plan	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**8**	**8.948**	**0.347**
No Plan	5	2.0	0	0.0	4	3.3	1	1.3			
250 max	9	3.6	2	3.7	5	4.2	2	2.6			
500 max	14	5.6	1	1.9	11	9.2	2	2.6			
More than 500	7	2.8	2	3.7	3	2.5	2	2.6			
Unlimited	216	86.1	49	90.7	97	80.8	70	90.9			
Sent texts per day	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**6**	**5.056**	**0.537**
0 - 40	155	61.8	30	55.6	80	66.7	45	58.4			
40 - 100	67	26.7	17	31.5	30	25.0	20	26.0			
100 - 300	27	10.8	6	11.1	10	8.3	11	14.3			
300 or more	2	0.8	1	1.9	0	0.0	1	1.3			

	Total	%	Symp.	%	Asymp.	%	Unrel.	%	df	χ^2	ρ
Characters in a text	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**10**	**7.897**	**0.639**
1 to 10	2	0.8	0	0.0	2	1.7	0	0.0			
10 to 50	73	29.1	14	25.9	40	33.3	19	24.7			
50 - 100	59	23.5	12	22.2	31	25.8	16	20.8			
100 -160	92	36.7	21	38.9	38	31.7	33	42.9			
160 or more	9	3.6	2	3.7	3	2.5	4	5.2			
don't know	16	6.4	5	9.3	6	5.0	5	6.5			
Method to text	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**6**	**5.669**	**0.461**
Thumbs	263	104.8	51	94.4	113	94.2	72	93.5			
Index Finger	10	4.0	3	5.6	5	4.2	2	2.6			
Pen	1	0.4	0	0.0	1	0.8	0	0.0			
Other	4	1.6	0	0.0	1	0.8	3	3.9			
Hand used to text	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**6**	**8.541**	**0.201**
Right	63	25.1	18	33.3	28	23.3	17	22.1			
Left	4	1.6	2	3.7	0	0.0	2	2.6			
Switch hands	26	10.4	3	5.6	16	13.3	7	9.1			
Both at the same time	158	62.9	31	57.4	76	63.3	51	66.2			
Other activities	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**10**	**7.146**	**0.712**
None	1	0.4	0	0.0	1	0.8	0	0.0			
Type on a computer	80	31.9	17	31.5	42	35.0	21	27.3			
Surf web on phone	1	0.4	0	0.0	0	0.0	1	1.3			
Play music	1	0.4	0	0.0	1	0.8	0	0.0			
2 activities or more	168	66.9	37	68.5	78	65.0	55	71.4			
Type on computer	167	99.4									
Play video games	64	38.1									
Hrs/wk on other activities	**251**	**100.0**	**54**	**100.0**	**120**	**100.0**	**77**	**100.0**	**14**	**19.563**	**0.145**
0 - 5	36	14.3	5	9.3	22	18.3	9	11.7			
5 to 10	66	26.3	12	22.2	37	30.8	17	22.1			
10 to 20	64	25.5	11	20.4	32	26.7	21	27.3			
20 - 30	39	15.5	9	16.7	15	12.5	15	19.5			
30 - 40	25	10.0	7	13.0	8	6.7	10	13.0			
40 - 50	9	3.6	5	9.3	2	1.7	2	2.6			
50 - 100	8	3.2	4	7.4	2	1.7	2	2.6			
100 or more	4	1.6	1	1.9	2	1.7	1	1.3			

Table 4. Experiences from texting

		n	%
Symptoms from texting	**Total**	**251**	**100.0**
	Symptomatic	54	21.5
	Asymptomatic	120	47.8
	S/s unrelated to texting	77	30.7

Table 4a. Experiences from texting for UO Students

		n	%
Symptoms from texting	**Total**	**186**	**100.0**
	Symptomatic	44	23.7
	Asymptomatic	89	47.8
	S/s unrelated to texting	53	28.5

Table 5. Texting profile of symptomatic cohort

	n	%	Female	%	Male	%	df	X^2	ρ
Symptoms	**54**	**100.0**	**44**	**100.0**	**10**	**100.0**	**7.0**	**10.905**	**0.143**
Pain	3	5.6	3	6.8	0	0.0			
Numbness	1	1.9	1	2.3	0	0.0			
Tingling	2	3.7	2	4.5	0	0.0			
Stiffness	34	63.0	25	56.8	9	90.0			
2 symptoms or more	14	25.9	13	29.5	1	10.0			
Stiffness	12	85.7							
Pain	11	78.6							
Location	**54**	**100.0**	**44**	**100**	**10**	**100**	**6**	**3.840**	**0.698**
Thumbs	28	51.9	21	47.7	7	70.0			
Hands	3	5.6	2	4.5	1	10.0			
Distal Limb	2	3.7	2	4.5	0	0.0			
Proximal Limb	1	1.9	1	2.3	0	0.0			
2 locations or more	20	37.0	18	40.9	2	20.0			
Thumbs	18	90.0							
Hands	12	60.0							
Severity	**54**	**100.0**	**44**	**100.0**	**10**	**100.0**	**3**	**2.281**	**0.516**
Low (0-3)	36	66.7	28	63.6	8	80.0			
Moderate (4-6)	17	31.5	15	34.1	2	20.0			
Severe (7-10)	1	1.9	1	2.3	0	0.0			
Treatment	**54**	**100.0**	**44**	**100.0**	**10**	**100.0**	**2**	**4.707**	**0.095**
Pause from texting	36	66.7	32	72.7	4	40.0			
Switch hands to text	1	1.9	1	2.3	0	0.0			
None	17	31.5	11	25.0	6	60.0			
Medical Attention	**54**	**100.0**	**44**	**100.0**	**10**	**100.0**	**2**	**2.521**	**0.284**
Yes	2	3.7	1	2.3	1	10.0			
None	52	96.3	43	97.7	9	90.0			

Graph 3. Number of texts sent per day

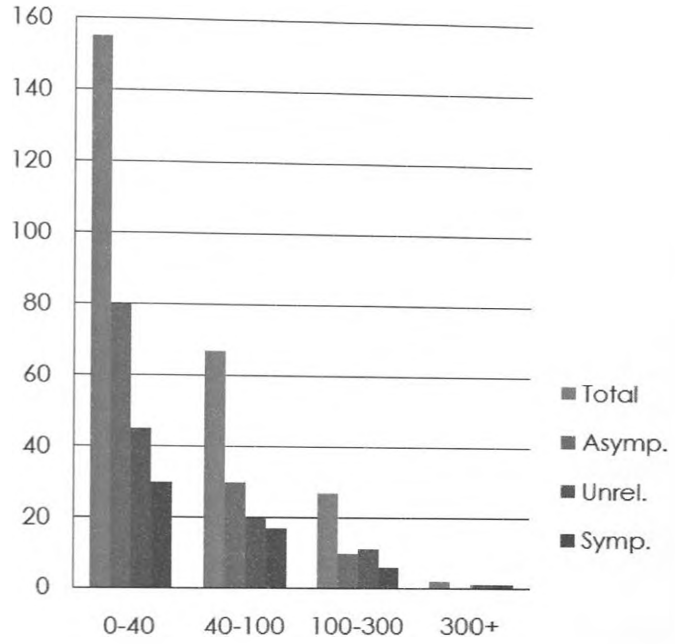


Table 6. Chi-square results of crosstabulation between variables "Hours/week spent on hand-intensive activities" and "experiencing signs and symptoms with "Display used" as the layer variable.

Layer variable		Value	df	X^2
Display1	Pearson Chi-Square	26.793	14	0.020
	N of Valid Cases	89		
Display 2	Pearson Chi-Square	6.250	6	0.396
	N of Valid Cases	5		
Display 3, 7, 8	Pearson Chi-Square	19.771	14	0.138
	N of Valid Cases	126		
Display 4	Pearson Chi-Square	9.956	12	0.620
	N of Valid Cases	23		
Display 5	Pearson Chi-Square	9.800	8	0.279
	N of Valid Cases	7		
Display 6	Pearson Chi-Square	--	--	--
	N of Valid Cases	1		
Total	Pearson Chi-Square	19.563	14	0.145
	N of Valid Cases	251		

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