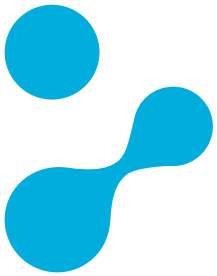


Satakunnan ammattikorkeakoulu
Satakunta University of Applied Sciences

ALEXANDRE CLINTON CHAPUIS

The physical activity of paraplegic individuals and its impact on the physiotherapeutic rehabilitation

DEGREE PROGRAMME IN PHYSIOTHERAPY
2025

ABSTRACT

Chapuis, Alexandre: The physical activity of paraplegic individuals and its impact on the physiotherapeutic rehabilitation
Bachelor's thesis
Degree programme in Physiotherapy
March 2025
Number of pages: 26

The study focused on the habits of paraplegic patients regarding their physical activity and the progress that this may have brought. According to studies undertaken, regular physical activity has a significant positive impact on the rehabilitation of paraplegic patients. Physical exercise helps these patients to improve their mobility, increase their muscular strength, optimize cardiac health and reduce many disease risks.

For the thesis, existing literature was reviewed for studying the impact of physical activity on the rehabilitation of paraplegic patients. This study compared structured exercise and traditional physiotherapy with the aim of linking physical activity levels to the effectiveness of rehabilitation. The main results shed light on improved fitness, muscle tone and cardio-respiratory health. This also helped increase patient motivation, allowing for better adherence to rehabilitation program and increased self-esteem for patients. This study revealed that physical activity optimizes rehabilitation outcomes, such as independence and overall quality of life. The methods used included circuit training, resistance exercises and health education, all under regular supervision by health care professionals.

The reason that led me to the study of this topic was that physical activity plays an important role in paraplegic rehabilitation, whilst in the meantime having its full effect on physiotherapy not completely understood. Exercise can enhance recovery by improving fitness, independence, and quality of life. This research helped me to fill the gap by comparing exercise-based rehabilitation with traditional physiotherapy. By also supporting long-term healing boosts motivation of the patients and helps design more effective rehabilitation programs by integrating exercise into treatment plans.

Keywords: paraplegia, physical activity, physiotherapy, rehabilitation, spinal cord injury, motor function, disability

CONTENT

1 INTRODUCTION

The subject concerning my research is one that has upset the back of health care professionals for decades: the physical activity for paraplegic patients during their rehabilitation and the rest of their life. Humans might have invented the wheel, but it still takes them some time to consider the gravity of the subject. For the concept of physical activity is nowadays considered as taboo in some societies, regarding the image of one with itself. It is not just about moving, but also about escaping the limitations that life has put in front of these patients. We should try to appreciate the different point of views and sensibilities, for it is a slippery subject.

To resume, this thesis' objective is to research the importance of physical activity in the rehabilitation of paraplegic patients. A literature review was done to properly argument on the subject, exploring practices and professional advancements. This analysis helped formulate a research problem centred on the impact of physical activity on the quality of life and autonomy of paraplegic individuals. From this, a research question emerged, seeking to determine the specific benefits of physical activity in this rehabilitation framework.

2 AIM AND OBJECTIVES

The aim of this thesis is to educate physiotherapists and physiotherapy students to understand the need of physical activity as a full part of the rehabilitation process for paraplegic patients as a mean to help both body and mind to heal as well as possible.

The objective of this thesis is to do a literature review and explain why **these** patients need physical activity during rehabilitation. The key is to learn not just how to adapt to the situation, but to transcend it.

3 PARAPLEGIA

3.1 Definition

Paraplegia refers to paralysis that occurs in the lower half of the body. It can be a result of an accident or a chronic condition. It is usually caused by damage to the spinal cord or brain. The key points concerning paraplegia are multiple, starting from the damage on legs and lower abdomen, the impact on the bladder or bowel, breathing and other automatic functions. (Kandola, 2020). For a better understanding of the spinal cord system, refer to figure 1.

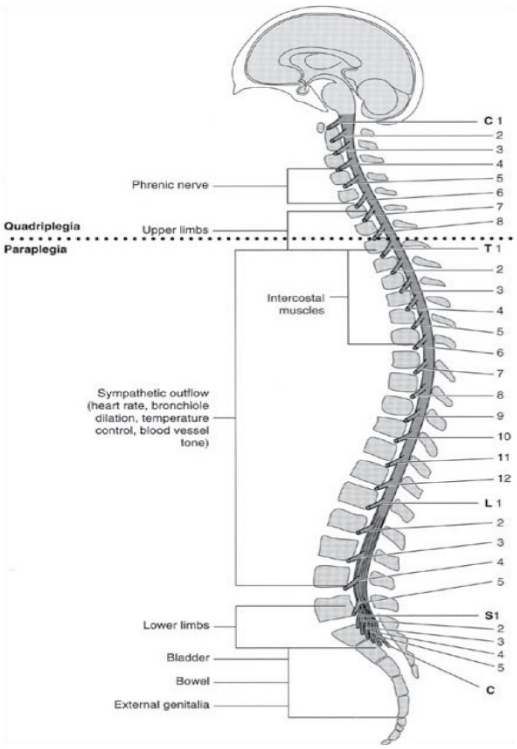
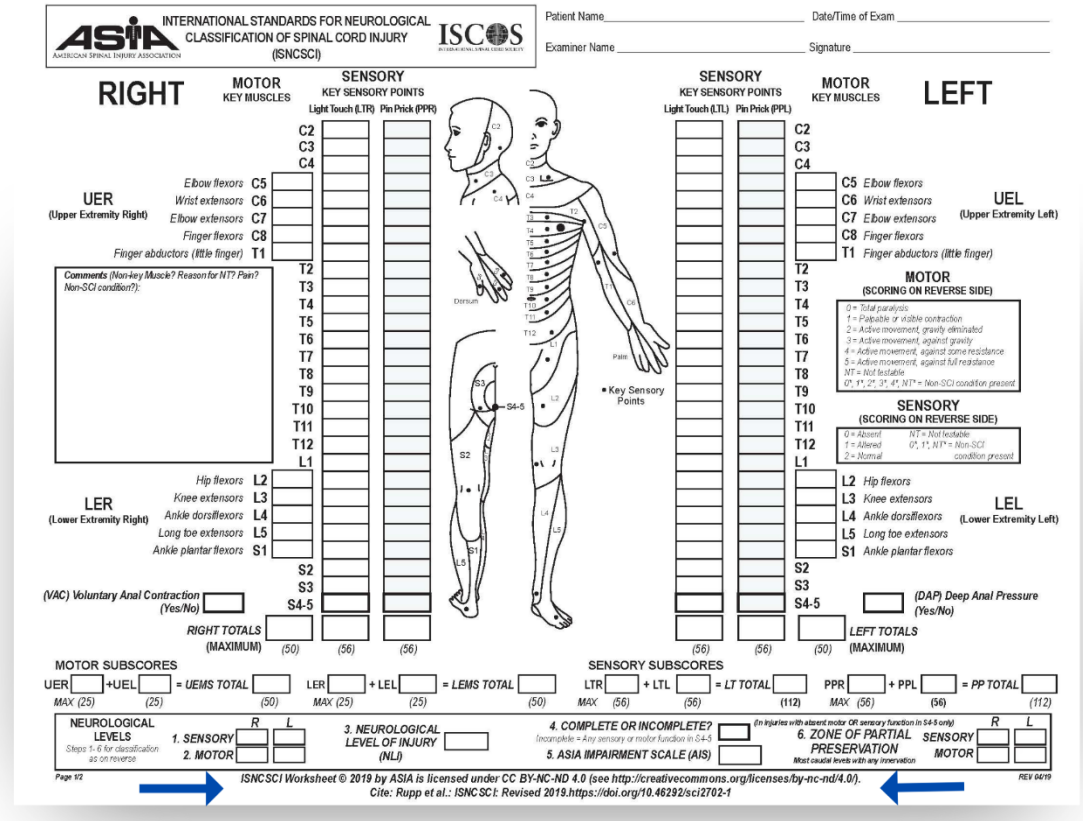


Figure 1 represents the spinal cord in its entirety.

The diagnosis of paraplegia typically involves medical imaging and neurological exams. Treatment of paraplegia focuses on managing symptoms and improving the patient's quality of life through physical therapy/rehabilitation, assistive devices (wheelchairs), medical management, bowel/bladder care programs, pain management and psychological support. The outlook of paraplegia varies depending on the severity and the causes of the pathology. With proper treatment and rehabilitation, many patients with paraplegia can have fulfilling lives and maintain some kind of independence. Ongoing care and prevention of health complications will be the work of health care professionals throughout the remaining of the paraplegic patients' lives. (Klebine, 2024). The medical specialists in USA base themselves on the American Spinal Injury Association (ASIA) board for neurological assessment. The American Spinal Injury Association International Standards for Neurological Classification of Spinal Cord Injury form used to evaluate spinal cord injury is presented. (American Spinal Injury Association. International Standards for Neurological Classification of Spinal Cord Injury.), As shown on Picture 2.



Picture 2. The American Spinal Injury Association International Standards for

Neurological Classification of Spinal Cord Injury form used to evaluate spinal cord injury is presented.

The first case ever recorded of paraplegia can be found on the Edwin Smith surgical papyrus from around 1600 BCE. The understanding of spinal cord injury was limited. (Hughes, 1987). The two World Wars led to a large number of spinal cord injuries, prompting more studies and treatment developments. (Siganporia, 2022a). Nowadays, while spinal cord injuries remain serious, advances have greatly improved survival rates and quality of life for most patients. (Siganporia, 2022b).

3.2 Causes of paraplegia

The reasons for paraplegia can be very different. The most common are spinal cord injury due to accidents (motor vehicle crashes, falls, sport injuries, penetrating injuries like gunshots or stabbings), medical conditions affecting the spinal cord (spinal cancer growth, infections to the spine, blood flow affect like ischemia, and congenital conditions such as spina bifida), neurological disorders (multiple sclerosis, Guillain-Barré syndrome and stroke). (Professional, 2024.)

It is of paramount importance to consider that paraplegia usually is the result of injuries or conditions affecting the spinal cord in the most cases thoracic, lumbar or sacral area. The severity of symptoms is depending in the level and complexity of the spinal cord injury. It is logical to say that some causes can be preventable (wearing seatbelts, avoiding falls, safe use of firearms). (Professional, 2024.)

3.3 Occurrence of paraplegia

The occurrence of paraplegia refers to a situation that takes place or exists in a given area. The annual incidence of traumatic spinal cord injuries (all pathologies including paraplegia) in Finland is 13,8 per 1 million people. The number

of cases is approximately 65 new cases every year. The main age of injures for men is around 40 years and 38 for women.

The majority of injuries happens under the age of 55. (Ahoniemi, 2008). In the gender distribution, 79% of patients with paraplegia were men. Concerning the causes of injuries for paraplegia, falls were the most common ones with 41.2%, followed closely by traffic accidents with 39.5%. The studies show that half of the patients with spinal cord injury had paraplegia. (Ahoniemi, 2011.)

3.4 Social and mental states of paraplegia

Patients affected with paraplegia suffer from this condition in different domains within the social and mental scopes. The mental scope observes effects like depression and anxiety due to the physical modifications to the patient's body. (UPMC, 2024). The major depressive disorder occurs in about 25% of adults with paraplegia, during their first rehabilitation or after they are initially discharged from hospital. The mental state of paraplegic patients can lead to other issues, such as substance abuse disorders or Post Traumatic Stress Disorder (PTSD), in a more prevalent rate than in the general population. (Budd, 2022). The social scope observes effects like the stigma that this physical condition has on both the patients and the members of the general public. (Ray, 1984). Patients most likely will need to adapt their lives to the new circumstances. (UPMC, 2024). The social relationships can be impacted (marital, familial). (Budd, 2022). There are challenges reintegrating into society and their own community after the diagnosis. (UPMC, 2024)

These two scopes can also be followed by sexual and personal impact, whilst also coping and adjusting to the condition. The factor of sexual impact hurts the body image, the loss of sexual functions is a significant challenge, the overall sense of identity and the self-worth of a patient are impacted. The factor of coping and adjusting affects the patient's ability to adapt to the disability. (UPMC, 2024). The patient can struggle with the resiliency to accept the situation. The ability to use effective coping mechanisms is important for mental

health. (Budd, 2022). The risks of depression and/or suicide are usually prevented whilst the patients are put into meaningful activities after discharge from the hospital. (UPMC, 2024).

4 PHYSICAL ACTIVITY

4.1 Definition

Physical activity can be describing any bodily movement produced by skeletal muscles that requires energy expenditure (the amount of energy an individual uses to maintain essential body functions). Physical activity encompasses all the different types of movement, such as leisure time activities, transport to get around and work/domestic activities. It can range all the way from light to intense efforts and can be done at any level of skills for enjoyment by everyone. The benefits of regular physical activity include prevention and management of pathologies like heart disease, cancer or diabetes, improved mental health and cognitive function, improved sleep and help in weight management.

The World Health Organization recommends at least 150 minutes of moderate-intensity physical activity per week for adults. On a global scale, around 31% of adults (1,8 billion people) do not reach this level. The increase of physical activity is seen of paramount importance in order to reduce the risk of disease around the globe. (WHO, 2024.)

The concept of physical activity is very present in ancient civilizations. In ancient China, Confucian teaching encouraged regular physical activity for health benefits. In India, yoga emerged around 5000 years ago as a way to balance the body, mind and spirit. In Ancient Greece, physical activity was considered as equally important as mental development. In Ancient Rome, all citizens aged 17 to 60 were required to maintain good physical condition for potential military service. Throughout the Dark and Middle Ages, hunting/gathering

lifestyles were brought back leading to an increase in physical activity levels. The Rennaissance renewed interest in human physicality, leading to rebirth of physical education programs in schools. From the Industrial Revolution until our time, an evolution of physical activity process was created in order to reach the several needs for physical care. (History of fitness, 2024)

4.2 Recommendation for physical activity

The many different groups that constitute the human family each need a proper program to practice physical activity. Regarding this statement, it is now important to show each group's adequate physical activity programs.

The children and adolescents could benefit from at least 60 minutes of moderate-to-vigorous physical activity daily. In addition to the vigorous activity there should be muscle-strengthening and bone strengthening activities about 3 times a week. (Physical Activity Basics, 2024).

The adults (from 18 to 64 years old) could benefit from at least 150 minutes of moderate-intensity aerobic or 75 minutes of vigorous-intensity aerobic per week. In addition, the inclusion of muscle strengthening activity at least 2 days per week that work all major muscle groups could be positive. (Physical Activity Basics, 2024b).

The older adults (65+) could benefit from the same recommendations as the adults regarding the aerobic, with a special focus on improving the balance with single foot standing activities. (Physical Activity Basics, 2024c).

A special precision is to be made for pregnant women. It is important for them to do at least 150 minutes of moderate-intensity aerobic per week for both the wellbeing of the mother and the child. (Website, N. , 2024).
The important thing to remember is to spread out activity throughout the week rather than doing it all at once. It is important to reduce the sedentary time and break the cycle of long periods without movement. It is of paramount

importance to consult a medical doctor before starting new exercise routine, especially if you have health conditions. Also, do not forget to mix up the types of activities in order to keep the process interesting and prevent plateaus, (being stuck in the same level of physical condition and ability), (Website, N, 2024). The last point is to not forget that any amount of physical activity is better than none, therefore, trying to incorporate more activity into one's routine gradually is always the way for an overall better health. (WHO, 2024b).

5 PHYSIOTHERAPEUTIC REHABILITATION FOR PARAPLEGIA

5.1 Overview of paraplegia

The level and completeness of the spinal cord injury determines the extent of the paralysis. (What is a Spinal Cord Level of Injury?, n.d.). For the most cases, it is traumatic injury; yet it can also occur due to non-traumatic causes like for example infections or cancerous growth. (Müller-Jensen, 2021). The patients with paraplegia do often experience secondary complications like pressure ulcers, respiratory issues and also loss of bone density. (Vecin, 2022).

An adequate assessment of paraplegia is critical to develop an individualized rehabilitation plan for the patient. (Quinones, 2024). The several components of the assessment combine neurological examination to determine the extent of the spial cord injury, the functional assessment of mobility/transfers/daily activities, range of motion and muscle strength evaluations, pain assessment, evaluation of respiratory and cardiovascular systems and the assessment of psychological factors like depression and anxiety. (Knadmin, 2022).

5.2 Importance of physical therapy in rehabilitation

Physical therapy usually plays a vital role in the rehabilitation process of patients affected by paraplegia. (MSKTC, 2024-b) The process of rehabilitation

passes by the setting of goals. (Maribo, 2020). These goals include maximizing functional mobility and independence, preventing secondary complications, improving overall quality of life and enhancing social participation and community reintegration. (Nas, 2015).

They are many components in the physiotherapist's intervention process for the betterment of the patient's rehabilitation process. (Barker, 2019). The mobility training combines transfer techniques, wheelchair mobility skills, standing and walking programs when appropriate and adaptive equipment training. The strength and endurance combine resistance exercises using proper body positioning and cardiovascular training through wheelchair sports or exercises. (MSKTC, n.d.). The range of motion and flexibility combine regular stretching to prevent contractures and maintenance of joint mobility. (Harvey, 2017). Pain management combines education on proper position to reduce pain and use of assistive devices and ergonomic techniques. (Greenwood, 2024). The prevention of secondary complications combines pressure ulcer prevention strategies, respiratory management techniques and bone health maintenance programs. (Hommel, 2018). The functional training combines activities of daily living (ADLs) training, transfer training to/from bed/toilet/shower/etc, and wheelchair accessibility modifications. (You, 2017). The assistive technology combines proper fitting and use of wheelchairs/orthotics/adaptive equipment and training on device operation and maintenance. (Nichd, 2018). The community integration combines access to accessible community resources and participation in adaptive sports and recreational activities. (UCLA, 2023).

The concept of physical activity is best practiced in collaborating closely with interdisciplinary team members including physicians, occupational therapists, physiotherapists and psychologists. (Foxrehab, 2021). It also uses evidence-based intervention tailored to individual needs and focuses on patient education and empowerment throughout the rehabilitation process. (Bhattad, 2022). This process addresses psychological factors that may impact recovery and provides ongoing support and follow-up care after the patient has left the formal rehabilitation process. (Kellezi, B., 2016).

5.3 Physical activity in the paraplegic rehabilitation process

The benefit of physical activity for patients with paraplegia in their rehabilitation journey is to be understood on many levels. In introduction, it's elemental to know that spinal cord injury leads to loss of motor function, sensation and automatic system regulation. (Henke et al., 2022). This is causing a shift from active to inactive lifestyles, leading to secondary complications like cardiovascular disease, metabolic disorders and obesity. (Nash, 2018). The physical impairments affect quality of life and can lead to early morbidity and mortality. (WHO, 2024a). Then, the physical activities can enhance physical fitness, functional capacity and participation. (Ramnath, 2018). The regular exercise could help prevent physical deconditioning, even if the levels of physical activity tend to lower after the rehabilitation program at the hospital. (Maher, 2017). It is of paramount importance to take in consideration the barriers to physical activity. Intrinsic factors could include low exercise self-efficacy, motivation and lack of proper knowledge, and extrinsic factors could include program costs, access to equipment and inaccessible facilities. (Blom, 2021.)

The benefits of exercise programs can improve physical capacities like strength, body composition, aerobic fitness and functional performance. You should consider at least 30 minutes aerobic exercise per day in order to prevent cardiovascular disease. Take into consideration that progressive resistance exercises are recommended to prevent muscle deconditioning (loss of muscular mass). (Voet, 2019). Let's think about intervention and outcomes of physical activity. For example, studies have shown positive effects of exercise programs on physical fitness and cardiometabolic health. The body weight-supported treadmill training and supervised exercise have found to improve participation and quality of life. Also, cognitive and behavioural approaches can help manage chronic pain and improve participation. (Franklin, 2022.)

The final part of this chapter would be the recommendations for the paraplegic patients of doing extra physical activity during their rehabilitation process. We should incorporate educational programs into paraplegic rehabilitation in order

to increase exercise self-efficacy. It is important to use circuit-based aerobic interval training to prevent boredom and minimize fatigue. The implementation of progressive resistance exercises in order to maintain muscle mass should be coupled with the measure of the participation in rehabilitation programs. (Hisham, 2022). The conclusion of this chapter would be that physical activity plays a critical role in the rehabilitation of patients with paraplegia. It offers many health benefits and clearly improves the overall quality of life. To understand one's physical activity needs to be the goal in providing proper comprehensive care. The limits that paraplegia poses onto the patient shall be fought with evidence-based physiotherapeutic interventions and the hard work of healthcare professionals. (Gómara-Toldrà, 2014.)

6 DISCUSSION

Physical activity is the basis for a successful rehabilitation outcome, with comprehensive mobility (combining ROM/stabilization/control of joints and muscles training) exercises training strongly improving functional autonomy. An individualized approach would usually be more efficient than standardized programs, whilst early intervention seems to improve the long-term recovery process. A more adequate rehabilitation programme needs the help of multi-disciplinary professionals that work together in the same goal of helping and assessing the patient to offer the best treatment possible. In this optic, both traditional and modern therapeutic protocols will be used with patient-centered rehabilitation targets to improve motivation and compliance of the patients.

This research process faced many difficulties in integrating diverse medical literature within multiple aspects whilst balancing theoretical knowledge with practical clinical applications. Understanding and using complex rehabilitations protocols and terminology was a hard task, knowing that it had to make sense with both physical and psychological aspects. The necessity of clarity with the different rehabilitation phases is to be made with the help of the integration of

treatment modalities. It was essential to balance the work with proper coverage and clear data access.

The research findings have important potential regarding future impact in multiple healthcare domains. In clinical practice, it could lead to an improvement in rehabilitation protocols, optimized mobility training programs, and more efficient results for the patient with the help of evidence-based practices. These lead to facilitating a better integration of traditional and modern therapeutic techniques. The academic world should benefit with the development of training materials for healthcare providers, the creation of patient educating programs, the establishment of clinical guidelines for rehabilitation teams and the financial resources for continued learning. Also, these findings would provide a base for future research, allowing studies in rehabilitation effectiveness, studies of new therapeutic approaches, comparative analyses of different rehabilitation methods and finally the contribution to the development of advanced rehabilitation protocols.

There are many ethical considerations that are emerging during this research process. The patient-centered ethics require a careful focus on the most accurate treatment and consideration of a patient regarding its goal-setting treatment choices, the protection of their privacy, a proper approach regarding the cultural and personal preferences in the rehabilitation program's planning. There needs to be professional responsibility in the scientific accuracy of the rehabilitation techniques, the transparency of the information and limitation in all the process and the acceptance of an adequate guideline. The importance of research integrity leads to a proper education in rehabilitation goals. It is finally necessary to make a clear distinction between evidence-based and emerging rehabilitation practices for an improvement of all the rehabilitation programs in the long term.

To illustrate my thesis and with the desire to inspire both the patients suffering from paraplegia and the rehabilitation health care professionals, I will show what physical activity during rehabilitation can lead to. In appendix 1 there are a few of the pictures I took while I was covering the summer and winter

paralympic games from 2006 to 2018 as an official photo reporter for the French paralympic committee.

REFERENCES

Ahoniemi, E., Alaranta, H., Hokkinen, E., Valtonen, K., & Kautiainen, H. (2008). Incidence of traumatic spinal cord injuries in Finland over a 30-year period. Spinal Cord, 46(12), 781–784. https://doi.org/10.1038/sc.2008.53

Ahoniemi, E., Pohjolainen, T., & Kautiainen, H. (2011). Survival after spinal cord injury in Finland. Journal of Rehabilitation Medicine, 43(6), 481–485. https://doi.org/10.2340/16501977-0812

Barker, K. L., Newman, M., Stallard, N., Leal, J., Lowe, C. M., Javaid, M. K., Noufaily, A., Adhikari, A., Hughes, T., Smith, D. J., Gandhi, V., Cooper, C., & Lamb, S. E. (2019, August 1). Intervention description and rationale. Exercise or Manual Physiotherapy Compared With a Single Session of Physiotherapy for Osteoporotic Vertebral Fracture: Three-arm PROVE RCT - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK545578/

Bhattad, P. B., & Pacifico, L. (2022). Empowering patients: Promoting patient education and health literacy. Cureus. https://doi.org/10.7759/cureus.27336

Blom, V., Drake, E., Kallings, L. V., Ekblom, M. M., & Nooijen, C. F. J. (2021). The effects on self-efficacy, motivation and perceived barriers of an intervention targeting physical activity and sedentary behaviours in office workers: a cluster randomized control trial. BMC Public Health, 21(1). https://doi.org/10.1186/s12889-021-11083-2

Budd, M. A., Gater, D. R., & Channell, I. (2022). Psychosocial Consequences of Spinal cord Injury: A Narrative review. Journal of Personalized Medicine, 12(7), 1178. https://doi.org/10.3390/jpm12071178

Chang, F., Zhang, Q., Xie, H., Yang, Y., Sun, M., Wu, A., Wu, J., Chen, G., Shen, F., Li, C., & Lu, J. (2020). Effects of a rehabilitation program for individuals with chronic spinal cord injury in Shanghai, China. BMC Health Services Research, 20(1). https://doi.org/10.1186/s12913-020-05181-x

Exercise after Spinal cord Injury (SCI) | MSKTC. (2024). h https://msktc.org/sci/factsheets/exercise-after-spinal-cord-injury

Foxrehab. (2021, July 26). Why healthcare professionals should need to collaborate. FOXRehab. https://foxrehab.org/clinician-healthcare-professional-collaboration-patient-care/

Franklin, B. A., Eijsvogels, T. M., Pandey, A., Quindry, J., & Toth, P. P. (2022). Physical activity, cardiorespiratory fitness, and cardiovascular health: A clinical practice statement of the American Society for Preventive Cardiology Part II: Physical activity, cardiorespiratory fitness, minimum and goal intensities for exercise training, prescriptive methods, and special patient

populations. American Journal of Preventive Cardiology, 12, 100425. https://doi.org/10.1016/j.ajpc.2022.100425

Gómara-Toldrà, N., Sliwinski, M., & Dijkers, M. P. (2014). Physical therapy after spinal cord injury: A systematic review of treatments focused on participation. Journal of Spinal Cord Medicine, 37(4), 371–379. https://doi.org/10.1179/2045772314y.0000000194

Greenwood, T. (2024, September 3). Managing Chronic Pain with Occupational Therapy: Strategies and Solutions. Alton Physical Therapy - 7 Metro East Locations. https://altonpt.com/managing-chronic-pain-with-occupational-therapy-strategies-and-solutions/

Harvey, L. A., Katalinic, O. M., Herbert, R. D., Moseley, A. M., Lannin, N. A., & Schurr, K. (2017). Stretch for the treatment and prevention of contractures. Cochrane Library, 2017(2). https://doi.org/10.1002/14651858.cd007455.pub3

Henke, A. M., Billington, Z. J., & Gater, D. R. (2022). Autonomic Dysfunction and Management after Spinal Cord Injury: A Narrative Review. Journal of Personalized Medicine, 12(7), 1110. https://doi.org/10.3390/jpm12071110

Hisham, H., Justine, M., Hasnan, N., & Manaf, H. (2022). Effects of Paraplegia Fitness Integrated training on physical function and exercise Self-Efficacy and adherence among individuals with spinal cord injury. Annals of Rehabilitation Medicine, 46(1), 33–44. https://doi.org/10.5535/arm.21127

History of fitness. (2024). https://www.unm.edu/~lkravitz/Article%20folder/history.html

Hommel, A., & Santy-Tomlinson, J. (2018). Pressure injury prevention and wound management. In Perspectives in nursing management and care for older adults (pp. 85–94). https://doi.org/10.1007/978-3-319-76681-2_7

Hughes, J. T. (1987). Historical review of paraplegia before 1918. Spinal Cord, 25(3), 168–171. https://doi.org/10.1038/sc.1987.30

Kandola, A. (2020, May 6). Everything you need to know about paraplegia. https://www.medicalnewstoday.com/articles/what-is-paraplegia

Kellezi, B., Coupland, C., Morriss, R., Beckett, K., Joseph, S., Barnes, J., Christie, N., Sleney, J., & Kendrick, D. (2016). The impact of psychological factors on recovery from injury: a multicentre cohort study. Social Psychiatry and Psychiatric Epidemiology, 52(7), 855–866. https://doi.org/10.1007/s00127-016-1299-z

Klebine, P. (2024). What is paraplegia? Spinal Cord Injury Model System. https://www.uab.edu/medicine/sci/faqs-about-spinal-cord-injury-sci/what-is-paraplegia

Knadmin. (2022, May 18). Neurological Examination and Classification of SCI | PM&R KnowledgeNow. PM&R KnowledgeNow. https://now.aapmr.org/neurological-examination-and-classification-of-sci/

Maribo, T., Jensen, C. M., Madsen, L. S., & Handberg, C. (2020). Experiences with and perspectives on goal setting in spinal cord injury rehabilitation: a systematic review of qualitative studies. Spinal Cord, 58(9), 949–958. https://doi.org/10.1038/s41393-020-0485-8

Maher, J. L., McMillan, D. W., & Nash, M. S. (2017). Exercise and Health-Related Risks of physical deconditioning after spinal cord injury. Topics in Spinal Cord Injury Rehabilitation, 23(3), 175–187. https://doi.org/10.1310/sci2303-175

UCLA Disability Studies Inclusion Labs. (2023, December 13). Making sport accessible | UCLA Adaptive Recreation - UCLA Disability Studies Inclusion Labs. https://dslabs.ucla.edu/videos/making-sport-accessible-ucla-adaptive-recreation/

Müller-Jensen, L., Ploner, C. J., Kroneberg, D., & Schmidt, W. U. (2021). Clinical presentation and causes of non-traumatic spinal cord injury: an observational study in emergency patients. Frontiers in Neurology, 12. https://doi.org/10.3389/fneur.2021.701927

Nas, K., Yazmalar, L., Şah, V., Aydın, A., & Öneş, K. (2015). Rehabilitation of spinal cord injuries. World Journal of Orthopedics, 6(1), 8. https://doi.org/10.5312/wjo.v6.i1.8

Nash, M. S., Groah, S. L., Gater, D. R., Dyson-Hudson, T. A., Lieberman, J. A., Myers, J., Sabharwal, S., & Taylor, A. J. (2018). Identification and Management of Cardiometabolic Risk after Spinal Cord Injury: Clinical Practice Guideline for Health Care Providers. Topics in Spinal Cord Injury Rehabilitation, 24(4), 379–423. https://doi.org/10.1310/sci2404-379

Patricia M. McSweeney. (2024). UPMC | Life Changing Medicine. https://www.upmc.com/services/rehab/rehab-institute/conditions/spinal-cord-injury/education-spinal-injury/psychological-issues

Quinones, C., Wilson, J. P., Kumbhare, D., Guthikonda, B., & Hoang, S. (2024). Clinical assessment and management of acute spinal cord injury. Journal of Clinical Medicine, 13(19), 5719. https://doi.org/10.3390/jcm13195719

Ramnath, U., Rauch, L., Lambert, E. V., & Kolbe-Alexander, T. L. (2018). The relationship between functional status, physical fitness and cognitive performance in physically active older adults: A pilot study. PLoS ONE, 13(4), e0194918. https://doi.org/10.1371/journal.pone.0194918

Raquel Siganporia. (2022a, April 26). The history of spinal cord injury. Aspire Law. https://www.aspirelaw.co.uk/the-history-of-spinal-cord-injury/

Raquel Siganporia. (2022b, April 26). The history of spinal cord injury. Aspire Law. https://www.aspirelaw.co.uk/the-history-of-spinal-cord-injury/

Ray, C., & West, J. (1984). I. Social, sexual and personal implications of paraplegia. Spinal Cord, 22(2), 75–86. https://doi.org/10.1038/sc.1984.15

MSKTC. (2024). Regain mobility with GAIT training after SCI https://msktc.org/sci/factsheets/spinal-cord-injury-and-gait-training

Vecin, N. M., & Gater, D. R. (2022). Pressure Injuries and Management after Spinal Cord Injury. Journal of Personalized Medicine, 12(7), 1130. https://doi.org/10.3390/jpm12071130

Voet, N. B., Van Der Kooi, E. L., Van Engelen, B. G., & Geurts, A. C. (2019). Strength training and aerobic exercise training for muscle disease. Cochrane Library, 2019(12). https://doi.org/10.1002/14651858.cd003907.pub5

Website, N. (2024, November 25). Physical activity guidelines for adults aged 19 to 64. nhs.uk. https://www.nhs.uk/live-well/exercise/physical-activity-guidelines-for-adults-aged-19-to-64/

NICHD. What are some types of assistive devices and how are they used? (2018, October,24). https://www.nichd.nih.gov/health/topics/rehabtech/conditioninfo/device

What you can do to meet physical activity recommendations. (2024, April 16). Physical Activity Basics. https://www.cdc.gov/physical-activity-basics/guidelines/index.html

WHO. (2024a, April 16). World Health Organization. Spinal cord injury. https://www.who.int/news-room/fact-sheets/detail/spinal-cord-injury

WHO. (2024, June 26). World Health Organization. Physical activity. https://www.who.int/news-room/fact-sheets/detail/physical-activity

UPMC. (2024) What is a Spinal Cord Level of Injury? Life Changing Medicine. https://www.upmc.com/services/rehab/rehab-institute/conditions/spinal-cord-injury/basics/level-of-injury

You, J., Kim, Y. L., & Lee, S. M. (2017). Effects of a standard transfer exercise program on transfer quality and activities of daily living for transfer-dependent spinal cord injury patients. Journal of Physical Therapy Science, 29(3), 478–483. https://doi.org/10.1589/jpts.29.478

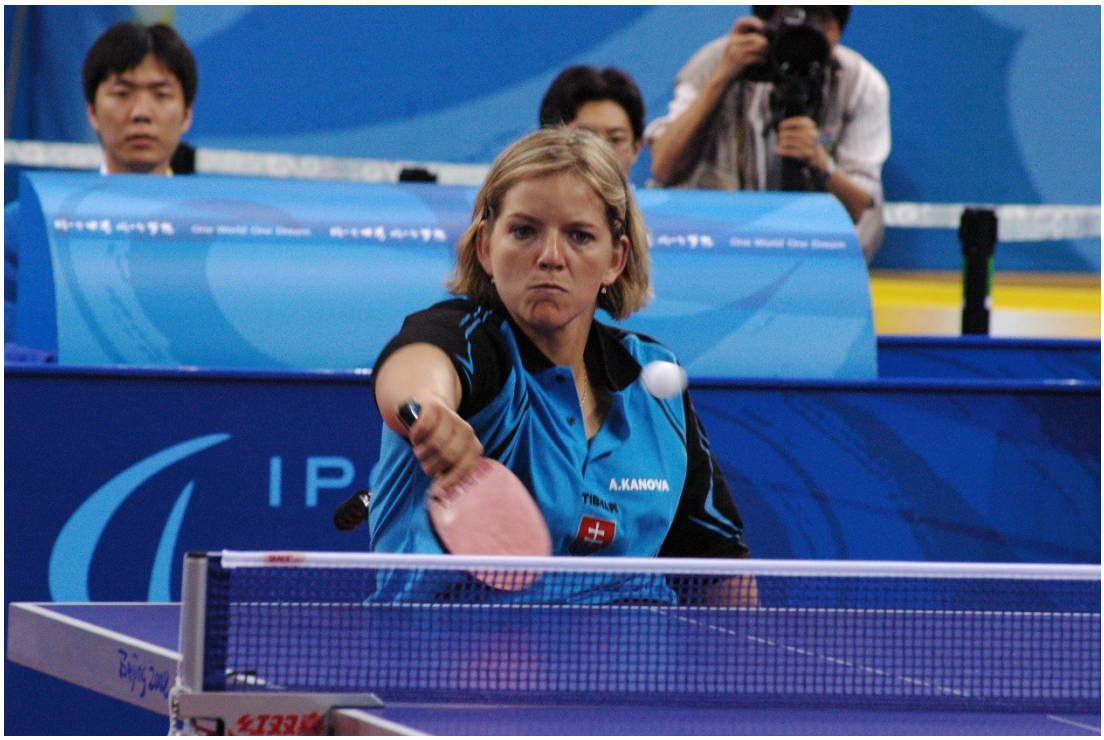
APPENDIX 1: PICTURES FROM THE SUMMER AND WINTER PARALYMPIC GAMES FROM 2006 TO 2018

Picture 3. London 2012, Tennis, single women

Picture 4. Beijing 2008, Wheelchair racing 100 m, single men

Picture 5. London 2012, Archery Wheelchair, single men

Picture 6. Rio 2016, Basketball Wheelchair, team men



Picture 7. Beijing 2008, Table Tennis, single women

Picture 8. Rio 2016, Rugby Wheelchair, team men

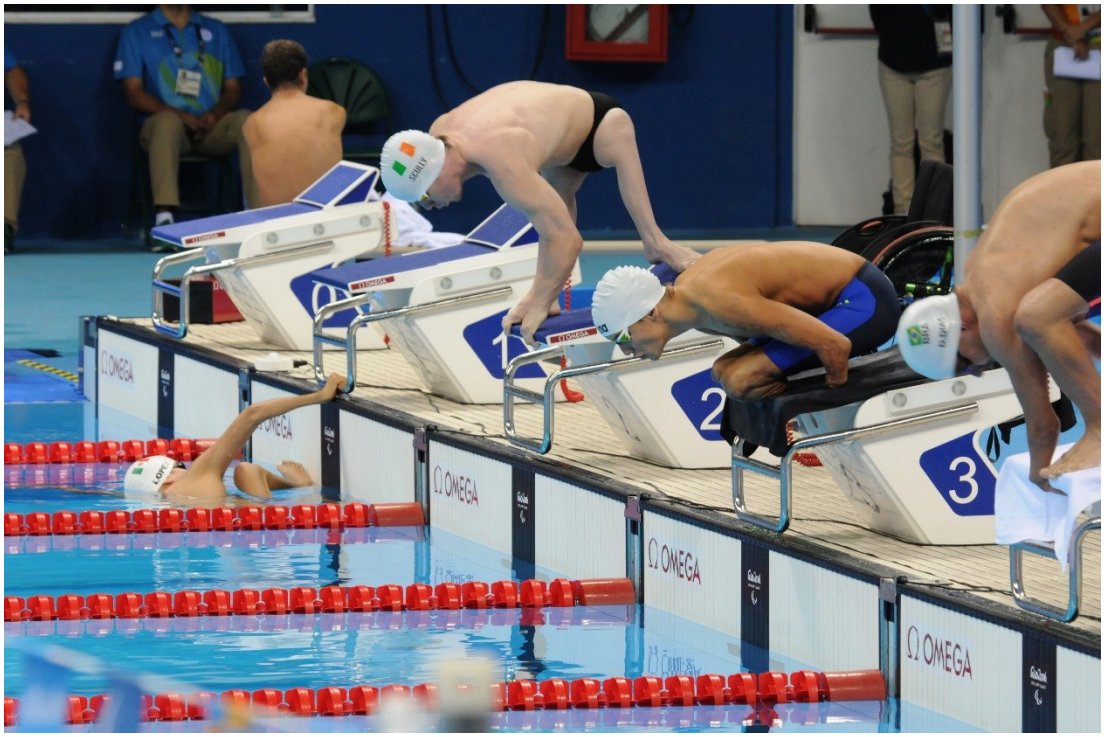
Picture 9. Sochi 2014, Hockey Wheelchair, team men

Picture 10. Sochi 2014, Curling Wheelchair, team mix

Picture 11. Pyeong Chang 2018, Wheelchair Cross-country skiing, single men

Picture 12. Pyeong Chang 2018, Wheelchair Alpine ski, single men

Picture 13. Beijing 2008, Fencing Wheelchair, single men



Picture 14. Rio 2016, Wheelchair Freestyle, single men