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Transboundary study for the Inclusion of spinal cord injured people in physical activities

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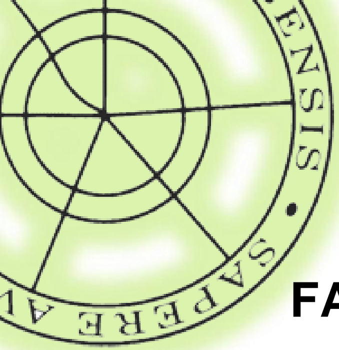

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Tesis doctoral en Personas con necesidades educativas especiales

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Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas

Transboundary study for the Inclusion of Spinal Cord Injured people in Physical Activities

João Miguel Quintino Guerreiro

Directores:

Prof. Dr. Pedro Saenz – Lopez Buñuel

Prof. Dr. José Tierra Orta

Prof. Dra. Sandra Pais

Huelva, Marzo de 2016

“João,
Com esta toalha eu mostro
A minha grande amizade
Ela não tem grande valor
Mas tem a sua utilidade

Eu penso que não vais avaliar
O valor que a toalha tem
Põe-se a mesa, levanta-se a mesa
E o pão e cima dela também

Pois ela até foi feita
Com muito amor e carinho
Pode ser que um dia o meu neto
Me dê em cima dela um chazinho”

Odete da Conceição Jesus

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iv. ABSTRACT

The main objective of the PhD thesis was to study the degree of physical activity (PA) of people with Spinal Cord Injury (SCI) and how it's relation to both the presence of shoulder pain (SP) and characteristics of the manual wheelchair (MWC). The study was carried out in the regions of Portugal (Algarve and Alentejo) and Spain (Huelva, Seville and Cadiz).

This study was divided in two phases, a **first phase** of translation and cross – cultural validation of questionnaires and a **second phase** to focus on the physical, psychological and social level of integration that both PA and/or adaptive sports may have on the improvement of quality of life (QOL), prevalence of SP and on the impact that MWC components may have on the participation level of subjects with SCI in PA and/or QOL.

Phase 1 was divided in three sub–studies (1 to 3) regarding cross – cultural validation of instruments to use in the cross–sectional study (second phase). The three sub-studies regarded the cross-cultural validation of the Physical Activity Scale for people with Physical Disabilities (PASIPD) in Portuguese and Spanish; the Quebec User Satisfaction with Assistive Technology 2.0 (QUEST 2.0) in Spanish and the Quality of Life Index (Ferrans&Powers) – SCI III (QLI – SCI III) in Portuguese and Spanish.

Psychometric analysis for PASIPD, QLI (Ferrans & Powers) – SCI III and QUEST 2.0 presented higher values of internal consistency and reliability than the original versions, indicating a good test – retest.

Phase 2 was divided in four sub–studies where we used the same methodology (sub-studies 4 to 7). We developed a cross-sectional evaluation of socio-demographic characteristics, level of PA, QOL, Self-perception of satisfaction with the MWC, anthropometric individual characteristics, MWC ergonomics, SP and Upper extremity isometric strength.

The majority of the study participants (63,46%) were engaged in regular PA (n=33). The most performed activities were basketball (15,38%), handcycling (13,46%) and paddle/ tennis (19,23%).

We observed a statistical difference in MWC dimensions for Portuguese and Spanish subjects. We also observed cases in Portugal and Spain where the subjects used only MWC or powered wheelchair (PWC) or changed PWC/MWC during the day or according to the performed activity. This was observed in subjects who presented more years since SCI and consequently have used MWC for along time.

We observed that there was a significant difference in the scores for SP and MWC seats heights, for Portugal and Spain. The median values for seat height were relatively higher for people with SP. And the values of QOL were influenced by the level of PA and the MWC type.

We observed a statistical difference in strength values for PA practice, in between Portuguese/ Spanish subjects, according to the presence of armrest and also for seat height. The shoulder flexion, shoulder abduction, shoulder extension and shoulder medial rotation were influenced by trunk control and the presence of SP. Seat height and years since SCI were found to influence upper extremity strength values.

The seat height and presence of shoulder pain influenced shoulder lateral rotation, elbow extension, elbow flexion and shoulder flexion.

There was a statistical difference in strength values among regions/provinces, mainly among Algarve/Alentejo and Seville.

In conclusion, the translation and cultural validation of PASIPD (Portugal and Spain), QLI (Ferrans & Powers) SCI – III (Portugal and Spain) and QUEST 2.0 (Spain) was carried out.

A demographic and anthropometric analysis of SCI (Algarve, Alentejo, Huelva, Seville and Cadiz) and identified type of MWC, dimensions and materials of the study areas was realized. A correlation with SP using the WUSPI with QUEST 2.0 and MWC components, PA and QOL was identified, with differences among Portugal and Spain.

Subjects who were enrolled in PA and adaptive sports showed clearly higher QOL.

PA also influenced strength values which were clearly higher in the Spanish group due to their bigger engagement in PA.

SP was associated with heavier MWC and lower strength in the upper extremity.

v. RESUMEN

El objetivo principal de esta tesis doctoral ha sido de estudiar el nivel de actividad física (AF) de sujetos con lesión medular (LM) y la relación con la presencia de dolor de hombro (DH) y las características de la silla de ruedas manual (SRM). Este estudio se desarrolló en Portugal (Algarve y Alentejo) y España (Huelva, Sevilla y Cádiz).

El estudio ha sido dividido en dos fases, la **primera fase** de validación cultural de cuestionarios y la **segunda fase** de enfoque en el nivel físico, psicológico y social de integración que la AF y/o el deporte adaptado pueden presentar en la mejora de la calidad de vida (CV), prevalencia de DH y el impacto que los componentes de la SRM pueden tener en la participación de los sujetos con LM en AF y/o CV.

La primera fase ha sido dividida en tres sub–estudios (1 a 3) de validación cultural de cuestionarios a utilizarse en el estudio transversal (segunda fase). Los tres sub-estudios ha sido para la validación cultural del *Physical Activity Scale for people with Physical Disabilitie*s (PASIPD) para portugués y castellano; el *Quebec User Satisfaction with Assistive Technology 2.0* (QUEST 2.0) para castellano y el *Quality of Life Index (Ferrans&Powers) – SCI III* (QLI – SCI III) para portugués y castellano.

Los análisis psicométricos para PASIPD, QLI (Ferrans & Powers) – SCI III y QUEST 2.0 presentaran valores más altos de consistencia interna y de confiabilidad que las versiones originales, indicando un bueno proceso de test – retest.

La segunda fase se ha dividido en cuatro sub-estudios, donde se ha utilizado la misma metodología (sub-estudios 4 a 7) Se ha desarrollado un estudio transversal de características socio-demográficas, nivel de AF, CV, percepción de la satisfacción con la SRM, características antropométricas, ergonomía de la SRM, DH y evaluación de la fuerza isométrica de los movimientos de miembro superior.

La mayoría de de los participantes (63,46%) realizaban AF regular (n=33). Las actividades más comunes han sido el baloncesto en silla de ruedas (15,38%), el handcycling (13,46%) y el pádel/ tenis (19,23%).

Se observó una diferencia estadística en las dimensiones de las SRM entre Portugal y España. Incluso, algunos sujetos (Portugal y España) utilizaban solo SRM u sillas de ruedas eléctricas (SRE) o cambiaban entre SRM/SRE al largo del día. Esto, se ha observado en sujetos que presentaban más años desde la LM y por lo tanto utilizaban silla de ruedas hace más tiempo. Hemos observado una diferencia significativa en los scores de DH y la altura del asiento entre Portugal y España. La mediana de la altura del asiento era relativamente más alta en sujetos con DH. Incluso, los valores de CV han sido influenciados por la actividad física y el tipo de SRM.

Se observó diferencia en los valores de fuerza en el nivel de AF, entre los sujetos de Portugal y España, para la presencia de reposabrazos y altura del asiento.

Los valores de flexión del hombro, abducción del hombro, extensión del hombro y rotación medial de hombro han sido influenciados por el control del tronco y la presencia de DH. Además, la altura del asiento y los años desde la LM han influido en los valores de fuerza del miembro superior.

La altura del asiento y la presencia de DH han influenciado la rotación lateral del hombro, extensión del codo, flexión del codo y flexión del hombro.

Los valores de fuerza han sido distintos entre regiones/provincias, con diferencia significativa entre Algarve/Alentejo y Sevilla.

En conclusión, la validación cultural del *PASIPD* (Portugal y España), *QLI (Ferrans & Powers) SCI – III* (Portugal y España) y *QUEST 2.0* (España) ha sido desarrollada.

Se ha desarrollado un análisis socio-demográfico y antropométrico de los sujetos con LM (Algarve, Alentejo, Huelva, Sevilla y Cádiz) y se ha identificado el tipo de SRM, las dimensiones y materiales.

Se identificaran correlaciones entre el DH y el QUEST 2.0, los componentes de la SRM, CV y AF, con diferencias entre Portugal y España. Los sujetos que realizaban actividad física y deporte adaptado presentaban valores de CV más elevados.

La AF influenció los valores de fuerza que han sido claramente más altos en el grupo de España debido a su práctica regular de AF. El DH ha sido asociado a SRM más pesadas y valores más bajos de fuerza de miembro superior.

vi. LIST OF ACRONYMS

AT – Assistive Technology

CG – Center of Gravity

Cm – centimeters; dimension unit

HHD – Hand Held Dynamometer

ICIDH – International Classification of Impairment, Disability and Handicap

Kg – Kilograms; Weight unit

MET – Metabolic Equivalent

MWC – Manual Wheelchair

MMT – Manual Muscle Testing

N – Newton; Force unit

PA – Physical Activity

PASIPD – Physical Activity Scale for Individuals with Physical Disabilities

PWC – Powered wheelchair

QLI (Ferrans & Powers) SCI – III – Quality of Life Index (Ferrans & Powers) Spinal Cord Injury – III version

- *FAMSUB* – Family Subscale.
- *HFSUB* – Health Subscale
- *PSPSUB* – Psychological Subscale
- *SOCSUB* – Social Subscale

QOL – Quality of Life

QUEST 2.0 – Quebec User Satisfaction with Assistive Technology version 2.0

- *AT* – Assistive Technology
- *SV* – Service
- *TS* – Total Score

SP – Shoulder pain

SCI – Spinal Cord Injury

UE – upper extremity

WUSPI – Wheelchair User Shoulder Pain Index

ROM – Range of motion

INTRODUCTION

1. INTRODUCTION

This chapter introduces and explains the intended development of the activities throw the justification of the theme, the objectives and the hypothesis of the investigation.

1.1. Justification of the theme

This is an academic research PhD study developed in a transboundary approach with spinal cord injury (SCI) subjects from Portugal and Spain, taking place in regions/ provinces with less number of clubs and athletes related to the density of population, know-how and a descending number in the past years (Annex I, page 211). The provinces/ regions, present different access to manual wheelchairs (MWC), maintenance and funding. We intend to focus on these bases to approach research, cooperation and promotion of quality of life (QOL), satisfaction with MWC and shoulder pain (SP) in subjects with SCI, performing physical activity (PA). For that reason, it is necessary to first develop a cross – sectional analysis of these regions/ provinces subjects, PA and how it is correlated with QOL, MWC and SP.

Paralympics are a way of expressing the disability and fighting against it. In the last decade, many efforts have been made to improve participation in PA and adaptive sports and on the investigation of new materials and assistive technology (AT) for the players, as well as on MWC skills. However, it is important to evaluate how this improvement for MWC can promote PA in daily living activities and the importance of inclusion in adaptive sports. Adaptive sports can have competitive and playful principles, and are the main way of the people with disabilities to improve their physical capacities, well being and general health condition. Allied to this, PA can improve social, psychological and QOL domains.

So, it is intended to study how the impact of PA, can improve QOL, MWC use, reduce prevalence of SP and improve upper extremity (UE) strength.

Spinal Cord Injury has a high incidence in the developed countries, leading to the use of MWC. And with the improvement of the rehabilitation process, there is an improvement of the average years since SCI. However, it is well known that MWC users tend to develop chronic SP caused by overuse in MWC mobility. It is pertinent to understand the presence and prevalence of SP in people with SCI and determine eventual influences of PA, MWC characteristics and self perception of QOL on SP. To our current knowledge no other study has focused on the relation of PA level and SP, QOL and strength in subjects with SCI that use MWC.

Our goal was also to care out this study in two distinct regions. Algarve, Alentejo and Andalucía are transboundary regions of the south of the Iberic Peninsula, cultural, geographically, socially and economically very similar, but with distinguished heath care systems, namely regarding access to MWC and other AT devices.

On a more personal note, this theme is due to the investigator's interest in SCI supporting devices such as MWCs and adaptive sports, the continuous focus on the national athletes and Paralympics, and the desire to create more technical and social opportunities for people with disabilities in the sports practice and daily living activities.

1.2. Study objectives

The main objective of the PhD thesis was to study physical activity level of people with SCI and it's relation with individual anthropometric characteristics, upper extremity strength, shoulder pain and type of MWC and the impact of these variables on QOL.

The study was carried out in the regions of Portugal (Algarve and Alentejo) and Spain (Huelva, Seville and Cadiz) which are transboundary to each other, and are less developed regions compared to the capital cities of Portugal or Spain regarding adaptive sports and inclusive recreational physical activities.

During the study it was our intention to focus on the physical, psychological and social level of integration that both physical activity and/or adaptive sports may have on the improvement of quality of life, assistive technology, prevalence of shoulder pain and on

the impact that MWC components may have on the participation level of subjects with SCI in Physical Activity and/or Shoulder Pain.

Because of the absence of validated instruments to measure quality of life, assistive technology desirability, physical activity and shoulder pain for each country, this study was divided in two phases with different sub – study objectives:

1) **First phase:** translation and cultural validation of questionnaires to be used in phase 2:
   a. ***Sub–Study 1***: To perform translation and cultural validation of Physical Activity Scale for People with Physical Disabilities for Portugal and Spain.
   b. ***Sub–study 2***: To perform translation and cultural validation of Quality of Life Index (Ferrans & Powers) SCI – III for Portugal and Spain.
   c. ***Sub–study 3:*** To perform translation and cultural validation of Quebec User Evaluation of Satisfaction with Assistive Technology – 2.0 for Spain.
2) **Second phase:** To do a cross sectional study in the transboundary area of Portugal and Spain with subjects who have SCI:
   d. ***Sub–study 4:*** to describe the characteristics of the subjects, anthropometric measurements and wheelchair characteristics. And to present the scores descriptive values of physical activity, quality of life, shoulder pain and satisfaction with wheelchair.
   e. ***Sub–study 5:*** To study the relation of MWC type of components to the subjects satisfaction and presence of SP in both countries.
   f. ***Sub–study 6:*** To study the relation between QOL and PA levels in subjects with SCI of both countries.
   g. ***Sub–study 7:*** To study the relation between isometric strength of upper extremity and MWC components.

1.3. Study hypothesis

Because MWC users require continuous use of the UE move, transfers, weight-relief lifts and perform other reaching activities (van Drongelen, van der Woude, & Veeger, 2011; Van Drongelen et al., 2005a; van Drongelen et al., 2005b); thus the Shoulder complex in MWC users have to bear greater mechanical forces than in an able-bodied person, which leads to overused injuries (Guo, Su, Wu, & An, 2003); and Regarding the UE kinematics

in MWC users with SP, the most referred difficulty is regarding weight relief raise and transfer process which need greater scapular upward rotation (Nawoczenski, Riek, Greco, Staiti, & Ludewig, 2012). We have divined the necessity to study the relation between MWC components and the prevalence of SP in subjects with SCI. Our hypothesis were:

1. Shoulder pain is observed in long time MWC users and is probably related to MWC components
2. The presence of shoulder pain may be related with subjects satisfaction regarding their MWC
3. Because of the differences in accessing MWC among the studied countries, MWC characteristics and subjects satisfaction will then be different in-between the studied regions.

Because the level of neurologic impairment was found to be a significant factor interacting with QOL (Middleton, Tran, & Craig, 2007) and pain intensity seems also to be an influential factor in reducing QOL, as those with high pain intensity are found to have significantly lower QOL (Middleton et al., 2007). We believe that regular PA and MWC components will influence QOL of SCI subjects, therefore the following hypothesis were defined:

1. Physical activity level will influence QOL
2. Manual wheelchair characteristics will influence QOL, PA level and shoulder pain.

Because it is known that MWCs lighter frame components influence overall weight of the MWC (Cooper et al., 2010); studies regarding MWC, seat height influence push time and push angles (Boninger, Baldwin, Cooper, Koontz, & Chan, 2000; Kotajarvi et al., 2004; van der Woude, Veeger, Rozendal, & Sargeant, 1989); and has been found that lower backrest height enables the arm to move more freely, increasing hand contact further back on the handrim, contributing to larger stroke angles (Yang, Koontz, Yeh, & Chang, 2012) influenced by handrim size (Guo, Su, & An, 2006). We hypothesis that:

1. The use of lighter MWCs in physical activity MWC users diminishes the presence of shoulder pain and influences UE isometric strength.
2. In lower seat heights a MWC user will show reduced SP, be more active and present higher values of UE strength.
3. Level of paraplegia will influence UE strength

REVIEW

2. REVIEW

This chapter is a review of published studies regarding disability, spinal cord injury, manual wheelchair components and ergonomic standards, wheelchair sports, anthropometric measurements and isometric strength and dynamometry evaluation.

2.1. Disability

Disability serves as an umbrella term for impairments, activity limitations or social participation restrictions. It represents a deviation from certain generally accepted population standards in the biomedical status of the body and its functions. Impairments can be temporary or permanent; progressive, regressive or static; intermittent or continuous. Also, when there is impairment, there is a dysfunction in the body functions, related to diseases, disorders or physiological states (World Health Organization, 2001).

ICIDH – 2 model organizes the different variables present in the health condition with a specific focus on the disability. This model organizes information in functioning and disability (body functions and structures, activities and participation) and contextual factors (environmental and personal factors) (World Health Organization, 2001).

Within the context of rehabilitation of chronic impairment, rehabilitation focuses on the restoration of locomotion, ambulation in its widest sense – body structures, activities and social participation. Currently, rehabilitation principles goes further than the simple restoration, compensation and adaptation of the sensor and motor functionality and independence in daily living (Van Der Woude et al., 2005). This indicates that the SCI rehabilitation depends on the relation of the impairments, cardiorespiratory/ pulmonary function, wheelchair skills or social and psychological context.

2.2. Spinal Cord Injury

Spinal Cord Injury results of a disease or trauma (Maestro, 2010) which changes the spinal cord normal function and produces lack of sensibility, motor functioning and visceral, sexual and trophic changes. SCI lesions can either have traumatic (80%) resulting from car accidents or non traumatic (20%) resulting from tumor or infectious causes. The clinical consequences of SCI depend on the level, degree of the lesion in the transverse plan, degree of lesion in the longitudinal plane and time passed since the SCI (Lianza, Casalis, & Greve, 2007).

2.2.1. Level of SCI

The level of SCI is determined by the most caudal segment of spinal cord with preserved motor and sensitive functions in both sides of the body. Lesions above T1 cause tetraplegia and all lesions beneath this level are classified as paraplegias (Lianza et al., 2007) and in general, the higher the level of SCI, the greater the loss of function (Price, 2010; Schmid et al., 1998).

2.2.1.1. Tetraplegia

When the level of injury occurs in the cervical region, the function of the UE and peak heart rate are mainly affected due to the injury being located in the spinal region associated with the brachial plexus and motor control (Price, 2010; Schmid et al., 1998).

In complete tetraplegia, there is a minor chance of functional motor recovery if the patient remains motor and sensory complete 1 month following injury. Only 10% of those with complete tetraplegia will convert to incomplete status experiencing recovery of sacral function but minimal motor recovery. For patients with incomplete tetraplegia, recovery in the upper and lower extremities the recovery of functional strength in individual muscles is good. But this ratio is lower compared with patients with incomplete paraplegia because impaired UE functions make ambulation more difficult (Talu, Swamy, & Berven, 2005).

2.2.1.2. Paraplegia

When the level of injury occurs in the thoracic area, lumbar area or below, UE function generally remains intact but result in different degrees of back, abdominal or lower limb function, accordingly with the level of SCI (Price, 2010).

For paraplegics, with complete lesion of 96% will remain complete following one month to the injury and 4% will convert to incomplete status. This conversion does not confer much motor recovery but may recover sacral functions resulting in bowel and bladder continence in half of the patients. Only 5% of patients with complete paraplegia will restore walking ability 1 year after injury (the incomplete paraplegia motor recovery is independent of the level of injury and 76% will attain community ambulation status). Therefore, differentiation of complete versus incomplete injuries is especially important in paraplegic to the reliability to predict future ambulation (Talu et al., 2005).

2.2.2. Degree of SCI in the transverse plane

SCI is considered complete when there is absence of motor and sensitive function at the myotomes and dermatomes innerved by the sacral segments of the spinal cord. An incomplete injury is defined as a preservation of motor function or sensation below the neurological level of Injury that includes the lowest sacral segments (Kirshblum & Benevento, 2009; Lianza et al., 2007)

2.2.2.1. ASIA Scale

The ASIA is the World's widely used model to indicate the muscles motor levels and sensitive dermatomes. It was introduced in 1969 (Frankel et al., 1969), a scale presenting 5 grades to classify traumatic SCI, with division into complete and incomplete injury and is now recommended and used by American Spinal Injury Association (http://www.asia-spinalinjury.org/):

A. Complete – No sensory or motor function is preserved in the sacral segments S4-S5.
B. Incomplete – Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5 (light touch, pin prick at S4-S5: or

C. deep anal pressure and no motor function is preserved more than three levels below the motor level on either side of the body.
D. Incomplete – Motor function is preserved below the neurological level, and more than half of key muscle functions below the single neurological level of injury have a muscle grade less than 3 (Grades 0-2).
E. Incomplete – Motor function is preserved below the neurological level and at least half (half or more) of key muscle functions below the neurological level have a muscle grade > 3.
F. Normal – If sensation and motor function are graded as normal in all segments and the patient had prior deficits.

2.2.2.2. Motor and sensitive scale

Analysis of SCI regards motor and sensitive scale. Motor levels are grouped in a muscle (0) functioning grade as total paralysis; (1) palpable or visible contraction; (2) active movement with range of motion (ROM) with gravity eliminated; (3) active movement, full ROM against gravity; (4) Active movement, full ROM against gravity and moderate resistance in a muscle specific position; (5) active movement, full ROM against gravity and full resistance in a muscle specific position expected from an otherwise unimpaired person; (5*) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors were not present; (NT) not testable. The sensitive level is determined by the dermatomes with pain sensibilities and slim tactile sensibility to check if they are preserved in both sides of the body. Pain and touch perceptions are evaluated in each of the sensitive key – points according to the scale, for absent (0), altered (1), normal (2) or NT (Ares & Cristante, 2007; Kirshblum & Benevento, 2009)

According to some authors (Ares & Cristante, 2007; Kirshblum & Benevento, 2009) due to SCI can result several syndromes:

- **Anterior cord syndrome** which is an incomplete lesion with loss of motor function and thermal and pain sensibility but with preservation of proprioception. In this case the lesion affects the anterior two thirds of the spinal cord preserving the posterior columns. There is a variable loss of motor and pinprick sensation relative preservation of light touch, proprioception and deep pressure sensation.

- **Central cord syndrome** which is an incomplete lesion of the cervical area, with more action on the upper limb body. It is characterized by motor weakness in the UE, sacral sparing and can also include bladder dysfunction and varying loss below the level of the lesion.
- **Brown – Sequard syndrome** which is an incomplete lesion that results in ipsilateral sensory loss at the level of the lesion with hemisection of the spinal cord resulting in motor and contralateral loss of temperature and pain below the lesion.
- **Conus medullaris** which is the terminal segment of the adult spinal cord, located at the inferior aspect of the L1 vertebrae. These lesions affects the lower lumbar roots supplying muscles to the lower part of the leg and foot, with this sparing the sacral segments with the loss of flaccid motor function and absence of sensibility in the lumbar – sacral segments.
- **Equine tail syndrome** which is a lesion inside and beneath the spinal cord with lose of flaccid motor and sensitive function in the muscles and dermatomes nerved by the affected areas and can be complete or incomplete according to the degree of lesion of the lumbar – sacral ruts.

2.2.2.3. Functional prognosis

Patients with upper cervical level injuries (C1 to C3) are typically dependent for daily activities including respiration. Patients with a C4 level of injury may be able to breathe without a ventilator but they are generally dependent for all other functional activities. Patients with a C5 SCI level need less assistance for activities of daily living with the use of specialized adaptive devices only. At the lower cervical levels (C6 to C8) individuals are likely to need assistance with bowel and bladder functions and management but they may be independent in other functional activities with the use of adaptive equipment. Patients with paraplegia are potentially independent in all self-care activities as well as with bowel and bladder management, however regarding ambulation, on the other hand, they remain dependent on the neurologic level (Talu et al., 2005).

2.2.3. Physiological changes with SCI

2.2.3.1. Bladder

Bladder changes are common in SCI subjects as urinary infection, calculus, refluxes are frequently present and the bladder tends to be atonic and with flaccid muscles (Ares & Cristante, 2007). The goals of management of the neurogenic bladder are to achieve an acceptable method of bladder drainage and preventing other health complications. Generally after the first month post injury, bladder may contract reflectively with loss of voluntary control, generally with frequency voiding at abnormally low bladder volumes (Kirshblum, 2009).

2.2.3.2. Bowel management

Most frequent bowel problems in people with SCI are the presence of fecal incontinence, trouble in evacuating and the need for assistance in releasing the intestine (Ares & Cristante, 2007). Bowel problems affect 27% of all individuals with chronic SCI, bowel abnormalities are many times aggravated due to altered colonic compliance, impaired transit time and poor dietary intake and the goal of an effective bowel program aims to minimize or eliminate the occurrence of unplanned bowel movements to evacuate (Kirshblum, 2009).

2.2.3.3. Cardiovascular

Most common Cardiovascular changes after SCI are due to interruption of communication between receptor organs and brainstem centers as well as interruption of the autonomic nervous system and these complications include orthostasis, cardiac arrhythmia, thermoregulatory disorders and autonomic dysreflexia (Kirshblum, 2009):

1. Orthostatic hypotension is more common in people with complete SCI above T6 and results of the reduction in blood pressure due to the change in body position toward the upright, causing lightheadedness, dizziness, syncope and numbness.

2. Cardiac arrhythmias – is seen common in the early weeks after injury and occur in patients with lesion above T5 level, due to inadequate supraspinal control of the sympathetic nervous system and unopposed vagal tone.
3. Thermoregulation – SCI decreases the ability of the hypothalamus to direct the periphery and allow thermoregulation so, patients with lesions above T5 are sometimes poikilothermic.
4. Autonomic dysreflexia – is a syndrome of massive imbalanced reflex sympathetic discharge occurring in patients with SCI above the splanchnic outflow (T6 level).

2.2.3.4. Skeletal Muscle

The most common complications in the skeletal muscle level are the heterotopic ossification and the osteoporoses. Heterotopic ossification occurs between the first month and first year with the development of bone tissue in the periarticular area. Osteoporoses are common by the reduction in the bone density caused by the SCI and absence of enervation (Ares & Cristante, 2007).

2.2.3.5. Pressure sores

Pressure sores generally appear in bony areas of the body, namely in people who stay during long periods in the same position and without preserved sensibility. IN SCI ASIA A and B impairment levels hospitalization is frequently a result of pressure sores (Garber & Rintala, 2003). Bony areas press the skin, reducing the blood circulation and lead to ischemia of the tissues (Ares & Cristante, 2007).

Stages of pressure sores are described in four (I – IV) degrees. Degree I affects the epidermis tissue nonblanchable erythematic of intact skin, which is not to be confused with reactive hyperemia. Degree II affects the epidermis layer and superficial layer of the dermis partial thickness, usually presenting an abrasion, blister or shallow crater (Garber, Rintala, Hart, & Fuhrer, 2000; Rintala, Garber, Friedman, & Holmes, 2008).

Degree III affects subcutaneous tissue, in this case there is a full thickness of skin loss with damage or necrosis of subcutaneous tissue that may extend down, but not through the underlying fascia, it appears as a deep crater with or without undermining the adjacent tissue. Degree IV affects muscle and bone areas full thickness skin loss with extensive

destruction, tissue necrosis, or damage to muscle, bone, or supporting structures (Garber et al., 2000; Garber & Rintala, 2003; Rintala et al., 2008).

To reduce the risk of developing pressure sores, it must be considered the use of seat cushions and inserts. Seat cushions can be divided into static or not energized and dynamic cushions or energized, depends on the action to relieve pressure. According to the material, static cushions can be classified into solids, liquids and gases. Solid cushions are made from polyurethane or oil – based foam, are lightweight, less expensive, easy to transfer and present a stable base and may not be the choice for a long term user because they are poor heat conductors, susceptible to pulling and tearing and may lose pressure relief properties (Batavia, 2010; Stockton et al., 2009).

Liquid cushions are composed of a gel or water and are easier to clean, can be positioned around the bony prominences, conducts heat away from the skin and adjusts better to body movements Air type cushions are lightweight, easy to clean, are compartmentalized, allows monitoring of pressure level, however may be unstable, which is critical for users with poor trunk control, may be difficult to transfer from and requires maintenance to maintain correct operation (Batavia, 2010; Stockton et al., 2009).

2.2.3.6. Respiratory

Pulmonary Function is more impaired in people with more severe neurologic deficits. Five years after discharge, people with complete tetraplegia pulmonary function are 80% of the predicted value, while people with other lesion groups approached the normal value for able-bodied people. Although, absolute levels of pulmonary function differ between lesion groups and is observed that a higher body mass index has a negative association with change in pulmonary function. It is shown that people with reduced pulmonary function suffer, from decline in fitness whereas people with stable or improved pulmonary function show improvement in fitness (Postma et al., 2013).

Among subjects with SCI 68% report one or more respiratory symptom, being breathlessness the most prevalent complaint present in 73% of the high tetraplegias (C5 and above), 58% of the low tetraplegias (C6–C8), 43% of the high paraplegias (T1–T7), and 29% of the low paraplegias (T8–L3) (Spungen, Grimm, Lesser, Bauman, & Almenoff, 1997). Breathlessness is also the most prevalent complaint among SCI subjects with neurologically complete cervical injury, those who need a motorized wheelchair for daily

activities, and non-athletes (Ayas et al., 1999; Grandas et al., 2005; Wien et al., 1999). Respiratory function increases with descending SCI levels down to level T10 below. They tend to level off and the values improve in a supine position when compared with the seated posture (Baydur, Adkins, & Milic-emili, 2001).

Another respiratory alteration in SCI subjects is altered VO_2 values which differ significantly between tetraplegia and paraplegia and between tetraplegia and subjects without SCI and they are shown to be highly correlated with heart rate (Leicht, Bishop, & Goosey-Tolfrey, 2012; Pelletier, Jones, Latimer-Cheung, Warburton, & Hicks, 2013).

2.2.4. Physical Activity induced Changes in SCI subjects

Individuals with SCI being actively involved in sports differ from physically inactive individuals. Functional effects such as the increase of physical resistance, mobility and coordination, as well as, social and psychological effects such as an increase in self-confidence, self concept or mental state have been reported (Anneken, Hanssen-Doose, Hirschfeld, Scheuer, & Thietje, 2010).

2.2.4.1. Physiologic capacity

Aerobic Capacity tested over a 20 year period of time in SCI athletes who performed MWC marathon and non – athletic, showed that athletes had a significant increase in body weight, maintaining cardiopulmonary capacity, with increase of VO_2max for individuals who repeatedly participate in marathon and/or practice regular exercise diminish it by 53% in sedentary lifestyle (Shiba et al., 2010).

Individuals with SCI that are actively involved in physical activities report a comparatively better QOL within physical, psychological, social and context field (Mojtahedi, Valentine, Arngrímsson, Wilund, & Evans, 2008). For subjects with SCI in Wingate anaerobic test it is shown that the optimal level of loading is directly related to the amount of muscular force that can be generated and therefore associated, with the amount of muscle mass that can be used in the generation of those forces (Jacobs, Johnson, Mahoney, Carter, & Somarriba, 2004).

2.2.4.2. Muscular Adaptations

In SCI paralyzed muscles below the lesion reduce volume and suffer important morphological and metabolic changes. The proportion of type IIB muscle fibers is increased and type I fibers decreased. Paralyzed muscles also show a decrease in both mitochondrial enzyme activity and capillary density, indicating low oxidative capacity (Hartkopp et al., 2003). Electric stimulated cycling for resistance training and walking exercises allow increased muscle mass and prevent atrophy (Giangregorio & McCartney, 2006).

The patterns of muscle recruitment are similar for persons with high paraplegia and low paraplegia. In high paraplegia cases, there is lack of trunk control created by paralysis of lower abdominals and back extensors, however, this does not affect the muscular response of the shoulder joint to the demands of MWC propulsion (Mulroy et al., 2004).

2.2.4.3. Bone adaptations

It is found that the longer the period since the SCI, the lower the values shown for bone mass density, particularly in lower limbs. It is also found that the earlier the athletes return to sports after the SCI, the higher the values of bone mass density in legs and body trunk, independent of age and sports type, indicating that early sports training and rehabilitation are useful in preventing bone loss (Miyahara et al., 2008).

The percentage of body fat is higher in each body region among MWC athletes in comparison with the physically able athletes; in particular, percentage of body fat in the arms of the MWC athletes are a significant influence of UE bone mass density, independent of age and the types of sports practiced (Miyahara et al., 2008). Also the percentage of body fat tends to increase as time passes since SCI in MWC athletes (Inukai, Takahashi, Wang, & Kira, 2006; Miyahara et al., 2008).

2.3. Prevalence of SCI

2.3.1.U.S.A.

Annual estimated incidences of SCI is approximately 40 per million of the population in the U.S.A. (12000 new cases) with estimated prevalence in 2012 from 236.000 – 327.000 cases. Estimations indicate about 80,6% of the SCI in the U.S.A. occur in males and from the year 2005 the average age at injury was 41 years, which was higher when compared to the data from 1973 (the average age 28,7 years) (NSCISC, 2012).

Since 2005 in U.S.A., traffic accidents represent about 39,2%, followed by falls (28,3%), violence (14,6%) and sports (8,2%). Frequent neurological levels and extent of lesion are incomplete tetraplegia (40,8%), complete paraplegia (21,6%), incomplete paraplegia (21,4%) and complete tetraplegia (15,8%). It's also important to note that over the last 15 years the percentage or incomplete tetraplegia has increased while complete paraplegia and incomplete tetraplegia has decreased (NSCISC, 2012).

2.3.2.Europe

Recent report estimates the larger numbers of SCI in European countries are Germany (48.000), Italy (70.000), Spain (35.000) and England & Wales (40.000) and the highest values of incidence are in Germany (1800), Italy (1400) and Spain (1200). The values of SCI tend to be more related to traumatic situations and a higher average percentage of cases in men (70%) when compared to women (30%) (Horsewell, 2007).

In Helsinki (Finland), the prevalence of SCI is about 28 per 100000 inhabitants, with the highest values between 45 – 59 years and the most often causes are falls (43%) followed by traffic accidents (35%). The distribution is different among tetraplegia (46%) and paraplegia (54%) and in incomplete (57%) and of complete (43%) lesion (Dahlberg, Kotila, Leppänen, Kautiainen, & Alaranta, 2005).

2.3.2.1. Portugal

Values of SCI for Portugal estimate there are 363 new cases every year and a major average of traumatic (300) when compared with non traumatic (63) cases (Horsewell, 2007).

The report in Physical Medicine and Rehabilitation, states an average annual incidence of traumatic SCI of 25 per million inhabitants and about 400 cases each year.(Direção Geral da Saúde, 2003). A retrospective study regarding traumatic SCI shows a gender distribution of 87% men to 13% women, with 66% of the cases occurring in ages between 20 and 60 years and the majority of the lesions located both in Thoracic or cervical areas (Andrade & Gonçalves, 2007).

2.3.2.2. Spain

Annual incidence of non traumatic SCI in the region of Aragon were 12.1 per million (1972 – 2008). The most common causes for non traumatic SCI in this province were tumor (34,8%), vascular diseases (15.5%), mechanical diseases (17.6%), infections (9.1%), and multiple sclerosis (7.8%) and with a gender predominance for females (56%) (van den Berg, Castellote, Mahillo-Fernandez, & de Pedro-Cuesta, 2012).

From 2000 to 2009, 10,274 people with a primary diagnosis of traumatic SCI represented 35.5% of traffic-related injuries (Pérez et al., 2011). The average annual incidence rate of hospital discharges with primary diagnosis of traumatic SCI in Spain during the period 2000–2009 was estimated to be 23.5 cases per million inhabitants (age standardized rates being 35.2 per million in men, 12.2 per million in women) (Pérez et al., 2012).

The average age values in Spain for car accident trauma SCI is 32 years in men and 34 in women, with half of the traumatic SCI cases being between 18 and 34 years. Andalucía presents a rate of incidence and gender distribution similar to the average Spanish values in car accidents (Pérez et al., 2011).

2.4. Quality of Life in SCI

Quality of Life evaluation stands for two main conceptualizations, (1) the objective approach, based on subjects characteristics that can be objectively measured and (2) the subjective approach that focus is the person's emotional or cognitive assessment of the congruence between his/her life expectations and achievements (Dijkers, 2003; Post & Noreau, 2005). In this study, QOL evaluation will be measured by a questionnaire to self report subjects perception with QOL.

Participation and personal factors prove to be the significant factors predicting the overall QOL in subjects with SCI. Level of participation in life situations influences satisfaction and well-being, so individuals with higher independence in activity present higher QOL (Chang, Wang, Jang, & Wang, 2012). SCI subjects present lower QOL scores than the general population, with a large impact on physical functioning, physical role limitations, pain, social functioning and vitality. The level of neurologic impairment presents a main influence on QOL, mainly in tetraplegia (Middleton et al., 2007).

In the social level, it is observed that subjects with SCI who indicate higher imbalance between effort and reward at work, report lower QOL, lower satisfaction with health, daily living activities, relationships and living conditions (Fekete, Wahrendorf, Reinhardt, Post, & Siegrist, 2014).

Depression in SCI subjects are related with social skills and this influences the subjects QOL (Müller et al., 2015). However, it is observed that depressed SCI subjects report exercise and antidepressants as the most favorable options. And in nondepressed SCI subjects, exercise is one of the primary choices (Fann et al., 2013). Also, functional satisfaction and QOL are improved in subjects who perform leisure time Physical Activities (Bassett & Martin Ginis, 2009).

Another main issue influencing QOL in subjects with SCI are pressure sores. Subjects report (65.3%) that the presence of a pressure sore reduces their activity at least to some extent and from these, 12% reported their QOL as very bad or bad. In the presence of three pressure sores subjects report significantly lower QOL with 52% of these subjects reporting their QOL as very bad or bad. Also, the presence of pressure sores has impact

on daily activities, mainly on ability to groom, feed independently and moving from one place to another, with a main impact on Individuals with tetraplegia (Lala, Dumont, Leblond, Houghton, & Noreau, 2014).

Regarding time since SCI, it is observed a negative relation with QOL. Subjects with more time since the SCI experience poorer QOL in Physical and mental Health domains, while, time since injury presents a better influence with their Physical Health. However, in older subjects but with higher education level, it is observed a better Mental Health related QOL (Saadat et al., 2010).

2.5. Assistive technology

Assistive technology (AT) includes several categories such as, mobility, sensory assistance, communication, personal care and recreation (Scherer & Parette, 2009). Wheelchairs, scooters, walkers, and canes are assistive technologies for mobility (Scherer, 2002). AT can facilitate participation by indirectly (treatment or therapy) or directly (physical assistance) enhancing and individual's mobility. Indirect, enhance mobility by reducing impairments at the body structure/function level by helping the body in repairing or redressing the body structure impairment, or by supporting rehabilitation of the impaired body function (Cowan et al., 2012).

Therapeutic technologies typically require clinical oversight to be set-up and operated, they are one modality in an overall rehabilitation plan, and are typically not designed to be used to execute daily activities they are operated by the user and are designed to be used to execute functional activities in the home and community. On the other hand, direct AT enhance mobility without altering the impaired body structure/function. This can augment or support impaired body structure or function or can replace the missing or impaired body structure or function (Cowan et al., 2012).

2.5.1.History of Wheelchairs

Wheelchair use in Europe may have started around 12th century, however, the first recorded use of MWC by disabled people in Europe dates to the 17th century. In the early part of that century, German mechanic and inventor Johann Hautsch made several rolling chairs. About 1655, a Disabled German watchmaker Stephan Farfler made a three-

wheeled chair propelled by the use of a rotary handle on the front wheel. A century later, James Heath (English inventor) introduced the bath chair that became popular as an apparatus for injured, sick, or disabled persons (Watson, n.d.; Woods, 2016).

In the middle of 19th century, wheelchairs presented wooden frames and seats and backs made of cane. However, one of the most-pivotal advances in MWC technology occurs in the 20th century with the invention of the folding system, especially by the invention in 1932 of the cross-frame wheelchair, by the engineers Everest and Jennings (Watson, n.d.; Woods, 2016).

2.5.2. Wheelchairs

Wheelchairs can be classified as either manual or powered. MWCs are designed to be propelled by the occupant (56 cm diameter wheels and light weight) or by an attendant (30 cm diameter wheels and heavy weight) (Batavia, 2010). Both MWC types present folding frames, brakes and front solid casters. In a MWC, there are important factors such as the surface over it is propelled, the rolling resistance of MWC and the distribution of the occupants weight (Green & Young, 2011; Batavia, 2010).

The enhancement of subjects MWC use can be due to (1) improvements in the AT mechanics, (2) improvements to the technical physical interface, and (3) improved shared control between the users and the technology (Cowan et al., 2012). The use of the MWC regards the interaction roles between physical wheeling capacity of the subject, his wheelchair skills and technique, environmental barriers and the quality of MWC design and fitting (van der Woude, Veeger, Dallmeijer, Janssen, & Rozendaal, 2001; Van Der Woude et al., 2009).

2.5.2.1. Manual wheelchairs

Manual wheelchairs are generally composed of two side frames connected by a cross-bar, a flexible seat and backrest to allow folding, two large driving wheels (rear), and two caster wheels (front). When a MWC is designed for temporary use it is not totally adapted to the user–close fit, postural support or pressure relief. In long-term users, the MWC must fit well and provide good postural support and pressure relief. There is a mobility

base to provide structure and mobility and seating system assembled in the mobility base for postural support (Batavia, 2010).

2.5.2.1.1. Mobility base

2.5.2.1.1.1. Frames

Frames can be folding or rigid. Folding frames are usually formed of two cross braces that give a more delicate ride as the frame flexes, absorbing the shock. This makes MWC heavier but folds into a more compact unit and can be stored. The rigid frame gives a more responsive ride, it is easier and lighter to push for an active MWC user and the back folds forward into the seat (Batavia, 2010; Furumasu, Gilinsky, & Krapfl, 1997). So, MWC selection is based both on the consumer, how the device will work within their lifestyle activities and how it will meet individuals' mobility goals. The lighter the overall weight, the more favorable the biomechanics and lower the risk of injury (Cooper et al., 2010).

We can also distinguish MWC based on their weight in ultralightweight (10 Kg), lightweight (14 Kg) or standard (20 Kg). The first type can be either folding or rigid, made of aluminum, titanium or composite; the second can be folding or rigid, are made of aluminum, steel or composite materials; and the last type are folding only, usually made of steel, are durable and less expensive (Furumasu et al., 1997).

Ultralightweight MWCs are made of stronger, higher grade materials and better components, are adjustable, to fit the user and once the rolling resistance is lower with larger diameter wheels (Brubaker, 1986). The change from the original steel into other materials, such as Aluminum, Titanium or Carbon fiber reinforced materials have a strong impact on the mass, stability, strength and endurance of MWCs (Cooper et al., 2010; Van der Woude, de Groot, & Janssen, 2006).

The rigid MWC of Aluminum and Titanium are less stable in the rearward direction when in least stable configuration and this result might be attributed to MWCs wider range of adjustability for the center of gravity (CG). A variety of MWC adjustments are necessary to fit any individual and a highly adjustable MWC requires accurate assessment to maximize maneuverability and match users preferences with stability requirements (Liu, Pearlman, et al., 2010). Titanium rigid frame MWC tends to have smaller dimensions and are lighter weight than ones with swing-away footrests of the same seat dimensions and are

expected to increase mobility and efficiency in daily living (Liu, Cooper, Pearlman, Cooper, & Connor, 2008)

A folding MWC is not necessarily preferable over a rigid MWC, have different frame structures and provide different advantages than rigid frame MWCs. Some users prefer ultralight folding MWCs due to the convenience of the folding mechanism and smoother rides resulting from the larger caster sizes. And others like rigid frames for their lighter weight and succinct design. (Liu, Pearlman, et al., 2010).

2.5.2.1.1.2. Axles

Forward axle position decreases rolling resistance, increases propulsion efficiency (Brubaker, 1986; Medola, Elui, Santana, & Fortulan, 2014; Rice et al., 2011) and has been associated with less muscle effort, smoother joint excursions and lower stroke frequencies (Masse, Lamontagne, & O'Riain, 1992). A forward axle position is associated with lower peak forces, less rapid loading of the handrim, less strokes to maintain the same speed, and greater hand contact angles (Boninger, Cooper, Baldwin, Shimada, & Koontz, 1999; Boninger, Baldwin, Cooper, Koontz, & Chan, 2000). Rear axle position enlarges stability because CG falls further anterior, increases the tendency to turn downhill and makes it difficult to push the MWC (Medola et al., 2014; Rice et al., 2011).

2.5.2.1.2. Seating system

2.5.2.1.2.1. Seat

The wheelchair seat allows chest support by the pressure distribution in the hips and thighs (Portáles, 2009) and a proper selection of seat width and depth is very important for comfort and stability. The seat must have a minimum angle for the anterior to the posterior of 1 degree and a maximum between 5º and 10º degrees, to secure the pelvis and back in the seat allowing more stability and respecting these principles:

1. ***Width:*** Narrow seat is not comfortable and hampers the access to the MWC. And wide one encourages the user to lean toward on one side and increased pressure over the buttocks. In addition, a seat wider than is necessary makes propulsion more difficult (Batavia, 2010; Portáles, 2009; Puente et al., 2000).

2. ***Depth:*** Depth has to be measured with the user so he is well supported at the backrest, mainly at the lumbar region with the anterior limit about 2,5 and 5 centimeters from the popliteal area and must be adapted to give support to a minimum of two thirds of the thigh. If the seat is too deep, the anterior part of the seat may press into the popliteal area and cause the patient to slide forward in the wheelchair and sacral sit. If the seat is too short, the patient may not have enough support under their thighs and may slide forward (Batavia, 2010; Portáles, 2009; Puente et al., 2000).
3. ***Height:*** The best position point relative to the elbow's angle and standardized posture with the hands on the handrim in the top center, indicate that 100º to 120º degrees, in respect to elbow movement are most appropriate for daily life and sport wheelchairs. The decreased push range and push time at higher seat heights must coincide with adaptations in the pattern of torque applied to the handrim (van der Woude et al., 2009; Veeger, van der Woude, & Rozendal, 1989). Push time and angles are higher in low seat height positions (Boninger et al., 2000; Kotajarvi et al., 2004; van der Woude et al., 1989).

2.5.2.1.2.2. Backrest

Backrests differ in height, shape, weight, hardness and adaptation and can be grouped into flexible, rigid or molded (May et al., 2004). Flexible backrests are used in the majority of MWC and users. They are flexible by the ability of the material to adapt and users can change the shape to improve the ability of relieving pressure. However, this structure does not allow a stable base of support for dynamic users performing propulsion, passing obstacles and going up and down slopes (Hong et al., 2011; May et al., 2004).

The limit of the backrest will depend on the user's pathology, control capacity and balance, but in most cases this limit will be 2,5 cm beneath the scapulas (Batavia, 2010). However, when it has to be higher it can be used as a headrest or an adaptation in the backrest (Portáles, 2009). To prevent shear on the skin and subcutaneous tissues at the Ischial tuberosities, it is proposed that the seat be adjusted in order to be perpendicular with the backrest (Snijders, Goossens, & Van Dijke, 2000).

Lower backrests enable the arm to move more freely and as a result the shoulder passes through a greater range of motion, increases shoulder extension and hand contact farther back on the handrim, contributing to larger stroke angles, resulting of the hand release

occurring farther forward on the handrim. Also, with a lower backrest, push times are longer and cadence is lower (Yang et al., 2012). On the other hand, with height, straight and almost vertical backrest it is observed that lumbar support is always overruled by forward push of the scapula and subjects adopt a forward bent posture to avoid contact with the backrest (Medola et al., 2014; Snijders et al., 2000).

2.5.2.1.2.3. Armrests

Armrests provide support for the patient's arms in a resting position, lateral support and a reaction point for the hands when the insensitive patient elevates the body at regular intervals to prevent restriction of circulation and pressure sores. MWC may present fixed, removable or no armrests, they must be positioned at a proper height and must allow 90º degrees of elbow flexion, resting and free of tensions on the UE and shoulder (Batavia, 2010).

2.5.2.1.2.4. Rear Wheels

Standard MWC rear wheels can be available from wire spokes, cast metal alloy or cast plastic (Batavia, 2010). Wheels are directly influenced by the material, position, weight distribution or front and rear axles distance (Portáles, 2009) and rear wheels depending on the type, size, camber of the wheels and tires can be solid or pneumatic.

Wheels with solid rubber tires are suitable for use on smooth surface and indoors, present no maintenance problems, are durable but less shock absorption (Batavia, 2010; Portáles, 2009), and transmits all terrain impacts to the user (Portáles, 2009) and present higher rolling resistance compared to pneumatic tires and a worse shock absorbance quality (Van der Woude et al., 2006).

The pneumatic tires provide shock absorption and are more suitable for rough surfaces and outdoor use, provide a more cushioned ride and their shock absorber action tends to prolong the life of a MWC when kept inflated properly (Batavia, 2010). They present bigger friction, more resistance, need more maintenance and are more comfortable by the ability of moving more smoothly in irregular terrains (Portáles, 2009). When tire pressure decreases below the standardized value, there is an associated increase of VO_2 (de Groot, Vegter, & van der Woude, 2013), correlation between heart rate and oxygen

consumption in subjects with SCI, in 50% or 25% of the required pressure, increasing energy expenditure (Sawatzky, Miller, & Denison, 2005) and with influenced rolling resistance (Sauret et al., 2012).

Rolling resistance is the force resistance to the movement of the wheelchair wheels. The rolling resistance on hard smooth surface is higher in active MWCs than in sport models, even with a 15% higher weight distribution on front wheels in active MWC than in sport models (Sauret, Vaslin, Bascou, Pillet, & Lavaste, 2011). On a hard smooth surface and carpet, the MWC deceleration increases when the mass distribution on the front casters augments, increasing the rolling resistance. The values are significantly higher on carpet than on the hard smooth surface and the resistance reduces when the radius of the wheels augments (Sauret et al., 2012).

2.5.2.1.2.5. Handrims

Standard handrims are circular steel tubes and are attached to the driving wheels of the MWC they allow control, providing a grip surface for self - propulsion and can add vinyl coated rings, knobs and projections for people who have problems gripping (Batavia, 2010; Medola et al., 2014). Kinetic and potential energy increases as the handrim size increases, increasing total mechanical energy during MWC propulsion. While propelling a larger handrim, the movement increases but the propulsion time does not change, the linear velocity of the segments becomes higher and the kinetic energy increases, resulting in a greater metabolic cost (Guo et al., 2006, 2003).

2.5.2.1.2.6. Camber

Standard MWC types have a neutral angle in rear wheels, however, most active models have a positive camber, allowing MWCs to be more stable in the propulsion phase (Batavia, 2010). A six degree camber is the most preferred position to increase stability and to improve hand comfort on the handrims (Perdios, Sawatzky, & Sheel, 2007). The residual torque increase is proportional to the increase of rear wheel camber, having numerous advantages such as better stability and turning speed for players (Faupin, Campillo, Weissland, Gorce, & Thevenon, 2004).

Rear wheel cambers have favorable influence on maneuverability, lateral stability by the wider base (Mason, Porcellato, van der Woude, & Goosey-Tolfrey, 2010; Veeger et al., 1989), but can be difficult to pass in narrow passages, greater strain on the rear wheel ball – bearing and an increase in rolling resistance (Batavia, 2010; Veeger et al., 1989).

2.5.2.1.2.7. Footrest

Footrests consist of a support bracket with a swing-away mechanism, and a pivot and slide-tube to which the footplates are attached. Leg rests consist of an elevating support bracket with swing-away mechanism with foot-plate, and ankle pad to support the back of the leg when elevated (Batavia, 2010). In the traditional models the bases are independent for each foot and extractable and on active and sports MWCs there's one single fixed footrest base, conserving in both cases an angle between hips and knees around 90º degrees or nearer to a better MWC adjustment (Portáles, 2009).

Low footrests tend to create more pressure in the back of the thighs, causing bad posture with the user leaning forward to find more support. On the other hand, very high ones promote minimum contact in the seat and more pressure in the Ischial tuberosities (Batavia, 2010; Portáles, 2009).

Subjects with SCI reveal differences in forward-reaching movement in different footrest conditions, lumbar SCI cases present less forward acceleration when compared with thoracic SCI with elastic footrest (Janssen-Potten, Seelen, Drukker, Spaans, & Drost, 2002). The differences are found in peak accelerations at the seat and footrest between the MWCs with caster forks and with suspension casters. MWC with suspension casters have different frequencies at which the peak accelerations occur for both the seat and footrest (Cooper et al., 2003).

2.5.2.2. Sport wheelchairs

Sport wheelchairs are adaptations of MWCs, many components are adapted according to the needs of each sport, and some are taken out. Following we will present briefly some adaptations of MWCs according to each sport.

In basketball, seat height is determined by players function level and team role. Wheelchair basketball players choose backrests as low as possible to allow upper limbs

and trunk to move freely. And some MWCs are equipped with forward bumpers on the footrests to reduce the risk of forward falls and foot injuries due to impacts (Liu, Rice, et al., 2010).

Rugby MWC have a camber from 16º to 20º degrees, significant bucketing (the knees high, relative to the rear end) helps with trunk balance and protection of the ball and low seat height for improved balance and maneuverability (Liu, Rice, et al., 2010; Rice et al., 2011). Aluminum frames are preferred in this sport because the weight reduction and metal guards covering the lower frames and wheel spokes protect the player and the MWC from the impact and improve stability by lowering the centre of gravity of the chair (Liu, Rice, et al., 2010).

A tennis MWC has to be fast and responsive to allow the athlete to cover the entire court, rear wheels are cambered, backrests are lower for trunk and upper limb movements and some players modify the MWC to have a single front caster or even a single anti tip caster to make the chair more responsive in turns with decreased diagonal direction stability (Liu, Rice, et al., 2010).

Handcycles can be grouped in upright handcycles, recumbent handcycles and kneeling handcycles. (Liu, Rice, et al., 2010). Backrest inclination of handcycling show that more upright backrest positions tend to result in lower shoulder load. The means glenohumeral contact force at a 60° degrees inclination angle is significantly lower than at other degrees, as well as relative muscle forces. And also, that a close crank position result in higher means relative muscle forces than the distant crank position (Arnet et al., 2014).

2.6. Seating posture

Human posture refers to the position of spinal segments with respect to each other and gravity. A good posture for a specific task represents a complex relation between biomechanics and neuromuscular function. It may be influenced by the demands to prevent movement, coordinate movement and safely load spinal segments or conserve energy. Before we can examine the efficiency and safety of dynamic spinal control it is necessary to examine common, low load and stationary postures such as standing and sitting (Claus, Hides, Moseley, & Hodges, 2009).

Schoberth (1962) as cited recently (Harrison, Harrison, Croft, Harrison, & Troyanovich, 1999) defines sitting postures based on the CG and the proportion of the body weight transmitted to floor by the feet:

- Middle position, the CG is above the Ischial tuberosities, feet transmit about 25% of the body weight to the floor and the spine is either straight or with a small kyphosis.
- Anterior position can be by a forward rotation of the pelvis, the CG is anterior to the Ischial tuberosities and the feet transmit more than 25% of body's weight to the floor.
- Posterior position, the CG is above or behind the Ischial tuberosities and less than 25% of the weight is transmitted to the feet and is obtained by posterior rotation of the pelvis and simultaneous kyphosis of the spine.

The support of body weight while lying, sitting, or standing needs the transmission of internal stabilizing forces by the supporting tissues to external support surfaces. This results in tissue-distorting forces being transmitted to the underlying soft tissues. Excessive or prolonged application of distorting mechanical forces can result in vascular occlusion, ischemia with eventual necrosis and the onset of a pressure sore. When a person is seated, the potential sites for pressure ulcers development are the Ischial tuberosities, Sacrum, Trochanters, Popliteal region, bony prominences of the spine, Scapulas and the Heels. Other sites with less frequency may include the elbows, medial aspect of knees, palms of the hand during MWC propulsion (Stockton et al., 2009).

Stabilizing the pelvis improves trunk balance, head control and UE control. The three points of control are supported beneath the pelvis, capturing the Ischial tuberosities in the seat cushion to prevent a posterior tilt; posterior support such as lumbosacral back support and anterior support is provided by the hip belt (Furumasu et al., 1997). To optimize pressure distribution, the contact surface area should be increased to disperse the pressures over a larger area of contact, in order to avoid pressure ulcers. Back recline redistributes sitting pressures from the buttocks to the back by opening the hip angle. If the orientation of the seat to the back angle it must be maintained for positioning, a fixed tilted space recline may be preferred (Furumasu et al., 1997; Stockton et al., 2009).

The ideal sitting position regards a symmetrical pelvis, with weight evenly distributed through both Ischial tuberosities and trunk should be in midline with the lumbar lordosis

maintained. When seated, there should be a 90º degree angle of flexion at the hips, with the thighs parallel to the floor and slightly apart. The knees and ankles also maintain 90 degrees flexion, with abduction at the knees and no inversion or eversion of the ankles (Nitz, 2000; Thirugnanachandran & Bateson, 2012).

Posterior position is a common sitting position which may occur when muscles of the trunk are unable to hold the spine upright against gravity. It can be the result of abnormal tone, tight hamstrings or limited hip flexion and can occur when sitting for long periods. Anterior position is less common and may be the result of increased lumbar lordosis, weak abdominal muscles or flexion contractures at the hip. It can increase pressure on the pubis with higher risk of ulcer formation (Thirugnanachandran & Bateson, 2012).

Test on pelvic movement and pressure distribution on static and dynamic propulsion indicate that during static condition, the average pressure measured by the normal group in the Ischial tuberosities are higher for people with SCI subjects in static and dynamic conditions when compared with able body subjects (Tam et al., 2003).

2.7. Anthropometric measurements

Anthropometry comes from the anthropology, science about the man (*anthropos:* the man and *logos:* science, in Greek). It leads with individual variation, physical characteristics of man, time and space (Nowak, 1996). Anthropometry is the study of measurement of the human body in terms of the dimensions of bone, muscle and adipose tissue. The more common used measurements include stature, circumferences, lengths and skinfolds (McArdle, Katch, & Katch, 2010; National Health and Nutrition Examination Survey, 2007).

Measurement of skinfolds in wheelchair athletes and its analyses must only be used to set targets for the amount of fat mass to be lost and can successfully be used in combination with changes noted in girth measurements (Reilly & Crosland, 2010).

In this investigation the anthropometric measurements used regard the most commonly used lengths and heights in people with physical disabilities, using a wheelchair (Barros & Soares, 2012; Das & Kozey, 1999; Jarosz, 1996; Kenward, 1971). It is very important to perform the correct anthropometric measurements at the time to select the MWC dimensions in order for the subject to be comfortable and well adapted, avoiding extreme pressure on the tissues. The protocols of measurements are detailed in the methodology.

2.8. Manual wheelchair movement

The pattern of movement associated with MWC propulsion can be divided into two general phases of UE movement, the propulsive phase and the recovery phase.

During the propulsive phase, subjects hands are in contact with the handrim and there is application of force in order to increase or maintain the velocity of the MWC, and this phase typically begins with the hands grasping the handrim near the top dead centre and finishes after the handrim rotates approximately 90 degrees. The recovery phase follows the propulsive phase, this phase begins when the UE is brought back to a position where a new propulsive phase can begin (Sanderson & Sommer, 1985).

A normal push occurs in the first 32% of the propulsion cycle and is divided into early push (0 – 10%) and late push (10 – 32%). The recovery phase occurs on the remaining 68% of movement and is divided into flow thru (32 – 40%), arm return (40 – 90%) and push preparation (90 – 100%) (Newsam et al., 1999).

Contact and release angles in MWCs depend on the arm segment lengths, handrim size and force vector produced. It can be seen that the energy added to the wheel during the push, the push angle, push frequencies are related to the energy added to the wheel during the push (Richter, 2001). These activities are essential for functional independence, QOL and even the life expectancy of people after an SCI, evaluating the mechanical load on the shoulder is important to an understanding of the mechanisms which may cause UE joint degeneration (Nyland et al., 2000).

2.8.1. Push phase

During the propulsion phase, the UE and trunk musculature exert effort to propel the wheel forward so that the UE segments are moved forward quickly. Therefore, the total mechanical energy during this phase increases, primarily due to increases in kinetic energy, especially the translational kinetic energy. Due to the movement constraint that the hand must follow the contour of the handrim during propulsion, the UE segments have to move downward, causing the potential energy to decrease (Guo et al., 2006, 2003). The mechanical energy pattern shows a complementary trend during most of the propulsion cycle and during terminal propulsion, the UE segments are decelerated by

eccentric muscle activity during the recovery phase. During the propulsion phase, the increase in total mechanical energy is from both proximal muscular power and proximal joint power (Guo et al., 2006).

Proximal joint power depends on trunk flexors shoulder flexors and trunk flexors acting concentrically to accelerate forward movement. At the same time, the shoulder flexor acts concentrically to speed up the shoulder flexion and generate joint power at the shoulder that is transferred to the forearm and hand to propel the wheel forward (Guo et al., 2006). The muscles act delivering handrim power during the push phase and accelerating the arm forward after release (Rankin, Richter, & Neptune, 2011).

During the propulsion phase, muscles with dominant activity during the push phase include the anterior deltoid, pectoralis major, supraspinatus, infraspinatus, serratus anterior, and biceps brachii. The onset of activity for these muscles occurs during the arm return or push preparation, remaining active until the early push to follow-through subphases (Mulroy, Gronley, Newsam, & Perry, 1996; Mulroy et al., 2004; Rankin et al., 2011) in a sequence of muscle transfer power between the handrim and the arm for maximum propelling of MWC (Rankin et al., 2011).

Muscle pectoralis major present early onset of activity and duration of muscle activity in the tetraplegia is higher when compared with paraplegia. The infraspinatus exhibits later onset of electromyography activity and great duration activity in tetraplegia compared with a group of low paraplegia (Mulroy et al., 2004). Middle deltoid, subscapular and latissimus dorsii groups are identified at the end of the push phase with biceps brachii delivering power to the handrim over the initial two-thirds of the push phase and with elbow Extension absorbing handrim power during the initial third of the push phase (Rankin et al., 2011).

2.8.2.Recovery Phase

The recovery phase requires muscles to (1) absorb power to decelerate the forward movement of the arm, (2) deliver power to accelerate the arm posteriorly, (3) again absorb power to decelerate the arm and (4) again deliver power to accelerate the arm anteriorly in preparation for handrim contact (Rankin et al., 2011).

During the initial recovery phase, the upper arm has proximal muscular power from the shoulder extensors, it acts concentrically to extend the shoulder and increases the potential energy of the upper arm segment and during late recovery phase, the total mechanical energy is increased by potential energy which is supplied by the proximal joint power. Also, the trunk flexors eccentrically contract to slow down the backward movement of the trunk and this joint power again is transferred from the upper arm to the forearm and hand for the next propulsion cycle (Guo et al., 2006, 2003). It is observed a more activation of deltoideus medialis, posterior and the trapeziums pars (Spaepen, Vanlandewijck, & Lysens, 1996), also the trunk movement and concentric contraction of trunk extensor accelerate the backward movement of the trunk (Guo et al., 2003).

2.8.3. Contact angles during wheelchair propelling

Contact angle is the angle of the position vector from the wheel center to the hand at the beginning of the push. When the hand is oriented vertically the angle is considered 0º and clockwise rotations represent a positive angular displacement and counterclockwise rotation a negative one. The release angle occurs when the elbow is completly extended and the hand finishes the contact moment with the handrim (Richter, 2001).

Static measurements holding wheelchair handrim can be made of the angles between 120 to 60º to the horizontal or -15º to 60º with 0º in the top dead center of the handrim (Lin et al., 2009; van der Helm & Veeger, 1996) and average contact angle of 100,3º to 110,3º in different wheelchair speeds with (Koontz, Cooper, Boninger, Souza, & Fay, 2002). Other authors studied the average stroke angle of 71º with the first contact on the left of the top dead centre and the push angle (Rankin et al., 2011) and also values of 108.3±21.3 degrees during MWC propulsion (Richter, Rodriguez, Woods, & Axelson, 2007).

Shoulder flexors and extensors and shoulder lateral rotators present large average stress values over the entire stroke. Both infraspinatus and mild deltoid present similar stress values between the two phases. Pectoralis major, anterior deltoid and corachobrachialis have higher average stresses during the push phase, while posterior deltoid has high average stress during the recovery phase. On the other hand, in minimize cadence conditions there is a much higher peak stress in the forearm muscles during both push and recovery phases and in supraspinatus during the recovery phase and it maximizes contact angle conditions increasing anterior deltoid, tricipetes and bicipes braquii power generation during the push phase (Rankin, Kwarciak, Richter, & Neptune, 2012).

This reality introduces the need of a better understanding of UE function and is related to the development of chronic shoulder pain.

2.9. Upper extremity

The human shoulder can be seen as the perfect compromise between mobility and stability and the joint complex allows for a large range of motion. The particular structure of the human shoulder in relation to other animals is thought to have played an important role in the evolution with the development of a more laterally twisted clavicle allowing a more autonomic mobility of the upper extremity and great ability to vertical climbing (Veeger & van der Helm, 2007).

The shoulder area connects the UE to the trunk with the scapula and clavicle bones, by the glenohumeral joint and is formed by the arm, forearm and hand areas. The arm is formed by the humerus which connects to the ulna in the humeral trochlea. The forearm is formed by the ulna (intern) and the radius (extern) bones connecting to the hand in the carpal area (Pina, 1995; Seeley, Stephens, & Tate, 2003).

Shoulder articulation allows flexion/extension, abduction/adduction, external/internal rotation and a combination of some movements of the circle (Samuelsson, Tropp, & Gerdle, 2004). The elbow can perform flexion/extension movements and pronation/supination by the movement of the radius bone over the ulna (Pina, 1995; Seeley et al., 2003).

The mobility of the glenohumeral joint is the result of motion in both the glenohumeral joint and scapulothoracic – gliding plane. Most of the thoracohumeral motion takes place in the glenohumeral joint, allowing elevation up to 120º. During abduction and forward flexion the largest rotations occur in the scapulothoracic and glenohumeral joint. The scapula rotates by approximately 45º to a maximum value of about 55º during 150º of arm elevation (Magermans, Chadwick, Veeger, & van der Helm, 2005).

The human UE has a large range of motions, due to (1) the loose connection of the scapula to the trunk, enabling sliding and rotating over the surface of the rib cage and moving the base of the arm, the ; (2) anatomical shape of the glenoid the humeral head;

and (3) glenohumeral joint allows the rotation in three directions as well as some translation and since the glenohumeral joint is loose (van der Woude et al., 2001).

2.9.1. Upper extremity lesion in manual wheelchair users

Manual wheelchair use requires continuous use of the UE for mobility, transfers, weight-relief lifts and reaching activities (van Drongelen, van der Woude, & Veeger, 2011; Van Drongelen et al., 2005a; van Drongelen et al., 2005b). UE pain complaints among MWC users are more common in the shoulder (30% to 73%) in the chronic SCI population (Boninger et al., 2003). A recent study shows that people with SCI show a greater range of motion of the scapula during MWC push phase under loaded conditions, with anterior tilting, downward rotation and protraction. People with tetraplegia show a greater range of change of scapular kinematics than paraplegia under loading conditions (Raina, McNitt-Gray, Mulroy, & Requejo, 2012).

Manual wheelchair overuse injuries may be related to three risk factors, individual factors (physical capacity, posture, skill level), environmental factors (floor surface, incline, MWC fit), and work requirements (magnitude and frequency of the load applied, direction of force, time of exposure, rest periods) (Hastings & Goldstein, 2004) and only work requirements can be changed by changing the MWC or the propulsion technique (Boninger et al., 2005).

2.9.2. Shoulder pain

Shoulder complex in MWC users have to bear greater mechanical forces than the able-bodied, which can lead to overuse injuries, hand/wrist problems, shoulder pain and other UE injuries (Guo et al., 2003). Subjects who experience higher superior forces and consistently propel with higher internal rotation movements to the shoulder may develop these types of imbalances (Mercer et al., 2006).

Due to anatomical limitations, the possible trajectory of the elbow is limited to a maximum range of 68.8º–83.4º or less. When the handrim is held at 120º, the reachable workspace has the most limited arc angle and the elbow can barely move. In contrast, when the hand holds the handrim at a 60º wheel angle, the shoulder is almost neutral or slightly flexed

and the wrist joint is ulnarly deviated and the joints have more freedom to move, which leads to the largest reachable workspace arc angle (Lin, Lin, & Su, 2009).

Shoulder pain is reported by 78% of the subjects with tetraplegia and 59% of the paraplegic since they started using MWCs (Curtis et al., 1999). Around the same percentage (60%) of SP has also been reported by wheelchair basketball players when compared to non paraplegics (51,17%) (Yildirim, Comert, & Ozengin, 2010).

Paraplegic subjects have reported higher pain level in certain activities, namely when loading MWCs into the car, pushing up ramps or inclines outdoor and performing usual daily activities (Samuelsson et al., 2004). Cinematically speaking when MWC users, do weight relief raises and transfer process they show a greater scapular upward rotation during transfer process and increased scapular anterior tilt, during lift – pivot phase. It has been found that UE discomfort and pain, may be responsible for the offset of scapular greater external rotation (Nawoczenski et al., 2012).

2.9. Physical Activity

Physical activity depends on immutable factors (age or gender) and modifiable factors (psychosocial determinants) (Humpel, Owen, & Leslie, 2002). The second are important in the context of Physical Activity promotion since these can be targeted in interventions (Ploeg, Beek, & Woude, 2004) and can bring up gains in terms of health and physical condition (Barata, 1997).

Being physically active is defined as performing daily activity five or more days a week in moderate intensity or three or more days in vigorous intensity. Where moderate intensity is considered 6 to 8 Metabolic equivalent (MET) (Walking or swimming) and vigorous intensity is considered as values superior to 8 MET in activities such as high impact aerobic (jogging). MET represents average VO_2 consumption in rest (1 MET = 3.5 mL O_2/Kg) and is influenced by the body composition, gender, age and body segments, among other factors but is very useful in comparing Physical Activity (Barata, 1997).

2.9.1. Physical Activity in disability

Being physically active has beneficial effects on both stamina and strength in people with mobility impairments, as well as on their ability to manage daily life activities and improving their psychological wellbeing (Hicks et al., 2003; Tordi et al., 2001).

Physical activity training has been shown to improve significantly ventilator function (Le Foll-de Moro, Tordi, Lonsdorfer, & Lonsdorfer, 2005), with a significant higher mechanical efficiency observed in trained subjects when compared to untrained subjects (Lovell, Shields, Beck, Cuneo, & McLellan, 2012).

Physical activity behavior is directly influenced by the barriers, skills and the persons intention to practice. The last one depends on the social influence, attitude and self-efficacy. Physical activity and its consequent benefits of a physically active lifestyle can be described at the levels of activities, participation and body functions and structures. So, improvements in body functions and structures can lead to improvements in muscle power, improvements in activities that can lead to a better performance of the activities and participation level of a physically active lifestyle can lead to a better performance in real life situations. The environmental factors such as the barriers for people with disability can be described as the poor availability and accessibility of equipment, lack of assistance for PA or absence of people with similar limitations. In subjects with disability, health condition and severity of the lesion are a determinant of PA behavior (Humpel et al., 2002; Ploeg et al., 2004).

A recent study observed that 55.5% of subjects with SCI reported to be involved in sports and among these, 83.2% perform recreational exercises and sports, also people with tetraplegia were less active in sports (38,6%) when compared with those with paraplegia (54,8%) (Anneken et al., 2010). Another study (Ginis et al., 2010) describes that the highest leisure time physical activity is in MWC users with paraplegia. In general, men are more active than women, MWC users are more active than power wheelchair (PWC) users and people using gait aids and participants with more severe injuries are significantly less active. A similar study (Warms, Whitney, & Belza, 2008) reports that wheelchair users spend 52,5% of the daily hours in light intensity activity and only 1% in strenuous activity.

Studies concerning the proximity of people's homes to the PA facilities (Arbour & Martin Ginis, 2009; Diez Roux et al., 2007; Reed & Phillips, 2005) indicated that it promoted PA behaviors. In a sample predominantly of men 72% of which propelled a MWC, it was observed that almost half of the subjects perceived their neighborhood to have an accessible physical activity facility (Arbour & Martin Ginis, 2009). Regarding the barriers to PA, the most frequently cited concerns were (1) intrapersonal or intrinsic, (2) resources, and (3) structural or architectural. A combination of barriers might limit the extent to which someone becomes or remains physically active. It is important to understand this complex interaction between the individual, their environment and their perceived barriers in order to develop effective strategies to overcome these obstacles and to promote healthy lifestyles (Scelza, Kalpakjian, Zemper, & Tate, 2005; Sisto & Evans, 2014).

Exercise prescriptions are widely used for rehabilitation of SCI people, such as homebased exercise programs for being more comfortable and in accordance with individual well being, endurance and strength exercise (Bizzarini et al., 2005; Freene, Waddington, Chesworth, Davey, & Goss, 2011; Hicks et al., 2003; Keyser, Rasch, Finley, & Rodgers, 2003; Mulroy et al., 2011; Park et al., 2010; Taylor & Fletcher, 2012).

2.10. Muscle Activity

Muscle strength measurement can be made by tensiometry, dynamometry, one repetition maximum (1 –RM) and by computer – assisted force and power output determinations. Tensiometry and dynamometry are based on tension applied to a device that shows the force of the subject. One Maximum Repetition (1 – RM) refers to the maximum amount of weight lifted one time in proper form during a standard weightlifting exercise and the weight is progressively increased on subsequent attempts until the person reaches maximum lift capacity (McArdle et al., 2010).

Muscle contractions can be of three types: a) isometric when there is no joint movement and muscular contraction occurs at velocity zero; when there is joint movement, muscular contractions can be b) isotonic, when movement occurs at a non constant velocity; isotonic contractions can be concentric or eccentric depending on the muscular length in the beginning and in the end of the contraction and; lastly, c) isokinetic when the muscular contraction occurs at a constant angular velocity, isokinetic contraction can also be both concentric or eccentric (Muscolino, 2006).

Thus, isometric muscle contractions are those that have a constant length or static contraction with a zero velocity of shortening. Isotonic muscle contractions involve movement under a constant load throughout the range of motion (ROM). Isokinetic contractions are those in which a load is moved at a constant rate of muscle contraction throughout the ROM. Concentric contractions cause muscle shortening, while eccentric contractions cause muscle lengthening (Sisto & Dyson-Hudson, 2007).

Muscle activation can be performed as isometric or static if the muscle activation occurs without observable change in muscle fiber strength or as dynamic muscle activation if produces movement of a skeletal body part. Concentric action, occurring when the muscle shortens and joint movement occurs as tension develops and eccentric actions, which occur when external resistance exceeds muscle force and the muscle lengthens while developing tension, represents the two types of dynamic muscle actions (McArdle et al., 2010). Muscular strength and endurance constitute two components of muscular fitness. Muscle strength refers to the ability of a muscle or muscle group to generate maximal force, and muscle endurance refers to the ability of a muscle or muscle group to produce force over multiple repetitions (Caspersen, Powell, & Christenson, 1985).

Muscular strength and endurance testing can provide valuable information regarding baseline fitness levels. However, because of the variability of SCI level and severity, norm-reference outcomes for muscular strength and endurance have been difficult to establish. Therefore, it is recommended that testing of muscular strength and endurance should be used to compare changes within an individual versus between individuals. A number of tests of muscular strength and endurance for persons with SCI have been used and include 1RM, 10RM, isokinetic, isometric, and manually facilitated testing. Dynamometry testing can be an excellent means of objectively quantifying changes in isolated isometric and isokinetic muscular strength and they are practical to measure UE in people with SCI where shared UE function is more likely and can be useful in providing objective measures of isolated UE strength. Hand-held dynamometers, although limited in scope, may be useful in clinical settings where hand grip and pinch grip muscular strength can be assessed (Sisto & Dyson-Hudson, 2007; Sisto & Evans, 2014).

2.10.1. Ways to access muscle Strength

Muscle strength is dependent on the length-tension relationship specifying that there is an optimal muscle length for maximal force generation. For isometric contractions, maximal

strength is specific for muscles only at the tested joint angle. For isokinetic contractions, the peak force will be angle dependent and specific to the velocity of the movement (Smith, Doherty, & Price, 2007). To access the physiological response to exercise in subjects with SCI, the arm crank is the most common exercise (Martel, Noreau, & Jobin, 1991; Smith et al., 2007; Wicks, Lymburner, Dinsdale, & Jones, 1977).

Computer assisted devices are based on microprocessor technology that rapidly quantifies forces, torques or moving patterns widely presented as isokinetic dynamometers, containing speed – controlling mechanisms that accelerate to a constant velocity with constant velocity (McArdle et al., 2010).

2.10.2. Upper extremity strength evaluation

Dynamometry includes the use of handheld dynamometers, handgrip dynamometers and isokinetic dynamometers. Strength is the force or moment produced by a single maximum voluntary isometric contraction and it refers to the ability of a muscle to develop active tension that produces force. Muscle power is the rate of doing work and, therefore, the product of force and velocity (Sisto & Dyson-Hudson, 2007).

2.10.2.1. Manual muscle testing

Manual Muscle Testing (MMT) has historically been the most common method used for assessing muscle strength wish bases on a 5 point grading scale and requires no testing equipment (Frese, Brown, & Norton, 1987; Scott, Bond, Sisto, & Nadler, 2004; Wadsworth, Krishnan, Sear, Harrold, & Nielsen, 1987). In MMT the patient's strength is graded according to his/her ability to move against gravity and then to hold manual resistance with a static isometric contraction of the muscle being tested (Lin, Hsu, Chang, Chien, & Chang, 2008).

2.10.2.2. Hand – Held Dynamometry

Hand – held dynamometry (HHD) protocols represent a good option for quantitative muscle testing because they are portable, economic and user friendly, they provide a quick, simple, valid, reliable and sensitive outcome measurement for the human muscle strength (Cadogan, Laslett, Hing, McNair, & Williams, 2011; Hébert, Remec, Saulnier,

Vial, & Puymirat, 2010; Taylor, Dodd, & Graham, 2004). They present low cost, greater ease of use, good acceptability in clinical settings and are quite affordable when compared with more complex devices. However, they can only measure one point in the ROM per measure; the examiner may be overcome by the subject's power and may provide inconsistent counter resistance during strength testing (Sisto & Dyson-Hudson, 2007).

Dynamometers contain strain gauges and fit in the palm of the hand allowing the operator to provide direct resistance to movement of the extremity and the force output value is obtained electronically (Vermeulen et al., 2005). This technique is performed with two testing methods: (1) the **Make technique** which requires the patient to exert a maximal isometric contraction while the examiner holds the dynamometer in a fixed position and (2) the **Break technique** requires the examiner to overpower a maximal effort by the patient, thereby producing a measurement of eccentric muscle strength (Bohannon & Andrews, 1987; Bohannon, 1988; Burns & Spanier, 2005).

The break test requires that the examiner have additional skills, such as the ability to move the limb at a constant velocity while the person being tested is asked to achieve a maximum contraction. In addition, if an HHD is used, the examiner must read the force output reading at the exact time the subject's limb begins to move. The instructions for the break test are for the examiner to apply as much force as possible without allowing any movement from the starting angle of the joint and the examiner must exert sufficient counterforce to overcome the maximal force exerted by the person being tested (Sisto & Dyson-Hudson, 2007).

When examining muscle strength using dynamometers, we must consider two relationships (Sisto & Dyson-Hudson, 2007):

- Length-tension – between the maximum tension in a muscle versus its length. Ideally, the muscle strength should be tested in its optimal length-tension position.
- Force-velocity – between the maximum muscle tension and velocity. Maximum force is inversely related to the velocity of muscle shortening.

2.10.2.2.1. Reliability

The reliability of an instrument stands for its consistency and in this case, it will present the reliability analysis of different devices. MicroFET2® muscle strength testing system has an accuracy of ±2%, Nicholas MMT® can measure force to 0.1 kg, Chatillon MSC® Series dynamometer measurement accuracy is >0.1% full scale and the Isobex® dynamometer is a microprocessor-controlled device that has a 1kg minimum threshold (Sisto & Dyson-Hudson, 2007).

Evaluation of interday (0.94 to 0.98) and intraday (0.88 to 0.99) reliability for shoulder abduction strength (1–2 weeks) present an excellent reliability (Magnusson, Gleim, & Nicholas, 1990). It is observed excellent inter and intrarater reliability between the make and break tests for Elbow Flexion/Elbow Extension performed by inexperienced examiners on persons with tetraplegia. It is also found no real evidence that either the make or break technique are more favorable than the other (Burns & Spanier, 2005).

Evaluation of inter and intra-rater reliability (Hayes, Walton, Szomor, & Murrell, 2002; Kolber, Beekhuizen, Cheng, & Fiebert, 2007) finds excellent reliability (0.79–0.92) for shoulder elevation, shoulder external rotation and shoulder internal rotation.

It is observed (Andersen, Christensen, Samani, & Madeleine, 2014) high reliability of HHD (ICC=0,89-0,98) for studying isometric measurements. Peak force measurements against resistance is reliable according to the values of ICC (0,91-0,99), for the use of a HHD, both for inter – examiner and intra – examiner (Cadogan et al., 2011), sustaining the use of HHD as a method of upper extremity measurement. HHD present high concurrent validity with stationary dynamometers for Shoulder Flexion, Shoulder Abduction, and Shoulder Lateral Rotation, maintaining high values with different testers (Roy et al., 2009).

Correlations for intrarater reliability of the HHD tests ranged from 0.89 to 0.96 for shoulder internal rotation and 0.89 to 0.94 for shoulder lateral rotation, representing very good reliability (May, Burnham, & Steadward, 1997).

2.11. Questionnaire investigation

Questionnaires are instruments of data collection that allow the participant to give written or spoken answers to a conjunct of questions. The purpose of these instruments is to

collect data about knowledge or known situations like attitudes or beliefs and can be self – administrated or filled out by the investigator. It is a fast and relative cheap means of obtaining data, using great samples and different areas; it is impersonal and the reliability and validity allows the correlation among participants. However, this instrument brings negative points, such as, low answering rate, representatively of the population and questionnaire's correct filling out (Fortin, 2009).

2.11.1. Reliability of questionnaires

Reliability of the questionnaire refers to the precision and consistency of the obtained measurements used by a measurement tool. It reports to the ability of the tool to measure in a constant way. Survey is reliable if it gives comparable results in comparable situations (Hill & Hill, 2005; Neuendorf, 2002).

Reliability can be estimated by test–retest reliability, parallel forms of reliability and by a split–half one. The first one refers to the degree of agreement between two data collections in two different moments, in a temporal difference of one week and one month and measured by the Pearson correlation coefficient. A device is considered stable when taking two measurements, with the same conditions and with similar sample, present similar results. The second is used once we have two versions of the same questionnaire and it is necessary to present the two versions to a similar sample and its nature and size should be the same as the sample used to test–retests reliability. The last topic, Split–half refers to the survey's internal reliability and estimates the consistency between each of the questions that form the questionnaire. It reports to the fact that each question is linked and has much correlation between them, greater will be the internal consistency of the tool and its use of the cronbach's alpha (Hill & Hill, 2005; Neuendorf, 2002).

2.11.2. Validity of questionnaires

Validity refers to the degree of precision in each of the concept is represented and may be evaluated as construct validity, theoretical validity and practical validity. Construct validity stands for the ability of the tool to measure the concept or construct defined theoretically. The questionnaire presents construct validity when the items form a representative sample of evaluation items to measure the study components and to evaluate it is usual to

ask an expert comity that evaluates the choosing of the questions(Hill & Hill, 2005; Moreira, 2004).

Theoretical validity stands for three aspects, convergent, if the measurement is correlated with other measures of the same variable; discriminate if it is not significantly correlated with other variables that are not theoretical, correlated and factorial. And practical validity stands for predictive, validity that a measurement has to predict values in other variable and simultaneous, values of the evaluated variable are collected at the same moment and its correlation is predictive of the validity (Hill & Hill, 2005; Moreira, 2004).

METHODOLOGY

3. METHODOLOGY

In this chapter we will explain the main objectives, methodology and variables of the study.

Subjects who self propel MWCs present a larger risk of developing upper extremity lesions, which have consequences in these individuals ability to carry out leisure activities related to physical activities , as well as, daily challenges and competitive adapted sport activities (Guo et al., 2006, 2003; Lin et al., 2009; Mercer et al., 2006). On the other hand it is known that , regular Physical Activity performed by people with mobility impairments, has beneficial effects on both stamina and strength, as well as on the ability to manage daily life activities and psychological well – being (Ditor et al., 2003; Hicks et al., 2003; Tordi et al., 2001).

Also, improvements in body functions and structure level can lead to improvements in muscle power and activities can lead to a better and simple performance of the activities and in the participation level an active lifestyle can lead to a better performance in real life situations (Ploeg et al., 2004).

Shoulder pain and physical activity level are highly interdependent, once the increase of the use of a MWC this increases shoulder pain, and shoulder pain decreases the motivation to perform physical activities in SCI subjects. Based on this we have identified the importance to study these variables together: MWC type, individual characteristics, shoulder pain and physical activity level and understand which one is more important to influence the practice of adaptive PA, in order to define strategies to improve inclusion of SCI people, improve their motivation to do Physical Activity according to subjects different cultures and country realities.

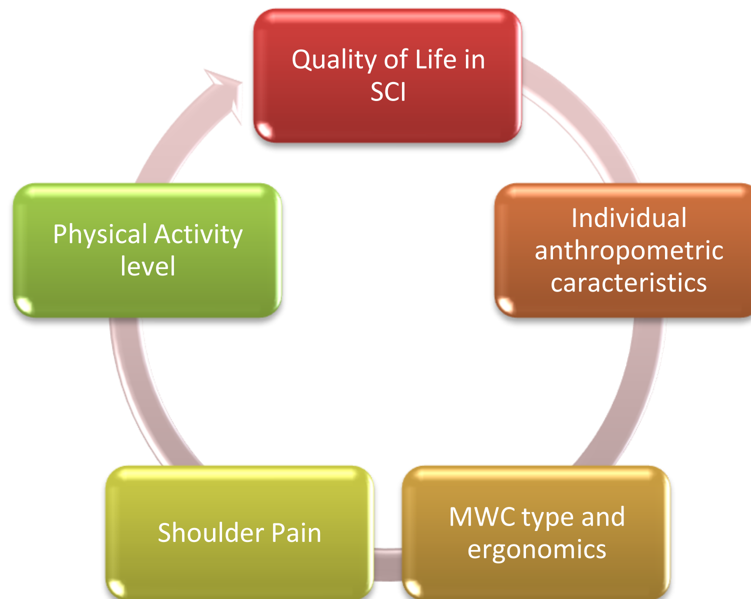


Figure 1: Diagram of second phase study areas

In order to fulfill are main objective we have carried out a cross sectional transboundary study in order to study the influence of shoulder pain, level of physical activity, anthropometric individual characteristics and type of wheelchair in the quality of life of subjects with SCI and how they are related in Portugal and Spain, to different health system, social and cultural realities.

3.9. Study objectives

The main objective of the PhD thesis was to study physical activity level of people with SCI and it's relation with individual anthropometric characteristics, upper extremity strength, shoulder pain and type of MWC and the impact of these variables on quality of life.

The study was carried out in the regions of Portugal (Algarve and Alentejo) and Spain (Huelva, Seville and Cadiz) which are transboundary to each other, and are less developed regions compared to the capital cities of Portugal or Spain regarding adaptive sports and inclusive recreational physical activities.

During the study it was our intention to focus on the physical, psychological and social level of integration that both physical activity and/or adaptive sports may have on the improvement of quality of life, assistive technology, prevalence of shoulder pain and on

the impact that MWC components may have on the participation level of subjects with SCI in Physical Activity and/or Shoulder Pain.

Because of the absence of validated instruments to measure quality of life, assistive technology desirability, physical activity and shoulder pain for each country, this study was divided in two phases with different sub – study objectives:

3) **First phase:** translation and cultural validation of questionnaires to be used in phase 2:
    a. ***Sub–Study 1***: To perform translation and cultural validation of Physical Activity Scale for People with Physical Disabilities for Portugal and Spain.
    b. ***Sub–study 2***: To perform translation and cultural validation of Quality of Life Index (Ferrans & Powers) SCI – III for Portugal and Spain.
    c. ***Sub–study 3:*** To perform translation and cultural validation of Quebec User Evaluation of Satisfaction with Assistive Technology – 2.0 for Spain.
4) **Second phase:** To do a cross sectional study in the transboundary area of Portugal and Spain with subjects who have SCI:
    a. **Sub–study 4:** to describe the characteristics of the subjects, anthropometric measurements and wheelchair characteristics. And to present the scores descriptive values of physical activity, quality of life, shoulder pain and satisfaction with wheelchair.
    b. **Sub–study 5:** To study the relation of MWC type of components to the subjects satisfaction and presence of SP in both countries.
    c. **Sub–study 6:** To study the relation between QOL and PA levels in subjects with SCI of both countries.
    d. **Sub–study 7:** To study the relation between isometric strength of upper extremity and MWC components.

3.10. Permissions

A formal permission of the Portuguese Data Protection Authority was requested and approved, October 1st 2013 (approval number 6785/2013). The study was carried out according to the identified approved guidelines (annex V, page 211).

3.11. Ethical approval

This study was approved by the ethical comity of the University of Huelva (Spain), the ethical comity of the Hospital of São João de Deus, the ethical comity of the Centro Hospitalar do Algarve and Unidade Local de Saúde do Baixo Alentejo (annex IV, page 211).

3.12. Methodology

3.12.1. First phase: cross–cultural validation

As previously stated because there were no constructed instruments in Portuguese and Spanish languages to study quality of life, physical activity and satisfaction with assistive technology in subjects with SCI, there was a need to translate and adapt culturally to the Portuguese of Portugal and the Spanish of Spain three instruments. Thus in the first phase of this thesis we did the cross–cultural translation and validation of the needed questionnaires.

This process was selected due to the absence of specific validated materials for the study of the population; these instruments have proven to have a good reliability and internal consistency in other cross–cultural validation processes; and for being suitable instruments to use outside a controlled environment. The Physical Activity Scale for People with Physical Disabilities, to measure exercise intensity by indicating mean days and hours performing physical activities; Quality of Life Index (Ferrans & Powers) – SCI version III asks respondents to classify satisfaction and importance of specific domains of SCI subjects quality of life; and Quebec User Satisfaction with Assistive Technology – 2.0 asks the user to classify the assistive technology regarding the device and service satisfaction with assistive technology for both native languages of Portugal and Spain.

3.12.1.1. Variables

The study variables for the first phase were the sociodemographic questionnaire (3.12.3.1.); the level of physical activity (3.12.3.2.); the quality of Life and subdimensions

of Health, Social, Psychological and Family (3.12.3.3.); and self perception of satisfaction with assistive technology and subdimensions of device and services (3.12.3.4.).

3.12.1.2. Instruments

3.12.1.2.1. Sociodemographic questionnaires

Socio demographic evaluation for Portuguese and Spanish sample (appendix 2, page 152) was performed with a written questionnaire filled out by the study sample and the questions regard age, gender, marital status, academic degree and if has/has not a job/professional occupation and type of physical disability.

3.12.1.2.2. Level of Physical Activity

To evaluate the level of physical activity we choose to translate and adapt culturally the Physical Activity Scale for People with Physical Disabilities (Washburn, Zhu, McAuley, Frogley, & Figoni, 2002).

3.12.1.2.3. Quality of Life

To evaluate quality of life we chose to translate and adapt culturally Quality of Life Index (Ferrans & Powers) – SCI version III (Ferrans & Powers, 1985; May & Warren, 2001).

3.12.1.2.4. Self perception of satisfaction with manual wheelchair

To evaluate self perception of satisfaction with MWC we chose to translate and adapt culturally Quebec User Evaluation of Satisfaction with Assistive Technology 2.0 (Demers, Ska, Giroux, & Weiss-Lambrou, 1999).

3.12.1.3. Protocol

Previous to the beginning of the process of translation and cross–cultural validation it was asked for the permission and obtained authorization from the authors of each questionnaire (Annex III, page 211).

To do the cross–cultural validation for Portugal and Spain of the three instruments we used the same methodology (Beaton, Bombardier, Guillemin, & Ferraz, 2000) which includes the phases of translation, synthesis of the translations, back translation, expert committee and test of the prefinal version.

3.12.1.3.1. *Sub–study 1:* Physical Activity Scale for People with Physical Disabilities

3.12.1.3.1.1. Cross–cultural validation for Portuguese of Portugal

The Portuguese process of translation was performed by two Portuguese native speakers, a physical therapist and an expert in English with a degree in translation English–Portuguese–English. Both translators worked separately and blind to each translation until the performance of the synthesis of the translations. After the synthesis of the translation, the back–translation process was performed by two subjects with a degree in health, blinded to the previous versions and English native speakers.

All versions were presented and discussed with an expert committee formed by an academic investigator with experience in questionnaire development, application and cross–cultural validation and two medical doctors who specialize in physical rehabilitation and have experience with people with physical disabilities, from a Portuguese Physical Medicine and Rehabilitation Center. Each expert worked separately and filled out a report (appendix 3, page 155) regarding the semantic, idiomatic, experiential and conceptual equivalence of the translated version when compared to the original and back translation documents. For each shown topic marked it was asked to mark the problem and arrange possible improvement solutions according to their experience. The investigator collected the reports and made the proposed changes before the prefinal process.

3.12.1.3.1.2. Cross–cultural validation for Spanish of Spain

Translation was performed by two translators, one English native speaker with knowledge of Spanish language and a Spanish native speaker with a degree in Physical Activity. Both translators worked separately and blind to each translation until the performance of the synthesis of the translations. Back translation process was performed by a Spanish native speaker but highly experienced in the English language, once he lived and studied

for several years in England where he obtained his degree in prosthetics and Orthotics, he was blind to the original and previous versions.

Expert comity was formed by an academic investigator with experience in survey application and cross–cultural validation and a medical doctor. Each expert worked separately and filled out a report (appendix 3, page 155) regarding the semantic, idiomatic, experimental and conceptual equivalence of the translated version when compared to the original, translation and back–translation documents. For each shown topic marked it was asked to mark the problem and arrange possible improvement solutions according to their experience. The investigator collected the reports and made the proposed changes before the previous sample questionnaire were filled out.

3.12.1.3.1.3. Prefinal process of the Portuguese and Spanish versions

To develop a prefinal version (appendix 4, page 156 and appendix 5, page 160) we first contacted several associations and adaptive sport clubs in the North and Center of Portugal and the regions of Badajoz and Caceres in Spain (annex II, page 211), it was also performed, to explain the study objectives and ask for the willingness to participate in the process.

Inclusion criteria for the selection of our sample were subject to having a physical disability, understanding of Portuguese/Spanish language, not having any intellectual disability and being an adult.

A sample of 56 subjects in Portugal and 33 in Spain with physical disabilities, were willing to volunteer to participate and to filled out questionnaire, twice with 1 to 2 weeks of intervals (test–retest). All participants filled out the informed consent previous to the study (appendix 9, page 175).

Besides the Physical Activity Scale for People with Physical Disabilities questionnaire each subject filled in the sociodemographic questionnaire previously described (appendix 2, page 152).

3.12.1.3.2. *Sub–study 2:* Quality of life Index (Ferrans & Powers) SCI version III

3.12.1.3.2.1. Cross–cultural validation for Portuguese of Portugal

The Portuguese process of translation was performed by two Portuguese native speakers, a physical therapist and an expert in English with a degree in translation English–Portuguese–English. Both translators worked separately and blind to each translation until the performance of the synthesis of the translations. After the synthesis of the translation, the back–translation process was performed by two subjects with a degree in health, blinded to the previous versions and English native speakers.

All versions were presented and discussed with an expert committee formed by an academic investigator with experience in questionnaire development, application and cross–cultural validation and two medical doctors who specialize in physical rehabilitation and have experience with people with physical disabilities, from a Portuguese Physical Medicine and Rehabilitation Center. Each expert worked separately and filled out a report (appendix 3, page 155) regarding the semantic, idiomatic, experiential and conceptual equivalence of the translated version when compared to the original and back translation documents. For each shown topic marked it was asked to mark the problem and arrange possible improvement solutions according to their experience. The investigator collected the reports and made the proposed changes before the prefinal process.

3.12.1.3.2.2. Cross–cultural validation for Spanish of Spain

Translation was performed by two translators, one English native speaker with knowledge of Spanish language and a Spanish native speaker with a degree in Physical Activity. Both translators worked separately and blind to each translation until the performance of the synthesis of the translations. Back translation process was performed by a Spanish native speaker but highly experienced in the English language, once he lived and studied for several years in England where he obtained his degree in prosthetics and Orthotics, he was blind to the original and previous versions.

Expert comity was formed by an academic investigator with experience in survey application and cross–cultural validation and a medical doctor. Each expert worked

separately and filled out a report (appendix 3, page 155) regarding the semantic, idiomatic, experimental and conceptual equivalence of the translated version when compared to the original, translation and back–translation documents. For each shown topic marked it was asked to mark the problem and arrange possible improvement solutions according to their experience. The investigator collected the reports and made the proposed changes before the previous sample questionnaire were filled out.

3.12.1.3.2.3. Prefinal process of the Portuguese and Spanish versions

To develop the prefinal version (appendix 6, page 163 and appendix 7, page 167) we first contacted to several associations and adaptive sport clubs in the North and Center of Portugal and the regions of Badajoz and Caceres in Spain (annex II, page 211), it was performed to explain the study objectives and ask for the willingness to participate in the process.

Inclusion criteria for selection of our sample where the subject present more than 2 years since SCI, a good understanding of Portuguese/Spanish language, not having any intellectual disability and being an adult

A sample of 23 subjects with SCI in Portugal and 10 in Spain, were willing to volunteer to participate and fulfilled out the questionnaires, twice with 1 to 2 weeks of interval (test–retest). All participants filled out the informed consent previous to the study (appendix 9, page 175).

Beside the Quality of Life Index (Ferrans & Powers) – SCI III questionnaire for each subject filled in the Socio demographic questionnaire previously described (appendix 2, page 152).

3.12.1.3.3. *Sub–study 3:* Quebec User Satisfaction with Assistive Technology–2.0

3.12.1.3.3.1. Cross–cultural validation for Spanish of Spain

The translation was performed by two translators, one English native speaker with knowledge of Spanish language and a Spanish native speaker with degree in Physical Activity. Both translators worked separately and blind to each translation until the performance of the synthesis of the translations. Back translation process was performed by a Spanish native speaker but highly experienced in the English language, once he lived and studied several years in England where he obtained his degree in prosthetics and Orthotics, he was blind to the original and previous versions.

An expert comity was formed by an academic investigator with experience in questionnaire application and cross–cultural validation and a medical doctor. Each expert worked separately and filled out a report (appendix 3, page 155) regarding the semantic, idiomatic, experimental and conceptual equivalence of the translated version when compared to the original, translation and back translation documents. For each shown topic marked it was asked to mark the problem and arrange possible improvement solutions according to their experience. The investigator collected the reports and made the proposed changes before the previous sample questionnaire was filled out.

To develop a prefinal version (appendix 8, page 171) they contacted several associations and adaptive sport clubs in the Spanish regions of Badajoz and Caceres (annex II, page 211) it was performed to explain the studies objectives and ask for the willingness to participate in the process.

Inclusion criteria are presenting physical disabilities, having and using daily an assistive technology and a good understanding of the Spanish language, not having any intellectual disability and an adult.

A sample of 26 subjects using assistive technology devices, were willing to volunteer to participate and filled out the questionnaire, twice with 1 to 2 weeks of interval (test – retest). All participants filled out the informed consent previous to the study (appendix 9, page 175).

Besides the Quebec User Evaluation of Satisfaction with Assistive Technology 2.0 each subject filled in the Socio demographic questionnaire previously described (appendix 2, page 152).

3.12.2. Second phase: Cross–sectional transboundary study Portugal–Spain

In the second part of this thesis we have preformed a Cross–sectional study in the transboundary area of Portugal and Spain, to study the physical activity level of the people with SCI and it relation with individual anthropometric characteristics, upper extremity strength, shoulder pain, type of MWC and quality of life.

The main investigator performed a period of data collection, during three months, in the region of Alentejo (Portugal) (annex VII, page 211).

3.12.2.1. Variables

The variables for the second phase of the study were a sociodemographic questionnaire (3.12.6.1), level of physical activity (3.12.6.2), quality of Life (3.12.6.3), self perception of satisfaction with the MWC (3.12.6.4), anthropometric individual characteristics (3.12.6.5), MWC ergonomics (3.12.6.6), shoulder pain (3.12.6.7) and upper extremity isometric strength using Hand–held dynamometer (3.12.6.8).

3.12.2.2. Instruments

3.12.2.2.1. Sociodemographic questionnaires

A previously described Sociodemographic information was collected with a predefined questionnaire developed according to the usually collected sociodemographic information and specific information regarding SCI. The questionnaire (appendix 1, page 151) regarded the items of age, gender, nationality, region/province, marital status, academic degree, labor activity, level and years since SCI and type of Physical Activity.

3.12.2.2.2. Level of Physical Activity

The PASIPD was developed for the use in epidemiologic studies of PA, health, and function of individuals with physical disabilities, organized in leisure time (6), household (6) and occupational activity (1) items. It inquires information regarding leisure activities, such as walking and wheeling outside the home other than specifically for exercise; light, moderate, and strenuous sport and recreation; exercise to increase muscle strength and endurance; household activity including light and heavy housework; home repair; lawn work; outdoor gardening; caring for another person; and occupational activity other than office work (Washburn et al., 2002).

Respondents are asked to indicate the number of days in the past 7 days that they participated in physical activities as never, seldom (1–2d/wk), sometimes (3–4d/wk), or often (5–7d/wk) and on average how many hours a day they participated (less than 1hr; 1 but less than 2hr; 2 to 4hr; more than 4hr). The score for the PASIPD was created by multiplying the average hours per day for each item by a MET value associated with the intensity of the activity and summing over items 2 through 13 (Washburn et al., 2002).

This instrument has been translated and cross-cultural validated into Dutch showing a good test – retest reliability (ρ=0.77) and a correlation validity of 0.30 to an accelerometer (van der Ploeg et al., 2007). In this study it was used the Portuguese and Spanish versions that were previously validated. The original version has been used with strong positive association with QOL (Liang et al., 2008; Stevens, Caputo, Fuller, & Morgan, 2008) and with MWC users with SCI and level of PA (Eriks-Hoogland, de Groot, Post, & van der Woude, 2011).

3.12.2.2.3. Quality of Life

Quality of Life Index (Ferrans & Powers) general version is a self applicable Index to evaluate self perception of QOL that has four sub–dimensions: health and functioning, social and economic psychological – spiritual and family. The respondent is requested to indicate how satisfied they are with 34 areas of life, as well as, how important they

consider each one of them to be. Ratings are made on a 1–6 scale ranging from very dissatisfied/unimportant to very satisfied/important. It yields a total score and four sub - dimension scores (Hagell & Westergren, 2006). Satisfaction scores are recoded by subtracting 3.5 from the score (1 to 6) and multiplying it by the importance score: (item score - 3.5) x importance score. This is done individually for each item and items within subscales are averaged together to create a mean score. An additional 15 points is then added to the mean score for each subscale to arrive at a total score (Semerjian, Montague, Dominguez, Davidian, & De Leon, 2005).

The Quality of Index (Ferrans & Powers) version for SCI was developed from the generic version of the Index presenting 36 items, 33 from the original and 3 specific additional questions for people with SCI (May & Warren, 2001).

Quality of Life Index (Ferrans and Powers) – SCI final version (III) resulted from the evaluation in terms of external and structural validity (May & Warren, 2002) and has already been used with a study in Physical Activity in SCI (Semerjian et al., 2005).

3.12.2.2.4. Self perception of satisfaction with the manual wheelchair

Quebec User Evaluation Satisfaction with Assistive Technology–2.0 (QUEST–2.0) is a self applicable instrument that was developed (Demers, Weiss-Lambrou, & Ska, 1996) to measure satisfaction with a wide range of AT in a structured and standardized way. It's stability and reproducibility are well described (Demers, Monette, Lapierre, Arnold, & Wolfson, 2002; Demers, Ska, et al., 1999; Demers, Weiss-lambrou, & Ska, 2002; Demers, Wessels, Weiss-Lambrou, Ska, & de Witte, 1999). The questionnaire has two subdimentions, one regarding the device itself and one the services.

The respondent is asked to rate his/her satisfaction with respect to different aspects, of the two dimensions using a five point scale, ranging from 1 (not satisfied) to 5 (very satisfied). Dimension of assistive devices questions are regarding dimension, weight, adjustments, safety, durability, simplicity of use, comfort and effectiveness of the device and the dimension services relating to the process of providing the assistive device namely: service delivery, repairs, professional services and follow–up services (Demers et al., 2002; Demers, Ska, et al., 1999; Demers et al., 1996, 2002; Demers, Wessels, et al., 1999).

QUEST – 2.0 can be found in a Dutch (Demers, Wessels, Weiss-Lambrou, Ska, & De Witte, 2001; Wessels & Witte, 2003); Taiwanese (Mao et al., 2010) version that presents a good internal consistency in AT (0.87), SV (0.84), TS (0.90) and a rest – retest stability from AT (0.90), SV (0.97) and TS (0.95). The Portuguese version (Rodrigues, 2003) that presents values of internal consistency of 0.79 (TS), 0.80 (AT) and 0.81 (SV). Test – retest reproducibility (7 to 11 days) of 0,93 (TS), 0,89 (AT) and (0,94) SV. The Spanish version for Colombia presents high values in AT (α=0.89) and SV (α=0.82) and 0.91 for TS (Mora Barrera, 2010). Also, there are two recent versions, one for Korean (Lee, Jung, & Park, 2013) with high values for AT (α=0,88 ; ρ=0,64) and SV (α=0,92 ; ρ=0,66) and a Brazilian version (Carvalho, Gois Júnior, & Sá, 2014) presenting high values in internal consistency for AT (0,862), SV (0,717) and TS (0,826).

3.12.2.2.5. Anthropometric individual characteristics

Based on other studies (Barros & Soares, 2012; Das & Kozey, 1999; Jarosz, 1996; Kenward, 1971) to evaluate individual Anthropometric characteristics the investigators have selected as relevant for the aim of this study to measure:

Seat height, seating stature, eye height, bi–acromial width, bi–deltoid width, trunk depth, thigh width, arms width, thorax width, elbow width, Knee width, elbow height, height of the popliteal cavity, forearm – hand length, heel height, shoulder height, buttock – popliteal cavity length, buttock – knee depth and arm length (appendix 10, page 194).

3.12.2.2.6. Manual wheelchair ergonomics

Based on other studies (Batavia, 2010; Portáles, 2009) MWC was evaluated (appendix 11, page197) regarding ergonomics (backrest and seat height, seat width and depth, legs depth, armrest height and casters, rear wheels and handrim diameter), mark/model, type and weight, main structure and rear wheel materials, years of use and also if subjects maintain the same MWC since their lesion and if they used a pressure ulcer cushion.

3.12.2.2.7. Shoulder Pain

The presence of shoulder pain was evaluated using Wheelchair User Shoulder Pain Index (WUSPI) Portuguese and Spanish versions.

This instrument is a self applicable Index to evaluate the presence and intensity of SP in daily activities. The questionnaire uses 15 visual analogue scales consisting of 10-cm lines anchored by ‘‘no pain’’ and ‘‘worst pain ever experienced” and subjects are asked to mark an ‘‘X’’ on the line to describe their shoulder pain intensity during that activity. The responses are measured in centimeters (cm) and summed, allowing for a maximum total raw score of 150. When participants do not perform all the activities listed on the WUSPI it is scored by using the performance-corrected score, whereby the total raw score is divided by the number of activities performed and multiplied by 15 (Curtis et al., 1995a; Curtis et al., 1999; Curtis, Kindlin, Reich, & White, 1995).

WUSPI is a reliable and validated instrument (KCurtis et al., 1995a, 1995b) which has been widely used in subjects with SCI (Dyson-Hudson et al., 2007; Mulroy et al., 2011; Nash, van de Ven, van Elk, & Johnson, 2007) during MWC propelling. It has also been used to evaluate the relation with Physical Activity (Gutierrez, Thompson, Kemp, & Mulroy, 2007) or QOL (Kemp et al., 2011).

In this study we used the Portuguese (Clara, 2001) and Spanish (Arroyo-Aljaro & González-Viejo, 2009) validated versions. The Portuguese version presents an internal consistency of 0.91 and test–retest reproducibility (72 hours) of 0.99. The Spanish version of WUSPI shows a high internal consistency (α=0,97) and a high test–retest reliability (ICC=0,99) (Arroyo-Aljaro & González-Viejo, 2009).

2.12.2.2.8. Upper extremity strength

Upper extremity strength was measured with a Hand–Held dynamometer, manual muscle tester - Model 01163 (*Lafayette Instruments* ®) (http://www.lafayetteinstrument.com/), with a range from 136.1 – 22.6kg (± 1% accuracy).

3.12.2.3. Cross–sectional transboundary procedures

3.12.2.3.1. Sample Selection

The sample was selected through the contact of adaptive sports clubs, Physical Medicine Centers and Hospital Services in order to indentify subjects meeting the inclusion criteria, in both countries.

3.12.2.3.2. Inclusion criteria

a) Age over 18
b) SCI – paraplegia beneath T1
c) 2 years or more since SCI lesion
d) Being mentally able to participate in the study
e) Resident in the geographic study areas of Portugal and Spain
f) Use daily a MWC

After being selected an explanation of the study objectives and necessary involvement of each subject was given to all who were willing to participate. The participants were free to leave the study at any moment without any perjury. All participants filled out the informed consent previously to the study (appendix 9, page 175).

Participants were then grouped according to level of lesion: in Low (< T7) and High paraplegia (≥ T7) (Gagnon, Koontz, et al., 2009; Gagnon, Verrier, et al., 2009; Kemp et al., 2011; Mulroy et al., 2011, 2004; Pelletier et al., 2013; Raina et al., 2012; Requejo et al., 2008; Schantz, Björkman, Sandberg, & Andersson, 1999) and according to geographic areas of Portugal (Algarve and Alentejo) or Spain (Huelva, Seville and Cadiz).

3.12.2.3.3. Written questionnaires

All subjects received a total of 5 questionnaires to fill in (Portuguese or Spanish) according to subject's origin:

1) Sociodemographic questionnaire
2) Portuguese or Spanish PASIPD
3) Portuguese or Spanish versions of QLI (Ferrans & Powers) version for SCI – III
4) Portuguese or Spanish QUEST – 2.0
5) Portuguese or Spanish WUSPI

The principal investigator was present during the filling out of the questionnaires to respond to any doubts the subjects might have.

3.12.2.3.4. Anthropometric individual characteristics

Anthropometric individual characteristics (appendix 10, page182) were measured with subjects sitting in their wheelchairs using anthropometric caliper (1 cm accuracy):

1) **Seated height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the top end of the head.
2) **Eyes height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the middle line of the eyes.
3) **Biacromial width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right acromiums.
4) **Bideltoid width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right deltoid area.
5) **Tight width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right thighs, proximal to the center of the left and right great Trochanters.
6) **Arms width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right middle area of the arms.
7) **Thorax width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right part of the thorax, proximal to the axils.
8) **Elbow width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the left and right epicondils of the arms.
9) **Elbow height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the center of the arm epincondile.
10) **Heigth of the knee** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the superior extremity of the patella.

11) **Height of the popliteal cavity** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the proximal area of the popliteal cavity, in the posterior part of the knee.
12) **Forearm–hand** length was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the epicondilus and the distal part of the hand.
13) **Heel height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the center of the external maleollo.
14) **Shoulder height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the ground and the deltoid area.
15) **Buttock–popliteal cavity depth** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the distal part of the buttock and the posterior part of the knee in the popliteal cavity.
16) **Buttock–knee depth** was measured with the subject seated on the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the distal part of the buttock and the anterior part of the patella.
17) **Arm length** was measured with the subject seated on the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the epincodilus and the deltoid.

3.12.2.3.5. Manual wheelchair ergonomics

Wheelchair ergonomics (appendix 11, page184) of components were measured with subjects sitting in their wheelchair and using anthropometric caliper (1 cm accuracy):

1) **Backrest height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the superior part of the seat and the upper end of the backrest.
2) **Seat height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the superior part of the seat and the ground. If the seat presented a positive inclination, then only measured the height of the seat in the back.

3) **Seat width** was measured with the subject seated in the wheelchair and the evaluator standing in front of him/her. The measurement was taken between the lateral part of the seat.
4) **Seat depth** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken closest to the backrest and the anterior part of the seat.
5) **Armrest height** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken between the superior part of the armrest and the ground.
6) **Casters diameter** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken closest to the center of the wheel.
7) **Rear wheels diameter** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken closest to the center of the wheel.
8) **Handrim diameter** was measured with the subject seated in the wheelchair and the evaluator standing lateral to him/her. The measurement was taken closest to the center of the wheel.

The information of mark/model, type, weight and main structure of the wheelchair were then confirmed and standardized according to the companies wheelchair characteristics and grouped in lightweight, ultralightweight – folding and ultralightweight – unfolding.

3.12.2.3.6. Upper extremity strength

In this study were measured the upper extremity movements of shoulder flexion, shoulder extension, shoulder abduction, shoulder lateral rotation, shoulder medial rotation, shoulder flexion and shoulder extension (table 1 and appendix 10, page 182), according to the measurement protocols for upper extremity (Andrews, Thomas, & Bohannon, 1996; Drolet, Noreau, Vachon, & Moffet, 1999; Sisto & Dyson-Hudson, 2007).

Upper extremity strength was performed according to previous used protocols (Drolet et al., 1999; Sisto & Dyson-Hudson, 2007; Stratford & Balsor, 1994) and the activities were explained previous to the beginning of the activities. It used a Lafayette ® Manual Muscle Tester Model 01163 in a maximum of three trials for movement and a rest period of 10 to 60 seconds between trials. The dynamometer was preadjusted in order to produce a

warning sound at 0 and 5 seconds, beginning and end of contraction. Trials were repeated when the subject performed compensatory movements or were doing the incorrect movement. To ensure the same stability among all subjects, all the force measurements were performed with the subjects sitting in the MWC and the examiner stabilized the articulations proximal to the required movement in order to avoid compensatory movements.

Table 1

Protocol of upper extremity strength measurement

Muscle action	**Limb/ joint Positions**	**Dynamometer placement**	**Stabilization**	**Reference**
Shoulder flexion	Shoulder flexed 90º, elbow extended and arm in neutral rotation	Just proximal to epicondyles of humerus	Axillary region	Andrews, Thomas & Bohannon (1996);
Shoulder extension	Shoulder and elbow flexed 90º, arm in neutral rotation	Just proximal to epicondyles of humerus	Superior aspect of shoulder	Andrews, Thomas & Bohannon (1996); Bohannon (1997); Drolet, Noreau, Vachon & Moffet (1999); Sisto and Dyson – Hudson (2007)
Shoulder abduction	Shoulder abducted 45º; elbow at 90º	Just proximal to lateral epicondyle of humerus	Superior aspect of shoulder	Andrews, Thomas & Bohannon (1996); Bohannon (1997)
Shoulder lateral rotation	Shoulder abducted 45º; elbow flexed	Just proximal to lateral styloid process	Elbow	Andrews, Thomas & Bohannon (1996); Bohannon (1997
Shoulder medial rotation				Andrews, Thomas & Bohannon (1996)
Elbow flexion	Shoulder at neutral; elbow flexed 90º; forearm supinated	Just proximal to lateral styloid process	Superior aspect of shoulder or arm	Andrews, Thomas & Bohannon (1996); Bohannon (1997); Drolet, Noreau, Vachon & Moffet (1999); Sisto and Dyson – Hudson (2007)
Elbow extension	Shoulder at neutral; elbow flexed 90º; forearm in neutral	Just proximal to lateral styloid process	Anterior aspect of shoulder or arm	Andrews, Thomas & Bohannon (1996); Bohannon (1997); Drolet, Noreau, Vachon & Moffet (1999); Sisto and Dyson – Hudson (2007)

STUDIES

4. STUDIES

This chapter describes and summarizes the results and discussion of the studies that were developed in this PhD thesis, they were developed between December of 2012 and September of 2015 (appendix 17, page 201). To promote the second phase of the activities it was written an article to the *Lemasur* journal (appendix 12, page 185).

In this chapter we will present the results and discussion of this study. We will present the results separated in two distinguished parts:

First phase – will be divided in three sub–studied regarding the cross cultural validation of the instruments used in the cross – sectional study with subjects with spinal cord injury:

- ***Sub–Study 1***: To perform translation and cultural validation of Physical Activity Scale for People with Physical Disabilities for Portugal and Spain.
- ***Sub–study 2***: To perform translation and cultural validation of Quality of Life Index (Ferrans & Powers) SCI – III for Portugal and Spain.
- ***Sub–study 3:*** To perform translation and cultural validation of Quebec User Evaluation of Satisfaction with Assistive Technology – 2.0 for Spain.

Second phase – we will present the results of the cross- sectional study of the effects of physical activity level and characteristic of manual wheelchairs on upper extremity strength, shoulder pain, quality of life conducted in Portugal and in Spain:

- ***Sub–study 4:*** to describe the characteristics of the subjects, anthropometric measurements and wheelchair characteristics. And to present the scores descriptive values of physical activity, quality of life, shoulder pain and satisfaction with wheelchair.
- ***Sub–study 5:*** To study the relation of MWC type of components to the subjects satisfaction and presence of SP in both countries.
- ***Sub–study 6:*** To study the relation between QOL and PA levels in subjects with SCI of both countries.
- ***Sub–study 7:*** To study the relation between isometric strength of upper extremity and MWC components.

4.1. Statistical analysis

4.1.1.Cross–cultural validation

For cross–cultural validation (sub–studies 1 to 3) we used psychometric statistical tests of reliability in alpha analysis for internal consistency (*α*) and slip–file to test–retest reliability (*ρ*). A descriptive analysis of sociodemographic data and scores data was also performed (Pereira & Patrício, 2013).

4.1.2.Cross – sectional

Previous to the statistical analysis of the sub–studies show 4 to 7 developed normality (appendix 18, page 202), phy (appendix 14, page 189) and Chi-square analysis (appendix 13, page 186).

4.1.2.1. Sub–study 4

Descriptive statistical methods were used to calculate means, standard deviation and percentage scores of the variables (Laureano & Botelho, 2010; Pereira & Patrício, 2013). This process was used for sociodemographic information, anthropometrics and QUEST – 2.0, WUSPI, PASIPD and QLI (Ferrans & Powers) scores, and for QUEST 2.0 items importance percentage among groups (Physical activity, country and MWC type). To test differences in-between groups at baseline Mann Whitney U test for independent samples

were applied regarding each studied variable. Alpha was set at 5% (Field, 2009; Olveira, 2009; Pereira & Patrício, 2013).

Kruskal-Wallis test (Field, 2009) was used to test differences in-between groups at baseline of wheelchair type and QUEST 2.0 scores. Alpha was set at 5%. Mann Whitney U test was used for Post-hoc analysis and tests were only considered significant if alpha below 0,05/number of groups.

4.1.2.2. Sub–study 5

To test relations in-between wheelchair components, QUEST – 2.0, WUSPI and years since SCI among samples from Portugal and Spain variables the nonparametric spearmen correlation test was used with alpha set at 5%. Once the studied variables did not present a normal distribution these were used (Laureano & Botelho, 2010; Olveira, 2009).

To test differences in-between groups at baseline Mann Whitney U test for independent samples were applied regarding each studied variable. Alpha was set at 5% (Field, 2009; Olveira, 2009; Pereira & Patrício, 2013). It was tested for the difference in wheelchair components for Portugal and Spain; for subject with and without shoulder pain and for the height of the manual wheelchair backrest.

The Mann Whitney U test (Field, 2009) was also applied to test the difference in physical activity, satisfaction with a wheelchair, shoulder pain and quality of life, regarding different wheelchair seat height; and for the presence of an armrest in the wheelchair according to age and years since SCI. Finally, with the sample divided in subjects from Portugal and Spain, we used the Mann Whitney U test for independent samples to look for difference in seat height, anthropometrics and shoulder pain in-between countries.

Kruskal-Wallis test (Field, 2009) was used to test differences in-between groups at baseline of between the level of physical activity and type of MWC. Alpha was set at 5%. Mann Whitney U test was used for Post-hoc analysis and tests were only considered significant if alpha below 0,05/number of groups.

4.1.2.3. Sub – study 6

To test relations in-between variables a spearmen correlation test and alpha was set at 5% and was used (Laureano & Botelho, 2010; Olveira, 2009). This test was used to test

for relations among physical activity, quality of life, shoulder pain and satisfaction with wheelchair. Results were considered a statistical significance for $\alpha < 0,05$.
To test the difference in-between groups the nonparametric test Mann Whitney U for independent samples was used with alpha set at 5%, confirming that groups were statistically alike for the level of paraplegia, country and manual wheelchair weight, for scores in physical activity and quality of life total score and subscale variables (Field, 2009; Olveira, 2009; Pereira & Patrício, 2013).
Kruskal-Wallis test (Field, 2009) was used to test differences in-between groups at baseline of between interaction in level of physical activity and type of MWC for quality of life. Alpha was set at 5%. Mann Whitney U test was used for Post-hoc analysis and tests were only considered significant if alpha below 0,05/number of groups.

4.1.2.4. Sub – study 7

Descriptive statistical methods were used to calculate means and standard deviation of upper extremity strength values (Pereira & Patrício, 2013).

The normal distribution of the variables were tested with the Kolmogorov – Smirnoff test, because variables showed to not have a normal distribution relations in-between were tested with a Spearmen correlation with the alpha set at 5% (Laureano & Botelho, 2010; Olveira, 2009). This was used to test for relations among upper extremity strength. Results were considered statistical significance for a $\alpha < 0,05$.
To test differences in-between groups at baseline Mann Whitney U (Field, 2009; Olveira, 2009; Pereira & Patrício, 2013) a test for independent samples was applied regarding each studied variable. Alpha was set at 5%. It was tested for the difference in strength values according to country, physical activity, paraplegia level, handrim diameter, presence of armrest, wheelchair weight and seat height, seat height and shoulder pain and seat height and years since SCI.
Kruskal-Wallis test (Field, 2009) was used to test differences in-between groups at baseline type of manual wheelchair and strength and region/province and strength. Alpha was set at 5%. Mann Whitney U test was used for Post-hoc analysis and tests were only considered significant if alpha below 0,05/number of groups.

4.2. Cross – cultural validation

4.2.1. Sub–study 1: Physical Activity Scale for People with Physical Disabilities

Aim of the sub – study: to cross – culturally validate Physical Activity Scale for People with Physical Disabilities for Portuguese of Portugal and Spanish of Spain.

4.2.1.1. Portuguese population

4.2.1.1.1. Descriptive statistics

A total of 56 subjects (13% ♀; 87% ♂) with an age distribution of 18 – 25 (24,1%), 26 – 35 (35,2%), 36 – 45 (24,1%), 46 – 55 (11,1%) and more than 55 (5,6%) were successfully selected according to procedures previously described (Chapter 3) and completed the test – retest versions.

The total sample was divided according to the etiology of the lesion in 42,9% SCI (n=24), 10,7% Cerebral Palsy (n=6), 8,9% Lower Limb Amputation (n=5), 3,6% Muscular Dystrophy (n=2), 3,6% Lower Limb disability (n=5), 1,8 % Multiple Sclerosis (n=1), 3,6% Congenital Malformation (n=2), 8,9% Upper Limb Disability (n=5) and 12,5% other types of disability (n=7).

Although the majority of the sample had completed high school education (75%), and 5,4 had a college degree, only 43,4 were actively working. Regarding marital status 62,5% were single, 25% married and 8,9% divorces.

The results of the PASIPD activity scores for the test (Av±SD) are 30,34±22,99 MET hr/d and retest value 27,09±23,61 MET hr/d.

4.2.1.1.2. Psychometrics

For the Portuguese cross – cultural validation the PASIPD showed an internal consistency value between tests (α=0,62) and retest versions (α=0,73), reliability in 1 to 2 weeks

(ρ=0,88) and ICC of 0,821 (95% CI: 0,75 to 0,88). Kappa analysis of agreement (appendix 19, page 204) for each of PASIPD questioned for the test – retest shows to be low but with different values among questions). The highest values were in “outdoor gardening” (0,65), “home repairs” (0,51), “caring for another person” (0,52) and “light housework” (0,54).

4.2.1.2. Spanish population

4.2.1.2.1. Descriptive statistics

A total of 33 subjects (33,3% ♀; 66,7% ♂) with an age distribution of 18–25 (9,1%), 26–35 (30,3%), 36–45 (33,3%), 46–55 (12,1%) and more than 55 (15,2%) were successfully selected according to procedures previously described (Chapter 3) and completed the test – retest versions.

Total sample was divided according to the etiology of the lesion in lower limb amputation (n=5), SCI (n=11), Multiples Sclerosis (n=1), Poliomyelitis (n=1), Hemiparesis (n=1) and other types of disability (n=12).

Although the majority of the sample had a college degree (39,4%), and 21,2% completed high School education, only 27,3% were actively working. Regarding marital status 63,6% were single and 36,4% married.

Approximately 63.6% being single and 36,4% married. Concerning labor status, only 27,3% are active. 21,2% completed high school, with only 39,4% completing basic education.

The results of the PASIPD activity scores for the test of 24,29±27,14 MET hr/d and 23,21±22,89 MET hr/d for the retest.

4.2.1.2.2. Psychometrics

For the Spanish cross – cultural validation of the PASIPD showed an internal consistency value between test (α=0,78) and retest versions (α=0,70), reliability between 1 to 2 weeks time (ρ=0,88) and ICC of 0,86 (95% CI: 0,78 to 0,92). Kappa analysis of agreement (appendix 19, page 204) for each of PASIPD between test and retest shows low/ medium

but different results among questions. The highest values were observed in “Strenuous Sport/ Recreational activities” (0,74), “Heavy housework” (0,76), “Home repairs” (0,61) and “Care for another person” (0,61).

4.2.1.3. Discussion

The application of PASIPD to the Portuguese population shows an acceptable internal consistency values for test (α=0,62) and good retest (α=0,73) values for the same topic. The reliability between 1 to 2 weeks time (ρ=0,88) and ICC of 0,82 (95% CI: 0,75 to 0,88). Internal consistency values for the total PASIPD are higher than the values (0,37 to 0,65) in the original version (Washburn et al., 2002). The Spanish version shows a good internal consistency values for test (α=0,78) and good for retest (α=0,70) values for the same topic. The reliability between 1 to 2 weeks time (ρ=0,88) and ICC of 0,86 (95% CI: 0,78 to 0,92). Internal consistency values for the total PASIPD were higher than the values (0,37 to 0,65) in the original version (Washburn et al., 2002).

These values indicate that both versions present a good internal consistency and test – retest reliability, regardless of the difference in culture, number of subjects and physical disabilities.

Reliability between test and retest for Spearmen correlation coefficient is high, presenting a good reliability among tests for both versions. These values are similar to the ones in the validation of the Dutch PASIPD version (0,77) (van der Ploeg et al., 2007).

Because in the beginning of this translation process we knew that it was possible then would be difficulty in contacting different populations with physical disabilities, namely due to the nature of the questionnaire, which applies to several types of physical disabilities. In order to try to overcome this difficulty, we covered the areas of Lisbon, Oporto, Braga, Leiria, Aveiro and Guimarães and the same procedure was applied in Spanish areas of Badajoz and Caceres.

The validation of the PASIPD for the Spanish and Portuguese population is very important to improve comparison and measure average physical activity in people with physical disabilities.

The values of PASIPD score are relatively higher in the Portuguese sample when compared to the Spanish ones. This may be explained by the level of activity presented by the subjects of the regions or by the type of physical disabilities. The obtained scores may also have been influenced in both regions due to the seasonality, as both the test and retest process was developed between October of 2013 and March of 2014, the coldest months in southern Europe, which may well reduce the level of PA in people with disabilities.

4.2.2. Sub–study 2: Quality of Life Index (Ferrans & Powers) SCI–III

Aim of the sub – study: to cross – culturally validate QLI (Ferrans & Powers) SCI - III for Portuguese of Portugal and Spanish of Spain.

4.2.2.1. Portuguese population

4.2.2.1.1. Descriptive statistics

A total of 23 subjects (13,6% ♀; 86,4% ♂) with an age distribution of 18–25 (22,7%), 26–35 (36,4%), 36–45 (22,7%), 46–55 (13,6%) and more than 55 (4,5%) were successfully selected according to procedures previously described (Chapter 3) and completed the test – retest versions.

Total sample was divided according to the etiology of the lesion in 8,7% complete cervical (n=2), 8,7% incomplete cervical (n=2), 21,7% complete thoracic (n=5), 13,0% incomplete thoracic (n=3), 17,4% complete lumbar (n=4), 8,7% incomplete lumbar (n=2), 4,3% complete thoraco-lumbar (n=1) and 4,3% incomplete thoraco–lumbar (n=1). 3 subjects (13%) did not response.

Although the majority of the sample had completed high school education (63,3%), and 4.5 had a college degree, only 40.9% were actively working. Regarding marital status 63.6% were single, 27,3% married and 9.1% divorced.

The QLI in test is (21,86±3,25) similar in HFSUB (22,80±3,53), SOCSUB (20,96±3,95), PSPSUB (23,47±4,28) and FAMSUB (19,27±4,89). Values in retest are, QLI (21,99±3,75),

HFSUB (22,67±4,20), SOCSUB (22,02±4,08), PSPSUB (23,25±4,52) and FAMSUB (19,22±4,46).

4.2.2.1.2. Psychometrics

For the Portuguese cross – cultural validation of QLI (Ferrans & Powers) – SCI III showed internal consistency values between test (α=0,91) and retest versions (α=0,95). Internal consistency was also high in HFSUB (test, α=0,81; retest, α=0,92), SOCSUB (test, α=0,71; retest, α=0,83), PSPSUB (test, α=0,88; retest, α=0,92) and FAMSUB (test, α=0,74; retest, α=0,63).

Temporal reliability (1 to 2 weeks) for test – retest is 0,784 for QLI, with similar values for HFSUB (ρ=0,79), SOCSUB (ρ=0,72), PSPSUB (ρ=0,72) and FAMSUB (ρ=0,85). Kappa analysis of agreement (appendix 19, page 204) for each question for test – retest shows low but differing between values among questions. The highest values are in “Faith in God” (0,70), “Job” (0,53) and “Emotional support from people other than your family” (0,57).

4.2.2.2. Spanish population

4.2.2.2.1. Descriptive statistics

A total of 10 subjects (10% ♀; 90% ♂) with an age distribution of 18 – 25 (10%), 26 – 35 (20%), 36 – 45 (40%), 46 – 55 (20%) and more than 55 (10%) were successfully selected according to procedures previously described (Chapter 3) and completed the test – retest versions.

Total sample was divided according to the etiology of the lesion in 10% complete cervical (n=1), 10% complete cervico–thoracic (n=1), 30% incomplete cervical (n=3), 20% complete thoracic (n=2), 10% complete lumbar (n=1) and 10% incomplete thoraco–lumbar (n=1).

The majority of the sample had completed basic education (60%) and 20% had a college degree, 90% were not working. Regarding marital status 70% were single and 30% married.

QLI for test presents scores of 18,82±4,54 and similar in HFSUB (19,13±6,13), SOCSUB (20,51±3,98), PSPSUB (19,51±7,28) and FAMSUB (15,55±4,03). In retest, QLI

(18,47±4,68), HFSUB (19,68±5,61), SOCSUB (18,72±4,19), PSPSUB (19,44±6,02) and FAMSUB (14,61±6,39) are similar.

4.2.2.2.2. Psychometrics

For the Spanish cross–cultural validation of QLI shows internal consistency values between test (*α*=0,94) and retest versions (*α* = 0,94). These values are also high in HFSAUB (test, *α*=0,89; retest, *α*=0,92), SOCSUB (test, *α*=0,69; retest, *α*=0,65), PSPSUB (test, *α*=0,92; retest, *α*=0,93) and FAMSUB (test, *α*=0,57; retest, *α*=0,83). Temporal reliability (1 to 2 weeks) for test–retest in QLI is 0,94, with similar values for HFSUB (*ρ*=0,90), SOCSUB (*ρ*=0,80), PSPSUB (*ρ*=0,97) and FAMSUB (*ρ*=0,84). Kappa analysis of the agreement (appendix 19, page 204) of each question for test – retest shows low but differing values between questions. The highest values were observed in “Education” (0,61), “Job” (0,54), “Emotional support from people other than your family” (0,54) and “Achievement of personal goals” (0,53).

4.2.2.3. Discussion

The application of the QLI (Ferrans & Powers) – SCI III (Spanish) showed for both test (*α*=0,94) and retest versions (*α* = 0,94) a very good internal consistency and similar values to the original generic version of the Ferrans & Powers QLI (*α*=0,90 to 0,93) (Ferrans & Powers, 1985). This shows that values in the Spanish version are between the average values obtained for this scale. For HFSUB (test, *α*=0,89; retest, *α*=0,92) and PSPSUB (test, *α*=0,92; retest, *α*=0,93) are shown values between cronbach’s alpha average for this subscales (HFSUB, $0.70<\alpha<0.94$; PSPSUB, $0.78<\alpha<0.96$). And SOCSUB (test, *α*=0,687; retest, *α*=0,65), and FAMSUB (test, *α*=0,57; retest, *α*=0,83) show in test or retest, good internal consistency, similar to the Portuguese version.

The application of the QLI (Ferrans & Powers) – SCI III (Portuguese) showed for both test (*α*=0,91) and retest versions (*α*=0,95) a very good internal consistency and similar values to the original generic version (Ferrans & Powers, 1985). This shows that values to the Portuguese version are between the average values obtained for this scale. Regarding

the HFSUB (test, α=0,81; retest, α=0,92) and PSPSUB (test, α=0,88; retest, α=0,92) showed values between the average cronbach's apha for this subscales (HFSUB, $0.70<\alpha<0.94$; PSPSUB, $0.78<\alpha<0.96$). And SOCSUB (test, α=0,71; retest, α=0,83), andFAMSUB (test, α=0,74; retest, α=0,63) show lower values, however, good internal consistency.

Temporal reliability (1 to 2 weeks) for test – retest were similar both in Portuguese and Spanish samples. In Spanish, for the QLI (ρ=0,94) and HFSUB (ρ=0,90), SOCSUB (ρ=0,80), PSPSUB (ρ=0,97) and FAMSUB (ρ=0,84) are higher than the generic version (Ferrans & Powers, 1985) (ρ=0,81 to 0,87) and presented a very good temporal reliability. As for the Portuguese samples, for the QLI (ρ=0,78) HFSUB (ρ=0,79), SOCSUB (ρ=0,72), PSPSUB (ρ=0,72) and FAMSUB (ρ=0,85) they were lower than the generic version (Ferrans & Powers, 1985), presenting however a very good temporal reliability.

QLI (Ferrans & Powers) SCI – III has been used in PA with SCI subjects (Semerjian et al., 2005), it shows a good way to show the evolution of QOL during the rehabilitation programs. However, there is a need for continuous improvement in the instrument for a better understanding by the participants.

4.2.3. Sub–study 3: Quebec User Satisfaction with Assistive Technology 2.0

Aim of the sub–study: to cross–culturally validate Quebec User Evaluation of Satisfaction with Assistive Technology – 2.0 for Spanish of Spain.

4.2.3.1. Descriptive statistics

A total of 26 subjects (32% ♀; 68% ♂) with an age distribution of 18–25 (4%), 26–35 (24%), 36–45 (40%), 46–55 (12%) and more than 55 (20%) were successfully selected according to procedures previously described (Chapter 3) and completed the test–retest versions.

Total sample was divided according to the etiology of the lesion in 41,7% SCI (n=10), 8,3% Lower Limb Amputation (n=2), 8,3% not specific motor disability (n=2), 8,3% Stroke (n=2), 4,2% poliomyelitis (n=1), and 29,2% other (n=7).

The majority of the sample had completed basic education (44%) and 32% had a college degree, only 20,8% were actively working. Regarding marital status 64% were single and 36% married. Regarding the use of AT it includes MWC (n=7), prosthetic devices (n=1),

PWC (n=6), walkers (n=1), walking canes (n=2), AFO (n=1) and other types not specified by the users (n=8).

QUEST 2.0 for test version TS is 3,87±0,81 and similar values for AT (3,95±0,82) and SV (3,69±0,98). In retest, values are similar in TS (3,77±0,82), AT (3,92±0,83) and SV (3,47±0,99). Both in test and retest (table 2), the three most important items selected by the subjects regarding the MWC were “safety”, “comfort” and “effectiveness”.

Table 2

Important factors in QUEST 2.0 item satisfaction

	Percentage (%) of answers	
	Test	Retest
Dimensions	6,5%	8,1%
Weight	7,8%	6,8%
Adjustments	7,8%	5,4%
Safety	22,1%	21,6%
Durability	11,7%	9,5%
Easy to use	9,1%	10,8%
Comfort	16,9%	20,3%
Effectiveness	13,0%	13,5%
Repairs/ servicing	2,6%	2,7%
Follow – up services	2,6%	1,4%

4.2.3.2. Psychometrics

QUEST–2.0 shows internal consistency TS values between test (α=0,87) and retest versions (α=0,88). Internal consistency is high for AT (test, α=0,88; retest, α=0,89) and SV (test, α=0,65; retest, α=0,63).

Temporal reliability (1 to 2 weeks) for test – retest in TS is 0,97, with similar values for AT (ρ=0,98) and SV (ρ=0,89). It presents an ICC (95%) of 0,94 (0,91 – 0,97), 0,81 (0,68 – 0,91), 0,94 (0,89 – 0,97) for AT, SV and TS respectively. Kappa analysis of the agreement (appendix 19, page 204) for each of the QUEST 2.0 question for test – retest shows high but differing values among questions. The lowest values are observed in “Ease in adjusting” (0,26), “Weight” (0,35) and “Dimensions” (0,39).

4.2.3.3. Discussion

The validation process of QUEST – 2.0 showed internal consistency values between test (α = 0,87) and retest versions (α=0,88). Internal consistency was high for AT (test, α=0,88; retest, α=0,89) and SV (test, α=0,65; retest, α=0,63). When compared to the Portuguese version, the Spanish version presents similar values in internal consistency (α=0,79) for total score and subscale of assistive technology (α=0,80) and just the Service subscale (α=0,81) is lower (Rodrigues, 2003).

Temporal reliability between 1 to 2 weeks for test–retest for a total score of 0,97, with similar values for Assistive Technology (ρ=0,98) and Service (ρ=0,89). Comparing to the Portuguese version, test–retest reliability (7 to 11 days), presents similar and good values for a Total Score of ρ=0,93 and for Assistive Technology subscale (ρ=0,89) and Service (ρ=0,94) (Rodrigues, 2003). These results are similar to those in the Dutch version in internal consistency (α=0.73 and 0.85) (Wessels & Witte, 2003).

Kappa values of constancy for test–retest are low for AT (0,26–0,71) subscale and good to very good on the SV subscale (0,45–0,80). This may be related to the differences among the subscales or the low number of subjects. However, the last factor does not stand for the other reliability and internal consistency values.

Comparing to the Taiwanese version of QUEST 2.0 we observe that the Cronbach's alpha of the AT, SV and TS are 0.87, 0.84 and 0.90, respectively, indicating high internal consistency. With regard to test–retest reliability, the ICCs (95% CI) for AT and SV, and TS are 0.90, 0.97 and 0.95, respectively, indicating excellent score agreement (Mao et al., 2010). The values for internal consistency are similar to those in the Spanish version. The ICC, values are also similar to the Taiwanese version, only lower in the SV. The values are similar to the values of the Spanish version for Colombia, which presents high values in AT (α=0.89) and SV (α=0.82) and for TS of 0.91 (Mora Barrera, 2010) and with the recent results for the Korean (Lee et al., 2013) for AT (α=0,88 ; ρ=0,64) and SV (α=0,92 ; ρ=0,66) and Brazilian versions (Carvalho et al., 2014) for internal consistency in AT (0,86), SV (0,72) and TS (0,83).

4.3. Cross sectional analysis

Transboundary Study Portugal-Spain of the relation between anthropometric measures, wheelchair characteristics, level of physical activity, quality of life, shoulder pain and upper extremity strength in subjects with SCI.

4.3.1. Sub–study 4: Portugal–Spain transboundary descriptive analysis in SCI

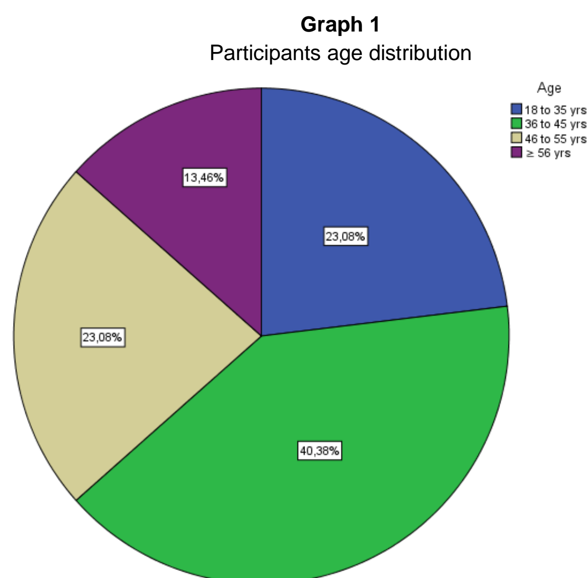
The aim of the sub–study: to describe the characteristics of the subjects, anthropometric measurements and wheelchair characteristics. And to present the scores descriptive values of physical activity, quality of life, shoulder pain and satisfaction with wheelchair.

4.3.1.1. Sociodemographic characteristics

A total of 52 subjects were studied in the transboundary regions of Portugal (Algarve and Alentejo) and Spain (Huelva, Seville and Cadiz) (Portugal, n=35; Spain, n=17).

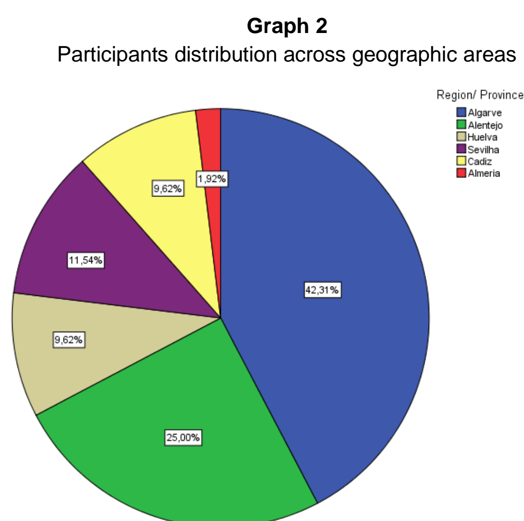
According to gender the sample was mainly composed by men 96.2% (n=50) versus 3.8% female (n=2). Age average of the sample was 42,63±9,16 (age±SD). Distribution of ages according to four age groups is presented in graph 1.

Graph 1
Participants age distribution



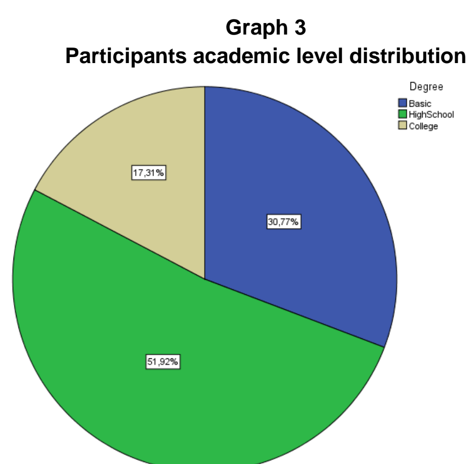
Distribution of participants across the 5 studied geographic areas of both countries is as following (graph 2). Subjects are from the regions/ provinces of Algarve (n=22, 42,3%), Alentejo (n=13, 25%), Huelva (n=5, 9,6%) Seville (n=6, 11,5%), Cadiz (n=5, 9,6%) and Almeria (Andalucía) (n=1, 1,9%).

Graph 2
Participants distribution across geographic areas

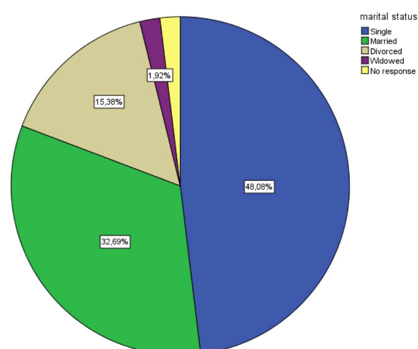


Academic level of total sample is represented in the following graph (nº3). Degree of the participants includes Basic education (n=16, 30,8%), high school degree (n=27, 51,9%) and academic degree (n=9, 17,3%). Regarding labor status, 24 (51,9%) are active, 27 (46,2%) inactive and 1 (1,9%) no response. And concerning marital status (graph 4), participants are single (n=25, 48,1%), married (n=17, 32,7%), divorced (n=8, 15,4%) or widowed (n=1, 1,9%) and one no response (n=1, 1,9%).

Graph 3
Participants academic level distribution

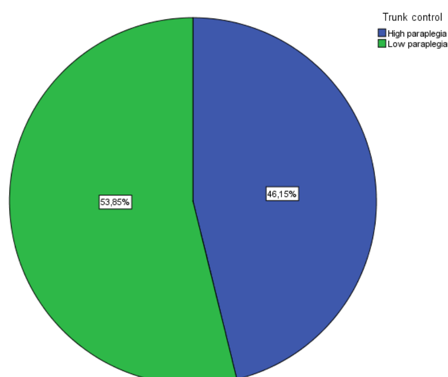


Graph 4
Participants marital status distribution



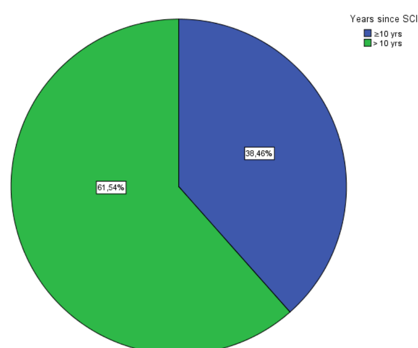
According to the inclusion criteria, participants presented High thoracic (T1–T6) (n=19, 36,5%), Low Thoracic (T7–T12) (n=30, 57,7%) and Lumbar (L1–L5) (n=3, 5,8%) paraplegia and were grouped as high (≥T7) (n=24, 46,2%) and low paraplegia (<T7) (n=28, 53,8%) (graph 5).

Graph 5
Participants trunk control distribution



Mean age of the subjects was 42,63±9,16 (AV±SD), ranged from 26 to 64. Years since SCI were 13,98±9,05 (AV±SD). According to time since SCI in years (graph 6), we grouped subjects in 2 to 10 (n=20, 38,5%) and more than 10 years (n=32, 61,5%).

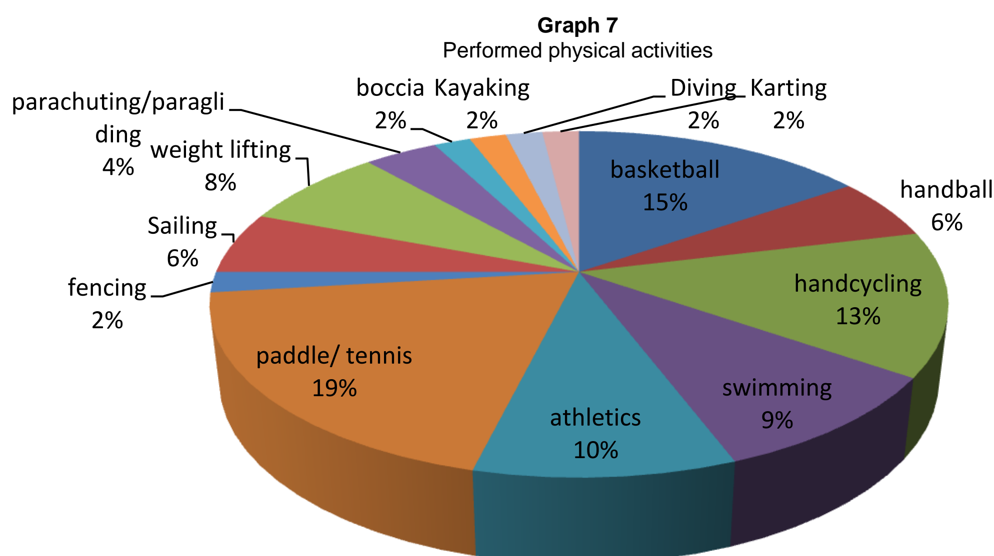
Graph 6
Years since SCI distribution



4.3.1.2. Physical Activity

Results from the sociodemografic questionnaire indicated that 63,46% (n=33) were engaged in regular physical activity with the remaining 36,54% (n=19) stating that they do not perform any physical activity. The performed activities were basketball (15,38%), handball (5,77%), handcycling (13,46%), swimming (9,62%), athletics (9,62%), paddle/tennis (19,23%), fencing (1,92%), Sailing (5,77%), weight lifting (7,69%), parachuting/paragliding (3,85%), boccia (1,92%), Kayaking (1,92%), Diving (1,92%) and Karting (1,92%) (graph 7).

Graph 7
Performed physical activities



4.3.1.3. Manual wheelchair characteristics

The analysis of MWC characteristics in between countries (Portugal n=35; Spain n=16) regard backrest height, seat height, seat width, seat depth, armrest height, wheels diameter, caster wheels diameter, handrim diameter and MWC total weight and median results are presented below (table 3).

Table 3

Median of MWC characteristics regarding the country study area (Av ± SD)

	Portugal (n = 35)	Spain (n = 16)	U	z	Sig. (2 -tailed)
Backrest height (cm)	34,00	32,50	259,00	-,427	,669
Seat height (cm)	46,00	43,50	217,00	-1,284	,199
Seat width (cm)	41,00	38,00	133,00	-3,007	,003
Seat dept (cm)	42,00	40,00	181,50	-2,016	,044
Wheels diameter (cm)	60,00	60,00	248,00	-,764	,445
Caster wheels diameter (cm)	12,00	10,00	114,00	-3,481	,000
Handrim diameter (cm)	53,00	52,00	223,500	-1,188	,235
Total weight (Kg)	12,00	11,00	174,500	-2,161	,031

The Mann Whitney U test shows significant difference in country regarding MWC dimensions (p<0,05), for seat width (U=133,00, z=-3,007, p=0,003), seat depth (U=181,50, z=-2,016, p=0,044), caster wheels diameter (U=114,00, z=-3,481, p=0,000) and MWC total weight (U=174,50, z=-2,161, p=0,031). Except for the rear wheels diameter, median values are higher in Portugal than in Spain for MWC components (appendix 16, page 191, table 61).

During the study, we observed some subjects only used MWCs, some however used both a MWC and a powered wheelchair or only powered ones. Regarding this, in Portugal, 3 subjects use MWCs and PWCs (8,6%) and 32 use only MWCs (91,4%). In Spain, 16 use MWCs (94,1%) and one subject uses only a PWC (5,9%).

For each study participant, the MWC was clustered into lightweight (n=8, 15,7%), ultralightweight folding (n=15, 29,4%) and ultralightweight unfolding (n=28, 54,9%), according to each MWC company information. According to each country, in Portugal 22,9% are lightweight wheelchairs, 40% ultralightweight (folding) wheelchairs and 37,1% ultralightweight (unfolding) models. In Spain it is observed 88,2% ultralightweight wheelchair models, with 5,9% for a ultralightweight wheelchair and 5,9% for PWC. Both in Portugal (51,4%) and Spain (58,8%), the main material in a MWC is Aluminum, followed by Titanium (25,7%) in Portugal and Carbon (23,5%) in Spain (table 4).

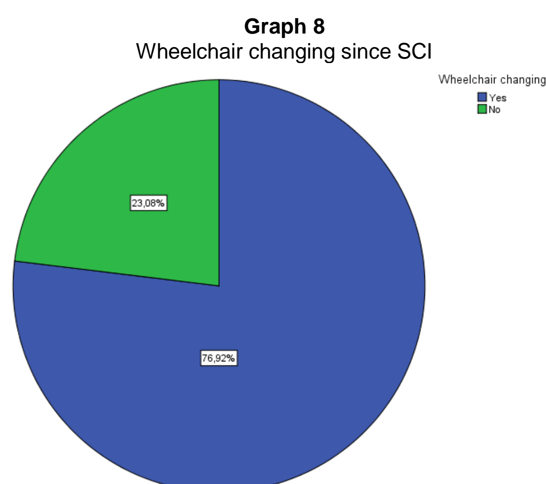
Table 4

MWC main material frequency

		MWC			
	PWC	Aluminum	Titanium	Carbon	Steel
Portugal (n=35)	0 (0%)	18 (51,4%)	9 (25,7%)	6 (17,1%)	2 (5,7%)
Spain (n=17)	1 (5,9%)	10 (58,8%)	2 (11,8%)	4 (23,5%)	0 (0%)

Regarding the health care system, the differences in time that SCI subject wait for their own MWC is considerable different, having been reported in Portugal (0,99 yr±2,47) and in Spain (0,59 yr±1,28). Time waiting for a MWC was also reported to be higher in high paraplegia (0,46yr±1,18) than in low paraplegia (1,20yr±2,70). The majority of the studied sample uses a cushion in the MWC (92,31%) and only 23,08% have stated to change/altered MWC (graph 8).

Graph 8
Wheelchair changing since SCI



Components dimensions, such as backrest height, seat (width, height and length), handrim diameter and total weight were observed to reduce from lightweight to ultralightweight (unfolding) models (table 5).

Table 5

MWC components average dimensions

	Backrest height (Cm)	Seat			Handrim diameter (cm)	Total Weight (Kg)
		High (Cm)	Width (Cm)	Length (Cm)		
Light – folding (n=8)	40,25±3,15	46,25±4,95	41,75±1,49	42,88±1,89	51,63±2,56	13,44±2,61
Ultra light – folding (n=15)	34,20±4,00	44,40±7,27	40,30±2,30	42,80±4,78	52,27±2,02	12,14±2,22
Ultra light – unfolding (n=28)	31,68±4,42	43,64±5,31	38,50±3,10	40,68±2,61	52,46±1,00	9,99±2,23

It was performed a Kruskal-Wallis test (table 6) regarding MWC types and it was observed a statistical difference in backrest height ($X^2_{(2)}$= 16,43; *p*=0,00), seat width ($X^2_{(2)}$= 9,77; *p*=0,008), casters diameter ($X^2_{(2)}$=16,76; *p*=0,00) and MWC weight ($X^2_{(2)}$= 12,91; *p*=0,002).

Table 6

Kruskal Wallis test for MWC type components

	Backrest height	Seat height	Seat Width	Seat depth	Wheels diameter	Casters diameter	Handrim diameter	MWC weight
Qui-square	16,43	4,33	9,77	5,57	2,86	16,76	,56	12,91
df	2	2	2	2	2	2	2	2
Sig.	,000	,115	,008	,062	,239	,000	,757	,002

a. Kruskal Wallis Test

b. Grouping variable: wheelchair type

We performed a post–hoc test using Mann – Whitney U test (appendix 20, page 207, tables 116 to 118). To avoid type I error, alpha was only considered significant below 0,0167 (0,05/number of groups). It is shown a significant difference of backrest height of Lightweight and ultralightweight models (folding: p=0,004; unfolding: p=0,000); seat width among ultralightweight folding and unfolding (p=0,005) and weight among ultralightweight unfolding with lightweight (p=0,002) and ultralightweight folding models (p=0,010). Caster wheels diameter shown differences among the three models, Lightweight and ultralightweight models (folding: p=0,003; unfolding: p=0,001) and among ultralightweight ones (p=0,008).

People who do not use the same wheelchair have an average of 16,35 yr (±8,60) since SCI, while subjects who present an average of 6,08 yr (±5,38) still use the same MWC.

4.3.1.4. Anthropometric analysis

Anthropometric measures were preformed in all subjects as previously explained (chapter 3). Mean values of these variables of both countries are presented in table 7 (height), table 8 (width) and table 9 (deepness). Median values present no statistical difference (p>0,05) for Portugal and Spain subjects. Mean ranks and sum scores are in appendix 16 (page 191, table 64).

Table 7

Median Anthropometric measurements – height

	Portugal (n=35)	Spain (n=15)	sig	U	Z
Seating stature	127,00	123,00	,378	221,00	-,881
Eyes height	117,00	114,00	,294	213,00	-1,050
Shoulder height	98,00	94,00	,100	185,00	-1,645
Elbow height	67,00	63,00	,088	182,00	-1,708
Knee height	67,00	61,00	,165	197,00	-1,388
Popliteal height	58,00	51,00	,096	184,00	-1,664
Foot height	9,00	7,00	,148	194,50	-1,448

Table 8

Median Anthropometric measurements – Width

	Portugal (n=35)	Spain (n=15)	sig	U	Z
Elbow	56,00	54,00	,319	215,500	-,997
Biacromial	33,00	35,00	,087	182,500	-1,709
Waist	40,00	37,00	,038	165,000	-2,078
Shoulder	48,00	50,00	,104	186,000	-1,626
Thoracic	35,00	35,00	,750	247,500	-,319

Table 9

Median anthropometric measurements – Depth

	Portugal (n=35)	Spain (n=15)	sig	U	Z
Forearm - hand	44,00	44,00	,807	251,000	-,244
Popliteal	45,00	46,00	,758	248,000	-,308
Gluteus to knee	55,00	55,00	,992	262,000	-,011
Shoulder	33,00	32,00	,367	220,000	-,903

4.3.1.5. QUEST 2.0 results

Results for QUEST 2.0 are presented below and organized according to the level of paraplegia (table 10), country (table 11), Physical Activity (table 12) and MWC type (table 13). Mean ranks and total scores for paraplegia level, country and physical activity are presented in appendix 16 (table 65, page 191).

Median scores are similar in High paraplegia (AT: 3,81; SV: 3,38; TS: 3,63) and in low paraplegia (AT:4,00; SV:3,00; TS:3,67) in all the domain of QUEST 2.0. There is no statistical difference for each paraplegia level for each subscale or total.

Table 10

QUEST 2.0 scores according to level of paraplegia

	Level of Paraplegia		U	Z	Sig.
	High (n=24)	Low (n=28)			
AT	3,81	4,00	283,50	-,966	,334
SV	3,38	3,00	283,00	-,977	,328
TS	3,63	3,67	321,00	-,276	,783

Median scores are similar in Portugal (AT: 4,00; SV: 3,25; TS: 3,83) and Spain (AT:3,75; SV:3,00; TS:3,50) in all the domain of QUEST 2.0. There is no statistical difference for each country for subscales or total score.

Table 11

QUEST 2.0 scores according to country

	Country		U	Z	Sig.
	Portugal (n=35)	Spain (n=17)			
AT	4,00	3,75	227,50	-1,369	,171
SV	3,25	3,00	286,00	-,225	,822
TS	3,83	3,50	238,00	-1,163	,245

Median scores are similar for those who perform (AT: 3,88; SV: 3,25; TS: 3,67) and do not perform (AT: 3,88; SV:3,75; TS:3,67) regular physical activity in all domains of QUEST 2.0. There is no statistical difference for each country for subscales or total score.

Table 12

QUEST 2.0 scores according to level of physical activity

	Physical Activity		U	Z	Sig.
	No (n=19)	Yes (n=33)			
AT	3,88	3,88	309,00	-,086	,932
SV	2,75	3,25	265,00	-,926	,355
TS	3,67	3,67	282,0	-,600	,549

According to MWC type, lightweight wheelchairs (AT: 3,14±0,99; SV: 2,69±0,62; TS: 2,99±0,80) users are less satisfied, followed by ultralightweight models that present similar values in the folding (AT: 4,01±0,80; SV: 3,13±1,03; TS: 3,72±0,76) and unfolding (AT: 3,90±0,82; SV: 3,19±0,91; TS: 3,66±0,76) mechanisms. One of the subjects only used PWC (AT: 3,00; SV: 2,25; TS: 2,75).

Table 13

QUEST 2.0 scores according to MWC type

		MWC		
	PWC (n=1)	Lightweight (n = 8)	Ultralight folding (n=15)	Ultralight unfolding (n = 28)
AT	3,00	3,14 ± 0,99	4,01 ± 0,80	3,90 ± 0,82
SV	2,25	2,69 ± 0,62	3,13 ± 1,03	3,19 ± 0,91
TS	2,75	2,99 ± 0,80	3,72 ± 0,76	3,66 ± 0,76

Kruskal-Wallis analysis (table 14) indicates no statistical difference among MWC characteristics and QUEST 2.0 scoring ($p<0,05$).

Table 14
Kruskal Wallis analysis for QUEST 2.0 scores according to MWC characteristics

	Assistive Technology	Service	Total Score
Qui-square	5,195	2,462	5,560
df	2	2	2
Sig.	,074	,292	,062

Each participant indicates (table 15) the three most important items in MWC. The most important items among all participants are weight (22,4%), ease of use (14,7%) and comfort (16,7%). In High paraplegia the three most important items are weight (20,8%), safety(16,7%) and ease of use (16,7%) when compared to low paraplegia, with weight (23,8%), comfort (17,9%) and dimensions and ease of use with (13,1%). The group with regular physical activity regards weight (24,2%) more than comfort (18,2%) and Dimensions (13,1%), versus ease of use (22.8%), weight (19.3%) and comfort (14%), for those who do not perform regular physical activity.

Table 15

Percentage for QUEST 2.0 most important items (1 – 11) according to MWC type, country and Physical activity

		1	2	3	4	5	6	7	8	9	10	11
MWC	Lightweight	12,50	20,80	0,00	4,20	0,00	25,0	20,80	4,20	8,30	0,00	4,20
	Ultralightweight Folding	4,40	20,00	0,00	8,90	6,70	20,0	15,60	15,60	4,40	4,40	0,00
	Ultralightweight Unfolding	13,10	23,80	3,60	13,10	11,90	8,3	16,70	6,00	1,20	2,40	0,00
Country	Portugal	10,50	20,00	1,00	9,50	4,80	18,1	17,10	10,50	4,80	2,90	1,00
	Spain	11,80	27,50	3,90	11,80	15,70	7,8	15,70	3,90	0,00	2,00	0,00
Physical Activity	No	7,00	19,30	0,00	7,00	5,30	22,8	14,00	10,50	7,00	5,30	1,80
	Yes	13,10	24,20	3,00	12,10	10,10	10,1	18,20	7,10	1,00	1,00	0,00

Note: 1–Dimensions, 2–Weight, 3–Adjustments, 4–Safety, 5–Durability, 6–Easy to use, 7–Comfort, 8–Effectiveness, 9–Service delivery, 10–Repairs/servicing, 11-Follow-up services

There is also a difference in Portugal and Spain samples. In Portugal, the subjects concern was more with weight (20%), ease of use (18,1%) and comfort (17,1%). In Spanish sample the MWC users concerns were more with weight (27,5%), comfort (15,7%) and durability (15,7%). Users with lightweight MWCs were more concerned mainly with ease of use (25%), comfort (20,8%) and weight (20,8%); ultralightweight folding MWC users concerns were mainly with weight (20%), ease of use (20%), comfort (15,6%) and effectiveness (15,6%); and ultralightweight unfolding users concerns were with weight (23,8%), comfort (16,7%), safety (13,1%) and dimensions (13,1%).

4.3.1.6. WUSPI results

WUSPI mean scores (table 16) are grouped for Physical Activity (yes=7,71; No=15,12), years since SCI (≤10 yrs=10,27; >10 yrs=8,46), country (Portugal=11,03; Spain=8,46) and level of paraplegia (High=15,12; Low=6,20).

There is no statistical difference (p>0,05) according to physical activity, country, level of paraplegia or years since SCI. Mean ranks and sum scores are in appendix 16 (page 192, table 66).

Table 16

WUSPI Score according to physical activity, country and trunk control

	Median	U	Z	Sig.
Physical Activity				
No (n =10)	15,12	49,00	-,423	,673
Yes (n =11)	7,71			
Country				
Portugal (n =16)	11,03	39,00	-,083	,934
Spain (n =5)	8,46			
Level of paraplegia				
High (n =10)	15,12	46,00	-,634	,526
Low (n =11)	6,20			
Years since SCI				
≤ 10 (n =8)	10,27	49,00	-,217	,828
> 10 (n =13)	8,46			

4.3.1.7. PASIPD results

PASIPD median scores (table 17) shows higher values in people who do regular PA (32,61) when compared to the other group (15,48). The values are also different in Portugal (26,61) and Spain (32,25) and in high paraplegia (34,29) and in low paraplegia (24,74). There is statistical difference ($p<0,05$) according to physical activity. Mean ranks and sum scores are in appendix 16 (page 192, table 67).

Table 17

PASIPD Score according to physical activity, country and trunk control

	Median	U	Z	Sig.
Physical Activity				
No (n =19)	15,48	201,00	-2,138	,033
Yes (n =33)	32,61			
Country				
Portugal (n =35)	26,63	291,00	-,127	,899
Spain (n =17)	32,25			
Level of paraplegia				
High (n =24)	34,29	291,00	-,826	,409
Low (n =28)	24,74			

4.3.1.8. QLI (Ferrans & Powers) – SCI III results

Median QLI (Ferrans & Powers) SCI – III total score and subscales (table 18) values are relatively higher in those who practice (QLI: 21,34; HFSUB: 21,47; SOCSUB: 20,38; PSPSUB: 21,79; FAMSUB: 18,29) and do not practice Physical activity (QLI: 20,28; HFSUB: 20,03; SOCSUB: 18,81; PSPSUB: 22,50; FAMSUB: 18,43) (appendix 16, page 192, table 68).

Table 18

QLI score for physical activity

	Physical Activity		U	Z	Sig.
	No (n = 19	Yes(n = 33)			
QLI	20,28	21,34	272,000	-,789	,430
HFSUBa	20,03	21,47	277,000	-,694	,488
SOCSUBb	18,81	20,38	270,500	-,817	,414
PSPSUBc	22,50	21,79	303,500	-,190	,849
FAMSUBd	18,43	18,29	289,500	-,456	,648

Median QLI (Ferrans & Powers) SCI – III total score and subscales (table 19) values are relatively higher in Portugal (QLI: 21,31; HFSUB: 22,37; SOCSUB: 21,00; PSPSUB: 21,71; FAMSUB: 19,64) than in Spain (QLI: 18,92; HFSUB: 19,00; SOCSUB: 16,94; PSPSUB: 20,43; FAMSUB: 17,93). Mean ranks and sum score are avaible in appendix 16 (page 213, table 66).

Table 19

QLI score for country

	Country		U	Z	Sig.
	Portugal (n=35)	Spain (n=17)			
QLI	21,31	18,92	180,500	-2,283	,022
HFSUBa	22,37	19,00	168,500	-2,517	,012
SOCSUBb	21,00	16,94	185,000	-2,195	,028
PSPSUBc	22,71	20,43	219,000	-1,532	,126
FAMSUBd	19,64	17,93	216,500	-1,580	,114

Median QLI (Ferrans & Powers) SCI – III total score and subscales (table 20) values are relatively higher in low paraplegia (QLI: 21,34; HFSUB: 21,60; SOCSUB: 20,63; PSPSUB: 22,82; FAMSUB: 20,07) than in high paraplegia (QLI: 19,11; HFSUB: 19,77; SOCSUB: 20,19; PSPSUB: 20,50; FAMSUB: 17,32) (appendix 16, page 213, table 66).

Table 20

QLI score for paraplegia level

	Paraplegia level		U	Z	Sig.
	High (n=24)	Low (n=28)			
QLI	19,11	21,34	217,500	-2,175	,030
HFSUBa	19,77	22,60	223,000	-2,074	,038
SOCSUBb	20,19	20,63	310,000	-,477	,633
PSPSUBc	20,25	22,82	250,500	-1,570	,117
FAMSUBd	17,32	20,07	202,000	-2,460	,014

4.3.1.9. Discussion

During the activities we tried to cover equally all the study regions/provinces. Although, the results show that it was possible to cover mainly only the regions from Algarve and

Alentejo, in the Portuguese areas, it was possible to communicate better with clubs, associations and subjects. It were contacted people in the areas of Seville and Cadiz and explained the study, but those subjects were not motivated to participate. Also, it was identified some difficulty in maintaining a close contact and communication with the regions of Huelva, Seville and Cadiz.

Subjects were grouped according to the trunk control level as if they present trunk control or do not present trunk control, according to the neurologic level. This step was taken due to the lack of lumbar lesion SCI subjects in the study and the need to group the subjects according to characteristics that might influence the variables in the study.

Mean age indicates that subjects are still young and active, allowing to be integrated in physical activities. Also, subjects present an average of 13,98 ± 9,05 (AV±SD) years since SCI, indicating that they are well experienced in MWC use and may have developed lesions associated with it. These allow to better associate the variable and have a more solid confirmation of its relations.

The results indicate that the majority of the subjects are engaged in regular physical activities (63,46%). However, we observe that team sports are played for the minority (basketball– 15,38%; handball– 5,77%) of subjects and that there is a wide range of sport activities.

Regarding MWC use, it is observed that although subjects present paraplegia, we observed cases in Portugal and Spain where the subjects use only PWC or change PWC/MWC during the day or according to the performed activity. This was observed in subjects who present more years since SCI and consequently have used MWC for along time. It is also observed that only in the Portuguese sample they used Lightweight MWCs. These devices are less stable, reliable or easy to use when compared to ultralight ones; and are heavier and this can influence in maneuverability of the subjects.

According to the subjects information, mean time waiting for a MWC was higher in Portugal than in Spain and it was also higher in high paraplegia than in low paraplegia and may be influenced by the differences in assistive technology prescription in both countries. We observe as a positive fact that 92,31% of the participants were using a cushion in the MWC but only 23,08% have already changed the MWC, using the same for a mean time of 6 years. Anthropometric measurements present no statistical significance among

Portuguese and Spanish samples, indicating that the differences in the measurements present no influence in the other variables.

There is no statistical difference in QUEST 2.0 scores for the satisfaction with the subjects MWC ($p>0{,}05$) for the level of Physical Activity (p=0,932 to 0,355), country (p=0,822 to 0,171) or level of paraplegia (p=0,783 to 0,328). However, on a closer look at the important items for a MWC, the selected answers and its percentages are different among groups. High and low paraplegia groups present similar concerns with weight and ease of use, followed by safety (high paraplegia) and comfort (low paraplegia). Due to the level of SCI, the level of autonomy and daily activities is similar, not having many concerns when expected if we had compared it with tetraplegia MWC users. But, when comparing with physical activity groups, the more active groups were more concerned with weight, comfort and dimensions of the MWC and for the people with no regular PA, they were more concerned with the ease of use, weight and comfort. This may be due to the need of propelling the MWC during the day and its autonomy and the ability of the MWC, in less active group to respond to the daily barriers in mobility. The more active group, being more physically capable to self propel the MWC, may be more concerned with the adjustment of the MWC to the user and weight.

There is also a difference in item satisfaction according to the type of MWC. Users with Lightweight MWCs being more concerned with ease of use, comfort and weight; ultralightweight (folding) MWC users concerns were mainly with weight, ease of use, comfort and effectiveness; and ultralightweight (unfolding) users concerns were more with weight, comfort, safety and dimensions. This is consistent with MWC studies (Liu et al., 2008; Liu, Pearlman, et al., 2010) indicating that Al ultralight folding MWCs or Ti ultralight rigid MWC are suitable for all MWC users, because some users prefer ultralight folding MWCs due to the convenience of the folding mechanism and smoother rides.

QLI (Ferrans & Powers) SCI - III total score and subscales (HFSUB; SOCSUB; PSPSUB and FAMSUB) values are relatively higher for one who practices PA, being similar with other studies (Bassett & Ginis, 2009) where it was shown significant positive relationship between the functional satisfaction and impact on QOL, with higher values for the people performing LTPA.

When we compare Portuguese and Spanish samples, it is observed that Spanish participants have relative lower levels of QLI (total scale and subscores), significant ($p<0,05$) by the analysis of U test for independent samples.

We observed a relative higher level of quality of life in people with a higher trunk control and these values are in according to a recent study (Chang et al., 2012) regarding QOL and the ICF components that showed that the participation in a live situation had a powerful influence on QOL, also indicating that individuals with higher independence in activity have higher QOL. The pattern of muscle recruitment is similar for high and low paraplegia and in the second case, there is only a lack of trunk control created by paralysis of the lower abdominals and back extensors, however, this does not affect muscular response to the demands of MWC propulsion (Sara J Mulroy et al., 2004). So, the differences in QOL might be influenced by the differences in trunk control, resulting in differences in subject's autonomy.

WUSPI results presented no statistical difference among physical activity, country, level of paraplegia or years since SCI. However, it is important to detach that median values were higher in the less active group or high paraplegia level indicating that might be a tendency related to less muscle strength or trunk control. It was also observed that shoulder pain scores were higher in Portuguese subjects, that were less engaged in physical activity that the Spanish ones.

PASIPD presented significance in according to the physical activity practice, indicating that more active subjects presented higher scores, resulting in higher values of energy consumption during each week. The same relation were not found in Portuguese/Spanish samples although, Spanish group being more active in sports. These results might have been because PASIPD scores are dependent on subjects activity during the last week (7 days) and there are factors that might have influenced the activity during questionnaire filling out, such as the weather or physical condition.

4.3.2. Sub–Study 5: study of MWC type and shoulder pain

The aim of the sub–study: to study the relation between different types of manual wheelchairs and components dimensions and prevalence of shoulder pain in Portugal and Spain.

4.3.2.1. Spearmen correlation coefficient results

Spearmen correlation coefficient among MWC components (table 21) shows correlations between backrest height with seat width (r_s=0,401), seat depth (r_s=0,373), armrest height (r_s=0,503), handrim diameter (r_s=-0,291) and WC weight (r_s=0,292). Similar relations are found between seat width with seat depth (r_s=0,455); casters (r_s =0,437), armrest height (r_s=0,288) and MWC weight (r_s=0,455). It was also found in correlation between casters diameter with MWC weight (r_s=0,402) and armrest height (r_s=0,284).

Table 21
Spearmen correlation coefficient among MWC components

		Seat height	Seat width	Seat depth	Armrest height	Casters diameter	Handrim diameter	MWC weight
Backrest height	Correlation Coefficient	-,043	,401**	,373**	,503**	,345*	-,291*	,292*
	Sig. (2 – tailed)	,766	,004	,007	,000	,013	,038	,037
Seat height	Correlation Coefficient		,013	-,026	,078	,306*	,164	,227
	Sig. (2 – tailed)		,929	,856	,587	,029	,251	,109
Seat width	Correlation Coefficient			,455**	,288*	,437**	-,020	,465**
	Sig. (2 – tailed)			,001	,040	,001	,891	,001
Seat depth	Correlation Coefficient				,284*	,275	-,244	,236
	Sig. (2 – tailed)				,043	,051	,084	,096
Armrest height	Correlation Coefficient					,368**	-,066	,225
	Sig. (2 – tailed)					,008	,645	,112
Casters diameter	Correlation Coefficient						,159	,402**
	Sig. (2 – tailed)						,266	,003

The more significant correlations from each country sample are resumed in the table below (table 22). Correlation with QUEST 2.0 (AT and TS) are different among Portugal (ATr_s=-0,448; TSr_s=-0,330) and Spain (ATr_s=0,510; TSr_s=0,622), regarding MWC seat height. There were found significant correlations of seat height with WUSPI (r=0,431) and QUEST 2.0 (AT and TS) with years since SCI (ATr_s=-0,395; TSr_s=-0,455) in Portugal.

Table 22
main correlations between country sample

			QUEST 2.0			
			AT	TS	WUSPI	Years since SCI
Portugal	Seat height (n = 35)	Correlation Coefficient	-,448	-,380	,431	,276
		Sig. (2 – tailed)	,007	,024	,010	,109
	QUEST 2.0 AT (n = 35)	Correlation Coefficient		,905	-,298	-,395
		Sig. (2 – tailed)		,000	,082	,019
	QUEST 2.0 TO (n = 35)	Correlation Coefficient			-,290	-,455
		Sig. (2 – tailed)			,091	,006
Spain	Seat height (n = 16)	Correlation Coefficient	,510	,622	-,094	,111
		Sig. (2 – tailed)	,044	,010	,730	,683
	QUEST 2.0 AT (n = 17)	Correlation Coefficient		,907	,096	-,029
		Sig. (2 – tailed)		,000	,715	,912
	QUEST 2.0 TO (n = 17)	Correlation Coefficient			,037	-,076
		Sig. (2 – tailed)			,889	,772

There were found spearmen correlation coefficients between WUSPI and QUEST 2.0 AT and anthropometrics (table 23). In the Portuguese sample, it was observed a correlation between QUEST 2.0 AT and seating stature (r_s=-0,358) and shoulder height (r_s=-0,444). In WUSPI it was found a correlation with thoracic width (r=-0,656). For Spanish sample, there was a correlation of QUEST AT and seating stature (r=0,533) and WUSPI and seat to head distance (r_s=-0,559).

Table 23

correlation to anthropometrics with QUEST 2.0 and WUSPI according to country sample

			Seating stature	Shoulder height	Thoracic width
Portugal (n = 35)	QUEST 2.0 AT	Correlation Coefficient	-,358	-,444	-,053
		Sig. (2 – tailed)	,034	,008	,761
	WUSPI	Correlation Coefficient	,202	,291	-,656
		Sig. (2 – tailed)	,245	,090	,000
Spain (n = 15)	QUEST 2.0 AT	Correlation Coefficient	,533	,309	,374
		Sig. (2 – tailed)	,041	,262	,170
	WUSPI	Correlation Coefficient	,423	,507	-,331
		Sig. (2 – tailed)	,116	,054	,229

4.3.2.2. Mann Whitney U test

Mann Whitney U test analysis for shoulder pain (table 24) showed no significant difference in the values of MWC dimensions (*p*>0,05) (appendix 16, page 192, table 69).

Table 24

Mann Whitney U test for MWC components regarding shoulder pain

	Shoulder pain		U	z	Sig.
	No (n = 30)	Yes (n =21)			
Backrest height	32,00	34,00	297,50	-,336	,737
Seat height	45,00	47,00	240,00	-1,441	,150
Seat width	40,00	40,00	291,50	-,453	,650
Seat depth	42,00	41,00	309,50	-,106	,915
Wheels diameter	60,00	60,00	291,00	-,541	,589
Casters diameter	11,50	12,00	217,00	-1,938	,053
Handrim diameter	52,00	52,00	299,50	-,307	,759
MWC weight	11,00	11,50	263,00	-1,004	,315

Based on the previous results, it was performed a second analysis regarding the influence of MWC components according to paraplegia level and shoulder pain (tables 25 and 26). The results showed no statistical significance for backrest height (*p*=0,543 – 0,860), seat height (*p*=0,500 – 0,155), seat width (*p*=0,983 – 0,154) or seat depth (*p*=0,484 – 0,500). The mean ranks and sum of scores are in appendix 16 (page 193, table 70).

Table 25

Mann Whitney U test for no shoulder pain grouped in paraplegia level

	Paraplegia level		U	Z	Sig. (2-tailed)
	High (n=13)	Low (n =17)			
Backrest height	32,00	32,00	96,000	-,609	,543
Seat height	45,00	44,00	94,500	-,674	,500
Seat width	40,00	40,00	110,000	-,021	,983
Seat depth	41,00	42,00	94,000	-,699	,484

Table 26

Mann Whitney U test for shoulder pain grouped in paraplegia level

	Paraplegia level		U	Z	Sig. (2-tailed)
	High (n = 10)	Low (n =11)			
Backrest height	35,00	33,00	52,500	-,177	,860
Seat height	47,00	45,00	35,000	-1,420	,155
Seat width	40,00	38,00	35,000	-1,427	,154
Seat depth	42,00	40,00	45,500	-,675	,500

It was performed Mann Whitney U test according to the presence/absence of shoulder pain in Portugal and Spain (table 27 and 28). It was observed a significant difference in the MWC seat width (U=7,00; z=-2,761; p=0,006), handrim diameter (U=14,00; z=-2,224; p=0,026), caster diameter (U=16,50; z=-2,027; p=0,043) and MWC weight (U=10,50; z=-2,451; p=0,014). The mean ranks and sum of scores are in appendix 16 (page 193, table 71)

Table 27

Mann Whitney U test for shoulder pain grouped in country

	Country		U	z	Sig. (2-tailed)
	Portugal (n = 16)	Spain (n =5)			
Backrest height	33,50	36,00	30,500	-,788	,431
Seat height	47,00	43,00	16,500	-1,957	,050
Seat width	40,50	38,00	7,000	-2,761	,006
Seat depth	42,00	40,00	29,500	-,875	,382
Wheels diameter	60,00	60,00	32,500	-,831	,406
Casters diameter	12,00	11,00	16,500	-2,027	,043
Handrim diameter	53,00	52,00	14,000	-2,224	,026
MWC weight	12,00	7,50	10,500	-2,451	,014

Table 28

Mann Whitney U test for no shoulder pain grouped in country

	Country		U	z	Sig. (2-tailed)
	Portugal (n=19)	Spain (n =11)			
Backrest height	34,00	32,00	81,500	-,993	,321
Seat height	45,00	44,00	102,500	-,087	,931
Seat width	41,00	38,00	61,000	-1,886	,059
Seat depth	43,00	40,00	61,000	-1,895	,058
Wheels diameter	60,00	60,00	99,000	-,264	,792
Casters diameter	12,00	10,00	46,000	-2,592	,010
Handrim diameter	52,00	52,00	100,500	-,178	,858
MWC weight	11,00	11,00	94,500	-,437	,662

The specific analysis of a MWC seat height was made for questionnaire scores and seat height dimensions regarding shoulder pain in Portugal and Spain. Mann Whitney U test showed significant difference in the values of WUSPI (U=219,00, z=-2,185, *p*=0,029). Median is higher for subjects who have higher seats (table 29). Mean ranks and sum scores are in appendix 16 (page 197, table 89).

Table 29

Mann Whitney U test for seat height and questionnaire scores

Seat height (median)	PASIPD	QUEST 2.0			WUSPI	QOL				
		AT	SV	TS		QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
20 to 45 (n=28)	27,91	3,94	3,00	3,63	,00	21,47	22,22	20,84	22,71	18,86
46 to 52 (n=23)	29,27	3,88	3,25	3,67	2,28	19,26	20,03	20,25	21,79	18,43
U	315,00	273,00	317,00	291,00	219,00	222,50	246,00	221,50	272,50	250,50
Z	-,133	-,930	-,095	-,588	-2,185	-1,884	-1,439	-1,903	-,937	-1,354
Sig. (2- tailed)	,895	,353	,924	,557	,029	,060	,150	,057	,349	,176

Using the same test for MWC dimensions, it was observed that a significant difference (table 30) in seat height of the Portuguese sample and the presence of shoulder pain. Median values are higher for subjects with shoulder pain and mean ranks and sum scores are detailed in appendix 16 (page 194, table 76). It was performed the same analysis for backrest height, without significant difference among shoulder pain (*p*>0,05).

Table 30

Mann Whitney U test for seat height according to country and shoulder pain

Shoulder pain		Seat Height				Backrest height			
		Median (cm)	U	Z	Sig. (2-tailed)	Median (cm)	U	Z	Sig. (2-tailed)
Portugal	No (n=19)	45,00	92,00	-1,996	,046	34,00	141,500	-,349	,727
	Yes (n=16)	47,00				33,50			
Spain	No (n=11)	44,00	23,00	-,514	,608	32,00	16,000	-1,313	,189
	Yes (n=5)	43,00				36,00			

The Mann Whitney U test for backrest height shows significant difference in the values of MWC dimensions (*p*<0,05), for seat width (U=157,00, z=-3,190, *p*=0,001), seat depth

(U=185,00, z=-2,660, *p*=0,008), caster wheels diameter (U=212,50, z=-2,190, *p*=0,029) and MWC weight (U=196,50, z=-2,443, *p*=0,015). Median values are higher for higher backrests in the measures of seat width and depth, wheel diameters, caster wheel diameters and MWC weight (table 31). The mean ranks and sum of scores are in appendix 16 (page 193, table 72).

Table 31

Mann Whitney U test for country and MWC components

	Backrest height (cm)				
	25 to 33 (n=26)	34 to 44 (n=25)	U	Z	Sig. (2-tailed)
Seat height	45,00	45,00	317,00	-,151	,880
Seat width	38,00	41,00	157,00	-3,190	,001
Seat depth	40,00	43,00	185,00	-2,660	,008
Wheels diameter	60,00	60,00	318,00	-,155	,877
Casters diameter	11,50	12,00	212,50	-2,190	,029
Handrim diameter	53,00	52,00	238,00	-1,699	,089
MWC weight	10,75	11,50	196,50	-2,443	,015

The Mann Whitney U test for use of armrest (table 32) shows significant difference in the age of the subjects (U=99,500, z=-2,440, *p*=0,015), with median values higher for older people (appendix 16, page 193, table 73).The same analysis for years since SCI was not statistical significant (U=198,500, z=-0,154, *p*=0,877).

Table 32

Mann Whitney U test for armrest, age and years since SCI

		Median	U	Z	Sig. (2-tailed)
Age	No (n=40)	39,50	99,50	-2,440	,015
	Yes (n=10)	48,50			
Years since SCI	No (n=41)	13,00	198,50	-,154	,877
	Yes (n=10)	13,50			

4.3.2.3. Manual wheelchair satisfaction and physical activity

It was performed a Kruskal-Wallis test (table 33) regarding MWC satisfaction according to physical activity practice. It was observed a statistical difference in QUEST 2.0 assistive technology subscale ($X^2_{(2)}$= 8,72; *p*=0,013) and total score ($X^2_{(2)}$= 9,27; *p*=0,010) for the group performing regular physical activity.

We performed a post–hoc test using Mann – Whitney U test (appendix 20, page 209, tables 126 to 128). To avoid type I error, alpha was only considered significant below

0,0167 (0,05/3) [α/number of groups]. It is shown no significant difference in QUEST 2.0 scores regarding wheelchair type in subjects performing regular physical activity.

Table 33

Kruskal-Wallis test of physical activity and MWC type for QUEST 2.0

Physical activity		Assistive technology	Service	Total Score
No	Chi-square	3,77	2,58	3,53
	df	2	2	2
	Sig.	,152	,276	,172
Yes	Chi-square	8,72	3,78	9,27
	df	2	2	2
	Sig.	,013	,151	,010

a. Kruskal Wallis test
b. Grouping variable: wheelchair type

4.3.2.4. Discussion

The positive correlation found among MWC components (*p*<0,05) is relatively low but significant in MWC use. This result shows that there is a proportional distribution of the measurements and when is necessary a higher backrest, there is associated to a higher armrest, and handrim diameter to easy MWC propelling. However the positive correlation of MWC weight indicates that for people who require more safety and higher components in the MWC, there is more weight in the MWC, which may be a limiting factor in the ability to propel the MWC and on the subjects autonomy and ability to perform physical activity, and MWC weight is the common factor indicated by all subjects in QUEST 2.0.

The difference in the country sample for Spearmen correlation coefficient show for Portugal, low negative correlation between seat height and satisfaction with the MWC and for Spain a higher and positive correlation showing a difference among the two countries samples and that subjects influence with a MWC is mainly associated with seat height. These results are consistent with studies (van der Woude et al., 2009; Veeger, van deWoude, & Rozendal, 1989) that detach the importance of MWC seat height for elbows angle and ability to better propel the MWC and most efficient values in respect of energy consumption during activities. Investigations (Boninger et al., 2000; Kotajarvi et al., 2004; van der Woude et al., 1989) suggest that push time and push angles are high in the lower seats. Although the results differ, the subjects PA and MWC may be different, however, it is very important to detach the influence shown by the MWC seat height.

There were found significant positive correlation in the Portuguese sample with seat height and WUSPI indicating that the presence of shoulder pain is related to higher MWC

seat height. The Mann Whitney U test for independent samples shows that there is a significant difference in the values of WUSPI for higher MWC seats, and this difference is also observed using the same test for a specific analysis for Portugal and Spain, and presence of SP. The median values for seat height are relatively higher for people with SP, explaining the observed difference. Also, higher MWC seats related to the presence of SP can help to explain the difference in MWC satisfaction and seat height among the two country samples.

To support these results, it was also found in the Portuguese sample a negative correlation to QUEST 2.0 AT with seating stature (p<0,05) and shoulder height (p<0,05), indicating that associated with higher seats, taller people tend to be less satisfied with their MWC, having probably some influence on propelling. In the Spanish sample, there is a positive correlation with QUEST 2.0 AT for seating stature (r_s=0,533), showing a clear difference between the two groups and that the seat height may have an important influence on MWC satisfaction. The Portuguese sample, also observed a strong negative correlation to WUSPI with thoracic width (p<0,05), which indicates that subjects with short values of width in the thoracic area are thinner. We found no objective relation, however, this might have associated a less muscle adaptation in thinner subjects. So, this reduces the ability to better propel the MWC, can start to use other muscle groups and enlarge the stress in the shoulder. We can only regard on previous works that indicate that SP is more common in tetraplegia MWC users (Mohammed & Dunn, 2014), which have less active muscular groups, regardless of the PA level (Brose et al., 2008; Curtis et al., 1999; Nawoczenski et al., 2012; Yildirim et al., 2010).

QUEST 2.0 scores present a negative correlation with years since SCI, indicating that the importance of the correct adaptation of the components, quality of the MWC and ability to use, are greater as the subject becomes older and uses the MWC for a long time. MWC users require continuous use of the upper extremity for daily activities (van Drongelen, van der Woude, & Veeger, 2011; Van Drongelen et al., 2005a; van Drongelen et al., 2005b) and shoulder complex has to bear great mechanical forces, that can lead to SP and other UE injuries (Guo et al., 2003; Mercer et al., 2006). These factors associated to a chronic situation might influence the use and the desirability of the MWC and influence QOL (Middleton et al., 2007). According to kruskal-Wallis test, QUEST 2.0 was influenced by the level of physical activity and the type of MWC. It was also observed from spearman correlation analysis that QUEST 2.0 scores were negatively correlated with years since

SCI (r=-0,395) in Portuguese subjects, indicating that they tend to be less satisfied with MWCs as years pass since SCI.

With low backrest, push times are longer; cadence is lower and stroke angles larger. The larger stroke angles result from hand contact further back on the handrim and hand release further forward on the handrim and larger movement (Yang et al., 2012). The results performed using Mann Whitney U test for backrest height show significant difference in the values of MWC components, for seat width, seat depth, armrest height, caster wheels diameter and MWC weight, showing significance with proportional distribution of the measurements and these can limit the ability to propel the MWC. Results shown no statistical difference in backrest height (p>0,05) for users with shoulder pain from Portugal and Spain. However, it is observed that subjects with shoulder pain present higher backrest, and according to previous studies (Hong et al., 2011; May et al., 2004; Medola et al., 2014), with a larger range of motion and ability to propel the MWC there is lower incidence of shoulder pain.

According to the previous established hypothesis that **shoulder pain is observed in long time MWC users and is correlated to the MWC components,** there was found a significant positive correlation in the Portuguese sample with seat height and WUSPI indicating that the presence of SP is related to a higher MWC seat height in the sample. There is a significant difference in the values of WUSPI for higher MWC seats for Portugal and Spain, and presence of shoulder pain. It was not possible to correlate shoulder pain with time since injury.

For the hypothesis is that **presence of shoulder pain presents a negative association with the satisfaction with MWCs**, QUEST 2.0 scores presents a negative correlation with years since SCI, indicating that the importance of the correct adaptation of the components, quality of MWC and ability to use it, are greater as the subject becomes older and uses the MWC for along time. QUEST 2.0 score is influenced by the years since the SCI and the type of MWC.

The hypothesis is that **MWC characteristics and its satisfaction will be different among study areas** was observed different in country sample for Spearmen correlation coefficient showing in the Portuguese sample a low negative correlation between seat high and satisfaction with the MWC and for Spanish a higher and positive correlation. To support these results, in the Portuguese sample, there was a negative correlation for

QUEST 2.0 AT with seating stature and shoulder height, indicating that associated with higher seats, taller people intend to be less satisfied with their MWC, probably having some influence on propelling. In the Spanish sample, there is a positive correlation with QUEST 2.0 AT for seating stature, showing a clear difference between the two groups and that the seat height may have an important influence on MWCs satisfaction.

4.3.3. Sub-Study 6: Study of quality of life and physical activity in people with SCI

The aim of the sub–study: to study the relation of physical activity and quality of life in Portugal and Spain

4.3.3.1. Spearmen correlation

Spearman correlation coefficient shows a correlation (table 34) between PASIPD and QLI (r_s=0,282) and HFSUB (r_s=0,289). It also shows correlations between QUEST 2.0 (AT) and QLI (r_s =0,341), HFSUB (r_s =0,321) and SOCSUB (r_s =0,365).

Table 34

Spearman correlation coefficient with PASIPD, QUEST 2.0, WUSPI and QLI

		QUEST 2.0			WUSPI	QOL			
		AT	SV	TS		QLI	HFSUB	SOCSUB	PSPSUB
PASIPD	Correlation Coefficient	,241	-,042	,196	-,012	,282*	,289*	,125	,214
	Sig. (2 – tailed)	,086	,766	,164	,932	,043	,038	,376	,127
QUEST 2.0 AT	Correlation Coefficient		,477**	,923**	-,139	,341*	,321*	,365**	,101
	Sig. (2 – tailed)		,000	,000	,326	,013	,020	,008	,476

4.3.3.2. Mann Whitney U test

We observed no statistical difference in age (U=121,50, z=-0,227, p=0,821) or the years since SCI (U=105,00, z=-1,119, p=0,263) in the practice of physical activity (table 35 and 36). Median age and years since SCI are higher for people performing physical activity. The mean ranks and sum of scores are in appendix 16 (page 194, table 74).

Table 35

Mann Whitney U test for country and scales

Country	Physical Activity	Age	Years since SCI	QOL				
				QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
Portugal (n=35)	Yes (n=17)	40,00	11,00	22,11	23,60	21,25	22,71	20,79
	No (n=18)	46,00	13,50	20,39	20,23	19,53	22,86	18,86
Spain (n=17)	Yes (n=16)	42,00	15,00	18,95	19,10	17,44	21,11	17,96
	No (n=1)	42,00	16,00	14,36	13,90	16,00	13,79	14,07

Table 36

Mann Whitney U test for physical activity, age, years since SCI and QLI sores

Physical Activity		Age	Years since SCI	QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
No	U de Mann-Whitney	6,500	6,000	1,000	2,000	3,000	1,000	2,000
	Z	-,457	-,549	-1,461	-1,279	-1,095	-1,461	-1,279
	Sig. (2 tailed)	,648	,583	,144	,201	,273	,144	,201
Yes	U de Mann-Whitney	121,500	105,000	65,500	57,500	66,000	97,500	90,000
	Z	-,227	-1,119	-2,540	-2,828	-2,522	-1,387	-1,657
	Sig. (2 tailed)	,821	,263	,011	,005	,012	,165	,097

The Mann Whitney U test for MWC handrim diameter (table 37) shows significant difference in the values of PASIPD (U=212,00, z=-2,129, *p*=0,033) and the median values are lower for lower handrim diameters. The mean ranks and sum of scores are in appendix 16 (page 194, table 75).

Table 37

Mann Whitney U test for handrim diameter and physical activity

Handrim diameter	PASIPD scores	U	Z	Sig. (2-tailed)
46 to 52 (n=24)	39,50	99,50	-2,440	,015
53 to 56 (n=25)	48,50			

4.3.3.3. Influence of wheelchair type in quality of life

It was performed a Kruskal-Wallis test (table 38) regarding MWC types according to quality of life scores. It was observed no statistical difference in QLI scores (*p*>0,05).

Table 38

Kruskal-Wallis test regarding quality of life and manual wheelchair

	wheelchair type_mecanic	N	Median	Mean Ranks	X^2	df	Sig.
QLI	Light – folding	8	21,30	27,38			
	Ultra light - folding	15	22,11	28,73	1,013	2	,603
	Ultra light - unfolding	28	19,76	24,14			
HFSUBa	Light – folding	8	21,17	26,94			
	Ultra light - folding	15	22,47	28,00	,531	2	,767
	Ultra light - unfolding	28	20,63	24,66			
SOCSUBb	Light – folding	8	20,66	27,13			
	Ultra light - folding	15	21,25	29,67	1,621	2	,445
	Ultra light - unfolding	28	20,25	23,71			
PSPSUBc	Light – folding	8	23,68	35,94			
	Ultra light - folding	15	22,71	26,90	5,029	2	,081
	Ultra light - unfolding	28	20,79	22,68			
FAMSUBd	Light – folding	8	18,43	25,56			
	Ultra light – folding	15	21,14	29,43	1,180	2	,554
	Ultra light - unfolding	28	18,18	24,29			

It was performed a second Kruskal-Wallis analysis (table 39 and 40) regarding MWC types according to quality of life scores dividing according to the practice of physical activity. It was observed a statistical difference (p<0,05) for QLI ($X^2_{(2)}$= 10,05; p=0,007), HFSUB ($X^2_{(2)}$= 7,71; p=0,021), SOCSUB ($X^2_{(2)}$= 9,54; p=0,008) and PSPSUB ($X^2_{(2)}$= 7,65; p=0,022) in the group performing regular physical activity.

We performed a post–hoc test using Mann – Whitney U test (appendix 20, page 208, tables 119 to 121). To avoid type I error, alpha was only considered significant below 0,0167 (0,05/number of groups). It is shown a significant difference in QLI (p=0,000), HFSUB (p=0,003), SOCSUB (p=0,003), PSPSUB (p=0,007) and FAMSUB (p=0,010) among ultralightweight folding and unfolding models.

Table 39

Kruskal-Wallis test for quality of life, manual wheelchair type (no physical activity practice)

	wheelchair type_mecanic	N	Median	Mean Ranks	Chi-square	df	Sig.
QLI	Light – folding	5	21,31	11,00			
	Ultra light – folding	8	18,21	6,25	5,76	2	,056
	Ultra light – unfolding	5	22,78	13,20			
HFSUBa	Light – folding	5	20,03	9,90			
	Ultra light – folding	8	19,65	6,69	5,20	2	,074
	Ultra light – unfolding	5	24,80	13,60			
SOCSUBb	Light – folding	5	18,06	9,00			
	Ultra light – folding	8	18,00	7,88	2,47	2	,291
	Ultra light – unfolding	5	21,06	12,60			
PSPSUBc	Light – folding	5	24,00	13,80			
	Ultra light – folding	8	20,04	6,31	6,22	2	,045
	Ultra light – unfolding	5	23,21	10,30			
FAMSUBd	Light – folding	5	18,43	9,20			
	Ultra light – folding	8	16,43	8,00	1,93	2	,381
	Ultra light – unfolding	5	19,64	12,20			

Table 40

Kruskal-Wallis test for quality of life, manual wheelchair type (physical activity practice)

	wheelchair type	N	Median	Mean Ranks	Chi-square	df	Sig.
QLI	Lightweight	3	21,30	17,00			
	Ultralightweight – folding	7	23,36	27,14	10,05	2	,007
	Ultralightweight – unfolding	23	19,34	13,91			
HFSUB	Lightweight	3	23,60	18,33			
	Ultralightweight – folding	7	24,63	25,71	7,71	2	,021
	Ultralightweight – unfolding	23	19,67	14,17			
SOCSUB	Lightweight	3	21,19	21,17			
	Ultralightweight – folding	7	23,50	26,14	9,54	2	,008
	Ultralightweight – unfolding	23	20,13	13,67			
PSPSUB	Lightweight	3	22,93	21,17			
	Ultralightweight – folding	7	25,71	25,07	7,65	2	,022
	Ultralightweight – unfolding	23	20,43	14,00			
FAMSUB	Lightweight	3	16,00	16,50			
	Ultralightweight – folding	7	23,14	24,86	5,96	2	,051
	Ultralightweight – unfolding	23	18,00	14,67			

4.3.3.4. Discussion

Data shows that older people and the more years passed since the SCI the more likely they are engaged in physical activity. Using Mann Whitney U test for Physical activity we found significant differences in the values of QLI, HFSUB and SOCSUB among different country samples, and the Spanish sample presents the lower median scores. No statistical differences were found in age or the years since the SCI in the practice of physical activity. According to the results presented in the precocious sub-study, it is not possible to clearly interpret the lower levels of quality of life in the Spanish group because almost all of these participants are engaged in regular physical activity; however there is less prevalence of SP and there is a relative good satisfaction with the manual wheelchair in this group. Due to the cultural differences in the study regions, quality of life score might be affected by other subjective variables or barriers (Scelza et al., 2005; Sisto & Evans, 2014) that might limit the extent to which someone becomes or remains physically active and influence QOL.

Spearman correlation coefficient shows a small but significant correlation between PASIPD (daily physical activity) and QLI (0,282) and HFSUB (0,289) indicating that regular physical activity has an important role on the subjects quality of life. This is consistent with other studies regarding regular physical activity and well–being in people with mobility impairments (Anneken et al., 2010; Hicks et al., 2003; Tordi et al., 2001). The

values of correlation in our study are low, but it is important to stress that in a similar sample of subjects with paraplegia, the engagement in physical activity promote QOL.

We also found a small correlation between satisfaction with the MWC (QUEST 2.0–AT) and QLI (0,341), HFSUB (0,321) and SOCSUB (0,365). According to a study regarding the influence of the MWC use (Van Der Woude et al., 2009), physical strain, fatigue and pain influence the MWC use and daily activity, so it was considered that quality of the MWC and its component might play an important role in SCI general QOL. Because subjects' autonomy and activity engagement depends on how good the MWC is.

The Kruskal–Wallis analysis indicates that the type of MWC and its desirability is different according to the user's activity and post-hoc test shows differences among MWC models. There is no linear relation from a lightweight MWC to the ultralightweight MWCs and the main difference observed between the folding and unfolding systems. According to previous MWC analysis (Liu et al., 2008; Liu, Pearlman, et al., 2010) unfolding models present a wide range of adjustability influencing the position of the CG. However, a highly adjustable MWC requires accurate assessment to maximize maneuverability and match users preferences with stability requirements. In our study, it is clear that the folding MWCs present a different desirability among level of physical activity and this might be related to subjects QOL, the ability in using the MWC and adapting it to daily life barriers and type of adjustments.

The Mann Whitney U test for MWC handrim diameter showed significant difference in the values of PASIPD (p=0,033), with mean rank values being lower for lower handrim diameters. Studies with different handrim sizes (Guo et al., 2006, 2003; Lin, Lin, Guo, & Su, 2011) showed that total mechanical energy during MWC propulsion increased with increased MWC's wheel size. Studies also indicate that longer pushes are proportional to an increase in stroke and beginning angles (de Groot, de Bruin, Noomen, & van der Woude, 2008) and that contact and release angles depend on arm segment lengths, handrim size and the energy added to the wheel (Richter, 2001). According to previous cited authors, the MWC adaptation and PA of the subject are influential factors and related better with MWC then give a better propulsion, improving subjects' autonomy.

According to our hypothesis that **Performance of regular physical activity will influence quality of life,** values of total and subscales (HFSUB; SOCSUB; PSPSUB and FAMSUB) are relatively higher in subjects who practices PA, we also observed that

Spanish participants have relatively higher levels of QOL in all subscales and total scores. We also found a correlation between PASIPD and QLI total score and Health Subscale indicating that regular PA has an important role on subjects QOL.

Regarding this hypothesis of **values of QOL, physical activity and shoulder pain are influenced by the characteristics of the MWC** used, we observed that there is a small correlation between satisfaction with MWC and QLI total score and subscales (Health and social). Also indicating that the type of MWC and its desirability, is different according to the user's activity and environment. No linear relation was observed between a lightweight and an ultralight MWC and the main differences were observed between the folding and unfolding systems. Finally, we found a statistical significance that MWC with handrim diameter and the values of PASIPD.

4.3.4. Sub–Study 7: Upper extremity isometric strength in paraplegia

The aim of the sub–study: to study the relation of upper extremity strength with physical activity, quality of life, prevalence of shoulder pain and wheelchair components.

4.3.4.1. Descriptive results

Strength values are grouped in physical activity (4.11.4.2.), level of paraplegia (4.11.4.3.) and country (4.11.4.4.) and are presented below in descriptive results, graph and Mann Whitney U test for independent samples.

4.3.4.2. Physical Activity

Descriptive values for practice of regular physical activity are presented in table 41. The average values for each movement are present in graph 9. Mann Whitney U test analysis for physical activity shows significant difference in the values of strength (p<0,05), for shoulder flexion (left–p=0,005; right–p=0,008), shoulder extension (right–p=0,005), shoulder Abduction (left–p=0,005; right–p=0,002), shoulder lateral rotation (left–p=0,036; right–p=0,032), elbow flexion (left–p=0,016; right–p=0,016) and elbow extension (left–p=0,013; right–p=0,041). Median values are higher for subjects who perform regular Physical Activity (appendix 16, page 218, tables 88 and 89).

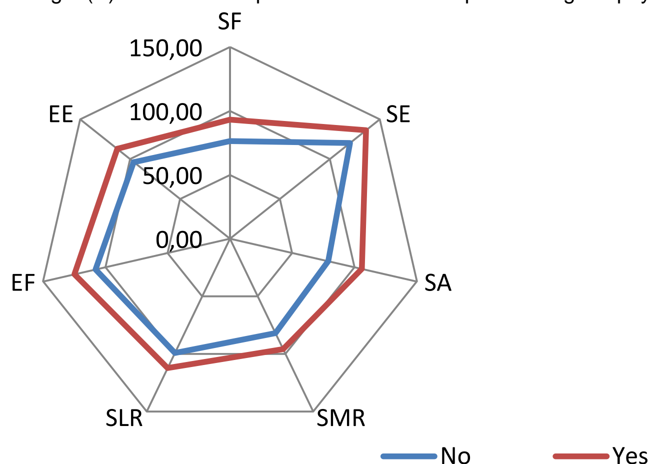
Table 41

Upper extremity strength values (N) in Physical activity

		Physical Activity		U	Z	Sig.
		No (n =19)	Yes (n =31)			
Shoulder Flexion	Left	74,19	87,91	154,000	-2,809	,005
	Right	81,05	113,68	161,000	-2,669	,008
Shoulder Extension	Left	122,50	137,20	203,500	-1,819	,069
	Right	118,58	147,98	153,000	-2,829	,005
Shoulder Abduction	Left	67,62	105,35	155,000	-2,788	,005
	Right	79,87	110,74	143,000	-3,028	,002
Shoulder Lateral Rotation	Left	80,36	97,02	189,500	-2,099	,036
	Right	82,32	109,47	187,500	-2,139	,032
Shoulder Medial Rotation	Left	108,09	126,71	224,000	-1,409	,159
	Right	86,24	106,82	197,500	-1,939	,053
Elbow Flexion	Left	102,90	123,48	174,000	-2,409	,016
	Right	99,47	136,51	174,000	-2,409	,016
Elbow Extension	Left	94,08	123,97	170,500	-2,479	,013
	Right	81,34	110,74	192,500	-2,039	,041

Graph 9

Upper extremity movement strength (N) for those who perform and does not perform regular physical activity



Note: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

4.3.4.3. Level of paraplegia

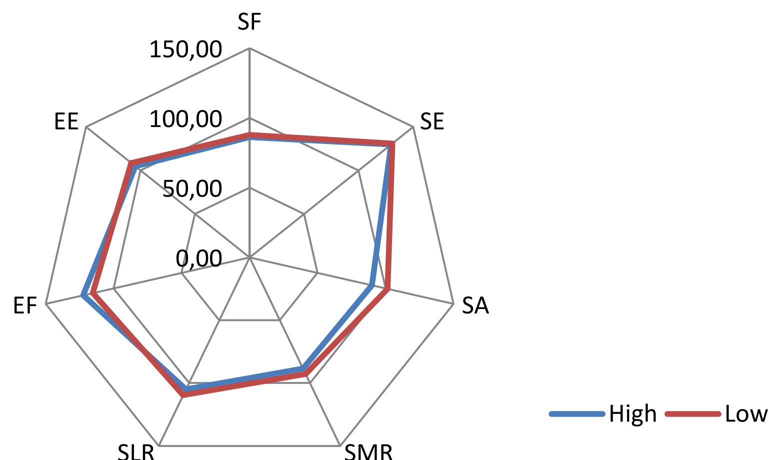
Descriptive values for the level of paraplegia are presented in table 42. The average values for each movement are present in graph 10. Mann Whitney U test analysis for paraplegia level shows no significant difference in the values of strength (p<0,05) for High or low paraplegia. Mean ranks and sum scores are in appendix 16 (tables 77 and 78, page 215).

Table 42

Upper extremity strength values (N) in paraplegia level

		Paraplegia level		U	Z	Sig.
		High (n= 24)	Low (n = 26)			
Shoulder Flexion	Left	81,68	80,70	297,000	-,291	,771
	Right	82,52	109,91	233,500	-1,525	,127
Shoulder Extension	Left	120,05	137,35	217,000	-1,845	,065
	Right	126,18	137,45	283,500	-,553	,580
Shoulder Abduction	Left	79,23	103,39	217,500	-1,835	,066
	Right	98,15	111,72	214,000	-1,903	,057
Shoulder Lateral Rotation	Left	85,51	90,80	236,500	-1,466	,143
	Right	87,56	102,17	262,500	-,961	,336
Shoulder Medial Rotation	Left	100,21	130,83	231,500	-1,563	,118
	Right	93,84	115,64	232,500	-1,544	,123
Elbow Flexion	Left	107,65	113,93	301,000	-,214	,831
	Right	118,24	128,48	277,000	-,680	,497
Elbow Extension	Left	97,76	117,50	239,500	-1,408	,159
	Right	92,12	108,93	255,500	-1,097	,273

Graph 10
Upper extremity movement strength (N) for high and low paraplegia



Note: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

4.3.4.4. Country

Descriptive values for country are presented in table 43. The average values for each movement are present in graph 11. Mann Whitney U test analysis for country shows a significant difference (p<0,05) for shoulder flexion (left–p=0,004; right-p=0,006), shoulder extension (left–p=0,037; right–p=0,000), shoulder abduction (left–p=0,006; right–p=0,002), shoulder lateral rotation (left–p=0,002; right–p=0,000), shoulder medial rotation (left–p=0,002; right–p=0,006), Elbow Flexion (left–p=0,000; right–p=0,000) and elbow

extension (left–*p*=0,001; right–*p*=0,000). Median values are higher for Spanish subjects (appendix 16, page 215, tables 75 and 76).

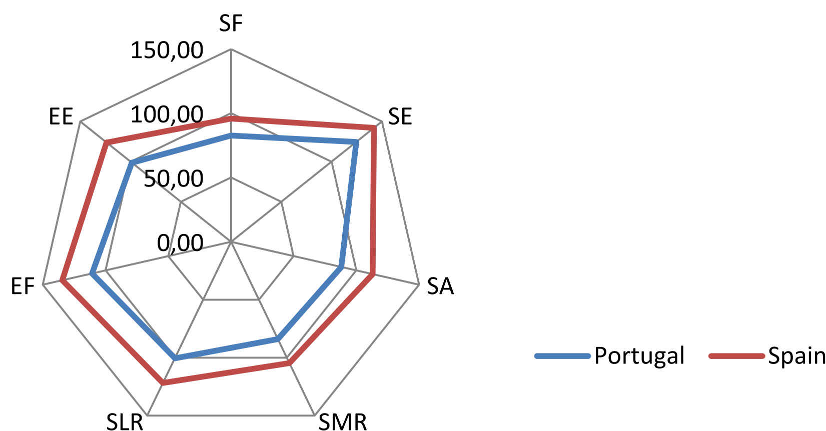
Table 43

Upper extremity strength values (N) in country

		Country		U	Z	Sig.
		Portugal (n=35)	Spain (n=15)			
Shoulder Flexion	Left	75,17	101,92	125,000	-2,911	,004
	Right	90,16	122,50	133,500	-2,732	,006
Shoulder Extension	Left	129,07	147,00	164,000	-2,085	,037
	Right	121,52	153,86	88,000	-3,695	,000
Shoulder Abduction	Left	82,32	122,99	132,000	-2,763	,006
	Right	87,22	121,52	115,000	-3,123	,002
Shoulder Lateral Rotation	Left	80,36	108,78	115,000	-3,123	,002
	Right	81,04	114,66	97,000	-3,504	,000
Shoulder Medial Rotation	Left	100,94	150,92	117,000	-3,081	,002
	Right	92,12	117,11	132,000	-2,763	,006
Elbow Flexion	Left	102,90	148,47	69,000	-4,097	,000
	Right	102,21	154,84	98,000	-3,483	,000
Elbow Extension	Left	103,88	142,10	103,500	-3,366	,001
	Right	87,22	125,44	93,000	-3,588	,000

Graph 11

Upper extremity movement strength (N) for Portugal and Spain sample



Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

4.3.4.5. Spearmen correlation analysis

It is observed a medium to high *Spearmen correlation coefficient* between force values for both sides and all measured movements, shoulder flexion/shoulder extension (0,628 to 0,743); shoulder abduction (0,644 to 0,881); shoulder medial rotation/shoulder lateral

rotation (0,461 to 0,835) and elbow flexion/elbow extension (0,515 to 0,834) (appendix 15, page 207).

4.3.4.6. Intraclass correlation coefficient

Cronbach alpha analysis for internal reliability shows a value of 0,965 among all (14) force measurements and similar values among left (α=0,926) and right (α=0,935) upper extremity measurements. Intraclass correlation coefficient shows a value of 0,965, p=0,000. Reliability value among left and right side is, ρ=0,973.

4.3.4.7. Analysis of strength and wheelchair characteristics

4.3.4.7.1. Handrim Diameter

The Mann Whitney U test for handrim diameter is presented in table 44. It was observed no significant difference in strength (p>0,05) in all upper extremity movements. Mean ranks and sum scores are presented in appendix 16 (page 199, tables 100 and 101).

Table 44

Upper extremity strength values (N) for handrim diameter

		Handrim Diameter (cm)		U	Z	Sig.
		46–52 (n=24)	53–56 (n=10)			
Shoulder Flexion	Left	83,94	80,07	297,500	-,050	,960
	Right	111,38	91,63	252,000	-,960	,337
Shoulder Extension	Left	129,07	135,24	297,500	-,050	,960
	Right	135,14	131,32	295,000	-,100	,920
Shoulder Abduction	Left	98,34	90,16	283,000	-,340	,734
	Right	109,42	93,10	272,500	-,550	,582
Shoulder Lateral Rotation	Left	94,57	84,28	253,000	-,940	,347
	Right	103,54	85,75	246,500	-1,070	,285
Shoulder Medial Rotation	Left	128,53	115,64	282,500	-,350	,726
	Right	105,50	103,88	276,000	-,480	,631
Elbow Flexion	Left	110,59	111,23	294,000	-,120	,904
	Right	128,72	116,62	259,000	-,820	,412
Elbow Extension	Left	116,72	113,19	294,500	-,110	,912
	Right	104,71	98,00	299,000	-,020	,984

4.3.4.7.2. Armrest

The Mann Whitney U test results for use of armrest are presented in table 45. It was observed that a significant difference in strength (p<0,05), shoulder flexion (left–p=0,038; right–p=0,039), shoulder extension (right–p=0,044), shoulder abduction (right–p=0,011) ,

shoulder lateral rotation (left–*p*=0,020). Median values are higher for subjects that do not use armrests (appendix 16, page 195, tables 81 and 82).

Table 45

Upper extremity strength values (N) for armrest use

		Armrest		U	Z	Sig.
		No (n =39)	Yes (n =10)			
Shoulder Flexion	Left	87,22	71,88	111,500	-2,072	,038
	Right	110,74	85,26	112,000	-2,059	,039
Shoulder Extension	Left	132,59	129,21	167,500	-,682	,495
	Right	142,59	119,41	114,000	-2,010	,044
Shoulder Abduction	Left	100,25	70,17	127,000	-1,687	,092
	Right	110,74	74,48	92,000	-2,555	,011
Shoulder Lateral Rotation	Left	94,08	72,13	101,500	-2,320	,020
	Right	101,82	89,43	135,000	-1,489	,137
Shoulder Medial Rotation	Left	115,64	128,28	180,000	-,372	,710
	Right	105,84	98,00	172,000	-,571	,568
Elbow Flexion	Left	120,54	102,66	127,000	-1,687	,092
	Right	127,89	101,23	166,000	-,719	,472
Elbow Extension	Left	115,93	107,65	151,500	-1,079	,281
	Right	103,88	89,33	168,000	-,670	,503

4.3.4.7.3. Wheelchair weight

Using Mann Whitney U test we compared the difference in upper extremity strength in different MWC weight (table 46). It was shown to have significant difference in the values of shoulder flexion (left–*p*=0,012), shoulder extension (left–*p*=0,006; right–*p*=0,001), shoulder abduction (left–*p*=0,019; right–*p*=0,048), shoulder lateral rotation (right–*p*=0,037), shoulder medial rotation (left–*p*=0,047; right–*p*=0,004) and elbow extension (left–*p*=0,035; right–*p*=0,033). Median values are lower for MWC users with a heavier MWC (appendix 16, pages 195 and 196, tables 83 and 84).

Table 46

Upper extremity strength values (N) for MWC weight

		Weight (Kg)		U	Z	Sig.
		6,5 to 11 (n =28)	11,5 to 16 (n =21)			
Shoulder Flexion	Left	89,52	75,17	170,000	-2,505	,012
	Right	112,21	86,53	218,500	-1,526	,127
Shoulder Extension	Left	144,89	124,95	158,500	-2,738	,006
	Right	152,88	119,85	131,500	-3,283	,001
Shoulder Abduction	Left	104,13	76,15	178,000	-2,344	,019
	Right	110,74	85,95	196,000	-1,980	,048
Shoulder Lateral Rotation	Left	90,65	85,95	253,500	-,818	,413
	Right	109,27	94,37	191,000	-2,081	,037
Shoulder Medial Rotation	Left	130,10	99,67	195,500	-1,990	,047
	Right	116,38	92,12	153,000	-2,849	,004
Elbow Flexion	Left	125,44	106,82	211,000	-1,677	,094
	Right	139,89	102,21	198,000	-1,940	,052
Elbow Extension	Left	125,93	101,92	189,500	-2,111	,035
	Right	119,07	87,91	188,500	-2,131	,033

The Mann Whitney U test for Physical Activity for the MWC weight (tables 47 and 48) shows significant difference in the values of force for MWC weight ($p<0,05$) and indicates that the higher ranks of force are in subjects who perform regular physical activity and use lighter MWCs. There is a statistical difference in the values of shoulder flexion (left–p=0,007; right–p=0,031), shoulder extension (right–p=0,031), shoulder abduction (left–p=0,023; right–p=0,007), shoulder lateral rotation (left–p=0,027; right–p=0,048), elbow flexion (left–p=0,007) and elbow extension (left–p=0,017) (appendix 16, tables 85 and 86, page 196).

Table 47

Upper extremity strength (N) regarding MWC weight (6,5-11kg) and physical Activity

		6,5 to 11 Kg (n =28)				
		Yes (n = 21)	No (n = 7)	U	Z	Sig.
Shoulder flexion	Left	97,51	74,19	24,000	-2,627	,009
	Right	118,58	89,87	33,000	-2,149	,032
Shoulder extension	Left	145,04	133,28	57,000	-,875	,381
	Right	166,31	117,31	33,000	-2,149	,032
Shoulder abduction	Left	122,99	67,62	31,000	-2,255	,024
	Right	124,46	87,22	24,000	-2,627	,009
Shoulder lateral rotation	Left	99,96	77,91	32,000	-2,202	,028
	Right	113,68	82,32	36,000	-1,990	,047
Shoulder medial rotation	Left	131,32	108,49	47,500	-1,380	,168
	Right	124,95	86,53	53,000	-1,088	,277
Elbow flexion	Left	141,12	100,94	24,000	-2,627	,009
	Right	146,02	114,66	39,000	-1,831	,067
Elbow extension	Left	131,81	94,08	29,000	-2,361	,018
	Right	122,50	76,15	43,000	-1,618	,106

Table 48

Upper extremity strength (N) regarding MWC weight (11,5-16kg) and physical Activity

		11,5 to 16 Kg (n =21)				
		Yes (n = 10)	No (n = 11)	U	Z	Sig.
Shoulder flexion	Left	77,62	69,29	50,000	-,353	,724
	Right	90,16	81,05	43,500	-,810	,418
Shoulder extension	Left	127,74	115,64	47,000	-,564	,573
	Right	116,62	124,95	53,000	-,141	,888
Shoulder abduction	Left	89,18	68,11	47,000	-,563	,573
	Right	106,62	79,87	46,000	-,634	,526
Shoulder lateral rotation	Left	94,57	85,75	53,000	-,141	,888
	Right	87,71	101,43	53,000	-,141	,888
Shoulder medial rotation	Left	95,75	108,09	53,000	-,141	,888
	Right	93,93	72,81	49,500	-,387	,698
Elbow flexion	Left	106,33	106,82	53,000	-,141	,888
	Right	119,22	98,49	38,000	-1,197	,231
Elbow extension	Left	101,43	113,19	54,000	-,070	,944
	Right	95,40	86,24	50,000	-,352	,725

4.3.4.7.4. Wheelchair seat height

Mann Whitney U test for MWC seat height (table 49) shows a significant difference in the values of force for different seat height (p<0,05), in the values of shoulder flexion (left–*p*=0,035), shoulder lateral rotation (left–*p*=0,007; right–*p*=0,044), shoulder medial rotation (left–*p*=0,048), elbow flexion (right–*p*=0,023) and elbow extension (right–*p*=0,007). Mean rank values are lower for MWC users who have higher seats than for the values of both UE force values (appendix 16, tables 87 and 88, pages 196 and 197).

Table 49

Upper extremity strength values (N) and seat height

		Seat height (cm)		U	Z	Sig.
		20 to 45 (n =26)	46 to 52 (n =23)			
Shoulder Flexion	Left	89,67	79,38	194,000	-2,104	,035
	Right	112,21	86,53	235,000	-1,282	,200
Shoulder Extension	Left	139,65	124,95	201,000	-1,963	,050
	Right	135,88	124,95	263,000	-,721	,471
Shoulder Abduction	Left	104,62	90,16	216,000	-1,663	,096
	Right	110,74	84,77	212,000	-1,743	,081
Shoulder Lateral Rotation	Left	98,49	80,36	164,500	-2,695	,007
	Right	106,33	94,08	198,500	-2,014	,044
Shoulder Medial Rotation	Left	130,58	97,02	200,500	-1,974	,048
	Right	109,76	92,12	218,000	-1,623	,105
Elbow Flexion	Left	119,81	106,82	229,500	-1,393	,164
	Right	133,43	100,25	185,500	-2,274	,023
Elbow Extension	Left	124,71	100,94	218,000	-1,623	,105
	Right	117,26	86,24	164,000	-2,705	,007

4.3.4.8. Shoulder pain and paraplegia level

The Mann Whitney U test for paraplegia level (tables 50 and 51) shows no significant difference in the values of force for level of paraplegia in the group with no shoulder pain (*p*>0,05). However, there is a statistical difference in the group with shoulder pain for the values of shoulder flexion (left–*p*=0,022; right–*p*=0,003), shoulder extension (left–*p*=0,004; right–*p*=0,03), shoulder abduction (left–*p*=0,001; right–*p*=0,001), shoulder medial rotation (left–*p*=0,018), elbow flexion (right–*p*=0,041) and elbow extension (left–*p*=0,041) (appendix 16, tables 96 to 99, pages 198 and 199).

Table 50

Upper extremity strength values (N) and paraplegia level, in a group with no shoulder pain

		Paraplegia level		U	Z	Sig.
		High (n=14)	Low (n=17)			
Shoulder Flexion	Left	93,59	75,17	84,000	-1,389	,165
	Right	109,42	91,63	109,500	-,377	,706
Shoulder Extension	Left	132,15	132,59	118,500	-,020	,984
	Right	142,59	133,57	91,000	-1,112	,266
Shoulder Abduction	Left	99,32	105,35	113,500	-,218	,827
	Right	109,42	110,74	119,000	,000	1,000
Shoulder Lateral Rotation	Left	94,42	88,20	114,500	-,179	,858
	Right	105,30	99,47	109,500	-,377	,706
Shoulder Medial Rotation	Left	119,56	131,32	107,500	-,457	,648
	Right	97,36	119,56	93,000	-1,032	,302
Elbow Flexion	Left	119,81	109,76	84,000	-1,390	,165
	Right	129,36	124,46	100,000	-,754	,451
Elbow Extension	Left	127,16	119,07	115,000	-,159	,874
	Right	104,71	116,91	106,000	-,516	,606

Table 51

Upper extremity strength values (N) and paraplegia level, in a group with shoulder pain

		Paraplegia level		U	Z	Sig.
		High (n=10)	Low (n=9)			
Shoulder Flexion	Left	69,09	86,53	17,000	-2,287	,022
	Right	71,20	114,66	9,000	-2,939	,003
Shoulder Extension	Left	103,24	142,10	10,000	-2,858	,004
	Right	96,04	142,59	18,500	-2,165	,030
Shoulder Abduction	Left	57,92	100,25	6,000	-3,184	,001
	Right	68,70	118,58	4,000	-3,348	,001
Shoulder Lateral Rotation	Left	72,86	96,33	22,000	-1,878	,060
	Right	63,21	104,17	24,500	-1,675	,094
Shoulder Medial Rotation	Left	88,20	108,09	16,000	-2,369	,018
	Right	70,56	103,88	27,500	-1,429	,153
Elbow Flexion	Left	97,61	127,40	22,500	-1,838	,066
	Right	90,01	129,07	20,000	-2,041	,041
Elbow Extension	Left	79,87	112,99	20,000	-2,042	,041
	Right	81,19	93,79	32,000	-1,061	,288

4.3.4.9. Shoulder pain and seat height

The Mann Whitney U test for seat height (tables 52 and 53) shows no significant difference in the values of force for seat height in the group with no shoulder pain (p>0,05). However, there is a statistical difference in the group with shoulder pain for the values of shoulder flexion (left–p=0,007), shoulder lateral rotation (left–p=0,007; right–p=0,032), elbow flexion (left–p=0,023; right–p=0,044) and elbow extension (right–p=0,014) (appendix 16, tables 92 to 95, page 198).

Table 52

Upper extremity strength values (N) and seat height, in a group with no shoulder pain

		Seat Height		U	Z	Sig.
		20 to 45 (n=20)	46 to 52 (n=10)			
Shoulder Flexion	Left	86,24	88,69	100,000	,000	1,000
	Right	110,40	87,07	81,000	-,836	,403
Shoulder Extension	Left	136,22	123,24	72,500	-1,210	,226
	Right	135,88	142,35	91,500	-,374	,708
Shoulder Abduction	Left	104,62	106,82	88,000	-,528	,598
	Right	110,74	111,87	96,000	-,176	,860
Shoulder Lateral Rotation	Left	93,74	88,20	83,000	-,748	,454
	Right	102,85	98,64	91,000	-,396	,692
Shoulder Medial Rotation	Left	131,57	128,87	83,500	-,726	,468
	Right	109,76	100,21	87,000	-,572	,567
Elbow Flexion	Left	113,19	136,22	90,500	-,418	,676
	Right	130,34	111,97	86,000	-,616	,538
Elbow Extension	Left	125,93	116,13	99,000	-,044	,965
	Right	117,26	100,94	83,000	-,748	,455

Table 53

Upper extremity strength values (N) and seat height, in a group with shoulder pain

		Seat Height		U	Z	Sig.
		20 to 45 (n=6)	46 to 52 (n=13)			
Shoulder Flexion	Left	105,35	69,29	8,000	-2,720	,007
	Right	114,17	86,53	30,000	-,789	,430
Shoulder Extension	Left	143,42	128,38	25,000	-1,228	,219
	Right	139,65	118,58	29,000	-,877	,380
Shoulder Abduction	Left	109,61	68,11	21,000	-1,579	,114
	Right	103,73	71,83	29,000	-,877	,380
Shoulder Lateral Rotation	Left	118,68	73,99	8,000	-2,719	,007
	Right	114,56	63,21	14,500	-2,151	,032
Shoulder Medial Rotation	Left	119,71	91,83	25,500	-1,185	,236
	Right	107,90	72,81	24,500	-1,272	,203
Elbow Flexion	Left	146,76	103,59	13,000	-2,281	,023
	Right	138,82	100,25	16,000	-2,017	,044
Elbow Extension	Left	118,48	94,08	23,000	-1,404	,160
	Right	112,80	68,31	11,000	-2,456	,014

4.3.4.10. Years since spinal cord injury and seat height

The Mann Whitney U test for paraplegia level (tables 54 and 55) shows no significant difference in the values of force for seat height in the group with less years since SCI (2 to 13yrs) (p>0,05). However, there is a statistical difference in the group with 14 to 47 yrs since SCI for the values of shoulder flexion (left–p=0,031), shoulder extension (left–p=0,003), shoulder abduction (left–p=0,009), shoulder lateral rotation (left–p=0,028), shoulder medial rotation (left–p=0,008; right–p=0,033), elbow flexion (right–p=0,008) and elbow extension (right–p=0,006) (appendix 16, tables 102 to 105, page 200).

Table 54

Upper extremity strength values (N) and seat height, according to years since SCI (2 to 13 yrs)

		Seat Height		U	Z	Sig.
		20 to 45 (n=16)	46 to 52 (n=8)			
Shoulder Flexion	Left	89,33	85,60	58,000	-,368	,713
	Right	109,07	95,16	61,000	-,184	,854
Shoulder Extension	Left	133,92	135,39	55,000	-,551	,582
	Right	133,92	143,08	50,000	-,858	,391
Shoulder Abduction	Left	93,10	97,85	57,000	-,429	,668
	Right	110,59	97,36	60,000	-,245	,806
Shoulder Lateral Rotation	Left	93,59	86,24	44,000	-1,225	,221
	Right	97,27	95,21	56,500	-,459	,646
Shoulder Medial Rotation	Left	112,06	117,11	63,000	-,061	,951
	Right	102,41	99,72	62,500	-,092	,927
Elbow Flexion	Left	114,41	119,41	54,500	-,582	,561
	Right	129,12	108,44	61,500	-,153	,878
Elbow Extension	Left	119,95	102,41	58,500	-,337	,736
	Right	108,93	100,45	55,000	-,551	,582

Table 55

Upper extremity strength values (N) and seat height, according to years since SCI (14 to 47 yrs)

		Seat Height		U	Z	Sig.
		20 to 45 (n=10)	46 to 52 (n=15)			
Shoulder Flexion	Left	90,16	68,89	36,000	-2,163	,031
	Right	119,56	80,36	50,500	-1,359	,174
Shoulder Extension	Left	155,58	121,52	21,000	-2,995	,003
	Right	137,84	118,58	48,000	-1,498	,134
Shoulder Abduction	Left	121,91	69,58	28,000	-2,607	,009
	Right	123,48	71,54	42,000	-1,831	,067
Shoulder Lateral Rotation	Left	100,45	75,46	35,500	-2,191	,028
	Right	110,74	73,50	42,000	-1,831	,067
Shoulder Medial Rotation	Left	140,97	94,08	27,500	-2,635	,008
	Right	118,68	72,81	36,500	-2,136	,033
Elbow Flexion	Left	133,28	102,41	40,000	-1,941	,052
	Right	152,88	99,47	27,500	-2,635	,008
Elbow Extension	Left	129,12	94,08	44,500	-1,692	,091
	Right	124,12	73,99	25,000	-2,774	,006

1.12.2.1. Wheelchair type

It was performed Kruskal-Wallis analysis (table 56) regarding strength values according to MWC type. It was found no statistical difference in strength values for difference MWC types.

Table 56

Upper extremity strength values (N) in different wheelchair types

		Wheelchair type			Chi-square	df	Sig.
		LtW (n=8)	ULW-F (n=15)	ULW-U (n=26)			
Shoulder Flexion	Left	71,54	87,91	86,88	5,32	2	,070
	Right	85,26	109,47	109,91	1,66	2	,437
Shoulder Extension	Left	129,21	122,50	136,22	2,68	2	,262
	Right	117,94	124,95	147,98	6,01	2	,050
Shoulder Abduction	Left	70,17	90,16	103,63	3,61	2	,165
	Right	81,10	90,16	110,59	3,40	2	,183
Shoulder Lateral Rotation	Left	72,13	85,26	94,91	5,30	2	,071
	Right	81,59	99,47	98,93	3,84	2	,147
Shoulder Medial Rotation	Left	104,52	99,47	129,36	3,02	2	,221
	Right	79,04	95,75	109,76	3,77	2	,152
Elbow Flexion	Left	103,24	107,51	125,44	3,13	2	,209
	Right	101,23	130,34	126,18	1,00	2	,605
Elbow Extension	Left	107,65	113,19	119,95	2,84	2	,241
	Right	66,00	98,00	113,83	6,13	2	,047

Legend: LtW (Lightweight), ULW-F (Ultralightweight – folding), ULW-U (Ultralightweight-unfolding)

1.12.2.2. Region distribution

It was performed Kruskal-Wallis analysis (table 57) for strength values for each region/province. It was observed a statistical difference (p<0,05) for the majority of upper extremity movements and both sides (left/right). The results were only not significant for shoulder flexion ($X^2_{(4)}$= 8,59; p=0,072) and shoulder extension ($X^2_{(4)}$= 8,51; p=0,075) in left side. We performed a post–hoc test using Mann–Whitney U test (appendix 20, pages 208 and 209, tables 122 to 125). To avoid type I error, alpha was only considered significant below 0,005 (0,05/10 groups). Results shown a significant difference in the regions of Algarve (p=0,001-0,008) and Alentejo (p=0,001-0,004) and the province of Seville.

Table 57

Upper extremity strength values (N) in regions/provinces

		Region/Province					Chi-square	df	Sig.
		Algarve (n=22)	Alentejo (n=13)	Huelva (n=3)	Seville (n=6)	Cadis (n=5)			
Shoulder Flexion	Left	74,7	75,5	122,5	114,7	87,2	8,59	4	,072
	Right	90,0	91,6	80,4	130,8	118,6	12,72	4	,013
Shoulder Extension	Left	129,4	122,5	121,5	171,7	137,2	8,51	4	,075
	Right	119,2	125,0	151,9	192,1	148,0	15,44	4	,004
Shoulder Abduction	Left	76,4	82,3	113,7	136,2	101,9	9,97	4	,041
	Right	86,6	90,2	107,8	137,2	110,7	12,76	4	,013
Shoulder Lateral Rotation	Left	84,8	77,9	103,9	125,9	100,0	9,85	4	,043
	Right	81,0	96,0	113,7	129,4	117,6	13,92	4	,008
Shoulder Medial Rotation	Left	100,9	115,6	127,4	168,1	150,9	16,42	4	,003
	Right	90,8	92,1	104,9	157,8	106,8	11,00	4	,027
Elbow Flexion	Left	103,2	102,9	157,3	160,2	123,5	16,90	4	,002
	Right	99,9	114,7	124,5	163,7	146,0	14,93	4	,005
Elbow Extension	Left	100,0	103,9	124,0	190,1	126,4	16,22	4	,003
	Right	90,8	86,7	120,5	166,6	117,6	15,10	4	,004

1.12.2.3. Discussion

All strength measurements were performed against gravity, excluding elbow extension and shoulder extension. However, we observed that all force values are relatively higher in the Physical activity group, indicating that physical activity influences higher muscle strength values such as observed in previous studies (Anneken et al., 2010).

Mann Whitney U test for independent samples shows a significant difference in the values of force for Portugal and Spain (p<0,05), for shoulder flexion, shoulder extension, shoulder abduction, shoulder lateral rotation, shoulder medial rotation, elbow flexion and elbow extension. There was also a significant difference in the force values for the group who perform regular Physical activity. Since, the majority of the Spanish sample practice regular Physical activity, we can conclude that the results of higher force values in Spain are associated to them having higher Physical activity, because the mean rank values are lower in the Portuguese sample than in the Spanish and lower for the group who does not practice regular Physical activity, these results are consistent with previous studies showing physiological changes with regular Physical activity (Jacobs et al., 2004; Russo, Bultrini, Brunelli, & Delussu, 2010; Shiba et al., 2010), QOL (Mojtahedi et al., 2008) and strength (Hicks et al., 2003; Tordi et al., 2001).

We observed that elbow extension present higher force values but the higher differences among forces between those who do and those who do not do regular Physical activity is observed in elbow flexion, shoulder flexion and shoulder abduction. This is also consistent with studies performed with EMG (Rankin et al., 2011) which indicated that muscles responsible for shoulder abduction, shoulder extension and shoulder medial rotation act mainly in the first third of propulsion, where it is necessary for a higher force capacity to promote MWC velocity in movement. Elbow flexor acts over the initial two-thirds of the push phase in a similar magnitude as the shoulder muscles and elbow extensors absorb handrim power during the initial third part of the push phase (Rankin et al., 2011) and elbow flexion and elbow extension (Rankin et al., 2012) generate a large amount of muscle power during the push and recovery phases in different MWC propulsion techniques. So, if these muscle groups act mainly during the MWC propulsion, they are considered to be the more developed groups and their effect can easily be observed during the hand-held dynamometry measurements, when compared with shoulder medial/ lateral rotation groups.

The armrest is not available for all MWC models, however we observed that with the Mann-Whitney U test that its use presents significant difference (*p*<0,05) for left arm shoulder flexion and shoulder lateral rotation and right arm shoulder extension and shoulder abduction, with higher values for who does not use armrests.

Regarding characteristics of the subjects, such as physical activity, age, years since SCI, and level of paraplegia, their influence in force might be due to the physical activity (1), MWC (2) or years since SCI (3), once the ability of upper extremity muscle activation and contraction are not affected by the level of SCI. Physical activity (1) is associated to higher muscle activation, resulting in more autonomy and performance in the MWC. However, MWC characteristics (2) and the presence of the armrest can influence angle and applied force in the handrim, influencing UE muscle performance. The first two hypothesis cannot be confirmed by the results and we can only rely on the number of years since the SCI (3) and the observed influence of MWC and degree of satisfaction (sub studies 5 and 6) that influence MWC propulsion and selection.

The values in the same test for the difference in the MWC weight showed significant differences (p<0,05) on the values of shoulder flexion, shoulder extension and shoulder abduction on the left arm and shoulder medial/ lateral rotation and elbow extension on the right arm, with mean rank values lower for MWC users with higher MWC weight. These results are different from other studies presented (de Groot et al., 2013) which compare the increment of 5 to 10 Kg influence to the MWC propulsion, in a controlled environment.

The increment of weight described above is similar to the difference among MWC weight study groups, however we did not asked this specifically once the study of all subjects used the actual MWC. It would be important in the future to analyze if the difference in MWC weight results are directly in a physical/muscle adaptation or if instead it depends on a persons MWC experience. By performing a second Mann – Whitney analysis splitting the two MWC weight groups, we observed that there is a statistical difference (*p*<0,05) in the force ranks of subjects who perform PA and use a MWC from the first group (6,5 to 11 Kg). However, it is not possible to assume that the difference in weight result directly from physical adaptations to the weight, resulting in better UE force and as stated (Liu, Pearlman, et al., 2010), the selection of the MWC and users preference dependent both on mechanical factors and subjective ones.

When comparing MWC seat height with Mann Whitney U test for independent samples, it shows significant difference in the values of strength for different seat heights (p<0,05), for shoulder flexion, shoulder lateral/medial rotation of the left arm and elbow flexion and extension of the right arm, with the mean rank values being lower for the MWC with higher seats. Strength values have shown also statistical difference in different seat height and shoulder pain groups and strength median values are higher in lower seats. The same relation is maintain for the years since SCI, indicating higher strength values in lower MWC seat heights. Propulsion percentage has been observed to decrease with seat height augmentation (Louis & Gorce, 2010) and muscle activation is different due to experience in MWC use, being consistent with years since SCI. A more recent study from the same authors (Gorce & Louis, 2012) indicated that angles at handrim amplitude are higher in expert users, resulting in higher propulsion and recovery times and less changing with seat height augmentation and significant change in elbow flexion/extension and shoulder flexion/extension both in expert and beginner MWC users with seat height augmentation.

We observed an influence of the interaction of paraplegia level and shoulder pain in the majority of upper extremity movements, with a clear indication that subjects with lower paraplegia level present higher strength. The patterns of muscle recruitment are similar for people with high and low paraplegia and in high paraplegia, there is a lack of trunk control created by paralysis of lower abdominals and back extensors, without affecting the muscular response of the shoulder to MWC propulsion (Mulroy et al., 2004). These may be a related directly to the force measurement and trunk control of the subjects that influenced the results; or the lack of balance without trunk control, may influence UE force because this is related to SP.

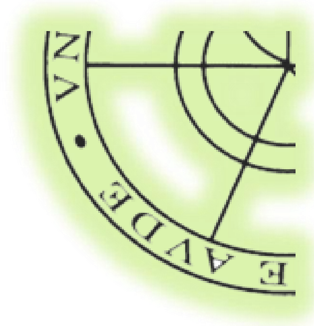
The Kruskal-wallis analysis shown a statistical difference (p<0,05) for the majority of upper extremity movements and both sides (left/right) in the different study regions/provinces of the study. The post–hoc test has shown a significant difference in the areas of Algarve, Alentejo and the province of Seville. These results confirm that the major difference among group activity were with subjects from Portuguese regions (Algarve/Alentejo) and the area of Seville were the more active and engaged in physical activities. The absence of a significant difference with the subjects from Cadiz, Huelva and Seville might have been because the majority of the subjects from these areas were practicing regular physical activities, maintaining a similar strength and activity level.

According to the hypothesis that the **use of lighter MWCs in physical active MWC users diminishes the presence of shoulder pain and influences UE static strength** we found that the presence of shoulder pain and MWC weight showed to influence the shoulder lateral rotation forces and that there is a significant influence of MWC weight. Also there is a clear influence of the interaction of paraplegia level and shoulder pain in the force values.

As indicated in the hypothesis that **in lower seat heights, the MWC user will have a reduction in shoulder pain, will be more active and present higher values of UE strength**, we found that there is a significant difference in the values of force for different seat heights, with the mean rank values being lower for users with higher MWC seats. Also, force values are different for seat height and shoulder pain and for seat height with years since SCI.

Regarding the hypothesis that **level of paraplegia will influence UE force movements** we observed that there is a clear influence of the interaction of trunk control level and SP for upper extremity strength movements.

DISCUSSION



2. DISCUSSION

This chapter groups the main results of the different studies performed in a general discussion regarding the developed activities.

5.1. Cross – cultural validation

Portuguese and Spanish versions present higher values of internal consistency than the values in the original version (Washburn et al., 2002) and the Dutch one (van der Ploeg et al., 2007). These indicate that both versions present a good internal consistency and test – retest reliability, regardless of the difference in culture and physical disabilities. One main limitation presented in both processes is the difficulty in contacting a population with physical disabilities and tried to cover the most density Portuguese areas and following a similar sample as the original version (Washburn et al., 2002) and the areas of Badajoz and Caceres in Spain. PASIPD score is relatively higher in Portuguese than is into Spanish group. This might be explained by the level of activity or by the type of physical disabilities.

QLI (Ferrans & Powers) – SCI III the Portuguese and Spanish versions show test and retest a very good internal consistency and temporal reliability with similar values to the original generic version of the Ferrans & Powers QLI (Ferrans & Powers, 1985). This instrument has been used in PA (Semerjian et al., 2005), it shows a great way to show the evolution of QOL during rehabilitation programs.

QUEST – 2.0 presents high values for internal consistency and test – retest reliability, similar to Portuguese (Rodrigues, 2003), Dutch (Wessels & Witte, 2003), Taiwanese (Mao et al., 2010) and Colombian (Mora Barrera, 2010) versions for TS and subscales.

5.2. Descriptive correlation study

There is no statistical difference in QUEST 2.0 scores for the satisfaction with subjects MWC ($p > 0,05$) for physical activity, country or level of paraplegia. However, there is a difference is the items important in Portugal and Spain samples. In Portugal, subjects concern more with weight (20%), easy to use (18,1%) and comfort (17,1%). In Spain, concerns are mainly with weight (27,5%), comfort (15,7%) and durability (15,7%).

Difference in country sample for Spearmen correlation coefficient show for Portugal, low negative correlation between seat high and satisfaction with the MWC and for Spain a positive correlation showing a difference among the two country samples and that subjects influence with the MWC is mainly associated with seat height. These results are consistent with studies (van der Woude et al., 2009; Veeger, van der Woude, & Rozendal, 1989) that describe the importance of the MWC seat height for elbow angle and ability to better propel the MWC and most efficient values in the respect to energy consumption during activities and that push time and push angles are high in the lower seats (Boninger et al., 2000; Kotajarvi et al., 2004; van der Woude et al., 1989).

There were found significant positive correlation in the Portuguese sample with seat height and WUSPI indicating that SP is related to higher MWC seats. It is shown a significant difference in the values of WUSPI for higher MWC seats. This difference is also observed for Portugal and Spain, and SP where the median values for seat height are relatively higher for people with SP, explaining the observed difference. And, MWC seat relation with SP can help explain the difference in satisfaction with seat height among the two country samples.

The Portuguese sample presents also a negative correlation for QUEST 2.0 AT with seating stature ($p<0,05$) and shoulder height ($p<0,05$), indicating that associated with higher seats, tall people intend to be less satisfied with their MWC, probably having some influence in propelling. For Spanish sample, there is a positive correlation with QUEST AT for seating stature, showing the clear difference between the two groups and that the seat height might have an important influence on MWC satisfaction.

There was a diferente in strength values for Portugal and Spain and for those who perform regular PA. Since, the majority of the Spanish sample practice regular PA, it indicates that the results of higher force values in Spain are associated to higher PA,

because the mdian values are lower in Portuguese sample and lower for the group who does not perform PA, which is consistent to the previous studies in SCI (Hicks et al., 2003; Jacobs et al., 2004; Mojtahedi et al., 2008; Russo et al., 2010; Shiba et al., 2010; Tordi et al., 2001).

When we compare Portuguese and Spanish samples, it is observed that Spanish participants have relative lower levels of QOL QLI and subscores, significant ($p < 0,05$) of the analysis of U test for independent samples. This tendency is difficult to explain by the sample of physical characteristics, because almost all of the participants are engaged in regular PA, there is less prevalence of SP and there is a relatively good satisfaction with the MWC. However, due to the cultural differences in the study regions, QLI might be affected to other subjective variables like health, social influence, family and physiological impact.

It is observed relatively higher levels of QOL for people with higher trunk control level. These values are according to a recent study (Chang et al., 2012) that shows that the level of participation in life situations influences satisfaction with current state and wellbeing, also indicating that individuals with higher independence in activities have higher QOL. Also. So, if in high paraplegia there is lower trunk control it can reduce the balance of the subject, available muscles to MWC propelling and the ability to move the MWC. As a result this might have to rely on other muscle groups.

QUEST 2.0 satisfaction presents a negative correlation with years since SCI, indicating that the importance of the correct adaptation of the components, quality of the MWC and ability to use, are greater as the subject becomes older and uses the MWC for along time. MWC users requires continuous use of UE (van Drongelen, van der Woude, & Veeger, 2011; Van Drongelen et al., 2005a; van Drongelen et al., 2005b) and the shoulder complex has to bear great mechanical forces, that can lead to SP and other UE injuries (Guo et al., 2003; Mercer et al., 2006). These factors are associated to a chronic situation that might influence the use and the desirability of the MWC and QOL (Middleton et al., 2007). According to the results, of QUEST 2.0 the satisfaction of the MWC was influenced by the years since the SCI and the type of MWC. There was observed a satisfaction with the improvement from a standard to a ultralightweight MWC in the first years since SCI, but for the older subjects there is less satisfaction for a better MWC.

With low backrest, push times are longer; cadence is lower and stroke angles larger. The larger stroke angles result from hand contact farther back on the handrim and hand release farther forward on the handrim (Yang et al., 2012) and when participants propel with the low backrests, MWC propulsion factors are improved. This is important because median values shown that subjects with SP present higher backrest heights which are consistent with previous studies (Hong et al., 2011; May et al., 2004; Medola et al., 2014) showing that for a larger range of motion there is lower incidence of SP.

A positive Spearmen correlation coefficient among MWC components (p<0,05) are relatively low but significant, between backrest height with seat width, seat depth, armrest height, handrim diameter and MWC weight. Similar relations were found between seat width, seat depth, casters and WC weight. This shows that there is a proportional distribution of the measurements and when is necessary a higher backrest, a higher armrest, and handrim diameter to easy MWC propelling. However the positive correlation of WC weight indicates that for those who require more safety and higher components in the MWC, there is more weight, which might be a limiting factor in the ability to propel the MWC and on subject's autonomy and ability to perform PA, making MWC weight the common factor indicated by all subjects in QUEST 2.0.

QLI (Ferrans & Powers) SCI - III total score and subscales (HFSUB; SOCSUB; PSPSUB and FAMSUB) values are relatively higher for those who practice PA, this being similar with other studies (Bassett & Ginis, 2009) where it was shown significant positive relationships between the functional satisfaction and the impact on QOL, with higher values for the people performing LTPA. Spearman correlation coefficient shows a small but significant correlation between PASIPD and QLI and HFSUB indicating that regular PA has an important role on subjects QOL. This is consistent with other studies regarding regular PA and well – being in people with mobility impairments (Anneken et al., 2010; Hicks et al., 2003; Tordi et al., 2001). The values of correlation are low, but important to enhance that in a similar sample (paraplegia), the engagement in PA enlarges QOL.

On the same standards a small correlation between satisfaction with the MWC (QUEST 2.0 – AT) and QLI, HFSUB and SOCSUB. According to a study regarding the influence of MWC use (Van Der Woude et al., 2009), it was observed that physical strain, fatigue and pain will influence MWC use and daily activity, so it is considered that the quality of the MWC and its components might play an important role in SCI general QOL. Because subjects autonomy and activity engagement depends on how good the MWC is.

According to previous studies (Liu et al., 2008; Liu, Pearlman, et al., 2010) the unfolding MWCs are less stable in the rearward direction and least stable when configuration results might be attributed to MWCs wider range of adjustability for the CG, however, a highly adjustable MWC requires accurate assessment to maximize manoeuvrability and match users preferences with stability requirements. In this study, it is clear that the folding MWC presents a different desirability among the level of PA and this might be related to the subjects QOL, the ability in using the MWC and adapting it to daily life barriers and type of adjustments.

The most frequently cited concerns about barriers to exercise fall into three areas: (1) intrapersonal or intrinsic, (2) resources and (3) structural or architectural (Scelza et al., 2005; Sisto & Evans, 2014). A combination of barriers might limit the extent to which someone becomes or remains physically active. For that reason, the observed results of QLI scores according to the MWC needs to be known globally because using the MWC depends on the barriers in daily activities and on PA, indicating that MWC, QOL and PA are well related.

The values in Mann Whitney U test for the difference in MWC weight shows significant difference ($p < 0,05$) on the strength values with mean rank values lower for MWC users with higher MWC weight. This evaluation is different from other studies (de Groot et al., 2013) that compare the increment of 5 to 10 Kgs influence to the MWC propulsion, in a controlled environment. The increment of mass described above is similar to the difference among MWC weight study groups, however it was not asked specifically since the study subjects used the actual MWC. There is a statistical difference ($p<0,05$) in the strength of subjects who perform PA and use slimmer MWC. However, it is not possible to assume that the difference in weight results directly from physical adaptations to the weight, resulting in better UE force and as stated (Liu, Pearlman, et al., 2010), the selection of the MWC and users preference dependent both on mechanical factors and subjective ones.

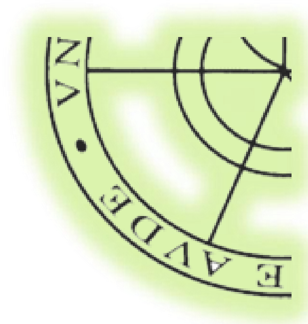
MWC seat height had shown a significant difference for strength values according to SP and years since SCI. Recent studies (Louis & Gorce, 2010) indicate that propulsion percentage decreases with seat height augmentation and muscle activation is different due to experience in MWC use. A recent study from the same authors (Gorce & Louis, 2012) indicates that angles at handrim amplitude are higher in expert users, resulting in higher propulsion and recovery times and changes less with seat height augmentation.

This indicates that the correct use of a MWC with a low seat has a positive influence in force values and since force is influenced by seat height, SP and years since SCI is important to reduce SP prevalence with the passing of years since SCI. So, if the subject has access to a correctly adapted MWC, there is a higher possibility to improve force values, improve ability in propelling and MWC satisfaction at long term, reducing the incidence of SP. It is important to detach that the improvement of these factors might have a positive influence in the improvement of PA.

Higher differences among forces between regular PA are observed in elbow flexion, shoulder flexion and shoulder abduction. This is consistent with studies performed with EMG (Rankin et al., 2011) that indicate shoulder abduction, shoulder extension and shoulder medial rotation and adduction act mainly at 30–34% of propulsion. Elbow flexors acts over the initial two-thirds of the push phase in a similar magnitude as the shoulder muscles and elbow extensors absorb handrim power during the initial third of the push phase (Rankin et al., 2011) and elbow flexion/elbow extension (Rankin et al., 2012) generate a large amount of muscle power during the push and recovery phases in different MWC propulsion techniques. So, if these muscle groups act mainly during the MWC propulsion, it is considered to be more developed groups and can be easily observed during the HHD strength measurements.

In resume and comparing the two country samples, it is possible to detach that the Portuguese sample presents less participation in PA, there is no statistical difference in MWC satisfaction, however, there is a negative correlation among MWC satisfaction and seat height and there is a statistical difference in the values of SP when compared to the Spanish group. The Spanish group presents a higher participation in PA, less prevalence of SP and less influence of MWC components on its desirability and on SP. However it is difficult to explain the difference in QOL among the two country samples. It is important to research more in this area, explore better the variables in future studies, to help improve QOL for the subjects with SCI and promote more and better PA habits.

CONCLUSION



6. CONCLUSION

This chapter summarizes the developed activities in the study, the archived results and the degree of compliance of the hypothesis.

In a general point of view, it is important to refer that the development of this project was an important step to knowing and interacting better with people with physical disabilities, specifically with SCI, to describe and to make contact with different types and alternatives of adapted physical activities. It was an opportunity to grow and develop skills in researching and also an important process developing interpersonal interaction skills; each study subject is a person and with each of them it is possible to learn outside of the study domains.

The general conclusion is that the development of a transboundary study was shown to be a very important process. This has allowed studying and comparing different realities regarding the MWC, adaptive sports and perception of the QOL and limitations due to SCI. And by visiting different regions in two countries it has been possible to observe similar characteristics on the subjects and similar concerns with SCI, so, it is important for the promotion of wider transboundary research.

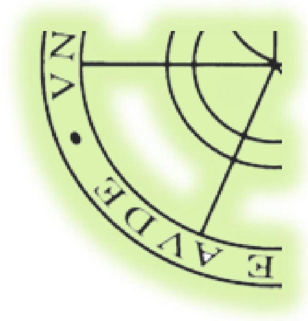
After completing the two study phases and regarding the previous defined objectives, it is possible to conclude that:

- the process of Translation and cultural validation of PASIPD (Portuguese and Spanish) was correctly performed
- the process of Translation and cultural validation of QLI (Ferrans & Powers) SCI – III (Portuguese and Spanish) was correctly performed

- the process of Translation and cultural validation of QUEST 2.0 (Spanish) was correctly performed
- It was developed a Demographic and anthropometric analysis of a SCI sample in the Algarve, Alentejo, Huelva, Seville and Cadiz. It identified differences in the type of wheelchairs, its dimensions and materials of the study areas.
- It identified a correlation with SP using the WUSPI with QUEST 2.0 and MWC components and perception of QOL, with clear differences among Portuguese and Spanish groups.
- It identified a statistical difference in the perception of QOL with regular physical activity in subjects.
- Isometric strength is higher in the group with regular PA and clearly higher in the Spanish group due to the majority of the participants being engaged in regular physical activities.
- The strength values are higher for those who perform PA with a statistical difference in the measurement forces of Portugal and Spain. The strength values are different in people who use/not use an armrest and show a difference in MWC weight and seat height.
- It is observed that force values are different according to level of paraplegia and SP and with the interaction of seat height and SP and Seat height with years since SCI.
- We found no significant difference in strength values according to the type of MWC.
- It was observed a statistical difference in the strength values according to the region/province of the subjects. There was a clear difference in the Portuguese regions where athletes had less regular performance of physical activities by comparing to the Seville province where the subjects were more experience and engaged in regular physical activities since SCI.

In resume, it is possible to conclude that there is a need to improve participation in adaptive sports for people with SCI, as a way to promote physical activity. However, it is also important to promote the necessary adaptations in assistive technology so the subjects can be more autonomous and have more ability in the MWC, reducing the prevalence of shoulder pain.

LIMITATIONS



7. LIMITATIONS

In this chapter is performed a reflection of the limitations and obstacles during the development of the activities and how it might have influenced the final outcome.

The main limitation of the study stands for the difficulty in contacting people with physical disabilities in the first part specifically with SCI, during part 2 of the study. Due to the characteristics of the sample, in the first phase we managed to contact mainly with clubs and associations of disability. It was difficult to find subjects to participate in the test – retest for QLI (Ferrans & Powers) SCII III, specifically for Spain sample.

In the second part, mainly in Spanish provinces it was extremely difficult to reach contacts and to motivate subjects to participate. We consider that it was due to the absence of associations working with subjects with SCI and because the subjects for the study maintain a certain level of autonomy and live in their own homes, being difficult to contact, promote the study and perform a first presentation of the activities/objectives.

Another limitation was the reduced interest of subjects in participating in the activities due to non compliance after receiving the questionnaires. Although talking with subjects or clubs/associations, there were twelve more questionnaires delivered in person in Spain that have not replied back. This limited the amount of participants in Spanish areas and the total sample of the study.

In phase 1, it was possible to contact a majority of subjects with physical disabilities, but a low number of subjects with SCI and the available contacts were mainly in associations related to adaptive sports practice. In phase 2, due to the need of reaching a high and representative sample of SCI subjects, it was needed to cover a displacement of a wide area. This factor limited the time to be with the participants.

The majority of the subjects were evaluated in their homes, according to their availability, a place more comfortable to the people; but where there might have been some influence in answering due to the presence of other family members in the most personal questions of the QOL.

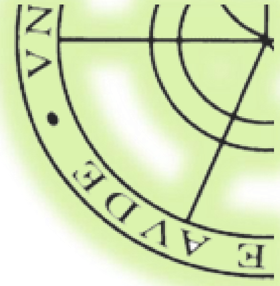
Regarding phase 2, we observed a certain difficulty in the evaluation of the force, anthropometrics and MWC. (1) Due to pain in the subjects in some force measurements they were not able to perform the total (three) measurements; (2) Sometimes, subjects found the questionnaires very long, and seemed not very motivated during the anthropometric and force measurements, this was seen as a limiting physiological factor in the cooperation and development of the activities.

Regarding the methodological there are some considerations:

- The process of cross – cultural validation could have been more complete with a larger sample and to have asked each participant the degree of understanding of each question. It would have been better to consider a longitudinal approach in order to perform questionnaire and force evaluation in different moments to confirm the reliability of the measured values.
- In the sequence of the displacement and the covered area explained above, it is intended that the seasonality influenced both phases of the study because with the autumn/ Winter (similar in Portugal and Spain study areas) the subjects intend to be more at home and being less active and might have influenced the QOL and PASIPD answering. This playing also an important role during the static strength evaluation during the second phase of the study.
- It was impossible to measure the MWC weight, and the values were asked to each participant and/or dependent on the information available in the MWC company manual. This does not guaranteed the real MWC weight, however it was evaluated that the average weight was inversely proportional from lightweight to ultralighweight MWCs, according to the standards.
- The evaluation of wheelchair skills was an intended topic to be developed during the study and considered as very important for a subjects relation with wheelchair autonomy and performance. However, this evaluation was abandoned due to the impossibility to develop a practical performance of these activities. It is considered that adding this variable would have resulted in a better correlation of the results among MWC satisfaction, measurements and real performance.

PRACTICAL IMPLICATIONS

FUTURE PERPECTIVES



8. PRACTICAL IMPLICATIONS AND FUTURE PERSPECTIVES

This chapter summarizes the practical implications and future perspectives to continue the development of the investigation of activities, complement the work in progress and improve the knowledge regarding SCI, MWC and related factors.

Practical implications of this PhD thesis study activities:

- To interact with subjects with SCI, to be aware of their limitations and to understand both physical, psychological and social behavior of the subjects
- To make contact with associations that work with disability, creating bridges for future cooperation in the investigation of this area. And with this, improving the research in the area of SCI and physical activity in people with disabilities.
- To Know physical activity practice habits, type of MWC, presence of shoulder pain and static strength in paraplegic subjects from the areas of Portugal and Spain
- To detach the importance of regular physical activity in the improvement of personal autonomy, QOL, isometric strength, its effect on the ability to propel the MWC and in the ability to overcome the barriers.
- To understand the role and importance of correct MWC dimensions, weight and materials to reduce shoulder pain and improve physical activity.
- To detach the importance of promoting muscle activity to enlarge handrim propulsion in the promotion of MWC autonomy.

- To detach the importance of physical activity in the promotion of quality of life in people with paraplegia.
- To compare and analyze the difference in the MWC in the transboundary areas
- To understand that similar regions/provinces, present different facilities, dynamics and promotion of adaptive sports practice

It is intended to improve the drawing of the study in a smaller scale, in a longitudinal study to evaluate the evolution of the force results and peak time related to the physical activity in a transboundary process. This small scale might also perform MWC skills of activities to better correlate it with the results and to better analyze the type of activities. From this point of view we might be able to analyze the correlation of subjects upper extremity isometric strength, MWC satisfaction, prevalence of shoulder pain and QOL.

In order to better evaluate the MWC it was intended to perform a biomechanical analysis regarding velocity, rolling resistance in distinct terrain to correlate the study to the daily life limitations of MWC propelling. This evaluation might be correlated also with SP, satisfaction with the MWC, anthropometrics, QOL and static strength.

Due to the use of MWCs in people with tetraplegia, it is important to evaluate the study variables in these sample groups, allowing better correlating results. Once this population presents lower isometric strength due to the neurological level, it is important to confirm if there are changes in other results and how they are influenced.

We consider it important to study the most common adaptive sports performed and to understand the reasons for the progressive reduction of athletes and clubs in these areas.

In a general point of view, join the transboundary relations, to promote cooperation in future projects in the investigation processes and to stimulate the transboundary adapted physical activity.

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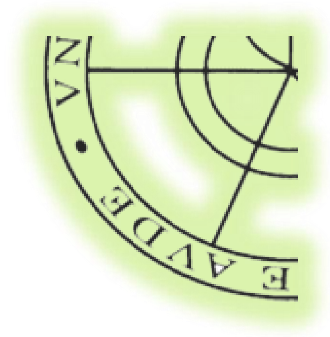
APPENDIX



10. APPENDIX

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Questionário Sociodemográfico

1) Dados demográficos

Idade: ____________

2) Género:

☐ Masculino ☐ Feminino

3) Nacionalidade ______________________________

4) Província/ região ______________________________

5) Estado civil:

☐ Solteiro/a
☐ Casado/União de facto
☐ Divorciado/Separado
☐ Viúvo/a

6) Habilitações literárias

☐ Ensino Básico
☐ Ensino Superior
☐ Ensino Secundário

7) Atividade profissional

☐ Sim ☐ Não

8) Nível da lesão ______________________________

9) Anos desde a lesão medular ______________________________

10) Pratica alguma atividade física de forma regular?

☐ Sim ☐ Não

11) Se sim, que atividade física pratica? ______________________________

Cuestionario Socio demográfico

1) Datos demográficos

Edad: _____________

2) Género:

☐ Masculino ☐ Femenino

3) Nacionalidad ______________________________

4) Provincia ______________________________

5) Estado civil:

☐ Soltero/a
☐ Divorciado/Separado
☐ Casado/pareja de hecho
☐ Viudo/a

6) Habilitaciones literarias

☐ Enseno Básico
☐ Enseno Secundario
☐ Enseno Superior

7) Actividad profesional

☐ Si ☐ No

8) Nivel da lesión ______________________________

9) Años desde la lesión medular ______________________________

10) ¿Practica alguna actividad física de forma regular?

☐ Si ☐ No

11) Se sí, ¿qué actividad física usted practica? ______________________________

Datos Socio demográficos

1) Dados demográficos

Edad: ________ años

2) Género:

□ Masculino □ Femenino

3) Estado civil:

□ Soltero/a □ Divorciado/a o Separado/a
□ Casado/a u Pareja de hecho □ Viudo/a

4) Estudios académicos:

□ Educación Básica □ Educación Secundaria
□ Educación Superior

5) Actividad profesional

□ Sí □ No

6) Tipo de incapacidad física:_____________________________________

7) Nivel y grado de lesión (solo personas con **Lesión Medular**)

□ Cervical
□ Lumbar □ Completa
□ Dorsal □ Incompleta

Questionário Sociodemográfico

1) Dados demográficos

Idade: _________ anos

2) Género:

☐ Masculino ☐ Feminino

3) Estado civil:

☐ Solteiro/a ☐ Divorciado/Separado

☐ Casado/União de facto ☐ Viúvo/a

4) Habilitações literárias

☐ Ensino Básico ☐ Ensino Secundário

☐ Ensino Superior

5) Atividade profissional

☐ Sim ☐ Não

6) Tipo de incapacidade física: ______________________________________

7) Nível e grau de lesão (apenas para pessoas com **Lesão Medular**)

☐ Cervical

☐ Lombar ☐ Completa

☐ Dorsal ☐ Incompleta

RELATÓRIO DE PAINEL DE PERITOS

O investigador João Guerreiro encontra-se a realizar uma tese de doutoramento intitulada Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas/ Transboundary study for the Inclusion of Spinal Cord Injured people in Physical Activities num projeto transfronteiriço de enfoque sobre o desporto adaptado e lesão medular.

O investigador encontra-se atualmente a realizar um processo de tradução e validação cultural para português (Portugal) de duas escalas internacionais - atividade física em pessoas com incapacidade física e índice de qualidade de vida para pessoas com lesão medular e seguindo as linhas orientadoras para este tipo de estudos (Beaton et al., 2000).

Como tal, é pedido a vossa excelência que analise as versões de tradução (T12) e retradução (BT12) e realize um relatório a partir do modelo disponível abaixo relativo aos campos de equivalência semântica, equivalência idiomática, equivalência experiencial e equivalência conceptual através do seu conhecimento e experiencia na área específica.

O investigador está disponível para eventuais esclarecimentos através do contacto de correio eletrónico jmguerreiro@ualg.pt ou pelo telemóvel 968076445.

Perito (a)

Grau académico	
Área de experiencia	
Nome	

Análise da escala

Título da escala	
Autores	

Campos

Nota: Deve reportar qualquer discrepância e apresentar possível resolução

1) Equivalência semântica	
Item	
Resolução	
2) Equivalência idiomática	
Item	
Resolução	
3) Equivalência experiencial	
Item	
Resolução	
4) Equivalência conceptual	
Item	
Resolução	

Assinatura do (a) Perito (a), ______________________

Assinatura do investigador ______________________

Data: ___/ _____/ ______

ESCALA DE ACTIVIDAD FÍSICA

PARA PERSONAS CON DISCAPACIDADES FÍSICAS

Instrucciones: Este cuestionario es sobre el nivel actual de la actividad física y el ejercicio. Por favor, recuerde que no hay respuestas correctas o erróneas. Simplemente necesitamos evaluar su nivel actual de actividad.

Actividad de tiempo libre

1. Durante los últimos siete días, ¿con qué frecuencia realizó actividades sedentarias como leer, ver la televisión, videojuegos, o hacer manualidades?
   1. Nunca (vaya a la pregunta nº 2)
   2. Esporádicamente u ocasionalmente (1 – 2d)
   3. A veces (3 – 4d)
   4. Frecuentemente (5 – 7d)

¿Cuáles fueron esas actividades?

____

De media, ¿cuántas horas al día dedicó a estas actividades sedentarias?

   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

2. Durante los últimos siete días, ¿con qué frecuencia camina, empuja la silla fuera de su casa para otra cosa que no sea específicamente el ejercicio? Por ejemplo, llegar al trabajo o a clase, pasear al perro, ir de compras, u otros recados.
   1. Nunca (vaya a la pregunta nº 3)
   2. Esporádicamente u ocasionalmente (1 – 2dias)
   3. A veces (3 – 4dias)
   4. Frecuentemente (5 – 7dias)

De media, ¿cuántas horas al día pasó en la silla de ruedas o empujándola fuera de casa?

   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

3. Durante los últimos siete días, ¿con qué frecuencia participó en deportes o actividades recreativas suaves, como bolos, golf con un carrito, caza o pesca, dardos, billar o piscina, ejercicios terapéuticos (terapia física u ocupacional, estiramientos, usando una estructura de pie) u otras actividades similares?
   1. Nunca (vaya a la pregunta nº 4)
   2. Esporádicamente u ocasionalmente (1 – 2 dias)
   3. A veces (3 – 4 dias)
   4. Frecuentemente (5 – 7 dias)

¿Cuáles fueron esas actividades?

____

De media, ¿cuántas horas al día dedicó a los deportes suaves o actividades recreativas?

   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

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4. Durante los últimos siete días, ¿con qué frecuencia practica deporte moderado y actividades recreativas como tenis en dobles, béisbol, golf sin un carrito, bailes de salón, desplazándose en su silla por placer u otras actividades similares?
   1. Nunca (vaya a la pregunta nº 5)
   2. Esporádicamente u ocasionalmente (1 – 2 dias)
   3. A veces (3 – 4 dias)
   4. Frecuentemente (5 – 7 dias)

¿Cuáles fueron esas actividades?

____

De media, ¿cuántas horas al día empleó en estos deportes moderados y estas actividades recreativas?

1. Menos de 1 hora
2. Más de 1 hora, pero menos de 2
3. De 2 a 4 horas
4. Más de 4 horas

5. Durante los últimos siete días, ¿con qué frecuencia practicó deportes extremos y actividades recreativas tales como correr, carreras de sillas (rehabilitación), empujar al aire libre, natación, danza aeróbica, rotaciones de brazo, ciclismo (con manos o piernas), tenis individual, rugby, baloncesto, caminar con muletas y tirantes, u otras actividades similares?
   1. Nunca (vaya a la pregunta nº 6)
   2. Esporádicamente u ocasionalmente (1 – 2 dias)
   3. A veces (3 – 4 dias)
   4. Frecuentemente (5 – 7 dias)

¿Cuáles fueron esas actividades?

____

De media, ¿cuántas horas al día empeló en estos deportes extremos o estas actividades recreativas?

1. Menos de 1 hora
2. Más de 1 hora, pero menos de 2
3. De 2 a 4 horas
4. Más de 4 horas

6. Durante los últimos siete días, ¿con qué frecuencia hizo algún ejercicio específico para incrementar la fuerza muscular y la resistencia como levantamiento de pesas, flexiones, dominadas, zambullidas, o flexiones en la silla de ruedas, etc?
   1. Nunca (vaya a la pregunta nº 7)
   2. Esporádicamente u ocasionalmente (1 – 2 dias)
   3. A veces (3 – 4 dias)
   4. Frecuentemente (5 – 7 dias)

¿Cuáles fueron esas actividades?

____

De media, ¿cuántas horas al día empleó en estos ejercicios para incrementar su fuerza muscular y resistencia?

1. Menos de 1 hora
2. Más de 1 hora, pero menos de 2
3. De 2 a 4 horas
4. Más de 4 horas

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Actividad doméstica

7. Durante los últimos siete días, ¿con qué frecuencia ha hecho alguna tarea de casa leve, como limpiar el polvo, barrer el suelo o lavar los platos?
   1. Nunca (vaya a la pregunta nº 8)
   2. Esporádicamente u ocasionalmente (1 – 2 dias)
   3. A veces (3 – 4 dias)
   4. Frecuentemente (5 – 7 dias)

De media, ¿cuántas horas al día pasó haciendo las tareas domésticas más leves?
   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

8. Durante los últimos siete días, ¿con qué frecuencia ha realizado alguna tarea de casa o quehacer duro, como pasar la aspiradora, fregar el suelo, limpiar las ventanas, o las paredes, etc?
   1. Nunca (vaya a la pregunta nº 9)
   2. Esporádicamente u ocasionalmente (1 – 2 días)
   3. A veces (3 – 4 días)
   4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día pasó haciendo las tareas domésticas o quehaceres más duros?
   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

9. Durante los últimos siete días, ¿con qué frecuencia ha hecho reparaciones en el hogar, como carpintería, pintura, barnizar los muebles, electricidad, etc?
   1. Nunca (vaya a la pregunta nº 10)
   2. Esporádicamente u ocasionalmente (1 – días
   3. A veces (3 – 4 días)
   4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día dedicó a las reparaciones del hogar?
   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

10. Durante los últimos siete días, ¿con qué frecuencia suele cuida su césped o patio incluyendo la eliminación de la siega, hojas o nieve, podando árboles o arbustos, o cortando leña, etc?
   1. Nunca (vaya a la pregunta nº 11)
   2. Esporádicamente u ocasionalmente (1 – 2 días)
   3. A veces (3 – 4 días)
   4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día empleó en cuidar su césped?
   1. Menos de 1 hora
   2. Más de 1 hora, pero menos de 2
   3. De 2 a 4 horas
   4. Más de 4 horas

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11. Durante los últimos siete días, ¿con qué frecuencia realiza el cuidado de su jardín al aire libre?
    1. Nunca (vaya a la pregunta nº 12)
    2. Esporádicamente u ocasionalmente (1 – 2 días)
    3. A veces (3 – 4 días)
    4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día pasó trabajando al aire libre en su jardín?

1. Menos de 1 hora
2. Más de 1 hora, pero menos de 2
3. De 2 a 4 horas
4. Más de 4 horas

12. Durante los últimos siete días, ¿con qué frecuencia cuida de otra persona, tal como su hijo, su cónyuge dependiente, u otro adulto?
    1. Nunca (vaya a la pregunta nº 13)
    2. Esporádicamente u ocasionalmente (1 – 2 días)
    3. A veces (3 – 4 días)
    4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día empleó en cuidar a otras personas?

1. Menos de 1 hora
2. Más de 1 hora, pero menos de 2
3. De 2 a 4 horas
4. Más de 4 horas

Actividad relacionada con el trabajo

13. Durante los últimos siete días, ¿con qué frecuencia trabajó de manera remunerada o como voluntario? (Excluyendo el trabajo que realiza principalmente sentado con un suave movimiento de brazo como es el trabajo de oficina, el trabajo informático, el trabajo de línea ligera de montaje, conducir un autobús o una furgoneta, etc).
    1. Nunca (vaya al FINAL)
    2. Esporádicamente u ocasionalmente (1 – 2 días)
    3. A veces (3 – 4 días)
    4. Frecuentemente (5 – 7 días)

De media, ¿cuántas horas al día dedicó a un trabajo remunerado o como voluntario?

1. Menos de 1 hora
2. Más1 hora, pero menos de 4
3. Más de 5 horas, pero menos 8
4. 8 horas o más

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ESCALA DE ATIVIDADE FÍSICA
PARA PESSOAS COM INCAPACIDADES FISICAS

Instruções: Este questionário incide sobre o seu nível atual de atividade física e exercício físico. Por favor, lembre-se de que não há respostas certas ou erradas. Apenas precisamos de avaliar o seu nível atual de atividade.

Atividades de Lazer

1. Nos últimos 7 dias, quantas vezes se ocupou com atividades sem esforço físico, tais como ler, ver televisão, jogar no computador ou fazer trabalhos manuais?
    1. Nunca (siga para a pergunta nº 2)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

    Quais foram essas atividades?

____

Em média, quantas horas por dia passou a fazer essas atividades sem esforço físico?
1. Menos de 1 hora
2. 1 hora mas menos que 2 horas
3. 2 horas – 4 horas
4. Mais de 4 horas

2. Nos últimos 7 dias, com que frequência caminhou, andou de cadeira de rodas, ou a propulsionou, fora de casa sem ser com o objetivo de fazer exercício? Por exemplo, ir para o trabalho ou para as aulas, passear o cão, ir às compras ou outras tarefas?
    1. Nunca (ir para a pergunta nº 3)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia andou de cadeira de rodas ou a propulsionou fora de casa?
1. Menos de 1 hora
2. 1 hora mas menos que 2 horas
3. 2 horas – 4 horas
4. Mais de 4 horas

3. Nos últimos 7 dias, com que frequência praticou desportos de baixa intensidade ou fez atividades recreativas, tais como caça ou pesca, dardos, bilhar (ou *snooker*), exercícios terapêuticos (fisioterapia ou terapia ocupacional, alongamentos, utilização de um *standing – frame*) ou outras atividades semelhantes?
    1. Nunca (ir para a pergunta nº 4)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Quais foram essas atividades?

____

Em média, quantas horas por dia praticou desportos ligeiros ou fez atividades recreativas?
1. Menos de 1 hora
2. 1 hora mas menos que 2 horas
3. 2 horas – 4 horas
4. Mais de 4 horas

4. Nos últimos 7 dias, com que frequência praticou desporto de moderada intensidade e fez atividades recreativas como ténis de pares, softebol, golfe sem carrinho, danças de salão, andar de cadeira de rodas ou propulsiona – la por lazer ou outras atividades semelhantes?
    1. Nunca (ir para a pergunta nº 5)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Quais foram essas atividades?

____

Em média, quantas horas por dia praticou esse tipo de atividades desportivas moderadas e fez atividades recreativas?
1. Menos de 1 hora
2. 1 hora mas menos que 2 horas
3. 2 horas – 4 horas
4. Mais de 4 horas

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5. Nos últimos 7 dias, com que frequência praticou atividades desportivas e recreativas de elevada intensidade tais como corrida em cadeiras de rodas (treino), propulsionar uma cadeira de rodas fora da estrada (pisos irregulares), natação, dança aeróbica, ciclo ergómetro de braços, ciclismo (com mãos ou pernas), ténis individual, basquetebol, andar com canadianas ou ortóteses ou outras atividades semelhantes?
   1. Nunca (ir para a pergunta nº 6)
   2. Raramente (1 – 2 dias)
   3. Algumas vezes (3 – 4 dias)
   4. Frequentemente (5 – 7 dias)

Quais foram essas atividades?
____

Em média, quantas horas por dia praticou essas atividades desportivas ou recreativas intensas?
   1. Menos de 1 hora
   2. 1 hora mas menos que 2 horas
   3. 2 horas – 4 horas
   4. Mais de 4 horas

6. Nos últimos 7 dias, com que frequência fez exercícios com o objetivo de aumentar a sua força muscular e a sua resistência, tais como levantar pesos, flexões, flexões em barra fixa, barras paralelas, ou *push – up* na cadeira de rodas, etc.?
   1. Nunca (ir para a pergunta nº 7)
   2. Raramente (1 – 2 dias)
   3. Algumas vezes (3 – 4 dias)
   4. Frequentemente (5 – 7 dias)

Quais foram essas atividades?
____

Em média, quantas horas por dia fez exercícios desse tipo para aumentar a força muscular e resistência?
   1. Menos de 1 hora
   2. 1 hora mas menos que 2 horas
   3. 2 horas – 4 horas
   4. Mais de 4 horas

Atividade doméstica

7. Nos últimos 7 dias, com que frequência fez algum tipo de tarefas domésticas leves, como limpar o pó, varrer o chão ou lavar a loiça?
   1. Nunca (ir para a pergunta nº 8)
   2. Raramente (1 – 2 dias)
   3. Algumas vezes (3 – 4 dias)
   4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a fazer tarefas domésticas leves?
   1. Menos de 1 hora
   2. 1 hora mas menos que 2 horas
   3. 2 horas – 4 horas
   4. Mais de 4 horas

8. Nos últimos 7 dias, com que frequência fez tarefas domésticas pesadas ou rotinas pesadas como aspirar, esfregar o chão, limpar as janelas ou as paredes, etc.?
   1. Nunca (ir para a pergunta nº 9)
   2. Raramente (1 – 2 dias)
   3. Algumas vezes (3 – 4 dias)
   4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a fazer tarefas domésticas ou rotinas pesadas?
   1. Menos de 1 hora
   2. 1 hora mas menos que 2 horas
   3. 2 horas – 4 horas
   4. Mais de 4 horas

9. Nos últimos 7 dias, com que frequência fez trabalhos de reparações domésticas como carpintaria, pintura, acabamentos de mobílias, trabalho com eletricidade, etc.?
   1. Nunca (ir para a pergunta nº 10)
   2. Raramente (1 – 2 dias)
   3. Algumas vezes (3 – 4 dias)
   4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a fazer reparações domésticas?
   1. Menos de 1 hora
   2. 1 hora mas menos que 2 horas
   3. 2 horas – 4 horas
   4. Mais de 4 horas

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10. Nos últimos 7 dias, com que frequência tratou do seu terreno/quintal ao cortar a relva, remover as folhas, podar árvores e aparar arbustos, cortar madeira, etc.?
    1. Nunca (ir para a pergunta nº 11)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a tratar do seu terreno?
    1. Menos de 1 horas
    2. 1 hora mas menos que 2horas
    3. 2 horas – 4 horas
    4. Mais de 4 horas

11. Nos últimos 7 dias, com que frequência fez jardinagem no exterior?
    1. Nunca (ir para a pergunta nº 12)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a fazer jardinagem no exterior?
    1. Menos de 1 hora
    2. 1 hora mas menos que 2 horas
    3. 2 horas – 4 horas
    4. Mais de 4 horas

12. Nos últimos 7 dias, com que frequência cuidou de outra pessoa como, por exemplo, de uma criança, um cônjuge dependente, ou outro adulto?
    1. Nunca (ir para a pergunta nº 13)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a cuidar de outra pessoa?
    1. Menos de 1 hora
    2. 1 hora mas menos que 2 horas
    3. 2 horas – 4 horas
    4. Mais de 4 horas

Atividades relacionadas com trabalho

13. Nos últimos 7 dias, com que frequência fez trabalhos pagos ou de voluntariado? (Não incluindo trabalhos que envolviam sobretudo estar sentado com pequenos movimentos de braços, como trabalho leve de escritório, trabalho de computador, trabalho leve em linhas de montagem, condução de autocarros ou carrinhas, etc.)
    1. Nunca (terminar)
    2. Raramente (1 – 2 dias)
    3. Algumas vezes (3 – 4 dias)
    4. Frequentemente (5 – 7 dias)

Em média, quantas horas por dia passou a fazer trabalhos pagos ou de voluntariado?
    1. Menos de 1 hora
    2. 1 hora mas menos que 4 horas
    3. 5 horas mas menos que 8 horas
    4. 8 ou mais horas

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Ferrans and Powers
ÍNDICE DECALIDAD DE VIDA©
LESIÓN DE LA MÉDULA ESPINAL VERSIÓN – III

PARTE 1. En cada una de las siguientes preguntas, por favor, escoja la respuesta que mejor describa cómo de ***satisfecho*** está con el apartado de su vida. Por favor, marque su respuesta rodeando el número. No hay respuestas acertadas o erróneas.

¿CÓMO DE *SATISFECHO* ESTÁ CON:	Muy insatisfecho(a)	Moderadamente insatisfecho(a)	Ligeramente insatisfecho(a)	Ligeramente satisfecho(a)	Moderadamente satisfecho(a)	Muy satisfecho(a)
5. Su salud?	1	2	3	4	5	6
6. Su atención médica?	1	2	3	4	5	6
7. La cantidad de dolor que soporta?	1	2	3	4	5	6
8. La cantidad de energía que tiene para realizar sus actividades diarias?	1	2	3	4	5	6
9. Su capacidad para cuidar de sí mismo/a sin ayuda?	1	2	3	4	5	6
10. Su capacidad para salir fuera de casa?	1	2	3	4	5	6
11. Su capacidad para despejar sus pulmones?	1	2	3	4	5	6
12. El control que tiene sobre su propia vida?	1	2	3	4	5	6
13. Los cambios que desearía en su vida?	1	2	3	4	5	6
14. La salud de su familia?	1	2	3	4	5	6
15. Sus hijos/as?	1	2	3	4	5	6
16. Su capacidad para tener hijos/as?	1	2	3	4	5	6
17. La felicidad de su familia?	1	2	3	4	5	6
18. Su vida sexual?	1	2	3	4	5	6
19. Su cónyuge, amante o pareja (en caso de tenerlo/a)?	1	2	3	4	5	6
20. No tener cónyuge, amante o pareja (en caso de no tenerlo/a)?	1	2	3	4	5	6
21. Sus amigos/as?	1	2	3	4	5	6

(Por favor, vaya a la página siguiente)

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Traducido por João Guerreiro, 2013

¿CÓMO DE *SATISFECHO* ESTÁ CON:	Muy insatisfecho(a)	Moderadamente insatisfecho(a)	Ligeramente insatisfecho(a)	Ligeramente satisfecho(a)	Moderadamente satisfecho(a)	Muy satisfecho(a)
22. El apoyo emocional que recibe de su familia?	1	2	3	4	5	6
23. El apoyo emocional que recibe de otras personas además de su familia?	1	2	3	4	5	6
24. Su habilidad para hacer frente a las responsabilidades familiares?	1	2	3	4	5	6
25. Lo útil que es para otros?	1	2	3	4	5	6
26. Las preocupaciones presentes en su vida?	1	2	3	4	5	6
27. Su vecindario?	1	2	3	4	5	6
28. Su casa, piso, o lugar en el que vive?	1	2	3	4	5	6
29. Su trabajo (si trabaja)?	1	2	3	4	5	6
30. No tener un trabajo (si está desempleado/a, jubilado/a o incapacitado/a)?	1	2	3	4	5	6
31. Su educación?	1	2	3	4	5	6
32. La capacidad que posee para hacer frente a las necesidades económicas?	1	2	3	4	5	6
33. Las cosas que hace para divertirse?	1	2	3	4	5	6
34. Sus oportunidades para un futuro feliz?	1	2	3	4	5	6
35. Su tranquilidad espiritual?	1	2	3	4	5	6
36. Su credo?	1	2	3	4	5	6
37. La consecución de sus metas personales?	1	2	3	4	5	6
38. Su felicidad en general?	1	2	3	4	5	6
39. Su vida en general?	1	2	3	4	5	6
40. Su apariencia personal?	1	2	3	4	5	6
41. Usted mismo en general?	1	2	3	4	5	6

(Por favor, vaya a la página siguiente)

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PARTE 2. En cada una de las siguientes preguntas, por favor, escoja la respuesta que mejor describa cómo de ***importante*** es el apartado para usted. Por favor, marque su respuesta rodeando el número. No hay respuestas acertadas o erróneas.

¿CÓMO DE *IMPORTANTE* ES PARA USTED:	Muy importante	Moderadamente importante	Ligeramente importante	Ligeramente importante	Moderadamente importante	Muy importante
5. Su salud?	1	2	3	4	5	6
6. El cuidado de su salud?	1	2	3	4	5	6
7. No sentir dolor?	1	2	3	4	5	6
8. Tener energías suficientes para sus actividades diarias?	1	2	3	4	5	6
9. Cuidar de sí mismo/a sin ayuda?	1	2	3	4	5	6
10. Ser capaz de salir fuera de casa?	1	2	3	4	5	6
11. Su capacidad para despejar sus pulmones?	1	2	3	4	5	6
12. Tener control sobre su vida?	1	2	3	4	5	6
13. Vivir tanto como desearía?	1	2	3	4	5	6
14. La salud de su familia?	1	2	3	4	5	6
15. Sus hijos/as?	1	2	3	4	5	6
16. Ser capaz de tener hijos/as?	1	2	3	4	5	6
17. La felicidad de su familia?	1	2	3	4	5	6
18. Su vida sexual?	1	2	3	4	5	6
19. Su cónyuge, amante o pareja (en caso de tenerlo/a)?	1	2	3	4	5	6
20. Tener cónyuge, amante o pareja (en caso de no tenerlo/a)?	1	2	3	4	5	6
21. Sus amigos/as?	1	2	3	4	5	6

(Por favor, vaya a la página siguiente)

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¿CÓMO DE *IMPORTANTE* ES PARA USTED :	Muy importante	Moderadamente importante	Ligeramente importante	Ligeramente importante	Moderadamente importante	Muy importante
22. El apoyo emocional que recibe de su familia?	1	2	3	4	5	6
23. El apoyo emocional que recibe de otras personas de su círculo?	1	2	3	4	5	6
24. Cuidar de las responsabilidades familiares?	1	2	3	4	5	6
25.Ser útil para otros?	1	2	3	4	5	6
26.No tener preocupaciones?	1	2	3	4	5	6
27.Su vecindario?	1	2	3	4	5	6
28. Su casa, piso, o lugar en el que vive?	1	2	3	4	5	6
29. Su trabajo (si trabaja)?	1	2	3	4	5	6
30. Tener un trabajo (si está desempleado/a, jubilado/a o incapacitado/a)?	1	2	3	4	5	6
31. Su educación?	1	2	3	4	5	6
32.Ser capaz de hacer frente a las necesidades económicas?	1	2	3	4	5	6
33.Hacer cosas para divertirse?	1	2	3	4	5	6
34.Tener un futuro feliz?	1	2	3	4	5	6
35.La tranquilidad espiritual?	1	2	3	4	5	6
36.Su credo?	1	2	3	4	5	6
37.Conseguir sus metas personales?	1	2	3	4	5	6
38.Su felicidad en general?	1	2	3	4	5	6
39.Estar satisfecho con su vida?	1	2	3	4	5	6
40. Su apariencia personal?	1	2	3	4	5	6
41.Sí mismo?	1	2	3	4	5	6

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Ferrans e Powers
ÍNDICE DE QUALIDADE DE VIDA©
VERSÃO PARA LESÃO MEDULAR – III

PARTE 1. Para cada uma das seguintes perguntas, escolha a resposta que melhor define o seu grau de ***satisfação*** para a área da sua vida em questão. Por favor assinale a sua resposta com um círculo à volta do número. Não há respostas certas nem erradas.

	EM QUE MEDIDA ESTÁ SATISFEITO COM:	Muito insatisfeito(a)	Moderadamente insatisfeito(a)	Ligeiramente insatisfeito(a)	Ligeiramente satisfeito(a)	Moderadamente satisfeito(a)	Muito satisfeito(a)
1.	A sua saúde?	1	2	3	4	5	6
2.	Os seus cuidados de saúde?	1	2	3	4	5	6
3.	A quantidade de dor que sente?	1	2	3	4	5	6
4.	A energia que tem para as atividades diárias?	1	2	3	4	5	6
5.	A capacidade de cuidar de si sem precisar de ajuda?	1	2	3	4	5	6
6.	À capacidade de se deslocar a sítios fora da sua casa?	1	2	3	4	5	6
7.	À sua capacidade expetorar, limpando os seus pulmões?	1	2	3	4	5	6
8.	O grau de controlo que tem sobre a sua vida?	1	2	3	4	5	6
9.	Às hipóteses que tem de viver tanto tempo quanto desejaria?	1	2	3	4	5	6
10.	A saúde da sua família?	1	2	3	4	5	6
11.	Os seus filhos?	1	2	3	4	5	6
12.	A capacidade de ter filhos?	1	2	3	4	5	6
13.	A felicidade da sua família?	1	2	3	4	5	6
14.	A sua vida sexual?	1	2	3	4	5	6
15.	O seu cônjuge, namorado/a ou companheiro/a (caso tenha um/a)?	1	2	3	4	5	6
16.	Não ter um cônjuge, namorado/a ou companheiro/a (caso não tenha um/uma)?	1	2	3	4	5	6
17.	Os seus amigos?	1	2	3	4	5	6

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EM QUE MEDIDA ESTÁ SATISFEITO COM:		Muito insatisfeito(a)	Moderadamente insatisfeito(a)	Ligeiramente insatisfeito(a)	Ligeiramente satisfeito(a)	Moderadamente satisfeito(a)	Muito satisfeito(a)
18.	O apoio emocional que recebe por parte da sua família?	1	2	3	4	5	6
19.	O apoio emocional que recebe por parte de outras pessoas que não os seus familiares	1	2	3	4	5	6
20.	À sua capacidade de cumprir com as responsabilidades familiares?	1	2	3	4	5	6
21.	Ser útil para os outros?	1	2	3	4	5	6
22.	À quantidade de preocupações que tem na sua vida?	1	2	3	4	5	6
23.	A sua vizinhança (vizinhos/ ambiente onde vive)?	1	2	3	4	5	6
24.	A sua casa, apartamento ou local onde vive?	1	2	3	4	5	6
25.	O seu emprego (caso esteja empregado)?	1	2	3	4	5	6
26.	O facto de não ter um emprego (caso esteja desempregado, reformado ou incapacitado)?	1	2	3	4	5	6
27.	A sua educação?	1	2	3	4	5	6
28.	A forma com que consegue tomar conta das suas necessidades financeiras?	1	2	3	4	5	6
29.	O que faz por divertimento?	1	2	3	4	5	6
30.	As hipóteses de ter um futuro feliz?	1	2	3	4	5	6
31.	A sua paz de espírito?	1	2	3	4	5	6
32.	A sua fé em Deus?	1	2	3	4	5	6
33.	A concretização dos seus objetivos pessoais?	1	2	3	4	5	6
34.	A sua felicidade no geral?	1	2	3	4	5	6
35.	A sua vida no geral?	1	2	3	4	5	6
36.	A sua aparência pessoal?	1	2	3	4	5	6
37.	A si mesmo no geral?	1	2	3	4	5	6

(Por favor continue na página seguinte)

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PARTE 2. Para cada uma das seguintes perguntas, escolha a resposta que melhor define o grau de ***importância*** que dá à área da sua vida em questão. Por favor assinale a sua resposta com um círculo à volta do número. Não há respostas certas nem erradas.

EM QUE MEDIDA É IMPORTANTE PARA SI:		Muito insignificante	Moderadamente insignificante	Ligeiramente insignificante	Ligeiramente importante	Moderadamente importante	Muito importante
1.	A sua saúde?	1	2	3	4	5	6
2.	Os seus cuidados de saúde?	1	2	3	4	5	6
3.	Não sentir dores?	1	2	3	4	5	6
4.	Ter energia suficiente para as atividades diárias?	1	2	3	4	5	6
5.	Cuidar de si sem precisar de ajuda?	1	2	3	4	5	6
6.	Conseguir deslocar-se a sítios fora da sua casa?	1	2	3	4	5	6
7.	A sua capacidade expetorar, limpando os seus pulmões?	1	2	3	4	5	6
8.	Ter controlo sobre a sua vida?	1	2	3	4	5	6
9.	Viver tanto tempo quanto gostaria?	1	2	3	4	5	6
10.	A saúde da sua família?	1	2	3	4	5	6
11.	Os seus filhos?	1	2	3	4	5	6
12.	Capacidade de ter filhos?	1	2	3	4	5	6
13.	A felicidade da sua família?	1	2	3	4	5	6
14.	A sua vida sexual?	1	2	3	4	5	6
15.	O seu cônjuge, namorado/a ou companheiro/a (caso tenha um/a)?	1	2	3	4	5	6
16.	Ter um cônjuge, namorado/a ou companheiro/a (caso não tenha um/a)?	1	2	3	4	5	6
17.	Os seus amigos?	1	2	3	4	5	6

(Por favor continue na página seguinte)

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EM QUE MEDIDA É IMPORTANTE PARA SI:	Muito insignificante	Moderadamente insignificante	Ligeiramente insignificante	Ligeiramente importante	Moderadamente importante	Muito importante
18. O apoio emocional que recebe por parte da sua família?	1	2	3	4	5	6
19. O apoio emocional que recebe por parte de outras pessoas que não os seus familiares	1	2	3	4	5	6
20. Cumprir com as responsabilidades familiares?	1	2	3	4	5	6
21. Ser útil para os outros?	1	2	3	4	5	6
22. Não ter preocupações?	1	2	3	4	5	6
23. A sua vizinhança (vizinhos/ ambiente onde vive)?	1	2	3	4	5	6
24. A sua casa, apartamento ou local onde vive?	1	2	3	4	5	6
25. O seu emprego (caso esteja empregado/a)?	1	2	3	4	5	6
26. Ter um emprego (caso esteja desempregado/a, reformado/a ou incapacitado/a)?	1	2	3	4	5	6
27. A sua educação?	1	2	3	4	5	6
28. Ser capaz de tomar conta das suas necessidades financeiras?	1	2	3	4	5	6
29. Fazer coisas por divertimento?	1	2	3	4	5	6
30. Ter um futuro feliz?	1	2	3	4	5	6
31. A paz de espírito?	1	2	3	4	5	6
32. A sua fé em Deus?	1	2	3	4	5	6
33. Concretizar os seus objetivos pessoais?	1	2	3	4	5	6
34. A sua felicidade no geral?	1	2	3	4	5	6
35. Estar satisfeito/a com a vida?	1	2	3	4	5	6
36. A sua aparência pessoal?	1	2	3	4	5	6
37. Você mesmo/a?	1	2	3	4	5	6

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Evaluación de la Satisfacción del Usuario con las Ayudas Técnicas. Encuesta Quebec

QUEST (Versión 2.0) traducción para Castellano

© L.Demers, R.Weiss-Lambrou, B.Ska, 2000[1] – versión en castellano por João Guerreiro 2013

Ayuda Técnica: ________________________________

Nombre del usuario: ____________________________

Fecha de la evaluación: _________________________

El objetivo de la encuesta **QUEST** es de evaluar cuanto satisfecho usted está con su ayuda técnica y con los servicios relacionados que usted ha experimentado. El cuestionario consiste de 12 ítems de satisfacción.

- Para cada uno de los 12 ítems, valore su satisfacción con sus ayudas técnicas y servicios relacionados que experimentó utilizando la siguiente escala de 1 a 5.

1	2	3	4	5
Nada satisfecho	Poco satisfecho	Mediamente satisfecho	Satisfecho	Bastante satisfecho

- Marque con un círculo el número que mejor describe su grado de satisfacción con cada uno de los 12 ítems.
- **No** deje preguntas sin respuesta
- Para cualquier ítem con lo que usted no ha sido "*bastante satisfecho*", comente en la sección de ***comentarios***.

Gracias por haber rellanado el cuestionario QUEST.

[1] Demers L, Weiss-Lambrou R, Ska B. *The Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0): An overview and recent progress.* Technology and Disability 2004; 14:101-105

1	2	3	4	5
Nada satisfecho	Poco satisfecho	Mediamente satisfecho	Satisfecho	Bastante satisfecho

AYUDA TECNICA ***¿Cuánto de satisfecho está usted con,***	
1. Las dimensiones (tamaño, altura, anchura, largura) de su ayuda técnica? *Comentarios:*	1 2 3 4 5
2. El peso de su ayuda técnica? *Comentarios:*	1 2 3 4 5
3. La facilidad de ajuste (Fijación, unión) de las partes de la ayuda técnica? *Comentarios:*	1 2 3 4 5
4. La seguridad de la ayuda técnica? *Comentarios:*	1 2 3 4 5
5. La durabilidad (resistencia, resistencia al desgaste) de la ayuda técnica? *Comentarios:*	1 2 3 4 5
6. La facilidad de utilizar la ayuda técnica? *Comentarios:*	1 2 3 4 5
7. Con el conforto de la ayuda técnica? *Comentarios:*	1 2 3 4 5
8. Con la eficacia de la ayuda técnica (el grado en el que la ayuda técnica se adapte a sus necesidades)? *Comentarios:*	1 2 3 4 5

1	2	3	4	5
Nada satisfecho	Poco satisfecho	Mediamente satisfecho	Satisfecho	Bastante satisfecho

SERVICIOS ***¿Cuánto de satisfecho está usted con,***	
9. El **proceso de entrega** (procedimientos, tempo que tarda) para obtener la ayuda técnica? *Comentarios:*	1 2 3 4 5
10. Las **reparaciones y servicio** (manutención) providenciado con la ayuda técnica? *Comentarios:*	1 2 3 4 5
11. La calidad de los **servicios profesionales** (información, atención) que recibe por utilizar la ayuda técnica? *Comentarios:*	1 2 3 4 5
12. Los servicios de **acompañamiento** (servicios de suporte permanente) recibidos para la ayuda técnica? *Comentarios:*	1 2 3 4 5

- Abajo esta la lista de los 12 ítems de satisfacción. por favor, **ELIJA LOS TRES ÍTEMS** que usted considera los más importantes. Por favor, coloque una X en las 3 cajas de su elección.

☐	1. Dimensiones	☐	7. Conforto
☐	2. Peso	☐	8. Eficacia
☐	3. Ajustes	☐	9. Proceso de entrega
☐	4. Seguridad	☐	10. Reparaciones y servicio
☐	5. Durabilidad	☐	11. Servicios profesionales
☐	6. Facilidad de uso	☐	12. Acompañamiento

QUEST

Hoja de cálculo

Esta página es para calcular las respuestas a las cuestiones

NO ESCRIBA EN ESTA PÁGINA

Numero de respuestas no validas____ [ ]

Sub escala del **aparato** ____ [ ]

Para los ítems 1 a 8, adicione las calificaciones de las respuestas validas y divida este soma por el número de ítems validos en la escala.

Calculo de sub escala de los **servicios**___________________________________ [ ]

Para los ítems 9 a 12, adicione las calificaciones de las respuestas validas y divida este soma por el numero de ítems validos en esta escala

Puntuación total del QUEST ____ [ ]
Para los ítems 1 a 12, adicione las calificaciones de las respuestas validas y divida este soma por el número de ítems validos.

Los 3 ítems más importantes de satisfacción:

____

____

____

DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Participação em estudo transfronteiriço sobre desporto adaptado e lesão medular

Por favor, leia com atenção a seguinte declaração e caso concorde em participar no estudo de sua livre vontade, rubrique a primeira pagina e assine a segunda.

O investigador João Miguel Guerreiro encontra-se a realizar uma tese de doutoramento intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* num projeto transfronteiriço de enfoque sobre o desporto adaptado e lesão medular. Este estudo é realizado entre as regiões do Algarve, Huelva, Sevilha e Cádis, em pessoas com paraplegia e com diferentes níveis de atividade física. Envolve o preenchimento de questionários validados para a população portuguesa nos campos da dor no ombro em utilizadores de cadeiras de rodas, nível de atividade física em pessoas com incapacidade física, grau de satisfação com as ajudas técnicas e perceção da qualidade de vida em pessoas com lesão medular, para que seja realizada uma correlação dos fatores mais importantes associados com as pessoas com paraplegia e que utilizam cadeira de rodas manual.

Dentro do mesmo estudo serão ainda realizadas medições da força isométrica estática dos membros superiores com um dinamómetro, realizadas medições antropométricas do participante e avaliação/ classificação da cadeira de rodas manual que utiliza.

Para a força estática serão realizadas medições (três medições) de abdução, flexão, extensão, rotação interna e rotação externa dos membros superiores. Será feita uma avaliação da cadeira de rodas com base nos componentes, marca, modelo, características e dimensões que apresenta e realização medições antropométricas envolvem a medição de larguras, comprimentos e alturas dos utilizadores, para estabelecermos os valores médios de determinadas medidas chave. Estas medições e avaliações têm como objetivo uma recolha mais ampla de dados sobre a população com lesão medular, permitir uma correlação mais ampla da informação e permitir um desenvolvimento mais preciso de trabalhos futuros na área da atividade física adaptada, cadeiras de rodas manuais e reabilitação de pessoas com lesão medular.

A participação neste estudo é anonima e voluntária, demora cerca de 120 minutos e envolve o preenchimento de quatro questionários e a avaliação/ medição de força estática, de medições antropométricas e da avaliação das cadeiras de rodas manuais. No que respeita aos questionários, todas as respostas serão tratadas de forma confidencial e os participantes individuais nunca serão identificados uma vez que todos os dados serão agregados e publicados de forma conjunta. Não existe riscos para os participantes, para além dos que se poderão encontrar na vida diária.

Os participantes poderão sair do estudo a qualquer momento e a recusa em participar não trará consequências ou perda de benefícios a que de outra forma tenham direito. Os resultados obtidos poderão vir a ser utilizados para futura publicação científica/ investigação.

Eu, ____, abaixo assinado, declaro ter lido e entendido a informação descrita acima, confirmo ter sido devidamente esclarecido sobre os objetivos e riscos do estudo. Tomei conhecimento que de acordo com as recomendações da Declaração de Helsínquia, a informação que me foi prestada versou os objetivos, métodos e o eventual desconforto da avaliação.

Desta forma, aceito participar neste estudo, respondendo às questões propostas e permitindo a recolha de informações. E aceito/ não aceito disponibilizar (riscar o que não interessa) o meu contacto de correio eletrónico __________________________ para receber os resultados do estudo.

Assinatura do investigador	Assinatura do participante
__________________________	__________________________

Data: ___/___/_____

O investigador está disponível para eventuais esclarecimentos através do contacto de correio eletrónico jmguerreiro@ualg.pt ou pelo telemóvel 968076445.

DECLARACIÓN DE CONSENTIMIENTO INFORMADO

Participación en estudio transfronterizo sobre deporte adaptado y lesión medular

Por favor, leía con atención la declaración que se sigue y caso concorde en participar en el estudio de libre voluntad, firme las dos páginas del documento.

El investigador João Miguel Guerreiro se encuentra a realizar una tesis doctoral intitulada de *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* en un proyecto transfronterizo de enfoque en el deporte adaptado y lesión medular. Este estudio es realizado entre las regiones de Algarve y Alentejo (Portugal) y las provincias de Huelva Sevilla y Cadis, en personas con paraplejía y diferentes niveles de actividad física. Requiere que sean rellenados cuestionarios validados para la población española en los campos del dolor de hombro en usuarios de sillas de ruedas, nivel de actividad física en personas con incapacidad física, grado de satisfacción con las ayudas técnicas y percepción de calidad de vida en personas con lesión medular, para que sea hecha una correlación de los factores más importantes asociados con las personas con paraplejía y que utilizan silla de ruedas manual.

En el mismo estudio van a ser realizadas mediciones de fuerza isométrica estática de los miembros superiores con un dinamómetro, mediciones de antropometría de los participantes y evaluación/ clasificación de la silla de ruedas manual que utiliza.

Para la medición de fuerza estática serán realizadas mediciones (tres mediciones) de abducción, flexión, extensión, rotación interna e rotación externa de los miembros superiores. Va a ser hecha una evaluación de la silla de ruedas con base en los componentes, marca, modelo, características y dimensiones que presenta y realización de mediciones antropométricas que requieren la medición de larguras, anchos y alturas de los usuarios para establecerse los valores medios de determinadas medidas clave. Estas mediciones y evaluaciones tiene como objetivo una recogida más amplia de datos de la población con lesión medular, permitir una correlación más amplia de la información y de permitir un desarrollo más preciso de trabajos futuros en el área de actividad física adaptada, sillas de ruedas manuales y rehabilitación de personas con lesión medular.

La participación en este estudio es anónima y voluntaria, tarda cerca de 120 minutos y requiere que se rellenen cuatro cuestionarios y la evaluación/ medición de fuerza estática, de mediciones antropométricas y de evaluación de silla de ruedas manual. Relativamente a los cuestionarios, todas las respuestas serán tratadas de forma confidencial y los participantes individuales nunca serán identificados una vez que todos los datos serán agregados y publicados de forma conjunta. No hay riegos para los participantes, además de los que se podrán encontrar en la vida diaria.

Los participantes podrán salir del estudio a cualquier momento y la recusa en participar no va a traer consecuencias o perdida de beneficencias que de otra forma tengan derecho. Los resultados obtenidos podrán ser utilizados para futura publicación científica/ investigación.

Yo, ____, firmado abajo, declaro haber leído y entendido la información descrita arriba, confirmo tener sido debidamente aclarado sobre los objetivos y riesgos del estudio. He tomado conocimiento de que segundo las recomendaciones de la Declaración de Helsinki, la información que me ha sido descrita incluye los objetivos, métodos y la eventual molestia de la evaluación.

Por lo tanto, acepto participar en este estudio, respondiendo a las cuestiones solicitadas y permitiendo la recorrida de información. Y acepto/ no acepto presentar (riscar lo que no interesa) mi contacto de correo electrónico _________________________ para recibir los resultados del estudio.

Firma del investigador   Firma del participante

_________________________   _________________________

Fecha: ___/___/_____

El investigador está disponible para aclarar posibles dudas a través del contacto de correo electrónico jmguerreiro@ualg.pt o por el móvil (+351) 968076445.

DECLARACIÓN DE CONSENTIMIENTO INFORMADO

Traducción y validación de la versión española (castellano) del *Quebec User Evaluation of Satisfaction with Assistive Technology 2.0*

Por favor, leía con atención la declaración que se sigue y firme caso concorde en participar en el estudio de forma voluntaria.

El investigador João Miguel Guerreiro se encuentra a realizar su tesis doctoral intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* en un proyecto transfronterizo de enfoque sobre el deporte adaptado y en la lesión medular.

La primera fase del estudio requiere la traducción y validación cultural para la población española de escalas internacionales teniendo en cuenta las líneas orientadoras para estos estudios donde se destacan las fases de traducción, traducción de vuelta, aprobación de la versión traducida por un comité de expertos y aplicación del cuestionario a un muestreo de participantes.

La participación en este estudio es anónima, demora cerca de 15 minutos y pedimos que rellene el cuestionario en dos momentos (el test y retest), en una diferencia máxima de 15 días. Todas las respuestas al cuestionario van a ser tratadas de forma confidencial y los participantes individuales nunca serán identificados porque los datos serán agregados y publicados de forma conjunta. No existen riesgos para los participantes además de los que se podrán encontrar en la vida diaria. Los resultados obtenidos podrán ser utilizados para futura publicación científica/ investigación.

La participación es voluntaria, los participantes podrán salir del estudio a cualquier momento y la recusa en participar no trae consecuencias o perdida de beneficios de que de otra forma tengan derecho.

Yo, ____, que firmo abajo, declaro haber leído y comprehendido la información descrita arriba, confirmo haber sido debidamente aclarado respecto a los objetivos y riesgos del estudio. He tomado conocimiento que de acuerdo con las recomendaciones de la Declaración de Helsínquia, la información que me ha sido fornecida engloba los objetivos, métodos y eventual molestia de la evaluación.

De esta forma, acepto participar en este estudio, contestando a las preguntas que me son pedidas y permitiendo la recorrida de informaciones. Y acepto/ no acepto fornecer (riscar lo que no interesa) mi contacto de correo electrónico ____________________ para recibir los resultados del estudio.

Firma del investigador	Firma del participante
________________________	________________________

Fecha: ___/___/_____

El investigador está disponible para aclarar cualquier duda que usted tenga a través del contacto de correo electrónico jmguerreiro@ualg.pt o por el móvil (+351)968076445.

DECLARACIÓN DE CONSENTIMIENTO INFORMADO

Traducción y validación de la versión española (castellano) de la versión III para lesión medular del cuestionario Ferrans & Powers de Calidad de Vida

Por favor, leía con atención la declaración que se sigue y firme caso concorde en participar en el estudio de forma voluntaria.

El investigador João Miguel Guerreiro se encuentra a realizar su tesis doctoral intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* en un proyecto transfronterizo de enfoque sobre el deporte adaptado y en la lesión medular.

La primera fase del estudio requiere la traducción y validación cultural para la población española de escalas internacionales teniendo en cuenta las líneas orientadoras para estos estudios donde se destacan las fases de traducción, traducción de vuelta, aprobación de la versión traducida por un comité de expertos y aplicación del cuestionario a un muestreo de participantes.

La participación en este estudio es anónima, demora cerca de 15 minutos y pedimos que rellene el cuestionario en dos momentos (el test y retest), en una diferencia máxima de 15 días. Todas las respuestas al cuestionario van a ser tratadas de forma confidencial y los participantes individuales nunca serán identificados porque los datos serán agregados y publicados de forma conjunta. No existen riesgos para los participantes además de los que se podrán encontrar en la vida diaria. Los resultados obtenidos podrán ser utilizados para futura publicación científica/ investigación.

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Firma del investigador	Firma del participante
________________________	________________________

Fecha: ___/___/_____

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DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Tradução e validação da versão portuguesa do questionário *Quality of Life Index (Ferrans & Powers) SCI Version III*

Por favor, leia com atenção a seguinte declaração e assine se concorda em participar no estudo de sua livre vontade.

O investigador João Miguel Guerreiro encontra-se a realizar uma tese de doutoramento intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* num projeto transfronteiriço de enfoque sobre o desporto adaptado e lesão medular.

A primeira fase do estudo envolve a tradução e validação cultural para população portuguesa de duas escalas internacionais tendo conta as linhas orientadoras para estes estudos onde se destaca as fases de tradução, retradução, aprovação da versão traduzida por painel de peritos e aplicação da escala a uma amostra de participantes.

A participação neste estudo é anonima, demorará cerca de 15 minutos e envolve o preenchimento do instrumento em dois momentos (o teste e o reteste), numa diferença máxima de 15 dias. Todas as respostas ao questionário serão tratadas de forma confidencial e os participantes individuais nunca serão identificados uma vez que todos os dados serão agregados e publicados de forma conjunta. Não existe riscos para os participantes, para além dos que se poderão encontrar na vida diária. Os resultados obtidos poderão vir a ser utilizados para futura publicação científica/ investigação.

A participação é voluntária, os participantes poderão sair do estudo a qualquer momento e a recusa em participar não trará consequências ou perda de benefícios a que de outra forma tenham direito.

Eu, ____, abaixo assinado, declaro ter lido e entendido a informação descrita acima, confirmo ter sido devidamente esclarecido sobre os objetivos e riscos do estudo. Tomei conhecimento que de acordo com as recomendações da Declaração de Helsínquia, a informação que me foi prestada versou os objetivos, métodos e o eventual desconforto da avaliação.

Desta forma, aceito participar neste estudo, respondendo às questões propostas e permitindo a recolha de informações. E aceito/ não aceito disponibilizar (riscar o que não interessa) o meu contacto de correio eletrónico ________________________ para receber os resultados do estudo.

Assinatura do investigador	Assinatura do participante
________________________	________________________

Data: ___/___/_____

O investigador está disponível para eventuais esclarecimentos através do contacto de correio eletrónico jmguerreiro@ualg.pt ou pelo telemóvel 968076445.

DECLARACIÓN DE CONSENTIMIENTO INFORMADO

Traducción y validación de la versión española (castellano) del PA Scale for People with Physical disabilities

Por favor, leía con atención la declaración que se sigue y firme caso concorde en participar en el estudio de forma voluntaria.

El investigador João Miguel Guerreiro se encuentra a realizar su tesis doctoral intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* en un proyecto transfronterizo de enfoque sobre el deporte adaptado y en la lesión medular.

La primera fase del estudio requiere la traducción y validación cultural para la población española de escalas internacionales teniendo en cuenta las líneas orientadoras para estos estudios donde se destacan las fases de traducción, traducción de vuelta, aprobación de la versión traducida por un comité de expertos y aplicación del cuestionario a un muestreo de participantes.

La participación en este estudio es anónima, demora cerca de 15 minutos y pedimos que rellene el cuestionario en dos momentos (el test y retest), en una diferencia máxima de 15 días. Todas las respuestas al cuestionario van a ser tratadas de forma confidencial y los participantes individuales nunca serán identificados porque los datos serán agregados y publicados de forma conjunta. No existen riesgos para los participantes además de los que se podrán encontrar en la vida diaria. Los resultados obtenidos podrán ser utilizados para futura publicación científica/ investigación.

La participación es voluntaria, los participantes podrán salir del estudio a cualquier momento y la recusa en participar no trae consecuencias o perdida de beneficios de que de otra forma tengan derecho.

Yo, ____, que firmo abajo, declaro haber leído y comprehendido la información descrita arriba, confirmo haber sido debidamente aclarado respecto a los objetivos y riesgos del estudio. He tomado conocimiento que de acuerdo con las recomendaciones de la Declaración de Helsínquia, la información que me ha sido fornecida engloba los objetivos, métodos y eventual molestia de la evaluación.

De esta forma, acepto participar en este estudio, contestando a las preguntas que me son pedidas y permitiendo la recorrida de informaciones. Y acepto/ no acepto fornecer (riscar lo que no interesa) mi contacto de correo electrónico ____________________ para recibir los resultados del estudio.

Firma del investigador	Firma del participante
________________________	________________________

Fecha: ___/___/_____

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DECLARAÇÃO DE CONSENTIMENTO INFORMADO

Tradução e validação da versão portuguesa do *PA Scale for People with Physical Disabilities*

Por favor, leia com atenção a seguinte declaração e assine se concorda em participar no estudo de sua livre vontade.

O investigador João Miguel Guerreiro encontra-se a realizar uma tese de doutoramento intitulada *Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas* num projeto transfronteiriço de enfoque sobre o desporto adaptado e lesão medular.

A primeira fase do estudo envolve a tradução e validação cultural para população portuguesa de duas escalas internacionais tendo conta as linhas orientadoras para estes estudos onde se destaca as fases de tradução, retradução, aprovação da versão traduzida por painel de peritos e aplicação da escala a uma amostra de participantes.

A participação neste estudo é anonima, demorará cerca de 15 minutos e envolve o preenchimento do instrumento em dois momentos (o teste e o reteste), numa diferença máxima de 15 dias. Todas as respostas ao questionário serão tratadas de forma confidencial e os participantes individuais nunca serão identificados uma vez que todos os dados serão agregados e publicados de forma conjunta. Não existe riscos para os participantes, para além dos que se poderão encontrar na vida diária. Os resultados obtidos poderão vir a ser utilizados para futura publicação científica/ investigação.

A participação é voluntária, os participantes poderão sair do estudo a qualquer momento e a recusa em participar não trará consequências ou perda de benefícios a que de outra forma tenham direito.

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Desta forma, aceito participar neste estudo, respondendo às questões propostas e permitindo a recolha de informações. E aceito/ não aceito disponibilizar (riscar o que não interessa) o meu contacto de correio eletrónico _________________________ para receber os resultados do estudo.

Assinatura do investigador   Assinatura do participante

_______________________   _______________________

Data: ___/___/_____

O investigador está disponível para eventuais esclarecimentos através do contacto de correio eletrónico jmguerreiro@ualg.pt ou pelo telemóvel 968076445.

Folha de recolhas

VALORES DE FORÇA ESTÁTICA

Movimento		Medições do Membro Superior Esquerdo			Medições do Membro Superior Direito		
		Força (Kg)	Pico (s)	Tempo (s)	Força (Kg)	Pico (s)	Tempo (s)
Flexão do ombro	1						
	2						
	3						
Extensão do ombro	1						
	2						
	3						
Abdução do ombro	1						
	2						
	3						
Rotação lateral do ombro	1						
	2						
	3						
Rotação medial do ombro	1						
	2						
	3						
Flexão do cotovelo	1						
	2						
	3						
Extensão do cotovelo	1						
	2						
	3						

MEDIÇÕES ANTROPOMÉTRICAS

Medições	Valores	Medições	Valores
Estatura (sentado)		Largura das coxas	
Largura do cotovelo		Largura dos braços	
Altura ao nível dos olhos		Largura do tórax	
Altura do ombro		Largura biacromial	
Altura do joelho		Altura do calcanhar	
Altura poplítea		Comprimento poplíteo	
Altura do cotovelo		Distancia dos glúteos aos joelhos	
Distancia do antebraço à mão		Comprimento do braço	
Alcance anterior		Alcance lateral	
Alcance inferior		Alcance Superior	

Protocolo de ergometria

Realização de 3 medições para cada atividade e para cada membro. Cada medição tem uma duração de 5 a 7 segundos com um descanso de máximo de 30 segundos entre cada. Será promovido o encorajamento durante cada medição, será feita estabilização para evitar movimentos compensatórios e sempre que ocorra algum movimento desse tipo a atividade é interrompida.

Hoja de medidas

VALORES DE FUERZA ESTÁTICA

Movimiento		Mediciones del Miembro Superior Izquierdo			Mediciones del Miembro Superior Derecho		
		Fuerza (Kg)	Pico (s)	Tiempo (s)	Fuerza (Kg)	Pico (s)	Tiempo (s)
Flexión de hombro	1						
	2						
	3						
Extensión de hombro	1						
	2						
	3						
Abducción de hombro	1						
	2						
	3						
Rotación lateral del hombro	1						
	2						
	3						
Rotación medial del hombro	1						
	2						
	3						
Flexión del codo	1						
	2						
	3						
Extensión del codo	1						
	2						
	3						

MEDICIONES ANTROPOMÉTRICAS

Mediciones	Valores	Mediciones	Valores
Estatura (sentado)		Ancho de las coxas	
Altura de los ojos		Ancho de los brazos	
Altura del hombro		Ancho del tórax	
Altura del codo		Ancho do codo	
Altura poplítea		Ancho biacromial	
Altura de la rodilla		Largo poplíteo	
Largo del brazo		Distancia dos glúteos a las rodillas	
Distancia do antebrazo a la mano		Altura del pie	
Alcance Superior		Alcance anterior	
Alcance inferior		Alcance lateral	

Protocolo de ergometría

Realización de 3 mediciones para cada actividad y para cada miembro. Cada medición tiene una duración de 5 a 7 segundos con un descanso máximo de 30 segundos entre cada. Será promovido el incentivo durante cada medición, va a ser hecha estabilización para evitar movimientos compensatorios y siempre que haya alguno movimiento de ese tipo, la actividad es interrumpida.

Análise e avaliação da cadeira de rodas

DIMENSÕES DA CADEIRA DE RODAS			
Componente	Dimensões (cm)	Componente	Dimensões (cm)
Altura do encosto		Altura do braço	
Altura do assento		Diâmetro das rodas traseiras	
Largura do assento		Diâmetro das rodas dianteiras	
Comprimento do assento		Diâmetro do aro de propulsão	
Comprimento das pernas			

ANÁLISE DO TIPO DE CADEIRA DE RODAS

Marca		
Modelo		
Tipo		
Peso		
Material principal		
Material das rodas traseiras		
Anos desde a aquisição da primeira cadeira de rodas		
Mantem a mesma cadeira de rodas?	☐ Sim	☐ Não
A cadeira de rodas apresenta uma almofada anti – escaras?	☐ Sim	☐ Não

Analice y evaluación de sillas de ruedas

DIMENSIONES DA SILLA DE RUEDAS			
Componente	Dimensiones (cm)	Componente	Dimensiones (cm)
Altura del respaldo		Altura del brazo	
Altura del asiento		Diámetro das ruedas traseras	
Ancho do asiento		Diámetro das ruedas delanteras	
Largo del asiento		Diámetro do aro de propulsión	
Largo de las piernas			

ANÁLISE DEL TIPO DE SILLA DE RUEDAS

Marca		
Modelo		
Tipo		
Peso		
Material principal		
Material das ruedas traseras		
Anos desde la adquisición de la primera silla de ruedas		
¿Mantiene la misma silla de ruedas?	☐ Si	☐ No
¿La silla de ruedas presenta cojín anti escaras?	☐ Si	☐ No

João Miguel Quintino Guerreiro
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Directores
José Tierra Orta (Universidad de Huelva)
Pedro Sáenz - López Buñuel (Universidad de Huelva)
Sandra Pais (Universidad del Algarve)

Convite à la participación en estudio transfronterizo sobre actividad física en lesión medular

Estimados lectores,
Soy docente en la Área Departamental de Ortoprotesia de la Escuela Superior de Salud de la Universidad del Algarve y es el área responsable por desarrollar, adaptar y aplicar protésica, ortésica y ayudas técnicas a la movilidad, como el ejemplo de las sillas de ruedas manuales (SRM). Es reconocida como una licenciatura en Portugal y otros países europeos como Reino Unido, Bélgica u Holanda.
Después de terminar el máster oficial en Actividad Físico – Deportiva en la Universidad de Huelva, he decidido compartir las dos áreas y desarrollar un proyecto direccionado a la promoción de actividad física en personas con discapacidad física. De la revisión de bibliografía, constato que la propulsión de la SRM es una actividad que requiere un elevado esfuerzo físico al largo del día para superar los obstáculos y asociado a esto surge el dolor crónica de hombro, cerca de dos anos después a la lesión medular (LM), limitando la adhesión al deporte adaptado. Pero la actividad física presenta un factor importante en la promoción de la calidad de vida y autonomía en la propulsión de la SRM.
De hecho, surge la necesidad de desarrollar un trabajo de investigación que intenta comprender la relación entre los componentes de la SRM, antropometría, evaluación biomecánica del miembro superior, calidad de vida, presencia de dolor crónica de hombro y nivel de actividad física.
Estoy desarrollando la tesis doctoral titulada de Estudio transfronterizo para la inclusión de personas con lesión medular en actividades físicas que se divide en dos fases. La primera fase se desarrolló a lo largo del año de 2013 e inicio de 2014, con la traducción y validación de cuestionarios internacionales y que la contado con la colaboración de asociaciones y clubes de deporte adaptado de Extremadura.
La segunda fase es el estudio transfronterizo entre Portugal (Algarve y Alentejo) y España (Huelva, Sevilla y Cádiz) y tiene como objetivo la comprensión del grado de participación de personas con LM en actividades físicas a través de la evaluación y correlación de dolor de hombro, nivel de actividad física, satisfacción con la SRM utilizada y percepción de calidad de vida. Son también realizadas mediciones de fuerza de miembro superior, mediciones de los componentes de las sillas de ruedas y mediciones antropométricas de los participantes.
Este estudio pretende describir y correlacionar los principales factores de las personas que utilizan SRM, observar como están relacionados para ayudar a desarrollar nuevas adaptaciones en SRM para reducir las limitaciones funcionales y dificultad de propulsión de SRM.
Al desarrollar las actividades a nivel transfronterizo se pretende acercar Algarve, Alentejo y Andalucía, promover la cooperación, permitir que se estudie los factores más importantes en el uso de una SRM, conocimiento más pormenorizado de las de la relación de estos factores en LM en esta área, para una mejor la inclusión, disminución de barreras y innovar en las SRM, promoviendo la calidad de vida y bien – estar.
Invito todos los lectores a participar para que el número de participantes sea el mayor posible, los resultados sean más representativos y por lo tanto las conclusiones puedan ayudar a mejorar y adaptar las SRM. Para la participación en el estudio, las personas deben presentar paraplejia, (lesión bajo de T1), mínimo de dos años pasado desde la lesión, ser adulto y utilizar una SRM para desplazamiento.
Agradezco a los clubes de EM Vista Azul Dos Hermanas, Club de Deporte Adaptado Bahía de Cádiz, Portufísico – S. L., Asociación ADIFLE (Lepe) y demás participantes individuales por la colaboración hasta el momento.

Saludos cordiales

Table 58

Chi square analysis

	1	2	3	4	5	6	7	8	9	10
2	1,010 Sig. 0,315									
3	2,836 Sig. 0,725	52 Sig. 0,000								
4	2,246 Sig. 0,691	5,872 Sig. 0,209	20,432 Sig. 0,432							
5	1,926 Sig. 0,382	2,799 Sig. 0,247	14,729 Sig. 0,142	13,327 sig. ,101						
6	,012 Sig. 0,911	2,849 Sig. 0,091	3,639 Sig. 0,602	3,27 Sig. 0,514	2,103 Sig. 0,349					
7	,244 Sig. 0,885	1,93 Sig. 0,381	6,012 Sig. 0,814	12,089 Sig. 0,147	4,836 Sig. 0,305	1,709 Sig. 0,425				
8	,012 Sig. 0,911	0,008 Sig. 0,927	2,578 Sig. 0,765	4,642 Sig. 0,326	2,401 Sig. 0,301	2,66 Sig. 0,103	35,234 Sig. 0,000			
9	3,613 Sig. 0,057	10,237 Sig. 0,001	13,672 Sig. 0,018	1,295 Sig. 0,862	1,367 Sig. 0,505	2,559 sig. 0,110	0,4 Sig. 0.819	0,018 Sig. 0,894		
10	,508 Sig. 0,476	5,686 Sig. 0	5,75 Sig. 0,331	7,277 Sig. 0,122	4,763 Sig. 0,092	3,656 Sig. 0,056	0,601 Sig. 0,740	0,131 Sig. 0,718	6,561 Sig. 0,010	
11	Sig. 0	28,808 Sig. 0,025	87,236 Sig. 0,272	39,073 Sig. 0,994	26,812 Sig. 0,727	21,215 Sig. 0,170	23,205 Sig. 0,872	12,496 Sig. 0,709	25,833 Sig. 0,056	41,484 Sig. 0,000
12	1,850 Sig. 0,396	11,435 Sig. 0,003	21,347 Sig. 0,019	10,236 Sig. 0,249	2,638 Sig. 0,620	4,32 Sig. 0,115	3,788 Sig. 0,435	0,44 Sig. 0,803	7,618 Sig. 0,02	19,868 Sig. 0,000
13	,173 Sig. 0,917	3,525 Sig. 0,172	11,048 Sig. 0,354	4,425 Sig. 0,817	2,999 Sig. 0,558	1,116 Sig. 0,572	3,18 Sig. 0,528	1,786 Sig. 0,409	3,124 Sig. 0,210	13,069 Sig. 0,000
14	7,570 Sig. 0,056	2,394 Sig. 0,495	12,573 Sig. 0,635	7,129 Sig. 0,849	1,806 Sig. 0,937	4,1 Sig. 0,251	3,738 Sig. 0,712	0,895 Sig. 0,827	3,917 Sig. 0,271	5,81 Sig. 0,121
15	,849 Sig. 0,357	1,821 Sig. 0,177	2,805 Sig. 0,730	4,682 Sig. 0,322	1,665 Sig. 0,435	2,809 Sig. 0,094	3,81 Sig. 0,149	0,931 Sig. 0,335	6,107 Sig. 0,013	0,523 Sig. 0,470
16	,173 Sig. 0,677	0,59 Sig. 0,442	6,779 Sig. 0,238	17,355 Sig. 0,002	1,274 Sig. 0,529	0,78 Sig. 0,377	3,795 Sig. 0,150	1,451 Sig. 0,228	0,249 Sig. 0,618	2,543 Sig. 0,111
17	,080 Sig. 0,777	1,263 Sig. 0	5,969 Sig. 0,309	2,695 Sig. 0,610	4,733 Sig. 0,094	0,55 Sig. 0,458	1,056 Sig. 0,590	0,03 Sig. 0,862	1,865 Sig. 0,172	0,4 Sig. 0,527
18	2,080 Sig. 0,149	0,787 sig,375	7,959 Sig. 0,159	3,529 Sig. 0,473	0,148 Sig. 0,929	1,238 Sig. 0,266	0,519 Sig. 0,771	0,31 Sig. 0,578	0,083 Sig. 0,773	0,005 Sig. 0,945
19	,425 Sig. 0,514	0,735 Sig. 0,391	11,425 Sig. 0,044	5,301 Sig. 0,258	1,979 Sig. 0,372	1,607 Sig. 0,205	2,191 Sig. 0,334	0,223 Sig. 0,637	0,036 Sig. 0,850	0,531 Sig. 0,466
20	,130 Sig. 0,718	1,457 Sig. 0,227	1,486 Sig. 0,915	2,081 Sig. 0,721	1,598 Sig. 0,450	3,586 Sig. 0,058	1,428 Sig. 0,490	0,599 Sig. 0,439	1,739 Sig. 0,187	0,381 Sig. 0,537
21	5,118 Sig. 0,024	0,082 Sig. 0,775	4,086 Sig. 0,537	2,577 Sig. 0,631	3,937 Sig. 0,140	4,883 Sig. 0,027	0,579 Sig. 0,749	0,042 Sig. 0,837	0,201 Sig. 0,654	0,08 Sig. 0,777
22	1,457 Sig. 0,227	0,130 Sig. 0,718	4,337 Sig. 0,502	1,69 Sig. 0,793	2,604 Sig. 0,272	0,406 Sig. 0,524	2,375 Sig. 0,305	0,765 Sig. 0,382	0,123 Sig 0,726	7,741 Sig. 0,005

Legend: Gender (1), country (2), Region/province (3), civil state (4), academic degree (5), professional activity (6), SCI level (7), level of paraplegia (8), PA (9), armrest (10)

Table 59

Chi square analysis

	11	12	13	14	15	16	17	18	19	20	21
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12	79,738 Sig. 0,000										
13	76,375 Sig. 0,000	9,858 Sig. 0,007									
14	81,248 Sig. 0,001	22,36 Sig. 0,001	2,618 Sig. 0,454								
15	27,209 Sig. 0,039	0,644 Sig. 0,725	3,647 Sig. 0,161	5,279 Sig. 0,152							
16	21,318 Sig. 0,167	6,933 Sig. 0,031	3,002 Sig. 0,223	3,565 Sig. 0,312	0,009 Sig. 0,924						
17	17,189 Sig. 0,373	1,839 Sig. 0,399	0,772 Sig. 0,680	4,098 Sig. 0,251	0,011 Sig. 0,918	,166 Sig. 0,683					
18	15,397 Sig. 0,496	1,796 Sig. 0,407	1,333 Sig. 0,513	11,091 Sig. 0,011	6,933 Sig. 0,008	1,083 Sig. 0,298	0,08 Sig. 0,777				
19	27,222 Sig. 0,027	6,312 Sig. 0,043	0,024 Sig. 0,878	3,162 Sig. 0,367	2,79 Sig. 0,095	0,886 Sig. 0,347	0,54~ Sig. 0,463	0,047 Sig. 0,828			
20	16,882 Sig. 0	3,837 Sig. 0,147	0,199 Sig. 0,655	1,199 Sig. 0,753	0,877 Sig. 0,349	0,271 Sig. 0,602	2,231 Sig. 0,135	3,315 Sig. 0,069	1,328 Sig. 0,249		
21	18,938 Sig. 0,217	0,784 Sig. 0,676	0,271 Sig. 0,602	0,277 Sig. 0,964	1,194 Sig. 0,275	0,369 Sig. 0,543	0,469 Sig. 0,493	0,002 Sig. 0,967	1,809 Sig. 0,179	15,259 Sig. 0,000	
22	21,133 Sig. 0,133	5,968 Sig. 0,051	4,554 Sig. 0,033	6,674 Sig. 0,083	0,134 Sig. 0,714	,469 Sig. 0,493	0,612 Sig. 0,434	,943 Sig. 0,332	3,934 Sig. 0,047	4,554 Sig. 0,033	,140 Sig. 0,709

Note: company and model (11), MWC type (12), WC type (13), main WC material (14), same WC (15), cushion (16), shoulder pain (17), years since SCI (18), WC weight (19), WC handrim (20), WC seat height (21) and WC backrest height (22).

Table 60
Phi analysis

	1	2	3	4	5	6	7	8	9	10
2	-0,139 Sig. 0,315									
3	0,234 Sig. 0,725	1,000 Sig. 0,000								
4	0,208 Sig. 0,691	0,336 Sig. 0,209	0,627 Sig. 0,432							
5	0,192 Sig. 0,382	0,232 Sig. 0,247	0,532 Sig. 0,142	0,506 Sig. 0,101						
6	0,015 Sig. 0,911	-0,234 Sig. 0,091	0,265 Sig. 0,602	0,251 Sig. 0,514	0,201 Sig. 0,349					
7	0,069 Sig. 0,885	0,193 Sig. 0,381	0,340 Sig. 0,814	0,482 Sig. 0,147	0,305 Sig. 0,305	0,181 Sig. 0,425				
8	-0,015 Sig. 0,911	-0,013 Sig. 0,927	0,223 Sig. 0,765	0,299 Sig. 0,326	0,215 Sig. 0,301	-0,226 Sig. 0,103	0,823 Sig. 0,000			
9	-0,264 Sig. 0,057	0,444 Sig. 0,001	0,5130 Sig. 0,018	0,158 Sig. 0,862	0,162 Sig. 0,505	0,222 Sig. 0,110	0,088 Sig. 0,819	0,018 Sig. 0,894		
10	-0,100 Sig. 0,476	-0,334 Sig. 0,017	0,336 Sig. 0,331	0,378 Sig. 0,122	0,306 Sig. 0,092	-0,268 Sig. 0,056	0,109 Sig. 0,740	0,051 Sig. 0,718	-0,359 Sig. 0,010	
11		0,744 Sig. 0,025	1,295 Sig. 0,272	0,867 Sig. 0,994	0,718 Sig. 0,727	0,639 Sig. 0,170	0,668 Sig. 0,872	0,490 Sig. 0,709	0,705 Sig. 0,056	0,902 Sig. 0,000
12	0,190 Sig. 0,396	11,435 Sig. 0,003	0,647 Sig. 0,019	0,448 Sig. 0,249	0,227 Sig. 0,620	0,291 Sig. 0,115	0,273 Sig. 0,435	,093 Sig. 0,803	0,3862 Sig. 0,022	0,624 Sig. 0,000
13	0,058 Sig. 0,917	0,260 Sig. 0,172	0,461 Sig. 0,354	0,292 Sig. 0,817	0,240 Sig. 0,558	0,146 Sig. 0,572	0,247 Sig. 0,528	0,185 Sig. 0,409	0,245 Sig. 0,210	0,506 Sig. 0,000
14	0,385 Sig. 0,056	0,217 Sig. 0,495	0,497 Sig. 0,635	0,374 Sig. 0,849	0,188 Sig. 0,937	0,284 Sig. 0,251	0,271 Sig. 0,712	0,132 Sig. 0,827	0,277 Sig. 0,271	0,338 Sig. 0,121
15	0,128 Sig. 0,357	-0,187 Sig. 0,177	0,232 Sig. 0,730	0,300 Sig. 0,322	0,179 Sig. 0,435	-0,232 Sig. 0,094	0,271 Sig. 0,149	-0,134 Sig. 0,335	-0,343 Sig. 0,013	0,101 Sig. 0,470
16	0,058 Sig. 0,677		0,361 Sig. 0,238	0,578 Sig. 0,002	0,157 Sig. 0,529	0,122 Sig. 0,377	0,270 Sig. 0,150	0,167 Sig. 0,228	-0,069 Sig. 0,618	-0,223 Sig. 0,111
17	0,039 Sig. 0,777		0,339 Sig. 0,309	0,228 Sig. 0,610	0,302 Sig. 0,094	0,103 Sig. 0,458	0,143 Sig. 0,590	-0,024 Sig. 0,862		0,089 Sig. 0,527
18	-0,200 Sig. 0,149	0,123 Sig. 0,375	0,391 Sig. 0,159	0,261 Sig. 0,473	0,053 Sig. 0,929	0,154 Sig. 0,266	0,100 Sig. 0,771	-0,077 Sig. 0,578	-0,040 Sig. 0,773	0,010 Sig. 0,945
19	-0,091 Sig. 0,514	-0,120 Sig. 0,391	0,473 Sig. 0,044	,322 Sig. 0,258	0,197 Sig. 0,372	0,178 Sig. 0,205	0,207 Sig. 0,334	-0,066 Sig. 0,637	-0,026 Sig. 0,850	0,102 Sig. 0,466
20	0,051 Sig. 0,718	0,169 Sig. 0,227	0,171 Sig. 0,915	0,202 Sig. 0,721	0,177 Sig. 0,450	-0,265 Sig. 0,058	0,167 Sig. 0,490	0,108 Sig. 0,439	-0,185 Sig. 0,187	-0,086 Sig. 0,537
21	-0,317 Sig. 0,024	0,040 Sig. 0,775	0,283 Sig. 0,537	0,225 Sig. 0,631	0,278 Sig. 0,140	-0,309 Sig. 0,027	0,107 Sig. 0,749	0,029 Sig. 0,837	-0,063 Sig. 0,654	-0,040 Sig. 0,777
22	-0,169 Sig. 0,227	-0,051 Sig. 0,718	0,292 Sig. 0,502	0,182 Sig. 0,793	0,226 Sig. 0,272	0,089 Sig. 0,524	0,216 Sig. 0,305	-0,122 Sig. 0,382	-0,049 Sig. 0,726	0,390 Sig. 0,005

Note: Gender (1), country (2), Region/province (3), civil state (4), academic degree (5), professional activity (6), SCI level (7), level of paraplegia (8), PA (9), armrest (10)

Table 61

Phi analysis

	11	12	13	14	15	16	17	18	19	20	21
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12	1,250 Sig. 0,000										
13	1,212 Sig. 0,000	0,440 Sig. 0,007									
14	1,262 Sig. 0,001	0,662 Sig. 0,001	0,227 Sig. 0,454								
15	0,723 Sig. 0,039	0,112 Sig. 0,725	0,265 Sig. 0,161	0,322 Sig. 0,152							
16	0,640 Sig. 0,167	0,369 Sig. 0,031	0,240 Sig. 0,223	0,264 Sig. 0,312	-0,013 Sig. 0,924						
17	0,575 Sig. 0,373	0,190 Sig. 0,399	0,122 Sig. 0,680	0,283 Sig. 0,251	0,014 Sig. 0,918	-0,057 Sig. 0,683					
18	0,544 Sig. 0,496	0,188 Sig. 0,407	0,160 Sig. 0,513	0,466 Sig. 0,011	-0,365 Sig. 0,008	-0,144 Sig. 0,298	0,039 Sig. 0,777				
19	0,731 Sig. 0,027	0,352 Sig. 0,043	-0,022 Sig. 0,878	0,249 Sig. 0,367	0,234 Sig. 0,095	0,132 Sig. 0,347	0,103 Sig. 0,463	0,030 Sig. 0,828			
20		0,274 Sig. 0,147	0,063 Sig. 0,655	0,153 Sig. 0,753	0,131 Sig. 0,349	-0,073 Sig. 0,602	0,209 Sig. 0,135	-0,255 Sig. 0,069	-0,161 Sig. 0,249		
21	0,609 Sig. 0,217	0,124 Sig. 0,676	0,073 Sig. 0,602	0,074 Sig. 0,964	0,153 Sig. 0,275	-0,085 Sig. 0,543	0,096 Sig. 0,493	-0,006 Sig. 0,967	-0,188 Sig. 0,179	0,547 Sig. 0,000	
22	0,644 Sig. 0,133	0,342 Sig. 0,051	0,299 Sig. 0,033	0,362 Sig. 0,083	-0,051 Sig. 0,714	0,096 Sig. 0,493	0,110 Sig. 0,434	0,136 Sig. 0,332	0,278 Sig. 0,047	-0,299 Sig. 0,033	-0,052 Sig. 0,709

Note: company and model (11), MWC type (12), WC type (13), main WC material (14), same WC (15), cushion (16), shoulder pain (17), years since SCI (18), WC weight (19), WC handrim (20), WC seat height (21) and WC backrest height (22).

Table 62

Isometric strength correlations

			SF	SE		SA		SLR		SMR		EF		EE	
rô de Spearman			R	L	R	L	R	L	R	L	R	L	R	L	R
SF	L	Correlation Coefficient	,718**	,628**	,739**	,732**	,701**	,671**	,701**	,461**	,543**	,661**	,649**	,585**	,638**
		Sig. (2 – tailed)	,000	,000	,000	,000	,000	,000	,000	,001	,000	,000	,000	,000	,000
	R	Correlation Coefficient		,640**	,682**	,747**	,813**	,667**	,789**	,535**	,589**	,586**	,727**	,650**	,602**
		Sig. (2 – tailed)		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
SE	L	Correlation Coefficient			,743**	,760**	,644**	,525**	,576**	,631**	,780**	,548**	,579**	,553**	,600**
		Sig. (2 – tailed)			,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	R	Correlation Coefficient				,706**	,726**	,629**	,758**	,668**	,745**	,738**	,676**	,660**	,633**
		Sig. (2 – tailed)				,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
SA	L	Correlation Coefficient					,881**	,674**	,780**	,602**	,678**	,705**	,706**	,688**	,691**
		Sig. (2 – tailed)					,000	,000	,000	,000	,000	,000	,000	,000	,000
	R	Correlation Coefficient						,731**	,794**	,656**	,631**	,649**	,703**	,714**	,630**
		Sig. (2 – tailed)						,000	,000	,000	,000	,000	,000	,000	,000
SLR	L	Correlation Coefficient							,835**	,640**	,595**	,745**	,640**	,691**	,700**
		Sig. (2 – tailed)							,000	,000	,000	,000	,000	,000	,000
	R	Correlation Coefficient								,708**	,673**	,721**	,770**	,758**	,775**
		Sig. (2 – tailed)								,000	,000	,000	,000	,000	,000
SMR	L	Correlation Coefficient									,752**	,588**	,572**	,821**	,725**
		Sig. (2 – tailed)									,000	,000	,000	,000	,000
	R	Correlation Coefficient										,515**	,563**	,701**	,766**
		Sig. (2 – tailed)										,000	,000	,000	,000
EF	L	Correlation Coefficient											,749**	,667**	,677**
		Sig. (2 – tailed)											,000	,000	,000
	R	Correlation Coefficient												,673**	,666**
		Sig. (2 – tailed)											.	,000	,000
EEn	L	Correlation Coefficient													,834**
		Sig. (2 – tailed)													,000
	R	Correlation Coefficient													
		Sig. (2 – tailed)													

Note: SF: Shoulder flexion; **SE**: shoulder extension; **SA**: Shoulder abduction; **SLR**: Shoulder lateral rotation; **SMR**: Shoulder medial rotation; **EF**: Elbow flexion; **EE**: Elbow extension

**. Correlation is significant at the 0,01 level (2 – tailed).

Table 63

Mean ranks and sum score from MWC characteristics regarding the country

	Portugal (n = 35)		Spain (n = 16)	
	Mean Ranks	Sum scores	Mean Ranks	Sum scores
Backrest height	26,60	931,00	24,69	395,00
Seat height	27,80	973,00	22,06	353,00
Seat width	30,20	1057,00	16,81	269,00
Seat depth	28,81	1008,50	19,84	317,50
Wheels diameter	25,09	878,00	28,00	448,00
Caster wheels diameter	30,74	1076,00	15,63	250,00
Handrim diameter	27,61	966,50	22,47	359,50
MWC weight	29,01	1015,50	19,41	310,50

Table 64

Mean ranks and sum score from anthropometrics regarding the country

	Portugal (n = 35)		Spain (n = 15)	
	Mean Ranks	Sum scores	Mean Ranks	Sum scores
		Height		
Seating stature	26,69	934,00	22,73	341,00
Eyes high	26,91	942,00	22,20	333,00
Shoulder high	27,71	970,00	20,33	305,00
Elbow high	27,80	973,00	20,13	302,00
Knee high	27,37	958,00	21,13	317,00
Popliteal high	27,74	971,00	20,27	304,00
Foot high	27,44	960,50	20,97	314,50
		Width		
Elbow	26,84	939,50	22,37	335,50
Biacromial	23,21	812,50	30,83	462,50
Waist	28,29	990,00	19,00	285,00
Shoulder	23,31	816,00	30,60	459,00
Thoracic	25,07	877,50	26,50	397,50
		Depth		
Forearm - hand	25,83	904,00	24,73	371,00
Popliteal	25,09	878,00	26,47	397,00
Gluteus to knee	25,49	892,00	25,53	383,00
Shoulder	26,71	935,00	22,67	340,00

Table 65

Mann Whitney U test for QUEST 2.0

QUEST 2.0		Physical Activity		Country		Paraplegia level	
		No (n=19)	Yes (n=33)	Portugal (n=35)	Spain (n=17)	High (n=24)	Low (n=28)
Assistive Technology	Mean Rank	26,26	26,64	28,50	22,38	24,31	28,38
	Sum of Ranks	499,00	879,00	997,50	380,50	583,50	794,50
Service	Mean Rank	23,95	27,97	26,83	25,82	28,71	24,61
	Sum of Ranks	455,00	923,00	939,00	439,00	689,00	689,00
Total score	Mean Rank	24,84	27,45	28,20	23,00	25,88	27,04
	Sum of Ranks	472,00	906,00	987,00	391,00	621,00	757,00

Table 66

Mann Whitney U test for WUSPI

		Mean Ranks	Sum Scores
Physical Activity	No (n = 10)	11,60	116,00
	Yes (n = 11)	10,45	115,00
Country	Portugal (n = 16)	10,94	175,00
	Spain (n = 5)	11,20	56,00
Paraplegia level	High (n = 10)	11,90	119,00
	Low (n = 11)	10,18	112,00
Years since SCI	≤10 (n = 8)	10,63	85,00
	> 10 (n = 13)	11,23	146,00

Table 67

Mann Whitney U test for PASIPD

		Mean Ranks	Sum Scores
Physical Activity	No (n = 19)	20,58	391,00
	Yes (n = (33)	29,91	987,00
Country	Portugal (n = 35)	26,69	934,00
	Spain (n = 17)	26,12	444,00
Paraplegia level	High (n = 24)	28,38	681,00
	Low (n = 28)	24,89	697,00

Table 68

Mann Whitney U test for QLI (Ferrans&Powers) – SCI III

		Physical Activity		Country		Paraplegia level	
		No (n= 19)	Yes (n = 33)	Portugal (n = 35)	Spain (n= 17)	High (n = 24)	Low (n = 28)
QLI	Mean Rank	24,32	27,76	29,84	19,62	21,56	30,73
	Sum of Ranks	462,00	916,00	1044,50	333,50	517,50	860,50
HFSUB	Mean Rank	24,58	27,61	30,19	18,91	21,79	30,54
	Sum of Ranks	467,00	911,00	1056,50	321,50	523,00	855,00
SOCSUB	Mean Rank	24,24	27,80	29,71	19,88	25,42	27,43
	Sum of Ranks	460,50	917,50	1040,00	338,00	610,00	768,00
PSPSUB	Mean Rank	25,97	26,80	28,74	21,88	22,94	29,55
	Sum of Ranks	493,50	884,50	1006,00	372,00	550,50	827,50
FAMSUB	Mean Rank	25,24	27,23	28,81	1008,50	20,92	31,29
	Sum of Ranks	479,50	898,50	21,74	369,50	502,00	876,00

Table 69

Mann Whitney U test for MWC components regarding shoulder pain – ranks

	No (n = 30)		Yes (n =21)	
	Mean Ranks	Sum scores	Mean Ranks	Sum scores
Backrest height	25,42	762,50	26,83	563,50
Seat height	23,50	705,00	29,57	621,00
Seat width	26,78	803,50	24,88	522,50
Seat depth	26,18	785,50	25,74	540,50
Wheels diameter	26,80	804,00	24,86	522,00
Casters diameter	22,73	682,00	30,67	644,00
Handrim diameter	25,48	764,50	26,74	561,50
MWC weight	24,27	728,00	28,48	598,00

Table 70

Mann Whitney U test for MWC components, shoulder pain and level of paraplegia

	No Shoulder pain				Shoulder pain			
	High paraplegia (n=13)		Low paraplegia (n = 17)		High paraplegia (n = 10)		Low paraplegia (n = 11)	
	Mean Ranks	Sum scores	Mean Ranks	Sum scores	Mean Ranks	Sum scores	Mean Ranks	Sum scores
Backrest height	14,38	187,00	16,35	278,00	11,25	112,50	10,77	118,50
Seat height	16,73	217,50	14,56	247,50	13,00	130,00	9,18	101,00
Seat Width	15,46	201,00	15,53	264,00	13,00	130,00	9,18	101,00
Seat depth	14,23	185,00	16,47	280,00	11,95	119,50	10,14	111,50

Table 71

Mann Whitney U test for MWC components, shoulder pain and country

	No Shoulder pain				Shoulder pain			
	Portugal (n = 19)		Spain (n = 11)		Portugal (n = 16)		Spain (n = 5)	
	Mean Ranks	Sum scores	Mean Ranks	Sum scores	Mean Ranks	Sum scores	Mean Ranks	Sum scores
Backrest height	16,71	317,50	13,41	147,50	10,41	166,50	12,90	64,50
Seat height	15,61	296,50	15,32	168,50	12,47	199,50	6,30	31,50
Seat Width	17,79	338,00	11,55	127,00	13,06	209,00	4,40	22,00
Seat depth	17,79	338,00	11,55	127,00	11,66	186,50	8,90	44,50
Wheels diameter	15,21	289,00	16,00	176,00	10,53	168,50	12,50	62,50
Casterwheels diameter	18,58	353,00	10,18	112,00	12,47	199,50	6,30	31,50
Handrim diameter	15,29	290,50	15,86	174,50	12,63	202,00	5,80	29,00
MWC weight	16,03	304,50	14,59	160,50	12,84	205,50	5,10	25,50

Table 72

Mann Whitney U test for backrest height and MWC components – ranks

Backrest height		Seat height	Seat width	Seat depth	Armrest height	Wheels diameter	Casters diameter	Handrim diameter	MWC Weight
25 to 33	Mean Rank	26,31	19,54	20,62	21,96	26,27	21,67	29,35	21,06
(N =26)	Sum of Ranks	684,00	508,00	536,00	571,00	683,00	563,50	763,00	547,50
34 to 44	Mean Rank	25,68	32,72	31,60	30,20	25,72	30,50	22,52	31,14
(N =25)	Sum of Ranks	642,00	818,00	790,00	755,00	643,00	762,50	563,00	778,50

Table 73

Mann Whitney U test for armrest, age and years since SCI – ranks

		Mean Rank	Sum of Ranks
Age	No (n = 40)	22,99	919,50
	Yes (n = 10)	35,55	355,50
Years since SCI	No (n = 41)	25,84	1059,50
	Yes (n = 10)	26,65	266,50

Table 74

Mann Whitney U test for country level and scales – ranks

Country	Physical Activity		Age	Years since SCI	QOL				
					QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
Portugal (n = 35)	Yes (n = 17)	Mean Rank	16,15	15,18	21,15	21,62	21,12	19,26	19,71
		Sum of Ranks	274,50	258,00	359,50	367,50	359,00	327,50	335,00
	No (n = 18)	Mean Rank	10,14	9,83	10,44	10,39	10,33	10,44	10,39
		Sum of Ranks	182,50	177,00	188,00	187,00	186,00	188,00	187,00
Spain (n =17)	Yes (n = 16)	Mean Rank	16,90	18,94	12,59	12,09	12,63	14,59	14,13
		Sum of Ranks	253,50	303,00	201,50	193,50	202,00	233,50	226,00
	No (n = 1)	Mean Rank	7,50	13,00	2,00	3,00	4,00	2,00	3,00
		Sum of Ranks	7,50	13,00	2,00	3,00	4,00	2,00	3,00

Table 75

Mann Whitney U test for MWC handrim diameter and scales – ranks

Handrim diameter		PASIPD
46 to 52 (n=24)	Mean Rank	21,65
	Sum of Ranks	563,00
53 to 56 (n=25)	Mean Rank	30,52
	Sum of Ranks	763,00

Table 76

Mann Whitney U test for seat height according to country and shoulder pain – ranks

Country		Shoulder pain	Mean Ranks	Sum Score
Seat height	Portugal	No (n = 19)	14,84	282,00
		Yes (n = 16)	21,75	348,00
	Spain	No (n = 11)	8,91	98,00
		Yes (n = 5)	7,60	38,00

Table 77

Mann Whitney U test for country and force – ranks

		SF		SE		SA	
		Left	Right	Left	Right	Left	Right
Portugal (n =35)	Mean Rank	21,57	21,81	22,69	20,51	21,77	21,29
	Sum of Ranks	755,00	763,50	794,00	718,00	762,00	745,00
Spain (n =15)	Mean Rank	34,67	34,10	32,07	37,13	34,20	35,33
	Sum of Ranks	520,00	511,50	481,00	557,00	513,00	530,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 78

Mann Whitney U test for country level and force – ranks

		SLR		SMR		EF		EE	
		Left	Right	Left	Right	Left	Right	Left	Right
Portugal (n =35)	Mean Rank	21,29	20,77	21,34	21,77	19,97	20,80	20,96	20,66
	Sum of Ranks	745,00	727,00	747,00	762,00	699,00	728,00	733,50	723,00
Spain (n =15)	Mean Rank	35,33	36,53	35,20	34,20	38,40	36,47	36,10	36,80
	Sum of Ranks	530,00	548,00	528,00	513,00	576,00	547,00	541,50	552,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 79

Mann Whitney U test for paraplegia level and force – ranks

Paraplegia level		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
High	Mean Rank	24,88	22,23	21,54	24,31	21,56	21,42
(n =24)	Sum of Ranks	597,00	533,50	517,00	583,50	517,50	514,00
Low	Mean Rank	26,08	28,52	29,15	26,60	29,13	29,27
(n =26)	Sum of Ranks	678,00	741,50	758,00	691,50	757,50	761,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 80

Mann Whitney U test for paraplegia level and force – ranks

		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
High	Mean Rank	22,35	23,44	22,15	22,19	25,04	24,04	22,48	23,15
(n =24)	Sum of Ranks	536,50	562,50	531,50	532,50	601,00	577,00	539,50	555,50
Low	Mean Rank	28,40	27,40	28,60	28,56	25,92	26,85	28,29	27,67
(n =26)	Sum of Ranks	738,50	712,50	743,50	742,50	674,00	698,00	735,50	719,50

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 81

Mann Whitney U test for Armrest and force – ranks

		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
No	Mean Rank	27,14	27,13	25,71	27,08	26,74	27,64
(n =39)	Sum of Ranks	1058,50	1058,00	1002,50	1056,00	1043,00	1078,00
Yes	Mean Rank	16,65	16,70	22,25	16,90	18,20	14,70
(n =10)	Sum of Ranks	166,50	167,00	222,50	169,00	182,00	147,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 82

Mann Whitney U test for Armrest and force – ranks

		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
No	Mean Rank	27,40	26,54	25,38	25,59	26,74	25,74	26,12	25,69
(n =39)	Sum of Ranks	1068,50	1035,00	990,00	998,00	1043,00	1004,00	1018,50	1002,00
Yes	Mean Rank	15,65	19,00	23,50	22,70	18,20	22,10	20,65	22,30
(n =10)	Sum of Ranks	156,50	190,00	235,00	227,00	182,00	221,00	206,50	223,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 83

Mann Whitney U test for MWC weight and force – ranks

		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
6,5 to 11	Mean Rank	29,43	27,70	29,84	30,80	29,14	28,50
(n =28)	Sum of Ranks	824,00	775,50	835,50	862,50	816,00	798,00
11,5 to 16	Mean Rank	19,10	21,40	18,55	17,26	19,48	20,33
(n =21)	Sum of Ranks	401,00	449,50	389,50	362,50	409,00	427,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 84

Mann Whitney U test for MWC weight and force – ranks

		SLR		SMR		EF		EE	
		Left	Right	Left	Right	Left	Right	Left	Right
6,5 to 11	Mean Rank	26,45	28,68	28,52	30,04	27,96	28,43	28,73	28,77
(n =28)	Sum of Ranks	740,50	803,00	798,50	841,00	783,00	796,00	804,50	805,50
11,5 to 16	Mean Rank	23,07	20,10	20,31	18,29	21,05	20,43	20,02	19,98
(n =21)	Sum of Ranks	484,50	422,00	426,50	384,00	442,00	429,00	420,50	419,50

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 85

Mann Whitney U test for MWC weight and force – ranks

MWC			SF		SE		SA	
weight	Physical Activity		Left	Right	Left	Right	Left	Right
6,5 to 11 (n=28)	No (n = 7)	Mean Rank	7,43	8,71	12,14	8,71	8,43	7,43
		Sum of Ranks	52,00	61,00	85,00	61,00	59,00	52,00
	Yes (n = 21)	Mean Rank	16,86	16,43	15,29	16,43	16,52	16,86
		Sum of Ranks	354,00	345,00	321,00	345,00	347,00	354,00
11,5 to 16 (n=21)	No (n = 11)	Mean Rank	10,55	9,95	10,27	10,82	10,27	10,18
		Sum of Ranks	116,00	109,50	113,00	119,00	113,00	112,00
	Yes (n = 10)	Mean Rank	11,50	12,15	11,80	11,20	11,80	11,90
		Sum of Ranks	115,00	121,50	118,00	112,00	118,00	119,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 86

Mann Whitney U test for MWC weight and force – ranks

			SLR		SMR		EF		EE	
WC weight	Physical Activity		Left	Right	Left	Right	Left	Right	Left	Right
6,5 to 11 (n=28)	No (n = 7)	Mean Rank	8,57	9,14	10,79	11,57	7,43	9,57	8,14	10,14
		Sum of Ranks	60,00	64,00	75,50	81,00	52,00	67,00	57,00	71,00
	Yes (n = 21)	Mean Rank	16,48	16,29	15,74	15,48	16,86	16,14	16,62	15,95
		Sum of Ranks	346,00	342,00	330,50	325,00	354,00	339,00	349,00	335,00
11,5 to 16 (n=21)	No (n = 11)	Mean Rank	10,82	11,18	11,18	10,50	11,18	9,45	10,91	10,55
		Sum of Ranks	119,00	123,00	123,00	115,50	123,00	104,00	120,00	116,00
	Yes (n = 10)	Mean Rank	11,20	10,80	10,80	11,55	10,80	12,70	11,10	11,50
		Sum of Ranks	112,00	108,00	108,00	115,50	108,00	127,00	111,00	115,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 87

Mann Whitney U test for seat height and force – ranks

		SF		SE		SA	
		Left	Right	Left	Right	Left	Right
20 to 45	Mean Rank	29,04	27,46	28,77	26,38	28,19	28,35
(n =26)	Sum of Ranks	755,00	714,00	748,00	686,00	733,00	737,00
46 to 52	Mean Rank	20,43	22,22	20,74	23,43	21,39	21,22
(n =23)	Sum of Ranks	470,00	511,00	477,00	539,00	492,00	488,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 88

Mann Whitney U test for seat height and force – ranks

Seat high		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
20 to 45	Mean Rank	30,17	28,87	28,79	28,12	27,67	29,37	28,12	30,19
(n =26)	Sum of Ranks	784,50	750,50	748,50	731,00	719,50	763,50	731,00	785,00
46 to 52	Mean Rank	19,15	20,63	20,72	21,48	21,98	20,07	21,48	19,13
(n =23)	Sum of Ranks	440,50	474,50	476,50	494,00	505,50	461,50	494,00	440,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 89

Mann Whitney U test for seat height and questionnaire scores – ranks

Seat height (median)		PASIPD	QUEST 2.0 AT	QUEST 2.0 SV	QUEST 2.0 TS	WUSPI	QOL QLI	QOL HFASUB	QOL SOCSUB	QOL PSPSUB	QOL FAMSUB
20 to 45 (n = 28)	Mean Ranks	26,25	27,75	26,18	27,11	22,32	29,55	28,71	29,59	27,77	28,55
	Sum Scores	735,00	777,00	733,00	759,00	625,00	827,50	804,00	828,50	777,50	799,50
46 to 52 (n =23)	Mean Ranks	25,70	23,87	25,78	24,65	30,48	21,67	22,70	21,63	23,85	22,89
	Sum Scores	591,00	549,00	593,00	567,00	701,00	498,50	522,00	497,50	548,50	526,50

Table 90

Mann Whitney U test for physical activity and force – ranks

Physical Activity		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
Yes	Mean Rank	30,03	29,81	28,44	30,06	30,00	30,39
(n = 31)	Sum Score	931,00	924,00	881,50	932,00	930,00	942,00
No	Mean Rank	18,11	18,47	20,71	18,05	18,16	17,53
(n =19)	Sum Score	344,00	351,00	393,50	343,00	345,00	333,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 91

Mann Whitney U test for physical activity and force – ranks

		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
Yes	Mean Rank	28,89	28,95	27,77	28,63	29,39	29,39	29,50	28,79
(n = 31)	Sum Score	895,50	897,50	861,00	887,50	911,00	911,00	914,50	892,50
No	Mean Rank	19,97	19,87	21,79	20,39	19,16	19,16	18,97	20,13
(n =19)	Sum Scores	379,50	377,50	414,00	387,50	364,00	364,00	360,50	382,50

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 92

Mann Whitney U test for seat height, force in no shoulder pain group – ranks

		SF		SE		SA	
		Left	Right	Left	Right	Left	Right
20 to 45	Mean Rank	15,50	16,45	16,88	15,08	14,90	15,70
(n =20)	Sum Score	310,00	329,00	337,50	301,50	298,00	314,00
46 to 52	Mean Rank	15,50	13,60	12,75	16,35	16,70	15,10
(n =10)	Sum Score	155,00	136,00	127,50	163,50	167,00	151,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 93

Mann Whitney U test for seat high, force in no shoulder pain group – ranks

		SLR		SMR		EF		EE	
		Left	Right	Left	Right	Left	Right	Left	Right
20 to 45	Mean Rank	16,35	15,95	16,33	16,15	15,03	16,20	15,55	16,35
(n =20)	Sum Score	327,00	319,00	326,50	323,00	300,50	324,00	311,00	327,00
46 to 52	Mean Rank	13,80	14,60	13,85	14,20	16,45	14,10	15,40	13,80
(n =10)	Sum Scores	138,00	146,00	138,50	142,00	164,50	141,00	154,00	138,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 94

Mann Whitney U test for seat height, force in shoulder pain group – ranks

		SF		SE		SA	
		Left	Right	Left	Right	Left	Right
20 to 45	Mean Rank	15,17	11,50	12,33	11,67	13,00	11,67
(n =6)	Sum Score	91,00	69,00	74,00	70,00	78,00	70,00
46 to 52	Mean Rank	7,62	9,31	8,92	9,23	8,62	9,23
(n =13)	Sum Score	99,00	121,00	116,00	120,00	112,00	120,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 95

Mann Whitney U test for seat height, force in shoulder pain group – ranks

		SLR		SMR		EF		EE	
		Left	Right	Left	Right	Left	Right	Left	Right
20 to 45	Mean Rank	15,17	14,08	12,25	12,42	14,33	13,83	12,67	14,67
(n =6)	Sum Score	91,00	84,50	73,50	74,50	86,00	83,00	76,00	88,00
46 to 52	Mean Rank	7,62	8,12	8,96	8,88	8,00	8,23	8,77	7,85
(n =13)	Sum Scores	99,00	105,50	116,50	115,50	104,00	107,00	114,00	102,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 96

Mann Whitney U test for level of paraplegia and strength in no shoulder pain group – ranks

		SF		SE		SA	
Level of paraplegia		Left	Right	Left	Right	Left	Right
High	Mean Rank	18,50	16,68	16,04	18,00	16,39	16,00
(n=14)	Sum Score	259,00	233,50	224,50	252,00	229,50	224,00
Low	Mean Rank	13,94	15,44	15,97	14,35	15,68	16,00
(n=17)	Sum Score	237,00	262,50	271,50	244,00	266,50	272,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 97

Mann Whitney U test for level of paraplegia and strength in no shoulder pain group – ranks

		SLR		SMR		EF		EE	
Level of paraplegia		Left	Right	Left	Right	Left	Right	Left	Right
High	Mean Rank	15,68	16,68	15,18	14,14	18,50	17,36	15,71	15,07
(n=14)	Sum Score	219,50	233,50	212,50	198,00	259,00	243,00	220,00	211,00
Low	Mean Rank	16,26	15,44	16,68	17,53	13,94	14,88	16,24	16,76
(n=17)	Sum Scores	276,50	262,50	283,50	298,00	237,00	253,00	276,00	285,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 98

Mann Whitney U test for level of paraplegia and strength in shoulder pain group – ranks

		SF		SE		SA	
Level of paraplegia		Left	Right	Left	Right	Left	Right
High	Mean Rank	7,20	6,40	6,50	7,35	6,10	5,90
(n=10)	Sum Score	72,00	64,00	65,00	73,50	61,00	59,00
Low	Mean Rank	13,11	14,00	13,89	12,94	14,33	14,56
(n=9)	Sum Score	118,00	126,00	125,00	116,50	129,00	131,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 99

Mann Whitney U test for level of paraplegia and strength in shoulder pain group – ranks

		SLR		SMR		EF		EE	
Level of paraplegia		Left	Right	Left	Right	Left	Right	Left	Right
High	Mean Rank	7,70	7,95	7,10	8,25	7,75	7,50	7,50	8,70
(n=10)	Sum Score	77,00	79,50	71,00	82,50	77,50	75,00	75,00	87,00
Low	Mean Rank	12,56	12,28	13,22	11,94	12,50	12,78	12,78	11,44
(n=9)	Sum Scores	113,00	110,50	119,00	107,50	112,50	115,00	115,00	103,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 100

Mann Whitney U test for handrim diameter and strength – ranks

		SF		SE		SA	
Handrim diameter (cm)		Left	Right	Left	Right	Left	Right
46–52	Mean Rank	25,10	27,00	24,90	25,21	25,71	26,15
(n=24)	Sum Score	602,50	648,00	597,50	605,00	617,00	627,50
53–56	Mean Rank	24,90	23,08	25,10	24,80	24,32	23,90
(n=25)	Sum Score	622,50	577,00	627,50	620,00	608,00	597,50

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 101

Mann Whitney U test for handrim diameter and strength – ranks

		SLR		SMR		EF		EE	
Handrim diameter (cm)		Left	Right	Left	Right	Left	Right	Left	Right
46–52	Mean Rank	26,96	27,23	25,73	26,00	24,75	26,71	24,77	24,96
(n=24)	Sum Score	647,00	653,50	617,50	624,00	594,00	641,00	594,50	599,00
53–56	Mean Rank	23,12	22,86	24,30	24,04	25,24	23,36	25,22	25,04
(n=25)	Sum Scores	578,00	571,50	607,50	601,00	631,00	584,00	630,50	626,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 102

Mann Whitney U test for seat height and strength, according to years since SCI (2 to 13yrs) – ranks

Seat height (cm)		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
20 to 45 (n=16)	Mean Rank	12,88	12,69	11,94	11,63	12,06	12,75
	Sum Score	206,00	203,00	191,00	186,00	193,00	204,00
46 to 52 (n=8)	Mean Rank	11,75	12,13	13,63	14,25	13,38	12,00
	Sum Score	94,00	97,00	109,00	114,00	107,00	96,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 103

Mann Whitney U test for seat height and strength, according to years since SCI (2 to 13yrs) – ranks

Seat height (cm)		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
20 to 45	Mean Rank	13,75	12,97	12,44	12,41	11,91	12,66	12,84	13,06
(n=16)	Sum Score	220,00	207,50	199,00	198,50	190,50	202,50	205,50	209,00
46 to 52	Mean Rank	10,00	11,56	12,63	12,69	13,69	12,19	11,81	11,38
(n=8)	Sum Scores	80,00	92,50	101,00	101,50	109,50	97,50	94,50	91,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 104

Mann Whitney U test for seat height and strength, according to years since SCI (14 to 47yrs) – ranks

Seat height (cm)		SF Left	SF Right	SE Left	SE Right	SA Left	SA Right
20 to 45 (n=10)	Mean Rank	16,90	15,45	18,40	15,70	17,70	16,30
	Sum Score	169,00	154,50	184,00	157,00	177,00	163,00
46 to 52 (n=15)	Mean Rank	10,40	11,37	9,40	11,20	9,87	10,80
	Sum Score	156,00	170,50	141,00	168,00	148,00	162,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

Table 105

Mann Whitney U test for seat height and strength, according to years since SCI (14 to 47yrs) – ranks

Seat height (cm)		SLR Left	SLR Right	SMR Left	SMR Right	EF Left	EF Right	EE Left	EE Right
20 to 45	Mean Rank	16,95	16,30	17,75	16,85	16,50	17,75	16,05	18,00
(n=10)	Sum Score	169,50	163,00	177,50	168,50	165,00	177,50	160,50	180,00
46 to 52	Mean Rank	10,37	10,80	9,83	10,43	10,67	9,83	10,97	9,67
(n=15)	Sum Scores	155,50	162,00	147,50	156,50	160,00	147,50	164,50	145,00

Legend: Shoulder flexion (SF), shoulder extension (SE), shoulder abduction (SA), shoulder medial rotation (SMR), shoulder lateral rotation (SLR), elbow flexion (EF) and elbow extension (EE)

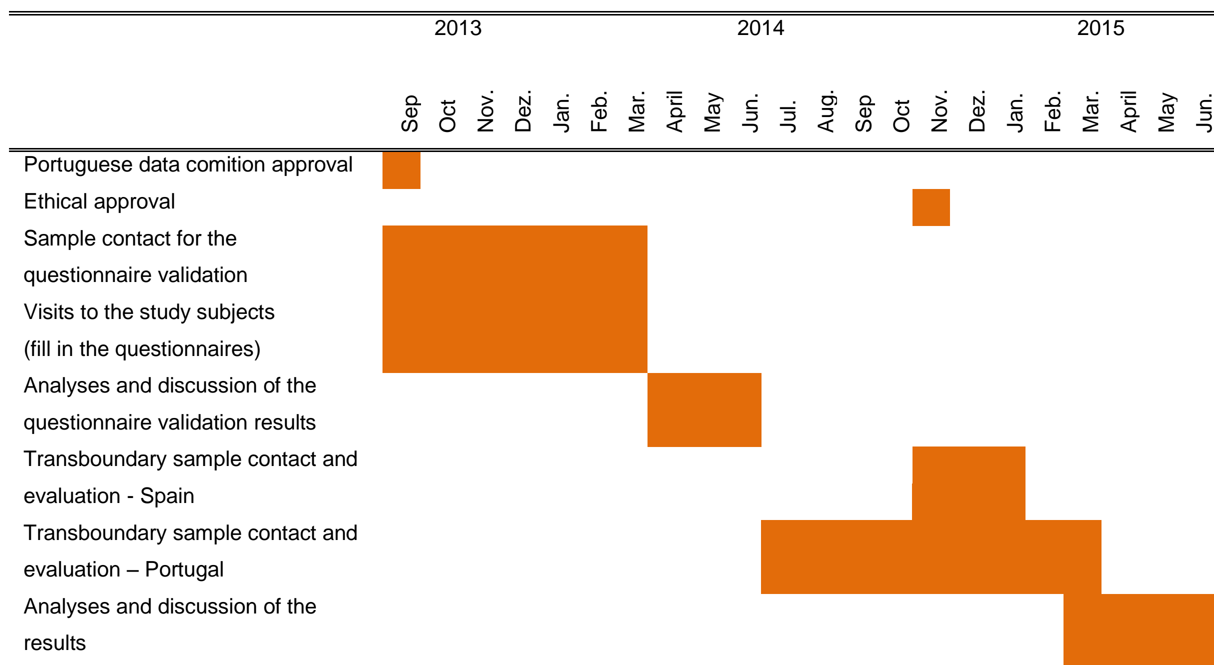


Table 106

Estimated development of the activities timeline

	2013										2014									2015	
	Sep	Oct	Nov.	Dez.	Jan.	Feb.	Mar.	April	May	Jun.	Jul.	Aug.	Sep	Oct	Nov.	Dez.	Jan.	Feb.	Mar.	April	May	Jun.
Portuguese data comition approval																						
Ethical approval																						
Sample contact for the questionnaire validation																						
Visits to the study subjects (fill in the questionnaires)																						
Analyses and discussion of the questionnaire validation results																						
Transboundary sample contact and evaluation - Spain																						
Transboundary sample contact and evaluation – Portugal																						
Analyses and discussion of the results																						

Wheelchair

Table 107

Analysis of normality for MWC components

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Backrest height	,107	51	,200*	,959	51	,073
Seat height	,192	51	,000	,792	51	,000
Seat Width	,151	51	,005	,931	51	,006
Seat depth	,131	51	,029	,834	51	,000
Armrest high	,489	51	,000	,513	51	,000
Wheels diameter	,333	51	,000	,773	51	,000
Caster wheels diameter	,338	51	,000	,774	51	,000
Handrim diameter	,237	51	,000	,836	51	,000
MWC Weight	,123	51	,053	,940	51	,013

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Isometric strength

Table 108

Analysis of normality for isometric strength

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Shoulder flexion	Left	,079	50	,200*	,988	50	,880
	Right	,120	50	,071	,965	50	,148
Shoulder extension	Left	,148	50	,008	,914	50	,001
	Right	,087	50	,200*	,975	50	,352
Shoulder abduction	Left	,083	50	,200*	,929	50	,005
	Right	,115	50	,095	,914	50	,001
Shoulder lateral rotation	Left	,094	50	,200*	,955	50	,058
	Right	,122	50	,059	,937	50	,010
Shoulder medial rotation	Left	,099	50	,200*	,950	50	,033
	Right	,087	50	,200*	,967	50	,179
Elbow flexion	Left	,142	50	,014	,953	50	,047
	Right	,081	50	,200*	,952	50	,040
Elbow extension	Left	,118	50	,081	,954	50	,052
	Right	,071	50	,200*	,955	50	,054

Anthropometric measurements

Table 109
Analysis of normality for anthropometric measurements

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Seating stature	,159	50	,003	,825	50	,000
Eyes height	,207	50	,000	,822	50	,000
Shoulder height	,212	50	,000	,759	50	,000
Elbow height	,178	50	,000	,776	50	,000
Knee height	,103	50	,200*	,964	50	,132
Popliteal height	,447	50	,000	,228	50	,000
Foot height	,152	50	,006	,914	50	,001
Elbow Width	,124	50	,053	,966	50	,153
Biacromial Width	,158	50	,003	,972	50	,278
Thigh width	,144	50	,011	,964	50	,135
Arm Width	,082	50	,200*	,984	50	,748
Thorax Width	,110	50	,182	,963	50	,123
Forearm to hand	,104	50	,200*	,985	50	,753
Popliteal distance	,094	50	,200*	,967	50	,183
Buttock to knee	,155	50	,004	,966	50	,162
Arm distance	,093	50	,200*	,966	50	,164

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Questionnaire scores

Table 110
Analysis of normality for questionnaire scores

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PASIPD score	,115	52	,083	,945	52	,018
QUEST 2.0 – AT	,114	52	,090	,916	52	,001
QUEST 2.0 – SV	,082	52	,200*	,982	52	,608
QUEST 2.0 – TS	,095	52	,200*	,947	52	,023
WUSPI	,340	52	,000	,528	52	,000
QLI	,087	52	,200*	,980	52	,522
HFSUBa	,080	52	,200*	,980	52	,515
SOCSUBb	,130	52	,028	,967	52	,156
PSPSUBc	,070	52	,200*	,982	52	,604
FAMSUBd	,071	52	,200*	,982	52	,607

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Kappa analysis for PASIPD (Portuguese sample)

Table 111
Kappa value for agreement among test – retest for PASIPD (Portuguese sample)

	Kappa	Asymp Std.error[a]	Aprox. X^b	Aprox. Sig.
Outside activities	,296	,069	5,271	,000
Light Sport/ Recreational activities	,287	,074	5,060	,000
Moderate Sport/ Recreational activities	,337	,077	6,152	,000
Strenuous Sport/ Recreational activities	,455	,076	8,092	,000
Exercise to increase muscle strength	,417	,073	7,087	,000
Light housework	,544	,072	10,908	,000
Heavy housework	,430	,097	5,941	,000
Home repairs	,507	,102	6,235	,000
Lawn work/ Yard Care	,414	,111	5,566	,000
Outdoor gardening	,646	,127	7,438	,000
Care for another person	,523	,098	7,933	,000
Work for pay or as a volunteer	,341	,102	4,976	,000

a. Not assuming the null hipotesis.
b. Using the asymptotic error assuming the null hypotesis.

Kappa analysis for PASIPD (Spanish sample)

Table 112
Kappa value for agreement among test – retest for PASIPD (Spanish sample)

	Kappa	Asymp Std.error[a]	Aprox. X^b	Aprox. Sig.
Outside activities	,482	,093	8,010	,000
Light Sport/ Recreational activities	,361	,089	5,740	,000
Moderate Sport/ Recreational activities	,401	,102	4,733	,000
Strenuous Sport/ Recreational activities	,740	,088	8,914	,000
Exercise to increase muscle strength	,421	,091	5,402	,000
Light housework	,474	,096	6,795	,000
Heavy housework	,757	,094	7,122	,000
Home repairs	,610	,134	5,540	,000
Lawn work/ Yard Care	,471	,204	4,065	,000
Outdoor gardening	,542	,155	4,919	,000
Care for another person	,613	,093	7,740	,000
Work for pay or as a volunteer	,557	,132	5,782	,000

a. Not assuming the null hipotesis.
b. Using the asymptotic error assuming the null hypotesis.

Kappa analysis for QUEST 2.0 (Spanish sample)

Table 113
Kappa value for agreement among test – retest for QUEST 2.0 (Spanish sample)

	Kappa	Asymp Std.error[a]	Aprox. X^b	Aprox. Sig.
Assistive device – Dimensions	,394	,132	3,224	,001
Assistive device – Weight	,349	,120	3,453	,001
Assistive device – Ease in adjusting	,257	,136	2,275	,023
Assistive device – Safe and secure	,428	,121	3,946	,000
Assistive device – Durability	,394	,136	3,470	,001
Assistive device – Easy to use	,705	,110	5,543	,000
Assistive device – Comfort	,680	,114	6,009	,000
Assistive device – Effective	,505	,136	3,655	,000
Services – service delivery	,749	,099	7,314	,000
Services – Repairs and servicing	,514	,112	5,401	,000
Services – Professional services	,449	,134	4,381	,000
Services – follow up services	,802	,091	8,137	,000

a. Not assuming the null hipotesis.
b. Using the asymptotic error assuming the null hypotesis.

Kappa analysis for QLI (Ferrans & Powers) SCI – III for Portuguese sample

Table 114

Kappa value for agreement among test – retest QLI (Ferrans & Powers) SCI – III for Portuguese sample

	Kappa	Asymp Std.error[a]	Aprox. Xb	Aprox. Sig.
Health	,374	,108	4,540	,000
Health Care	,286	,111	3,259	,001
Pain	,240	,096	4,053	,000
Energy (Fatigue)	,228	,126	2,356	,018
Ability to take care of yourself	,305	,134	2,941	,003
Ability to go places	,336	,100	4,366	,000
Ability to clear lungs	,377	,112	4,536	,000
Controlo ver life	,442	,119	4,409	,000
Chances for living as long as you would like	,316	,121	3,454	,001
Famility health	,127	,137	1,231	,218
Children	,529	,125	4,949	,000
Ability to have children	,450	,101	9,942	,000
Family happiness	,207	,102	2,170	,030
Sex life	,404	,106	5,650	,000
Spouse, lover, or partner	,380	,118	3,760	,000
Not having a spouse, lover, or partner	,504	,111	5,373	,000
Friends	,499	,127	4,846	,000
Emotional support from family	,431	,105	4,646	,000
Emotional support from people other than your family	,569	,112	6,503	,000
Ability to take care of family responsibilities	,330	,124	3,167	,002
Usefulness to others	,399	,141	3,399	,001
Worries	,243	,095	4,282	,000
Neighborhood	,261	,103	3,864	,000
Home	,442	,108	4,946	,000
Job	,526	,120	4,375	,000
Not having a job	,290	,098	5,018	,000
Education	,325	,120	3,090	,002
Financial needs	,305	,123	3,305	,001
Things for fun	,422	,122	4,080	,000
Chances for a happy future	,276	,121	2,792	,005
Peace of mind	,201	,102	2,307	,021
Faith in God	,695	,101	8,408	,000
Achievement of personal goals	,372	,112	3,617	,000
Happiness in general	,371	,123	3,466	,001
Life satisfaction in general	,448	,120	4,441	,000
Personal appearance	,431	,120	4,043	,000
Self	,416	,121	3,718	,000

a. Not assuming the null hipotesis.
b. Using the asymptotic error assuming the null hypotesis.

Kappa analysis for QLI (Ferrans & Powers) SCI – III for Spanish sample

Table 115

Kappa value for agreement among test – retest for QLI (Ferrans & Powers) SCI – III for Spanish sample

	Kappa	Asymp Std.error[a]	Aprox. Xb	Aprox. Sig.
Health	,375	,164	2,970	,003
Health Care	,277	,172	2,246	,025
Pain	,412	,167	3,424	,001
Energy (Fatigue)	,255	,126	3,635	,000
Ability to take care of yourself	,444	,150	4,781	,000
Ability to go places	,359	,126	3,085	,002
Ability to clear lungs	,195	,127	2,178	,029
Control of your life	,310	,134	2,965	,003
Chances for living as long as you would like	,247	,135	3,104	,002
Facility health	,438	,156	4,358	,000
Children	,444	,039	3,162	,002
Ability to have children	,255	,114	3,721	,000
Family happiness	,263	,126	4,029	,000
Sex life	,348	,139	4,117	,000
Spouse, lover, or partner	,494	,149	3,751	,000
Not having a spouse, lover, or partner	,390	,155	3,443	,001
Friends	,091	,140	,861	,389
Emotional support from family	,419	,167	3,721	,000
Emotional support from people other than your family	,535	,159	4,519	,000
Ability to take care of family responsibilities	,529	,156	4,534	,000
Usefulness to others	,556	,160	5,522	,000
Worries	,341	,149	3,651	,000
Neighborhood	,255	,126	3,635	,000
Home	,286	,156	2,405	,016
Job	,535	,213	3,162	,002
Not having a job	,326	,143	3,514	,000
Education	,605	,165	4,435	,000
Financial needs	,302	,125	3,073	,002
Things for fun	,419	,143	4,254	,000
Chances for a happy future	,444	,150	4,781	,000
Peace of mind	,425	,160	3,969	,000
Faith in God	,333	,160	3,354	,001
Achievement of personal goals	,529	,152	4,534	,000
Happiness in general	,302	,141	2,990	,003
Life satisfaction in general	,432	,148	4,136	,000
Personal appearance	,444	,161	4,472	,000
Self	,294	,124	2,786	,005

a. Not assuming the null hipotesis.
b. Using the asymptotic error assuming the null hypotesis.

Table 116

Mann-Whitney post-hoc test for manual wheelchair components

	Wheelchair type	n	Mean Ranks	Sum Score	U	Z	Sig.
Backrest height	Light - folding	8	17,50	140,00	16,00	-2,85	,004
	Ultra light - folding	15	9,07	136,00			
Seat height	Light - folding	8	13,94	111,50	44,50	-1,01	,314
	Ultra light - folding	15	10,97	164,50			
Seat width	Light - folding	8	14,63	117,00	39,00	-1,38	,167
	Ultra light - folding	15	10,60	159,00			
Seat depth	Light - folding	8	13,69	109,50	46,50	-,88	,380
	Ultra light - folding	15	11,10	166,50			
Wheels diameter	Light - folding	8	12,81	102,50	53,50	-,48	,630
	Ultra light - folding	15	11,57	173,50			
Caster wheels diameter	Light - folding	8	17,63	141,00	15,00	-3,00	,003
	Ultra light - folding	15	9,00	135,00			
Handrim diameter	Light - folding	8	10,75	86,00	50,00	-,67	,506
	Ultra light - folding	15	12,67	190,00			
MWC weight	Light - folding	8	14,50	116,00	40,00	-1,32	,188
	Ultra light - folding	15	10,67	160,00			

Table 117

Mann-Whitney post-hoc test for manual wheelchair components

	Wheelchair type	n	Mean Ranks	Sum Score	U	Z	Sig.
Backrest height	Light - folding	8	30,75	246,00	14,00	-3,74	,000
	Ultra light - unfolding	28	15,00	420,00			
Seat height	Light - folding	8	24,63	197,00	63,00	-1,87	,061
	Ultra light - unfolding	28	16,75	469,00			
Seat width	Light - folding	8	27,56	220,50	39,50	-2,78	,005
	Ultra light - unfolding	28	15,91	445,50			
Seat depth	Light - folding	8	25,63	205,00	55,00	-2,19	,029
	Ultra light - unfolding	28	16,46	461,00			
Wheels diameter	Light - folding	8	16,50	132,00	96,00	-,73	,466
	Ultra light - unfolding	28	19,07	534,00			
Caster wheels diameter	Light - folding	8	29,00	232,00	28,00	-3,26	,001
	Ultra light - unfolding	28	15,50	434,00			
Handrim diameter	Light - folding	8	16,38	131,00	95,00	-,67	,503
	Ultra light - unfolding	28	19,11	535,00			
MWC weight	Light - folding	8	28,44	227,50	32,50	-3,05	,002
	Ultra light - unfolding	28	15,66	438,50			

Table 118

Mann-Whitney post-hoc test for manual wheelchair components

	wheelchair type_mecanic	N	Mean Ranks	Sum Score	U	Z	Sig.
Backrest height	Ultra light - folding	15	26,83	402,50	137,50	-1,85	,064
	Ultra light - unfolding	28	19,41	543,50			
Seat height	Ultra light - folding	15	25,33	380,00	160,00	-1,28	,201
	Ultra light - unfolding	28	20,21	566,00			
Seat width	Ultra light - folding	15	27,23	408,50	131,50	-2,02	,044
	Ultra light - unfolding	28	19,20	537,50			
Seat depth	Ultra light - folding	15	25,80	387,00	153,00	-1,47	,143
	Ultra light - unfolding	28	19,96	559,00			
Wheels diameter	Ultra light - folding	15	18,27	274,00	154,00	-1,68	,092
	Ultra light - unfolding	28	24,00	672,00			
Caster wheels diameter	Ultra light - folding	15	28,60	429,00	111,00	-2,67	,008
	Ultra light - unfolding	28	18,46	517,00			
Handrim diameter	Ultra light - folding	15	22,50	337,50	202,50	-,20	,842
	Ultra light - unfolding	28	21,73	608,50			
MWC weight	Ultra light - folding	15	28,63	429,50	110,50	-2,57	,010
	Ultra light - unfolding	28	18,45	516,50			

Appendix 20: Post-hoc tests from Kruskal-Wallis analysis

Mann-Whitney U tests

Table 119

Mann Whitney post hoc test for quality of life in physical activity group (UltF and UltU)

	QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
Mann-Whitney U	14,000	22,000	22,000	27,500	29,000
Wilcoxon W	290,000	298,000	298,000	303,500	305,000
Z	-3,261	-2,869	-2,869	-2,599	-2,525
Asymp. Sig. (2 – tailed)	,001	,004	,004	,009	,012
Exact Sig. [2*(1-tailed Sig.]	,000[b]	,003[b]	,003[b]	,007[b]	,010[b]

Legend: Lightweight – folding (ltF), ultralightweight – folding (UltF) and ultralightweight - unfolding UltU

Table 120

Mann Whitney post hoc test for quality of life in physical activity group (ltF and UltU)

	QLI	HFSUBa	SOCSUBb	PSPSUBc	FAMSUBd
Mann-Whitney U	30,000	28,000	16,500	18,500	32,500
Wilcoxon W	306,000	304,000	292,500	294,500	308,500
Z	-,361	-,522	-1,446	-1,284	-,161
Asymp. Sig. (2 – tailed)	,718	,602	,148	,199	,872
Exact Sig. [2*(1-tailed Sig.]	,762[b]	,648[b]	,157[b]	,211[b]	,880[b]

Legend: Lightweight – folding (ltF), ultralightweight – folding (UltF) and ultralightweight - unfolding UltU

Table 121

Mann Whitney post hoc test for quality of life in physical activity group (ltF and UltF)

	QLI	HFSUB	SOCSUB	PSPSUB	FAMSUB
Mann-Whitney U	6,000	8,000	5,000	7,000	7,000
Wilcoxon W	12,000	14,000	11,000	13,000	13,000
Z	-1,026	-,570	-1,254	-,798	-,798
Asymp. Sig. (2 – tailed)	,305	,569	,210	,425	,425
Exact Sig. [2*(1-tailed Sig.]	,383[b]	,667[b]	,267[b]	,517[b]	,517[b]

Legend: Lightweight – folding (ltF), ultralightweight – folding (UltF) and ultralightweight - unfolding UltU

Table 122

Mann Whitney post hoc test for upper extremity strength in region/province

		Algarve/Alentejo			Algarve/Huelva		
		U	Z	Sig.	U	Z	Sig.
Shoulder Flexion	Left	139,00	-,137	,891	21,00	-1,00	,315
	Right	129,00	-,478	,633	30,00	-,25	,802
Shoulder Extension	Left	140,00	-,102	,918	32,00	-,08	,933
	Right	118,50	-,836	,403	20,00	-1,09	,277
Shoulder Abduction	Left	139,00	-,137	,891	25,00	-,67	,503
	Right	142,00	-,034	,973	32,00	-,08	,933
Shoulder Lateral Rotation	Left	135,00	-,273	,785	24,00	-,75	,452
	Right	128,50	-,495	,620	26,00	-,59	,558
Shoulder Medial Rotation	Left	114,00	-,990	,322	27,00	-,50	,616
	Right	131,00	-,410	,682	32,50	-,04	,967
Elbow Flexion	Left	128,00	-,512	,608	12,00	-1,76	,079
	Right	120,00	-,785	,432	26,00	-,59	,558
Elbow Extension	Left	119,00	-,819	,413	19,00	-1,17	,242
	Right	139,50	-,119	,905	26,00	-,59	,558

Table 123

Mann Whitney post hoc test for upper extremity strength in region/province

		Algarve/Seville			Algarve/Cadis		
		U	Z	Sig.	U	Z	Sig.
Shoulder Flexion	Left	21,00	-2,52	,012	39,00	-,999	,318
	Right	10,50	-3,11	,002	36,00	-1,19	,236
Shoulder Extension	Left	19,00	-2,63	,008	39,00	-,999	,318
	Right	9,00	-3,19	,001	25,00	-1,87	,061
Shoulder Abduction	Left	19,00	-2,63	,009	44,00	-,69	,492
	Right	19,00	-2,63	,008	28,00	-1,69	,092
Shoulder Lateral Rotation	Left	20,50	-2,55	,011	32,50	-1,41	,160
	Right	10,00	-3,14	,002	18,00	-2,31	,021
Shoulder Medial Rotation	Left	12,00	-3,03	,002	13,00	-2,62	,009
	Right	20,00	-2,58	,010	35,00	-1,25	,212
Elbow Flexion	Left	7,00	-3,30	,001	21,00	-2,12	,034
	Right	12,00	-3,02	,002	25,00	-1,87	,061
Elbow Extension	Left	6,00	-3,36	,001	22,00	-2,06	,039
	Right	5,00	-3,42	,001	17,00	-2,37	,018

Table 124

Mann Whitney post hoc test for upper extremity strength in region/province

		Alentejo/Huelva			Alentejo/Seville			Alentejo/Cadis		
		U	Z	Sig.	U	Z	Sig.	U	Z	Sig.
Shoulder Flexion	Left	12,00	-1,01	,313	11,00	-2,46	,014	19,00	-1,33	,183
	Right	15,00	-,61	,544	3,00	-3,16	,002	23,50	-,89	,375
Shoulder Extension	Left	19,00	-,07	,946	10,00	-2,54	,011	23,00	-,94	,349
	Right	14,00	-,74	,459	6,00	-2,89	,004	7,50	-2,47	,014
Shoulder Abduction	Left	13,00	-,87	,382	4,00	-3,07	,002	18,00	-1,43	,153
	Right	17,00	-,34	,737	4,00	-3,07	,002	6,00	-2,62	,009
Shoulder Lateral Rotation	Left	13,00	-,87	,382	7,00	-2,81	,005	14,00	-1,82	,068
	Right	15,00	-,61	,544	7,00	-2,81	,005	15,00	-1,73	,084
Shoulder Medial Rotation	Left	17,50	-,27	,788	6,00	-2,90	,004	9,50	-2,27	,023
	Right	15,00	-,61	,545	6,00	-2,90	,004	14,00	-1,82	,068
Elbow Flexion	Left	7,00	-1,68	,092	3,00	-3,16	,002	16,00	-1,63	,104
	Right	17,00	-,34	,737	2,00	-3,25	,001	14,00	-1,82	,068
Elbow Extension	Left	16,00	-,47	,638	5,00	-2,98	,003	17,50	-1,48	,139
	Right	18,00	-,20	,840	11,00	-2,46	,014	14,00	-1,82	,068

Table 125

Mann Whitney post hoc test for upper extremity strength in region/province

		Huelva/Seville			Huelva/Cadis			Seville/Cadis		
		U	Z	Sig.	U	Z	Sig.	U	Z	Sig.
Shoulder Flexion	Left	8,00	-,26	,796	5,00	-,75	,456	8,00	-1,28	,201
	Right	1,00	-2,07	,039	5,50	-,60	,549	4,00	-2,01	,045
Shoulder Extension	Left	3,00	-1,55	,121	6,00	-,45	,655	7,00	-1,46	,144
	Right	3,50	-1,43	,154	7,00	-,15	,881	4,00	-2,01	,044
Shoulder Abduction	Left	4,00	-1,29	,197	6,00	-,45	,655	7,50	-1,37	,170
	Right	2,00	-1,81	,071	4,00	-1,05	,294	10,00	-,92	,360
Shoulder Lateral Rotation	Left	7,00	-,52	,604	7,00	-,15	,881	13,00	-,37	,714
	Right	5,00	-1,03	,302	4,00	-1,04	,297	11,00	-,73	,465
Shoulder Medial Rotation	Left	2,00	-1,81	,071	2,00	-1,64	,101	9,00	-1,10	,273
	Right	2,00	-1,82	,070	5,00	-,75	,456	4,00	-2,01	,044
Elbow Flexion	Left	8,00	-,26	,795	7,00	-,15	,881	8,00	-1,28	,200
	Right	,00	-2,33	,020	4,50	-,90	,368	5,00	-1,83	,067
Elbow Extension	Left	1,00	-2,07	,039	4,00	-1,04	,297	4,00	-2,01	,045
	Right	1,00	-2,07	,039	6,00	-,45	,655	4,00	-2,01	,045

Table 126

Mann Whitney post hoc test for QUEST 2.0 scores in a group of physical activity, according to MWC type

	wheelchair type	n	Mean Ranks	Sum Score	U	Z	Sig.
QUEST 2.0 Assistive Tecnology	Light - folding	3	4,00	12,00	6,00	-2,29	,022
	Ultra light - unfolding	23	14,74	339,00			
QUEST 2.0 Total score	Light - folding	3	5,00	15,00	9,00	-2,05	,040
	Ultra light - unfolding	23	14,61	336,00			

Table 127

Mann Whitney post hoc test for QUEST 2.0 scores in a group of physical activity, according to MWC type

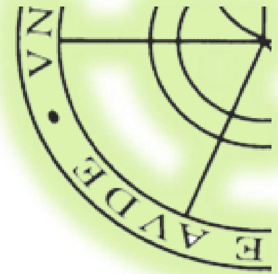
	wheelchair type	n	Mean Ranks	Sum Score	U	Z	Sig.
QUEST 2.0 Assistive Tecnology	Ultra light - folding	7	20,57	144,00	9,50	-1,54	,123
	Ultra light - unfolding	23	13,96	321,00			
QUEST 2.0 Total score	Ultra light - folding	7	21,71	152,00	9,00	-1,62	,106
	Ultra light - unfolding	23	13,61	313,00			

Table 128

Mann Whitney post hoc test for QUEST 2.0 scores in a group of physical activity, according to MWC type

	wheelchair type	n	Mean Ranks	Sum Score	U	Z	Sig.
QUEST 2.0 Assistive Tecnology	Light - folding	3	2,00	6,00	,000	-2,40	,016
	Ultra light - folding	7	7,00	49,00			
QUEST 2.0 Total score	Light - folding	3	2,00	6,00	,000	-2,39	,017
	Ultra light - folding	7	7,00	49,00			

ANNEXES



11. ANNEXES

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