

Handheld devices

By Tamara Mitchell



Small electronic devices have become a part of many people's lives throughout the world. Some people have become almost completely dependent upon one of these devices for not only making and receiving phone calls and checking the time, but for one of the countless other functions they can perform including text messaging, emailing, taking photographs, reading books, listening to music, watching movies, searching the internet, getting directions while driving, finding discounts on local meals, emailing, and posting to Facebook. The fact that handheld devices are so ubiquitous, and they are actually a near-necessity in some situations, means that people are spending a lot more time interacting with them.

While handheld devices are almost miraculous in their capabilities, it's important to understand that interacting with these devices present real challenges from the standpoint of ergonomics. The user tends to hover close to the device to see it and users are required to do some fairly tedious and detailed manual manipulations to hold it and to interact with it.

The Physical Challenges

With technology changing so rapidly, research on this topic becomes quickly obsolete as input methods and devices change. The general rules of ergonomics apply regardless of the device. The risk for Repetitive Strain Injury (RSI) exists where there is:

- Repetitive motion
- Done in an awkward posture
- Using some force
- Without allowing sufficient rest

Text messaging and hand strain. Text messaging is a very useful means of communicating when a message is brief, when the message is not urgent and it can be read when the recipient decides to read it. Text messages and conversations can be accomplished in environments where an audible conversation is not appropriate. Texting is one of the activities performed on a mobile device that may be potentially physically harmful if the thumbs are used extensively, repetitively, forcefully, and for a long period of time. 91% of mobile device users text, email, or instant messaging.¹

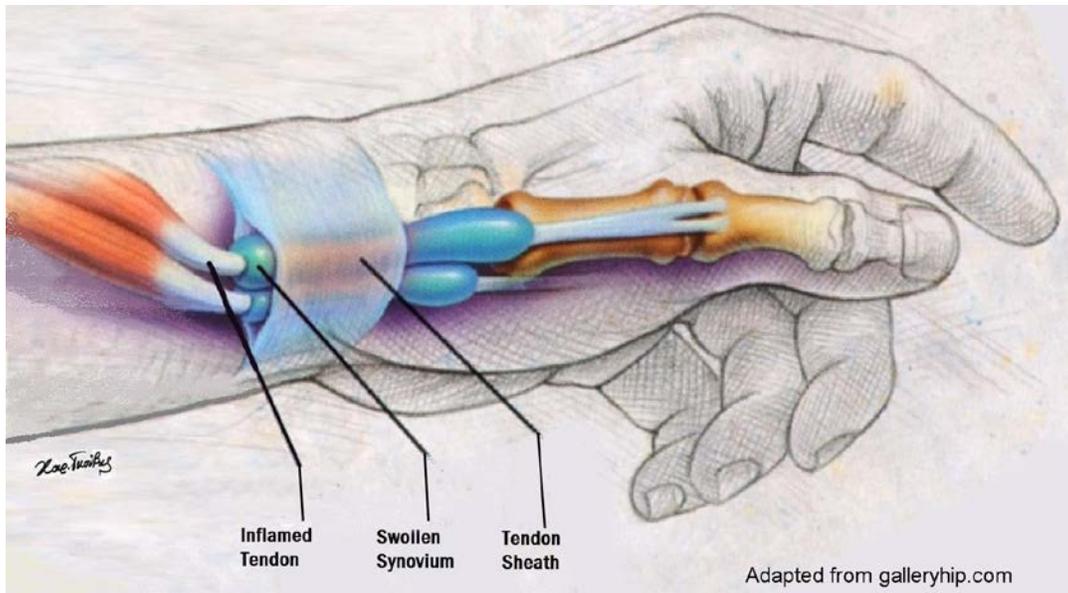
While several hand positions are used during text messaging, over half of users have been found to prefer the use of the thumbs, at least with small devices in the size range of 3.5 inches.^{1,2} Holding the phone with both hands and texting using both thumbs results in significantly faster and more accurate than when texting using one hand and one thumb.² Using a one-handed grip while texting with the thumb constrains hand movement, requires a more awkward posture of the hand, and requires stabilizing the phone with the hand while tapping resulting in greater hand tension.² Users tend to use the right index finger in combination with other fingers with a larger touch screen (9.5 inches) perhaps because the keys are larger, the device is generally held in the lap, and this encourages people to type more as they would on a conventional keyboard.¹ Using a two-handed grip resulted in wrist and thumb joint positions that were significantly less stressful to the hand than using a one-handed grip, specifically more extended wrist and thumb postures.² Phone movement was less with the two-handed grip than with the one-handed grip also.²



Photo courtesy of BaltimoreSun.com

Keystroke force has been shown to be greater for devices with physical keypads rather than those with touch screen keyboards because the physical keys require more force for activation.^{1,3} Thumb muscles, finger flexor muscles, and wrist extensor muscles were all shown to have significantly greater activity when using a physical keypad rather than a touch screen.¹ This muscle activity was not found to be related to whether the person used one or two thumbs to text.¹ When the user was texting on a physical keypad, holding the device in one hand while texting with the same hand, there was significantly greater muscle activity in the wrist extensor muscles.¹ On the surface, it would seem that the use of touch screen keyboards would be the preferred method since they clearly require less force, however typing speed was 60% lower and accuracy was over 10% less on the virtual keyboards.³ In another study, typing speed was 4 times slower on a tablet computer in comparison to a laptop or netbook computer.⁴ In addition, self-reported comfort of the hands, wrists, arms, and shoulders as well as overall preference for keyboard style were vastly lower for virtual keyboards than for physical keyboards.³ Perhaps as people use touch screen keyboards more this will change, but preference may have something to do with the tactile feedback users receive when interacting with physical keypads or keyboards.

Research has shown that extensive use of the thumbs while texting on cell phones results in DeQuervain's tenosynovitis, tenosynovitis of the Extensor Pollicis Brevis and/or the Extensor Pollicis Longus which is a swelling and inflammation of the tendon sheath and thickening of the synovial fluid in the sheath.⁵ Other symptoms of reported have been pain in the forearm with burning, numbness, and tingling around the thumb area with stiffness of the wrist and hand.⁶



Upper body strain.

The most common physical injuries associated with the use of handheld devices aside from damage to the hands during texting, is myofascial pain syndrome of the neck and upper back as well as thoracic outlet syndrome.⁶ Research showed that the injuries were significantly more likely to occur in the dominant hand and upper extremity.⁶

People spend an average of 2 to 4 hours a day with their heads tilted down reading or texting on mobile devices.⁷ High school students may spend even more time using mobile devices in this poor posture.⁷ As the head leans farther forward, the load on the neck, upper back, and spine increases dramatically adding wear and tear, and degeneration in these areas even possibly leading to the need for future surgery.⁷ It is critical that people interact with their mobile devices with a neutral spine and become aware when their posture is hunched over to avoid muscle tension and injury.⁷

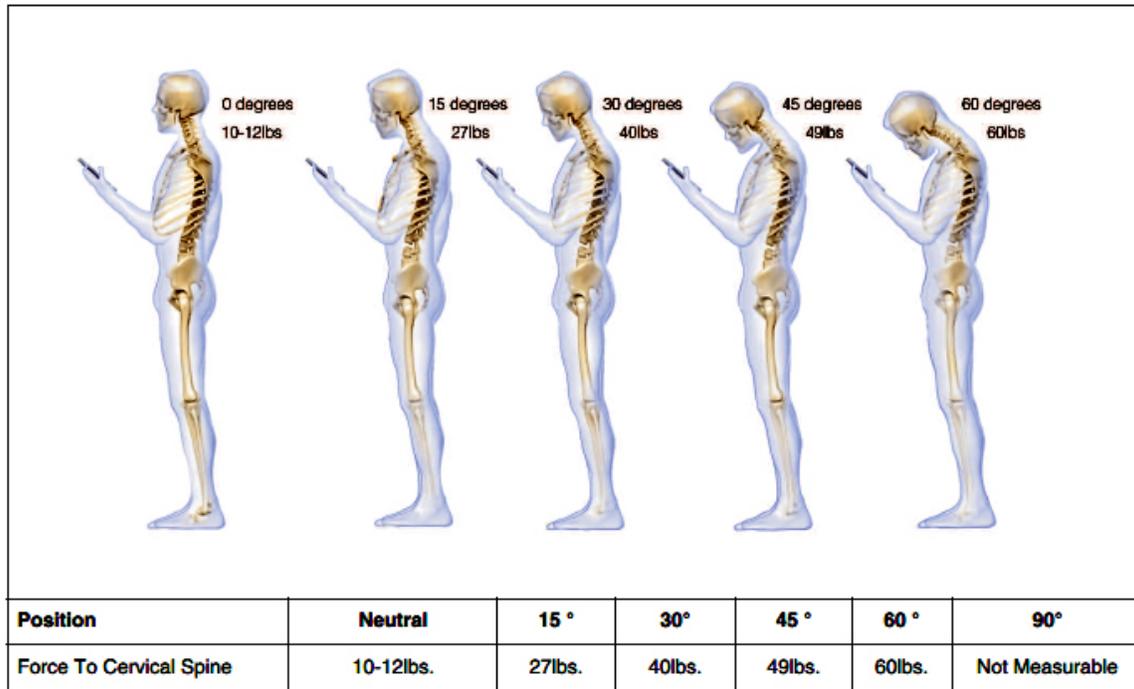


Illustration derived from Reference 7

Contrary to what one might expect, mobile devices with larger screens are associated with greater slumping postures because the device is heavier and people tend to use them in their laps.¹ This results in greater upper trapezius muscle activity as the upper back flexes more and these muscles must work harder to support the weight of the head.¹ In one study, none of the participants chose to place a 3.5 inch device (cell phone) in their laps.¹ In another study, typing on a tablet computer vs. a laptop or netbook resulted in significantly greater non-neutral wrist, elbow, and neck postures, though there was significantly less wrist deviation when using the tablet computer probably because people tended to type with one finger rather than typing with both hands on a standard or small scale keyboard.⁴ Sitting on a sofa rather than sitting at a computer workstation resulted in more stressful postures for the wrists, elbows, and neck.⁴



Psychophysiological effects of text-messaging.

Research has shown that there are increases in respiration rate, heart rate, skin conductance, and tension in the trapezius and thumb muscles during text messaging.⁸ 83% of the subjects in one study reported hand and neck pain during texting and they held their breath and experienced arousal when receiving text messages.⁸ Most subjects were unaware of their physiological changes. At the onset of receiving a text message, subjects held their breath and then continued to breathe shallowly and rapidly. When sending text messages, breathing was shallow and rapid,

heart rate, skin conductance, and muscle tension in the thumb and trapezius were increased.⁸ After texting, physiology returned to normal. The task of focusing on a small digital screen, composing a text message, tightening of the neck and shoulders, and stabilization of the trunk muscles to perform fine motor movements all indicate a predisposition to long-term physical problems.⁸

Mental Challenges

The benefits and risks in using internet technology and cell phones probably lies in achieving a balance in taking advantage of the opportunities it offers while placing limits and being aware of the possible risks.⁹

Psychosocial Benefits	Psychosocial Risks
<ul style="list-style-type: none"> • Sense of freedom • Unlimited potential • Efficiency • Accessibility • Simplification of many tasks • Connectedness to others • Social control • Security – being able to always reach someone • Global “connectedness” 	<ul style="list-style-type: none"> • Feelings of dependence on the equipment • Possible addiction and reliance • Need to constantly acquire new competence • Reluctance regarding time spent on equipment • Invasiveness, disruption, and distraction • Disturbance by phones and conversations in public places • Lack of control • Too much information • Difficult to find what is needed • Relationships intangible, possible social isolation, and anonymity • Being left out if don’t participate

Quite a lot of research has been done to understand the impact of smartphone, cell phone, and electronic media on adolescent children, especially with regard to usage after going to bed. The impact of text messaging, using Facebook or chat, calling, or playing games has been of interest with regard to its impact on keeping kids awake after lights out, the effects of resulting sleep deprivation, and increased symptoms of depression are all of interest, especially since the occurrence of adolescent depression has increased dramatically since 1960.¹⁰ Development of depressive symptoms during adolescence results in a high rate of recurrence in adulthood, so determining controllable factors that may reduce adolescent depression is of great interest.¹⁰ The following things have been found:

- Adolescents owning a smartphone tend to use the device more than adolescents owning a conventional mobile phone and they tend to go to sleep later than their peers. Research showed that the type of device did not significantly affect overall sleep duration, sleep difficulties, or symptoms of depression.¹⁰
- Use of electronic media in bed before sleep is related to higher levels of depressive symptoms.¹⁰
- Use of electronic media in bed before sleep is related to shorter sleep duration and more sleep difficulties.¹⁰

- Sleep difficulties, though not sleep duration, appears to be strongly involved in the mediating relationship between electronic media usage and symptoms of depression. So use of electronic media appears to be related to sleep disturbance which may lead to daytime dysfunction such as depression.¹⁰

These results indicate that adolescents (and probably adults) could benefit from adhering to the habit of leaving the cell phone or smart phone in another room and shutting it off when going to bed so that lights out and bedtime are unplugged and disturbance from the device is eliminated.

Nomophobia is the anxiety brought on a large number of people when faced with the inability to communicate through a mobile device.^{11,12} It is being considered for inclusion in the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* which is the primary manual for assessing psychiatric diseases.¹² The disorder is characterized by behaviors that are actually becoming fairly common:¹²

- spending considerable time on one or more devices and always carrying a charger
- feeling anxious or nervous at the thought of losing, misplacing, or being unable to use the device for some reason
- checking the device frequently to see if messages or calls have come in
- always keeping the device switched on and sleeping with the device near the bed
- limiting face-to-face interactions and prefer this type of communication
- incurring debts or high expenses from using the mobile device.

Of course, as with any mental disorder, it's a matter of degree to which some or all of these symptoms are exhibited. There is actually a very high percentage of people (70% women, 61% men, and 77% youngsters and adolescents) who exhibit symptoms of nomophobia and it is prevalent in many countries and cultures.¹² Those who suffer from Panic Disorder and agoraphobia are especially susceptible to nomophobia and exhibit intense physical and psychological symptoms when they are apart from or unable to use a mobile device.¹¹ Anxiety and stress produce very unhealthy mental and physical responses in the body.¹³

Avoiding injury from handheld devices.

Prevention is certainly desirable, since rehabilitation is intensive and expensive. Every person has a different physical tolerance to the stresses and strains of repetitive strain injury, so there cannot be a hard and fast rule regarding how much usage is too much. In fact each device has a unique user interface design and each user adopts a method of interaction and a habitual posture that is unique to them. Take notice if you are beginning to feel any tension, stiffness, or soreness in your hands, wrists, shoulders, or neck. One study included only people who sent at least 25 text messages or emails a day or people who browsed the internet or played games for more than 1 hour per day using a handheld device with following symptoms of pain.⁶ Those should probably be viewed as an outside limit to anyone's tolerance, though many people exceed this on a regular basis.

Researchers continuously attempt to design key layouts that are more efficient from a usage or logical letter sequencing standpoint or allow chording of multiple keys, however acceptance of alternate key layouts to the traditional QWERTY layout meets with consumer resistance.^{14,15}

Injury prevention strategies suggested are:^{2,6}

- Select devices that are designed to permit typing or usage with all the fingers rather than just the thumb or one finger.
- When typing or tapping, if thumbs are used, hold the device with both hands and use both thumbs.
- Limit the total hours of usage.
- Take frequent short breaks between usage.
- Maintain correct posture.
- Use voice to text software when possible.
- To avoid psychological dependence, get in the habit of turning the device off when communication is not necessary especially at night. Consider taking a day each week to totally unplug from technology.

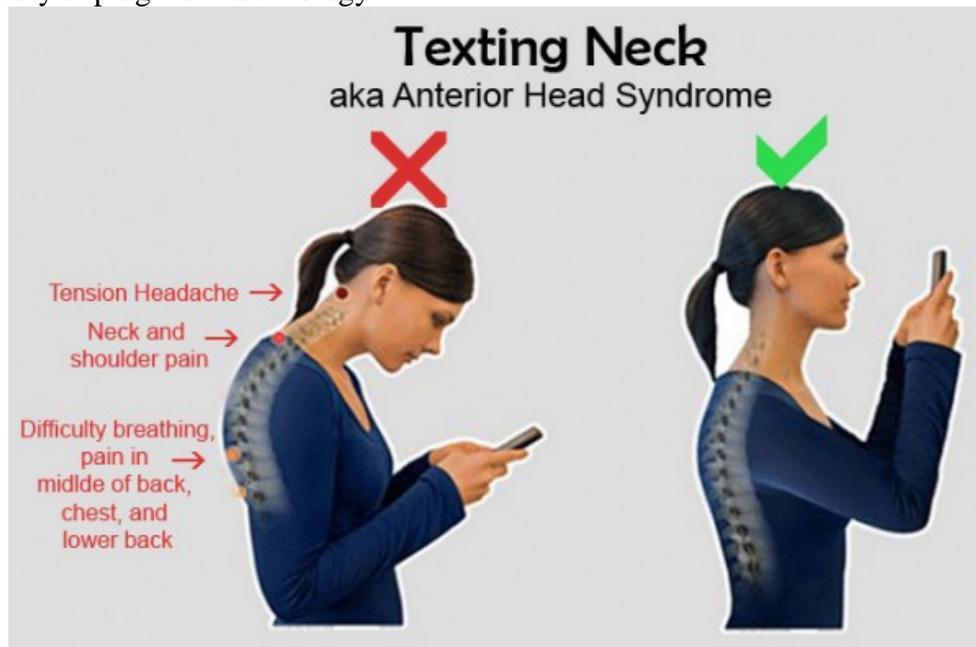


Illustration courtesy of Summerlandmassage.com

We provide further tips for using cell phones and tablets on our website:

http://www.working-well.org/Website/laptop_tips.html

We also provide recommendations for accessories which can help reduce upper body and hand strain on our products web page: <http://www.working-well.org/Website/plaptop.html#tablets>

Rehabilitation

Rehabilitation has been shown to be very effective in treating hand and upper body injuries resulting from handheld device overuse.⁶ Treatment is intensive, expensive, and time-consuming. In the end, it concludes with the establishment of healthy usage habits which could have been developed in the first place to prevent injury.

A 2-4 week program of rehabilitation of four phases based on pain level was used in one study to successfully heal and retrain handheld device users.⁶

❖ Phase I

- Soft tissue mobilization including trigger point release, myofascial release, positional release, and muscle energy techniques.

- Grade 1 and 2 mobilization of the upper extremity for pain
 - Range of motion exercises for the elbow, wrist, and finger joints
 - Ultrasound, low level laser therapy, contrast bath, and taping
- ❖ *Phase II*
- Gentle active and passive stretching of the muscles of the upper extremity, especially the hand
 - Hand exercises inside a water tub (Hydrotherapy)
 - EMG biofeedback for retraining the muscle during usage of handheld devices and ergonomic modification
- ❖ *Phase III*
- Strengthening of the upper extremity muscles especially the hand
 - Postural awareness and retraining
- ❖ *Phase IV*
- Improving hand activity usage in everyday living
 - Maintenance of regained function by involvement in leisure and sport activities
 - Home program for maintenance

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This article and all of our articles are intended for your information and education. We are not experts in the diagnosis and treatment of specific medical or mental problems. When dealing with a severe problem, please consult your healthcare or mental health professional and research the alternatives available for your particular diagnosis prior to embarking on a treatment plan. You are ultimately responsible for your health and treatment!

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