Universidad de La Laguna
Escuela Universitaria de Enfermería y Fisioterapia

Trabajo Fin de Grado

Grado en Fisioterapia

Analysis of the possible disorders related to the inadequate mobile phone usage among Health Sciences students at the University of La Laguna.

Análisis de las posibles alteraciones relativas al uso inadecuado del teléfono móvil entre el alumnado de Ciencias de la Salud de la Universidad de La Laguna.

Alexis Jorge Hernández

Curso 2015/2016 – Julio

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AUTORIZACIÓN DE LOS TUTORES PARA LA PRESENTACIÓN DEL TRABAJO FIN DE GRADO

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DATOS ALUMNO:

Apellidos	JORGE HERNÁNDEZ	Nombre	ALEXIS
DNI	43378498S	Dirección	CARRETERA GENERAL EL AMPARO Nº 211
		C. Postal	38438
Localidad	ICOD DE LOS VINOS	Provincia	SANTA CRUZ DE TENERIFE
Teléfono	680305484	E-mail	alax_yo@hotmail.com

TÍTULO DE TRABAJO DE FIN DE GRADO:

ANALYSIS OF THE POSSIBLE DISORDERS RELATED TO THE INADEQUATE MOBILE PHONE USAGE AMONG HEALTH SCIENCES STUDENTS AT THE UNIVERSITY OF LA LAGUNA

ANÁLISIS DE LAS POSIBLES ALTERACIONES RELATIVAS AL USO INADECUADO DEL TELÉFONO MÓVIL ENTRE EL ALUMNADO DE CIENCIAS DE LA SALUD DE LA UNIVERSIDAD DE LA LAGUNA

TUTORES:

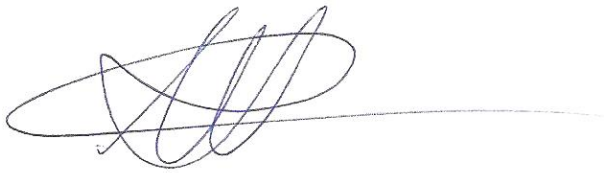
Apellidos: MARTIN HERNÁNDEZ **Nombre:** JOSÉ JAIME

Apellidos: PÉREZ GONZALEZ **Nombre:** HERMINIA

AUTORIZACIÓN DE LOS TUTORES

D JOSE JAIME MARTÍN HERNÁNDEZ, profesor del Departamento de FILOLOGÍA INGLESA Y ALEMANA y Dª HERMINIA PÉREZ GONZÁLEZ, profesora del Departamento de CIENCIAS MÉDICAS BÁSICAS, con docencia en la Sección de Medicina, Enfermería y Fisioterapia de la Facultad de Ciencias de la Salud, **AUTORIZAN** a D **ALEXIS JORGE HERNÁNDEZ** a presentar la propuesta de **TRABAJO FIN DE GRADO,** que será defendida en JULIO de 2016.

En La Laguna, a 5 de julio de 2016



Fdo.: José Jaime Martín Hernández Herminia Pérez González

SRA. PRESIDENTA DEL TRIBUNAL DE EVALUACIÓN

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ABSTRACT

The relationship between body posture and different physical loads, as well as the possible musculoskeletal symptoms resulting from them, have been extensively studied by sciences such as Ergonomics. Linking postural study with electronic devices, computers have been the most common field of study, due to the widespread of their use in work environments and the importance of preventing potential risks. However, rapid technological advances over the last decades have opened a new and relatively unexplored field of study: mobile phone usage. This device has become a tool for everyday use, and posture arising from its use could generate impacts worthy of being studied.

The aim of this end of degree project is to analyze the possible negative effects of mobile phone usage among young university students. Thus, we want to obtain objective data that serve as a reference to formulate a proper prevention, education and postural awareness of the population.

To do this, a cross-sectional study has been proposed with a specifically designed questionnaire which will be answered by the Health Sciences students at the University of La Laguna. Students from 17 to 25 years old who do not have musculoskeletal disorders and agree to participate in the study will be selected.

Using the data obtained, a prevention plan will be conducted in which we will give guidelines about proper mobile phone usage, focusing on those variables most likely to improve.

Key words: *Posture, musculoskeletal system, mobile phone, negative effects, university students*.

RESUMEN

La relación entre la postura corporal y las diferentes cargas físicas, así como los posibles síntomas musculoesqueléticos derivados de las mismas, han sido estudiadas ampliamente por ciencias como la Ergonomía. Al relacionar este estudio postural con los dispositivos electrónicos, el campo de estudio más común ha sido el de los ordenadores, dada la extensión de su uso en entornos laborales y la importancia de la prevención de los posibles riesgos derivados. Sin embargo, el rápido avance tecnológico de las últimas décadas nos abre un campo de estudio novedoso y poco explorado: el uso del teléfono móvil. Este dispositivo se ha convertido en una herramienta de uso diario, y las posturas derivadas de su uso podrían generar efectos dignos de ser estudiados.

El objetivo de este proyecto de fin de grado es analizar los posibles efectos negativos del uso de teléfono móvil en estudiantes universitarios jóvenes. Así, queremos obtener datos objetivos que nos sirvan de referencia para realizar una adecuada prevención, educación y concienciación postural de la población.

Para ello, hemos propuesto un estudio transversal con un cuestionario específicamente diseñado, el cual será respondido por el alumnado de Ciencias de la Salud de la Universidad de La Laguna. Seleccionaremos a alumnos de 17 a 25 años que no posean patologías musculoesqueléticas y acepten participar en el estudio.

Con los datos obtenidos, realizaremos un plan de prevención en el que daremos pautas de uso adecuado del teléfono móvil, centrándonos en aquellas variables que sean susceptibles de mejorar.

Palabras clave: *Postura, sistema musculoesquelético, teléfono móvil, efectos negativos, estudiantes universitarios*.

1. BACKGROUND AND CURRENT STATUS

1.1. Posture and Spine

1.1.1. Ergonomic concepts

Ergonomics has been traditionally described as the science responsible for designing work environments, including tools and how to use them, in order to adapt optimally to workers and their characteristics, in order to prevent occupational hazards and improve worker productivity[1].

More recently, however, the definition of Ergonomics has become more extensive and includes the study of interactions between humans and the elements of a system, and seeks to optimize human well-being throughout the system performance[2]. We see therefore that this science not only covers work environments, but also incorporates the areas of daily life. However, something that does not vary in this science regardless of its definition is that it focuses on the study of posture.

Posture must correspond to a specific body position in space that minimizes the anti - gravitational stresses in body tissues. Poor posture is the result of poor relations between body parts. These interrelationships cause muscle tension and muscle shortening, which prevent or hinder the execution of appropriate joint movements and the possibility of causing pain[3].

On the other hand it is also considered that an ideal position is that which exists when the external auditory meatus is aligned with the vertical postural line. This line, viewed from the side, goes slightly ahead of the ankle joint and the center of the knee joint, slightly behind the center of the hip joint and through the shoulder joint and the external auditory meatus[4].

1.1.2. Forward head posture

A high prevalence of spine postural deviations in children and adolescents have been related to forward head posture (FHP) and protracted shoulders (PS) as the most common deviations[5].

Fig 1. Forward Head Posture Fix Discount. [Internet]. Discountsphere. Available from: http://discountsphere.com/forward-head-posture-fix-discount/ [6]

We see that FHP is one of the most common postural disorders in patients with neck problems. Having FHP means that the head has an anterior* position with regard to the theoretical plumb line, which is perpendicular to the horizontal line through the body's gravity center. Therapists measure the severity of this anterior* positioning of the head as low, moderate or high, without using any objective or numeric value. They are based on their experience and their perception of what is "ideal", but this is considered as a potential error source[7].

One objective method of assessing head posture is through measuring the craniovertebral (CV) angle. This is the angle formed between the line through the spinous process of C7 and the line coming out from this process and through the tragus of the ear. This method represents the anterior or posterior position of the lower cervical spine, and the associated upper cervical flexion or extension. This makes it a reliable, objective and easy to use method, which produces immediate results, so it is an ideal way to measure head/neck posture[8].

FHP may appear by an anterior translation of the head, lower cervical flexion or both, and could have an association with an increase in the upper cervical extension[9]. PS is an anterior acromion displacement in reference to the spinous process of C7, often associated with a protracted, above swiveled and internally rotated scapula, and a shortening of the pectoralis minor muscle.

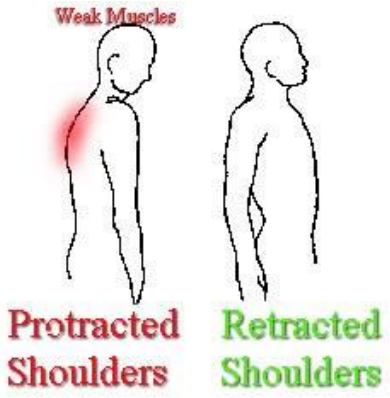

Fig 2. Posture problems. [Internet] Ask the trainer.

Available from: http://www.askthetrainer.com/posture-problems/ [10]

It has been attempted to characterize the postural alignment of the head and shoulders in the sagittal plane of Portuguese teenagers from 15 to 17 years in a natural upright posture, the possible relationship between the studied posture angles and neck-shoulder pain; as well as gender differences in shoulder postural angles and neck pain. In this cross-sectional study participated 275 adolescents (122 males and 153 females) with ages between 15 and 17. Head, neck and shoulders sagittal angles were measured using Photogrammetry and an analysis software.

Their results showed that 68 % of participants presented FHP, while 58 % had PS. In addition, 48 % of the total sample showed both postural deviations.

They have noticed adolescent males with neck pain showed lower main cervical angle than the ones without cervical pain. In regard to gender differences, 59% of female adolescents had regular neck pain, in contrast with 19% that was observed in males. Overall 38 % suffered neck pain regularly[11].

One theory to explain these findings is that it may be due to improper use of heavy backpacks and psychosocial factors such as depression or stress, lack of ergonomic furniture in schools and the enormous amount of hours teenagers spend with poor posture at school and in front of the computer or television[12].

1.1.3. Cervical spine disorders

The primary function of the cervical spine is to guide the head against gravity forces, while allowing multi-directional movement. To complete this task, cervical spine should be mechanically stable, in both static and dynamic postures. In a

neutral upright posture, cervical spine movement's passive resistance is minimal and destabilizing gravitational forces are offset by force moments of the anterior and posterior cervical muscles. Particularly, most segmental deep cervical muscles such as the deep cervical flexor (DCF) play an important role in cervical lordosis control and support, as well as in maintaining cervical spine postural form[13].

Neck shoulder pain (NSP) prevalence has increased in the last years, especially among young people. Approximately 17% of 16 year-old people experience recurrent NSP at least once a week during the last 6 months[14].

It has also been mentioned that 22 % of 12 year-old subjects experienced prolonged NSP. Prolonged NSP causes among adolescents are multi-factorial and include physical and psychological individual factors. In terms of physical factors, spinal posture may be associated with prolonged NSP in adolescents[15].

In the frontal plane, some evidence proved that scoliosis can cause long-term neurological damage in adults, suggesting a possible connection with chronic pain reported by other authors[16]. In the sagittal plane, studies on adults have shown that prolonged NSP may be associated with increased neck flexion postures[17].

There are several studies linking excessive FHP with neck pain. So it has been reported that approximately 60% of individuals with neck pain had FHP. The assumption that greater neck flexion is worse is based on the biomechanical principle relating increased lever arm (from head mass center to head/neck and neck/chest rotation axes) with an increased gross moment. It has been suggested that prolonged FHP may increase loads on non-contractile structures and abnormal stress in the posterior cervical structures, and could cause myofascial pain[18].

FHP and PS are very common postural deviations in adolescents. The direct relationship between FHP and neck pain is demonstrated, and the last one significantly affects other measures such as CV postural angle. We see that gender also has an important effect on posture and neck pain, as women showed lower cervical angle and more pain[11]. In 2008, C.H.T. Yip et al.[19] published a comprehensive study to determine whether there are differences in CV angle between patients with and without cervical pain. They also wanted to determine whether there is any relationship between head position, measured by the CV angle in patients with cervical pain, and the level of disability in these patients. For this

study, they used a control group (without cervical pain) composed of 52 subjects, and a 62 people group with neck pain.

After performing the appropriate measurements in both groups, they found that CV angle in patients with cervical pain was significantly lower than in patients without pain. Hanten et al. (2000)[20] suggested that clinical assessment of patients with neck pain should focus on cervical mobility rather than the position of the head at rest. They found that the position of the head at rest was not significantly different between patients and healthy population. However, other authors[19] showed significant differences at FHP in patients with neck pain when compared with patients without pain. Therefore, it seems that the relationship between posture and pain is a remarkable factor for the doctors, and correction and postural reeducation should be considered an essential part of prevention and treatment for patients with neck pain[19].

Some data were also found that analyze muscle activation in the cervico- brachial region in different sitting positions. A significant reduction was discovered in the thoracic cervical muscle activation, including the cervical erector spinae (CES) and the upper trapezius (UT), when subjects adopted an upright sitting posture[21].

1.1.4. Lumbar spine disorders

Low back pain (LBP) is the first cause of years lived with disability all around the world[22]. The prevalence of ever suffering LBP throughout one's life is very high, so that it has been documented that it reaches 80 %, whereas the point prevalence of chronic low back pain (CLBP) is 20%. Advanced age, female sex, smoking and lack or excess of physical activity are important risk factors for LBP in adolescents[23].

Joao Paulo Caneiro et al. published a study in order to investigate how three sitting postures (lumbo-pelvic, thoracic upright and slump sitting) affected head and neck posture and the cervical- thoracic muscle activity[24].

These three postures were described by O'Sullivan as follows:

"Slump Sitting – posterior rotation of the pelvis, thoraco-lumbar spine relaxed while looking straight ahead.

Lumbo-pelvic Upright Sitting – anterior rotation of the pelvis in order to achieve a neutral lordosis of the lumbar spine and relaxation of the thorax.

Thoracic Upright Sitting – anterior rotation of the pelvis, thoraco-lumbar spine extended and with shoulder blades slightly retracted"[25].

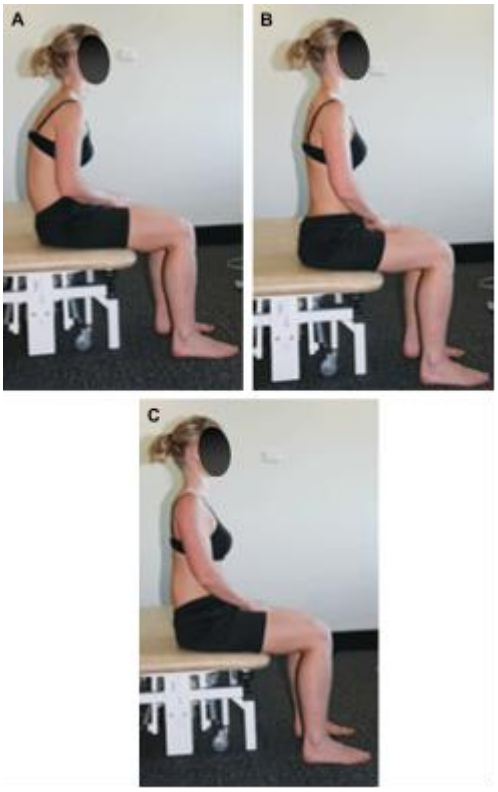

Fig 3: Thoraco-lumbar sitting postures: (a) Slump sitting, (b) Lumbo-pelvic upright sitting, (c) Thoracic upright sitting. [24]

The study results showed that the three previously defined positions generated significant differences in head and neck mobility, and muscle activation of cervical erector spinae (CES) and thoracic erector spinae (TES). These results demonstrate a clear relationship between thoracolumbar spinal posture, head/neck posture and its motor activity.

Slump sitting posture, when compared with lumbo-pelvic upright sitting, appeared to be associated with an increase in thoracic flexion and head and neck flexion, and a greater anterior translation of the head. These findings were also associated with increased activation of the CES and TES muscles.

As for the thoracic upright sitting posture compared to lumbo-pelvic sitting is associated with an increase in thoracic extension and decreased head/neck flexion, with a tendency toward the back translation of the head. This was accompanied with an increase on TES muscle activity and a decrease in CES muscle activity compared to the other positions. This reduction may be due to an increase in activation of the anterior surface neck muscles, resulting in a mutual inhibition of cervical extensors.

Whatever the case, the overall increase in TES activation at thoracic upright sitting can expose cervico-thoracic spine to greater compressive load through its multisegmental joints.

In addition, lumbo-pelvic sitting showed a relatively neutral head/neck alignment, and reduced superficial extensor muscle activity of cervico-thoracic region when compared with slump sitting.

The only studied muscle which did not change its activity significantly between the three positions was the upper trapezius (UT). This suggests that UT role does not vary in maintaining those thoraco-lumbar static postures where upper extremities and eye-hand coordination demand is minimal.

These findings support the important role of the thoraco-lumbar spine in head and neck region's postural training[24].

Ney Meziat Filho[26] in 2015 investigated the prevalence of LBP and its association with postural habits adopted by teenagers at home while watching television or using the computer. 1102 high school students from Rio de Janeiro, Brazil, participated in this cross-sectional study. The teenagers completed a questionnaire that included demographic variables, lifestyle, posture, while using the computer and watching TV, playing video games time and the presence and impact of LBP. All of the above in order to measure the association between postural habits at home and LBP.

The prevalence of LBP was found to be 46.8% (18.2% chronic and 28.6% acute), somewhat alarming since they were teenagers. As a result of LBP, 23% of the students took medication, 9.1% missed classes and 8.2% went to the doctor. As regards the postural habits, slump posture while watching television or using the computer was related to CLBP. This association is predictable because the slump posture causes great demands on lower back posterior passive tissues and a very frail muscle activation[27]. Remaining seated on the bed while watching TV and lying face down while using the notebook also produces considerable stress in passive tissues but in opposite directions. In the latter two positions, the hip joints are near the end of their range of motion. When sitting on the bed, the end of the range of hip flexion produces naturally a tendency to excessive lumbar flexion. However, when remaining face down on the bed hips are near the end of their range of extension, so that an excessively extended lumbar trend occurs.

There is therefore an important relationship between inadequate postural habits and low back pain in adolescents. This association could be an evidence of the population's spending a long time in inadequate posture without the counterweight of moderate level of physical activity[26].

Other authors have demonstrated that changes in the thoracolumbar sitting posture are related to significant changes in trunk muscles activation. Thus, they found a reduced muscular activity on the TES, the internal oblique and the superficial lumbar multifidus in a sitting upright posture when compared with a slump sitting posture. More recently, the effect of three different sitting thoracolumbar postures (slump, thoracic upright and lumbo-pelvic) in the curvature of the spine and activation of the trunk muscles in subjects without pain was compared. These three positions produced different levels of trunk muscles' activity[25].

Existing evidences which link thoraco-lumbar spinal posture with cervical posture and cervico-thoracic muscle activation are still limited. Falla et al.[28] compared muscle activation of the deep neck flexors (DNF), TES and lumbar multifidus during a sitting posture correction from a slump to a neutral stance. The results showed that the activity of DNF and lumbar multifidus was significantly higher when the postural correction was facilitated by a therapist. However, they did not take measures to quantify changes in cervical or thoracolumbar posture[28].

Lumbo-pelvic posture in the sagittal plane and in a sitting position has been linked to prolonged NSP among teenagers, also analyzing the possible differences between genders. 1593 adolescents were studied, with or without prolonged NSP, measuring their usual positions in the sitting position using digital photographs in the sagittal plane. The images were analyzed by special software to calculate the cervicothoracic and lumbo-pelvic postural angles. In addition, a questionnaire was used to measure different aspects that might have an interest or relationship with NSP in adolescents (pain frequency, intensity and other related factors).

5.3% of adolescents was found to report prolonged NSP, with a higher prevalence in females (6.5%) than males (4.5%). Women sat with a more upright posture but with greater lumbar lordosis than men. However, when both sexes were analyzed together, those with prolonged NSP had similar postural patterns that the whole female group. These data suggest that postural differences between with and without pain groups could be explained simply by the gender difference[29].

Prolonged NSP has also been associated with an increase in lumbar extension and anterior pelvic tilt in a sitting position. It is remarkable that adolescents with pain did not sit closer to the end of its flexion range, as it has been revealed to happen in adults with low back pain[25].

Adolescents with prolonged NSP tend to have more lordotic spine, as they sat with more lordosis and their slump posture was more lordotic than what they saw in individuals without pain. The fact that there were no differences between normal and slump posture between the two groups suggests that there is a structural difference, rather than a motor response to pain.

Changes in lumbo-pelvic posture significantly alter motor control patterns in individuals without pain. The lack of association between NSP and the cervicothoracic posture, and the weak association with lumbar-pelvic posture, indicate that posture could have only a small influence on prolonged NSP. Gender, however, shows a greater association with posture than pain. These data require further research with regard to posture interventions, because small changes did not produce the desired effect, but it is believed that performing these everyday changes from an early age can lead to significant long term health consequences[28].

It is possible that the increase in lumbar lordosis in observed subjects with prolonged NSP has an influence in neck motor control in a similar way[29].

Deborah Falla et al.[28] conducted a study in order to investigate the activation of the DCF muscles, in conjunction with the lumbar multifidus and thoracic erector muscles during a postural correction sequence. They wanted to determine whether a specific sitting posture reeducation in patients with neck pain is necessary to achieve the specific recruitment of DCF muscles, or if simply ordering patients to "sit up straight" spontaneously would be equally effective.

As a result, they found that the activation of the deep cervical flexors (DCF) and the lumbar multifidus muscles was significantly higher in the posture correction provided by the therapist, compared to the independent correction.

Postural reeducation is a recommended practice for treating patients with any cervical spine dysfunction. That study’s results showed that the reeducation of sitting posture to an upright spinal position promotes the activation of DCF muscles. However, further research is needed to appreciate the benefits of this exercise on patient's symptoms and postural form. In addition, it highlights the need for clinical

skill and precision in postural reeducation for patients with neck pain to achieve optimal results of this self-help exercise[28].

1.2. Computers and musculoskeletal system

The use of computers in offices has dramatically increased last years, which means that these workers spend much more time in front of the computer. These changes, accompanied by an increased prevalence of poor posture, result in neck pain. FHP (forward head posture) and rounded shoulders are defined as protrusion of the head and shoulders in the sagittal plane[30]. The relationship between FHP, rounded shoulders and neck pain is arguable, because not all studies agree with their direct relationship[9].

Neck pain is very common in sedentary jobs where there is a significant use of the computer, since working with visual display terminals increases FHP, including lower cervical flexion-extension and protracted shoulders. Consequently, computer workers adopt a more forward and flexed head posture, which increases static tension in the neck and shoulders muscles.

Shin Seung -Je et al[31] in 2014 carried out a study involving young people between 20 and 30 years of age. All individuals were completely healthy and reported no back or neck pain from at least 1 year before the study. The measured parameters were the pressure pain in upper trapezius (UT), cervical mobility range and flexo-relaxation cervical range. The instruments used to measure them were a pressure algometer, a Cervical Range of Motion Instrument and an electromyograph (EMG). These variables were measured in these subjects before and after working with visual display terminals for 30 minutes.

Pain threshold when pressing the right UT was found to decrease significantly. Extension, left lateral flexion, right lateral flexion and right rotation in cervical range of motion was also found to diminish considerably. The rest of the measured variables did not suffer significant variations.

Therefore, it is demonstrated that only 30 minutes of working with the computer or other visual terminal produces a significant deterioration in these variables, and it is enough to cause pain. The range of cervical mobility is also found to be far more tender to change with pain. It was reported the necessity to develop a device for self-

measuring cervical range of motion and be able to monitor musculoskeletal changes among patients[31].

Parisa Nejati et al.[30] published in 2014 a study, the objective of which was to discover the relationship between neck pain and poor posture in the head, cervicodorsal spine and shoulders. This study was focused on Iranian office workers, using a photographic method.

They evaluated 46 subjects without cervical pain and 55 with neck pain, all office workers. Analyses were performed in an upright posture, facing forward and in a natural working posture. Thoracic and cervical posture were measured by the high thoracic (HT) and craniovertebral (CV) angles respectively. The position of the shoulders was measured in the sagittal plane by the protrusion of the acromion.

The results showed a significant difference between the CV and / or HT angles between symptomatic and asymptomatic individuals, only during computer work. In other words, participants with neck pain had poorer posture during working time, so the HT and CV angles are positively related to cervical pain, while the position of the shoulders is not. It is also interesting to know that asymptomatic individuals worked fewer hours with the computer than individuals with neck pain, a fact that contributes to directly relate these two variables[30].

However, other authors have reported that there is no positive relationship between the sagittal positions of the cervical and thoracic spine and neck pain, even with people with neck pain showing a higher HT angle (7.34 degrees) compared to those without neck pain[32].

Another aspect to consider is the importance of gender. In a 2011 study, neck and shoulder pain was analyzed, relating it to the usual position of the spine and the use of computers, and paying special attention to the results in each gender.

The study was conducted with a sample of 1483 people, 759 male and 724 female, with an average age of 14.1 years. After analyzing various parameters, it was found that about half of adolescents used the computer 7 or more hours a week, with greater use by males. Females sat more erect and with a greater pelvic tilt. In addition, 29% of adolescents reported neck and shoulder pain in the previous month, with a higher prevalence in females.

Variables related to computer use were cervical flexion, cervicothoracic angle, trunk angle and thoracic flexion, 4 out of the 8 variables measured. There were great

differences in cervical flexion in males, reaching a growth of 4.5° when the increase in computer usage exceeded 21 hours per week. This parameter had not significant variations in females. However, females with 14-21 hours of weekly computer usage increased in 4º their pelvic tilt compared to those who did not use the computer. Differences in men were lower for this parameter.

Surprisingly, the relationship between neck and shoulder pain and the use of computer was opposite between both genders, seeing that in men the risk of this type of pain increased with the use of computer, whereas in women the risk decreases.

Neck and shoulder pain was found, therefore, to be related to computer use, but in a more complex way than it is commonly thought[33].

As we can see, although differences in computer use have decreased, male teenagers are still using it more than females, and the nature of its use is also different. It has been shown that females have a greater upright posture than males, with less thoracic kyphosis and more lumbar lordosis. In addition, in females the prevalence of neck and shoulder pain is greater than in males[34].

1.3. Mobile phones and musculoskeletal system

Access and exposure to different types of information and communication technologies (ICT) such as computers and mobile phones has increased dramatically over the past decade. The use of these ICT among young adults has been studied in aspects of experience, attitudes, health beliefs and the prevalence of perceived stress, depressive symptoms and sleep disturbances[35]. However, there is a lack of knowledge about the physical exposures arising from mobile phone usage and the best way to measure and characterize these exposures.

With each new generation of smartphones, there are new built-in functions, which lead to an increased exposure and use of small built-in (on screen) keyboards. In younger people, these exposures can be of great importance because of its developing musculoskeletal structure, their tendency to use the mobile phone for texting and playing, and the likelihood of higher exposures due to the implementation of these activities repeatedly[36].

These repetitive activities, however, have considerable impacts on adults as well. Thus, first carpo-metacarpal (CMC) arthritis in adults has been related to excessive mobile phone usage and active writing with this device for more than three years[37].

There are studies linking a high number of repetitive keystrokes with hand problems, especially DeQuervain's tenosynovitis and osteoarthritis of the joint at the base of the thumb, the first CMC joint[37,38].

Laboratory work has shown that thumb movements along the mini-keyboard while performing a task such as sending a text message, lead the finger to the end of its range of motion. Typical postures were analyzed while sending text messages and it was found that the thumb came to 79% of its maximum abduction range and 55% of its maximum flexion range. They claim that placing the thumb on static postures as those confers unfavorable static charges on the intrinsic and extrinsic muscles of the thumb[39].

Sophia Berolo[40], in 2011, published a cross-sectional study with an online questionnaire, a sample of which consisted of 140 people from the University of Waterloo in Canada, both students and staff. 98% of study participants used a mobile phone, and the average time spent using this device on a normal day was 4.65 h.

84% of participants reported pain of any severity in at least one part of the body. 32% had pain in their right elbow and forearm, 27% in their left elbow and forearm, 52% in their right shoulder, 46% in their left shoulder, 68% in the neck and 62% on top of the back. The pain in both hands was more common at the base of the thumbs.

The results indicated that the total time spent using the phone on a normal day is significantly associated with having some pain in the right shoulder, left shoulder and neck. In addition, time invested in playing and internet surfing had a significant relationship with pain at the base of the right thumb.

Since 94% of the participants were right-handed, and only 26% used both thumbs to type on the keyboard, they concluded that repetitive thumb movements required for tasks such as playing games or surfing the internet, combined with the time spent on these activities, places unfavorable loads on joints and muscles of the right thumb, and are a major risk factor for various diseases of these structures. They also found a consistent relationship between mobile phone usage and neck-shoulder

pain, leading them to think that the use of these devices is also a risk factor for musculoskeletal pain in this area[40].

Very few experimental studies have focused on postural differences and their correlation with cell phone use and neutral posture.

In 2015, Xiaofei Guan et al.[41] conducted a study with the aim of analyzing the correlation of head and neck positions with mobile phone usage by photographic measurement. To do this, they measured head and neck inclination angle, the variation in the advancement of the head and gaze angle in 186 subjects from 17 to 31 years of age, both in neutral position and using mobile phone. As a result, they found that the position of the head significantly moved forward with mobile phone usage. In addition, subjects showed greater inclination of the head and lesser of the neck than in the neutral position while looking at the mobile phone. The distance between the tragus and the spinous process of C7 increased significantly during mobile phone usage, confirming a more advanced position of the head.

It was also demonstrated that the value of the head and neck inclination angles is related to the gaze angle. As the gaze angle increases, subjects also showed a more forward position of the head. Therefore, while the phone is held above or below eye level, this resulted in changes in neck and head extension. The recommended posture to keep head and neck in a comfortable range includes keeping the gaze angle between 40° and 60° while looking at the mobile phone screen. Regarding to gender differences, a more forward head posture was found in men.

The authors emphasize the limitations of existing studies in this area, and ask for more extensive research, a survey to check dose-response relationship between mobile phone usage length and neutral posture, as well as studies involving more extensively the role that gender plays in these postural differences together with more studies correlating phone use and pain[41].

Significant postural changes related to the use of mobile phone can be the result of the key role of vision. In a study carried out with blind subjects, it was found that these subjects had their heads in a 4.3º lower position in the neck and 4.5 ° tilted forward, in a neutral position and comparing it with neutral postures in healthy individuals[42]. Several other studies confirm this fact, which suggests that vision clearly influences posture.

In 2010 a study was carried out with 60 young people aged from 19 to 25 years old, with the objective of evaluating thumb positions and movements, as well as muscle activity on shoulders, forearms and hands while using mobile phones to send text messages. Muscle activity and thumb positions were found to be affected depending on the position and type of task performed with the mobile phone (holding the phone vs writing).

It has also been noticed that the use of mobile phones among pedestrians leads to increased cognitive distraction, reduces situational awareness and increases unsafe behaviors[43].

On the other hand, other authors report that mobile phone usage during ambulation causes gait disorders that may have significant impact on real life. More specifically, the increase in longitudinal and lateral deviation while typing could lead people to not stop in time or ignore stimuli from their environment, which can lead to accidents and endanger both their own health and the community one[44].

2. JUSTIFICATION

The production of mobile phones increased from 450 million a year in 2011 to 984 million in 2013, and more than 50% of the population in Western countries owns a mobile phone[45].

Text messages and data transmission through mobile devices have increased dramatically worldwide. In the United States, between December 2006 and June 2008, the number of text messages sent increased more than 400% to 75 billion text messages per month. In the second quarter of 2010, text messaging services were used most frequently among 13-17 year-old children (3339 texts/month), and with smaller numbers among children aged between 18-24 years old (1630 texts/month), so that figures nearly doubled since 2008[46].

Approximately a decade ago, the main health concern about mobile phones was cancer, either brain tumors or acoustic neuromas[47]. Currently, however, usage patterns of mobile phones have completely changed, and they are not only used to talk and listen. While their main function were voice calls, new features, applications and touch screens have made those functions controlled with fingers, such as games or messaging applications, mainstream.

A recent study in the Netherlands found that 3% of cyclists used a phone, mainly to write but not to call, which differs from what had been noticed 5 years before[48]. Therefore, health concerns related to mobile phones have moved into addictive use, psychological impact and musculoskeletal symptoms[49].

Epidemiological data concerning behaviors and preferred positions among mobile phone users are very important to evaluate their effect on health. Changes in the use of mobile phones not only include how long they are used, but also how and why they are used[50].

The quick worldwide acceptance of text messaging has increased concerns about the fact that its routine use could lead to major musculoskeletal disorders (MSDs). A growing number of studies have identified arthritis, tendinitis, and tenosynovitis in the first carpometacarpal joint (CMC) among people who send a large volume of text messages[38].

Other studies have shown associations between symptoms in the neck, shoulders or hands with the daily number of text messages sent or duration of use of handheld mobile devices. It remains still unknown what particular exposures when writing with mobile devices are associated with such symptoms[40].

In 2012, Gold et al.[51] published an observational study aimed to characterize the positions and writing styles employed by college students when using mobile devices, and also determine if there were any gender differences in these parameters.

The study included a total of 859 college-age individuals. 61% were female and 39% were male. At least half of the individuals held the phone with both hands and wrote with both thumbs. Just over a third were writing with the right thumb while holding the mobile phone only with the right hand. Most of the subjects were right-handed writers (91%, including bilateral); and 9% used the left hand to write. Nearly half of individuals used a QWERTY keyboard, about one-third used a touch screen, and 18.8% used an alphanumeric keyboard. As for the positions, about two thirds were standing, while just over a third were sitting when using their mobile device. The typical writing position with the mobile device includes a flexed neck, neutral trunk, arms and forearms, and wrists from writing side in a non-neutral position. Half of the subjects had a neutral inner elbow angle at writing side while the other half had this angle lesser than 90° [51].

It has been shown that non-neutral wrist positions can increase the pressure in the carpal tunnel, so they could be related to the carpal tunnel syndrome[52], and can be a risk factor for wrist, hand and arm disturbances. Furthermore, neck flexion has been identified as a risk factor for office workers and dental professionals. This suggests that the writing on mobile phones, linked to the parameters described above, could pose a risk of musculoskeletal disorders (MSDs) for users.

In Spain, however, studies related to this topic are practically nonexistent. Possible differences in the use of mobile phones because of cultural difference and habits and the lack of studies in our country about the possible musculoskeletal risks of using mobile devices, justify the need for further research in this area.

In addition, the university population, and more specifically the students from health sciences related areas, can be an interesting population to study because of their health formation and the possible knowledge they may have about potential

risks of using mobile devices, as well as the increase in their daily use of these devices.

3. HYPOTHESIS

The above-described observational studies on the use of mobile phones show that most of the population does not have proper posture when using these devices. Conversely, we can see that they show a forward head posture and in most cases an excessive head angulation.

On the other hand, increased daily time spent using mobile phone involves longer time holding the device in non-neutral postures, and a greater number of screen keystrokes with their thumbs, something that can lead to potential musculoskeletal risks.

We can also see that a sedentary lifestyle can bring numerous health problems, such as shortening of the tendons, loss of strength, fatigue and circulation and blood pressure problems. These problems can lead to painful situations in multiple body parts.

Considering these aspects, we have formulated the following hypotheses:

- The higher the daily use of mobile phones, the greater the prevalence of musculoskeletal problems.
- Physiotherapy students will be more aware of postural risks related to using portable devices that Nursing and Medicine students.
- Most of the subjects will show an incorrect posture while using the mobile phone.
- Those with a sedentary lifestyle will suffer more pain than the subjects with an active way of life.

To do this we set the following objectives:

4. OBJECTIVES

4.1. General objectives

- To analyze the possible influences of using mobile phones, focused on the musculoskeletal system, among young university students.
- To provide objective data about the possible negative effects these devices produce when they are not used properly, which will serve as reference for an adequate prevention and health education of the population.

4.2. Specific objectives

- To investigate the possible effects that a systematic use of mobile phones can cause in spine and upper limbs.
- To determine whether there is any variation in the response, depending on gender.
- To assess the level of knowledge of young people about the potential impact of the use of mobile devices when certain factors are not considered.
- To study whether there are any differences considering which degree is being held by the target population of our study.
- To inform about the risks of using these devices and propose action lines to promote a better use of them, with a preventive aim.

5. MATERIALS AND METHODS

5.1. Type of study

An observational cross-sectional descriptive study will be carried out in order to determine the level and ways of mobile phone usage among the student population from the University of La Laguna.

5.2. Population and sample

Those health sciences campus students from Physiotherapy, Nursing and Medicine Grades who voluntarily want to participate in this project will be taken as our study population.

To do this detailed information will previously be provided about the objectives and aspects of the methodology in this study on the different courses and degrees, in order to facilitate the incorporation of students to the study.

The gender will be randomly distributed, taking into account the different gender rate that currently exists among university students, as well as the possible differences between grades.

- **Inclusion criteria**: There will be included in our study those subjects who meet the following criteria:
  - Health sciences students.
  - Age range between 17 and 25 years old.
  - Voluntary agreement to join the study.
  - Not having disorders related to the musculoskeletal system.
- **Exclusion criteria**: Therefore, the following criteria will be an exclusion reason if a potential participant meets any of them:
  - Not being studying a Medicine, Nursing or Physiotherapy degree.
  - Age above 25 years old or below 17 years old.
  - Having disorders related to the musculoskeletal system.
  - Not properly fulfill all parameters established in this study.

5.3. Data collection methods

5.3.1. Questionnaire

A carefully prepared questionnaire which collects personal data, and also data related to mobile phone usage and its potential consequences has been developed.

This questionnaire has been designed specifically for our study, regarding to the data provided by the scientific literature in the preliminary review and the previously set objectives.

The questionnaire has 3 sections: General data, Mobile phone usage and Overall health and possible alterations. The variables to be measured in each of these sections will be subsequently developed.

5.3.2. Validation

It is necessary to ensure that the results obtained by this method are reliable; hence the questionnaire must undergo a validation process. This will consist of two steps:

- First step:

A panel of experts will be featured. This panel will be composed of an average of 10-15 people who know about the matter, including the evaluator, experts in the field and professionals in Physiotherapy.

These experts will provide information to improve the questionnaire itself and comply with the level of audience and the objectives of this study. The panel's recommendations will aim to facilitate clarity of the questions, their relevance, if the number of questions is appropriate, or if the response time is also correct. They may suggest changing questions, eliminating some of them, appropriate use of words or changes in the questionnaire design. These recommendations will be considered when modifying the questionnaire.

- Second step:

The second step is the pilot project, in order to ascertain the consistency of the questionnaire. This requires a number of 25 people representing the study participants. Ideally those selected for the pilot project should not participate later in

the study, but they will have similar characteristics to the participants. There will be taken as candidates those students who study physiotherapy, nursing or medicine degrees, explaining to them the purpose of the study. Once they accept, they will be distributed the questionnaire, which they must complete together with recording observations for questions in which they have had any difficulty answering, in order to make the necessary corrections.

Once participants have answered the questionnaire, we must determine the consistency index. The index is usually ascertained through a statistical program like SPSS, Systat, etc. The index is expected to be above 70. The index is generated by individual questions. Questions that fail to meet the required index will be deleted. Once the final questionnaire is obtained, it will be provided to study participants.

5.3.3. Variables

Variables used are as follows:

- **In the General data section:**

-Age: Given the inclusion criteria we know it will range between 18 and 25 years. However, knowing the data for each participant we can find out if there are significant differences in patterns of mobile phone usage or lifestyle among younger and older students. In addition, we can discover whether students of the first courses have differences in the understanding of the potential risks of inappropriate use of mobile phones compared to the ones of more advanced courses.

-Gender: As we have previously said, the gender ratio will be random. However, we will try that both sexes are represented in all degrees, to analyze possible differences regarding gender.

-Degree studied: They will have to choose between all 3 degrees included in the study, Medicine, Nursing and Physiotherapy. Thanks to these data we can know whether there are differences in the understanding of the possible risks between degrees, as we discussed in the Hypothesis section.

- **In the Mobile phone usage section:**

-Having a mobile phone: With this question we will measure the extent of this device use in the studied population. It is expected that the entire sample answer yes to this question.

-Daily mobile phone usage: With a binary response (yes/no) we will analyze whether the use of this device is part of the daily routine of respondents.

-Holding the mobile phone: With questions 6 and 7 of the annexed questionnaire we will try to discover the most common ways to hold the mobile phone. So, we will see if it is held with one hand (right or left) or both, and in case it is held with one hand, if participants alternate between both hands or hold it always with the same one.

-Knowledge of the possible health effects caused by improper use of mobile phones: We asked on a 1 to 5 scale (Poor, fair, neutral, good, excellent) what degree of knowledge they have on these possible effects. We will link these data with the degree studied, sex and other variables. We will also ask if they do something to prevent these risks, letting them specify their preventive action if so. These data will help us later to make an appropriate prevention plan.

-Mobile phone using time: To do this, 3 questions will be formulated. The first one is directed to the time band in which they spend more time on this device (Before 11 am, 11 am to 4 pm or after 4 pm). The second question focuses on how often the mobile phone is used in ranges starting from less than 5 minutes to over 1 hour. With this question we will determine the degree of addiction and the need to look at the mobile phone. The third question is about the maximum time using mobile phone uninterruptedly, to determine if they maintain the positions associated with the use of mobile phone up for long periods of time, and relate that to the possible resulting musculoskeletal symptoms.

-Posture while using the mobile phone: We will ask if they believe subjectively that they maintain a correct posture while using their mobile phone. Then we will measure a more objective figure, asking whether they tilt their head down to look at the screen or raise the screen to eye level, with the last one being the most correct way.

-Position while using the mobile phone: Respondents will be asked about what is the most common position when using their mobile phone, to choose between lying, sitting, standing and walking. We will value the most common positions for each age and sex, and relate them to musculoskeletal symptoms they have. We will also ask them if they usually use the mobile phone while walking down the street, something that has proven to generate risks where traffic safety is concerned.

- **In the Overall health and possible alterations section:**

- General consideration of their health: On a scale which includes the values Very bad, Bad, Normal, Good and Excellent, we assess the subjective perception of the respondent's own health.

-Sport or physical activity: First, we will ask if they perform (or not) some kind of sport or physical activity. If so, we will determine how many days a week (1 day, 2/3 days, 4/5 days or every day) and how many hours a day (1 or less, 2/3 hours, more than 3 hours) they devote to their activity. We will relate these data with mobile phone usage, to determine whether increased physical activity leads to better posture and a more controlled use or not.

-Musculoskeletal symptoms: The last variables measured are those relating to possible physical symptoms suffered by respondents. First, we will ask if they suffer from any neck, thoracic or lumbar pain or soreness. Then we will ask them if they suffer from headaches. Then we will determine if they have any pain in thumbs, hands or wrists. In the next question, we will ask for the pain in the shoulder or elbows. In these questions, respondents can choose more than one option if they consider to be suffering pain in more than one of the questioned areas. We will also ask if they suffer from some kind of tingling or numbness frequently. Finally, we will ask them if they link any of their suffered disorders (if they do) with the mobile phone usage. These variables about suffered pain provide us important data for the study, because we will be able to relate them with almost all variables measured before. It will help us, for example, to find out whether those with an active lifestyle suffer fewer symptoms, or if there is any relationship between the symptoms and the different styles and positions of mobile phone usage.

5.4 Statistical analysis

Statistical analysis will be carried out with the Statistical Package for the Social Sciences (SPSS) statistical analysis software V19.0 (SPSS, Chicago, IL). Descriptive statistics of the variables will be made by using absolute and relative frequencies (%) in the case of qualitative variables. Quantitative variables depending on their following or not a normal distribution will be described as mean and standard deviation (MD, SD) and minimum and maximum range or median and interquartile range respectively (P50/P25-P75).

5.5. Study limitations

The data obtained in the study can only be applied for the purpose of this work. We will be unable to analyze non-university population, but we will be able to find out further and more specific issues about the population which is being focused on.

5.6. Ethical aspects

Voluntary participation in the study will be required. The anonymity of the participants is guaranteed. The data collected by the study will be handled only by the researcher of this work.

5.7. Spending plan

We have developed an estimate of the total costs which will involve carrying out our study describing in detail these expenses individually.

Item	Expense
Panel of experts	1400€
Questionnaire and informative papers impression	40€
Questionnaire distribution costs	30€
Hiring a professional statistician	300€
TOTAL	**1770€**

Table 1. Spending plan

5.8. Schedule

Based on the total population data, we have established a rough estimate of the months required for the different steps in the realization of our study. It includes time for data collection, processing and analysis of these data, writing the draft copy, review and subsequent correction of the draft copy, preparation of a report and conclusions, as well as a plan of feedback standards from our data.

Steps	Timing (2016-2017)							
	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Informative visit to Medicine, Nursing and Physiotherapy degrees								
Needed permissions request								
Candidate selection								
Questionnaire review by expert panel								
Pilot project								
Obtaining questionnaire consistency index								
Questionnaire corrections								
Final questionnaire validation by the expert panel								
Data collection								
Data processing								
Data analysis								
Report elaboration								
Drawing conclusions								
Development of a feedback guidelines plan								

Table 2. Schedule

7. FINAL CONSIDERATIONS

Once we obtain and analyze all the data, we will develop a feedback guidelines plan. This will be a prevention plan in which we will give guidelines about proper mobile phone usage, focusing on those variables most likely to improve.

We will conduct our prevention plan with our study population, Health Sciences students at the University of La Laguna, but it could be extrapolated to other university students, in order to spread prevention strategies as wide as possible.

Our plan will have the following steps:

- Educational talks: We will visit their classrooms and give them general information about mobile phone usage and its potential risks. We will try to raise awareness on them about the musculoskeletal risks related to improper mobile phone usage, and give them some basic postural tips to prevent them.
- Posture workshops: We will divide them into smaller groups, in order to teach them individually tailored tips, which will improve their posture when using the mobile phones and reduce related musculoskeletal loads. They will also be taught a routine of physical exercises focused on strengthening those muscles which maintain upright spinal posture, and improve their overall health.

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8. APPENDIX 1: QUESTIONNAIRE IN SPANISH

Universidad de La Laguna
Escuela Universitaria de Enfermería y Fisioterapia

CUESTIONARIO - PROYECTO FIN DE GRADO
FISIOTERAPIA 2015 2016

- **Datos generales**

1. ¿Qué edad tiene?

_____

2. ¿Cuál es su sexo?

□ Hombre □ Mujer

3. ¿Qué titulación estudia?

□ Enfermería
□ Fisioterapia
□ Medicina

- **Uso del teléfono móvil**

4. ¿Posee usted un teléfono móvil?

□ Sí □ No

5. En caso afirmativo, ¿lo usa usted a diario?

□ Sí □ No

6. ¿Sujeta el dispositivo normalmente con la mano derecha, izquierda o ambas?

□ Derecha
□ Izquierda
□ Ambas

7. Si solo lo sujeta con una mano, ¿siempre es la misma o varía entre ambas?

□ La misma □ Ambas

8. ¿Conoce usted los posibles efectos que puede producir el uso inapropiado del teléfono móvil en su salud?

Nada (1)	Muy poco (2)	Algo (3)	Bastante (4)	Totalmente (5)

9. Si es así, ¿hace algo para prevenirlos? (En caso afirmativo especificar)

□ Sí □ No

10. ¿En qué franja horaria le dedica usted más tiempo a usar su teléfono móvil?

□ Antes de las 11 A.M.
□ Entre 11 A.M y 4 P.M.
□ A partir de las 4 P.M.

11. ¿Cada cuánto tiempo suele revisar su teléfono móvil?

□ Menos de 5 minutos
□ Entre 5 y 15 minutos
□ Entre 15 minutos y 30 minutos
□ Entre 30 minutos y 1 hora
□ Más de 1 hora

12. ¿Cuánto tiempo al día como máximo suele dedicar al móvil de forma ininterrumpida?

□ Menos de 5 minutos
□ Entre 5 y 15 minutos
□ Entre 15 minutos y 30 minutos
□ Entre 30 minutos y 1 hora
□ Más de 1 hora

13. ¿Considera usted que su postura al usar el teléfono móvil es correcta?

□ Sí □ No

14. ¿Inclina usted su cabeza hacia abajo al usar el móvil o levanta la pantalla hasta la altura de los ojos?

□ Inclino la cabeza □ Levanto la pantalla

15. ¿Suele usar el teléfono móvil mientras camina?

□ Sí □ No

16. ¿En qué posición usa más a menudo el teléfono móvil?

□ Sentado
□ Acostado
□ De pie (en estático)
□ Caminando

- **Estado general de salud y posibles alteraciones**

17. ¿En general, cómo considera su salud?

Muy mala	Mala	Normal	Buena	Excelente

18. ¿Realiza algún deporte o actividad física?

□ Sí □ No

19. En caso afirmativo, ¿cuántos días a la semana le dedica?

□ 1 día
□ 2/3 días
□ 4/5 días
□ Diariamente

20. ¿Y cuantas horas al día?

□ 1 o menos
□ 2/3 horas
□ Más de 3 horas

21. ¿Sufre usted de dolores o molestias cervicales, dorsales o lumbares? En caso afirmativo especificar.

□ Sí □ No

□ Cervical □ Dorsal □ Lumbar

22. ¿Sufre usted de dolores de cabeza?

□ Sí □ No

23. ¿Sufre usted dolor en pulgares, manos o muñecas? En caso afirmativo especificar.

□ Sí □ No

□ Pulgares □ Manos □ Muñecas

24. ¿Sufre usted dolor en hombros o codos? En caso afirmativo especificar.

□ Sí □ No

□ Hombros □ Codos

25. ¿Sufre algún tipo de adormecimiento o sensación de hormigueo con cierta frecuencia?

□ Sí □ No

26. ¿Relaciona usted alguna de estas dolencias con el uso de su teléfono móvil?

□ Sí □ No

9. APPENDIX 2: QUESTIONNAIRE IN ENGLISH

Universidad de La Laguna
Escuela Universitaria de Enfermería y Fisioterapia

QUESTIONNAIRE – END OF DEGREE PROJECT

PHYSIOTHERAPY 2015 2016

- **General data**

1. How old are you?

_____

2. What is your gender?

□ Male □ Female

3. What degree are you studying?

□ Medicine
□ Nursing
□ Physiotherapy

- **Mobile phone usage**

4. Do you own a mobile phone?

□ Yes □ No

5. If so, do you use it every day?

□ Yes □ No

6. Do you usually hold your mobile phone with your left hand, your right hand or with both hands?

□ Left
□ Right
□ Both

7. If you hold it with just one hand, do you always use the same or swift it between them both?

□ Same hand □ Swift hands

8. What is your knowledge about the possible negative effects that inappropriate mobile phone usage can cause to your health?

Poor (1)	Fair (2)	Neutral (3)	Good (4)	Excellent (5)

9. Do you do something to prevent these effects? In the answer is Yes, please specify.

□ Yes □ No

10. What time period do you spend more time when using your mobile phone?

□ Before 11 A.M.
□ Between 11 A.M and 4 P.M.
□ After 4 P.M.

11. How often do you usually check your mobile phone?

□ Less than 5 minutes
□ Between 5 and 15 minutes
□ Between 15 and 30 minutes
□ Between 30 minutes and 1 hour
□ More than 1 hour

12. How long do you usually spend using your mobile phone uninterruptedly?

□ Less than 5 minutes
□ Between 5 and 15 minutes
□ Between 15 and 30 minutes
□ Between 30 minutes and 1 hour
□ More than 1 hour

13. Do you consider that your posture when using the mobile phone is correct?

□ Yes □ No

14. Do you tilt your head down when using the phone or raise the screen to eye level?

□ Tilt head down □ Raise the screen to eye level

15. Do you usually use your mobile phone while walking?

□ Yes □ No

16. In which position do you use your mobile phone more often?

□ Sitting
□ Lying down
□ Standing
□ Walking

- **Overall health and possible alterations**

17. In general, how do you consider your health?

Very bad	Bad	Normal	Good	Excellent

18. Do you practise any sport or physical activity?

□ Yes □ No

19. If you do, how many days a week do you practise it?

□ 1 day
□ 2/3 days
□ 4/5 days
□ Every day

20. How many hours a day?

□ 1 hour or less
□ 2/3 hours
□ More than 3 hours

21. Do you suffer from any cervical, thoracic or lumbar pain? If you do, please specify.

□ Yes □ No

□ Cervical □ Thoracic □ Lumbar

22. Do you suffer from headaches?

□ Yes □ No

23. Do you suffer from any pain in your thumbs, hands or wrists? If you do, please specify.

□ Yes □ No

□ Thumbs □ Hands □ Wrists

24. Do you suffer from any pain in your shoulders or elbows? If you do, please specify.

□ Yes □ No

□ Shoulders □ Elbows

25. Do you suffer from any kind of numbness or tingling with a certain frequency?

□ Yes □ No

26. Do you relate any of these ailments with mobile phone usage?

□ Yes □ No