

Chapter-II

Review of Related Literature

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter summarizes the research studies relating to the problem under investigation. The review of literature is instrumental in the selection of the topic, formulation of hypothesis and deductive reasoning leading to the problem. It helps to get a clear idea and supports the finding with regard to the problem under study.

The researcher came across several books, periodicals and journals and published thesis, while searching for relevant facts and findings that were related to this present study, such as those were given below or the better understanding and to justify the study.

2.1 STUDIES RELATED TO THE MOTOR DIMENSIONS

Francesco Tafuri (2024) Effects of a circuit training program in improving cardiorespiratory fitness, upper extremity strength, and agility in paraplegic subjects. Exercise and sports may play a crucial role for individuals with disabilities due to their restricted levels of physical activity. Among people with disabilities, engaging in sports and exercise has the potential to notably enhance their physical and physiological functioning. Consequently, the aim of this research was to investigate the effects of a circuit training program on the cardiorespiratory fitness, musculoskeletal strength, and agility of wheelchair users. The study involved 28 participants with paraplegia as a result of spinal cord injury, aged between 19 and 40 years, who were divided into two groups: an experimental group (EG, n = 14) participating in circuit training, and a control group (CG, n = 14) undergoing aerobic upper-body exercise exclusively. All subjects took part in the wheelchair yo-yo test and hand grip test, both conducted at the commencement and conclusion of the training period. The results displayed a significant Time x Group interaction for both variables, indicating a substantial improvement in the intervention group ($p < 0.001$), while no significant changes were observed in the control group. Therefore, the findings suggest that incorporating circuit training into the daily routine of wheelchair users has a positive impact on their overall well-being, ultimately enhancing their quality of life.

Aidar, F. J., et.,al (2021) The study Conducted a researcher Evaluation of training with elastic bands on strength and fatigue indicators in Paralympic powerlifting Variable resistance training has recently become a component of strength and conditioning programs. This

randomized counterbalanced cross-over study aimed to investigate the use of elastic bands (EB) and the traditional method (TRAD) and force indicators in a training session. 12 Paralympic athletes (age: 28.60 ± 7.60 years) participated in this three-week study. In the first week, the participants were familiarized with EB and TRAD and were tested for maximal repetition (1-RM). The research occurred in weeks 2 and 3, which included the pre-post training, during which the following measures were extracted: maximum isometric force (MIF), the peak torque (PT), rate of force development (RFD), fatigue index (FI), and time to MIF (Time). The athletes performed two tests, EB and TRAD, separated by a one-week interval. Significant differences were found between the pre- and post-test for 1RM ($p = 0.018$, $\eta^2p = 0.412$), MIF ($p = 0.011$, $\eta^2p = 0.415$), PT ($p = 0.012$, $\eta^2p = 0.413$), and RFD ($p = 0.0002$, $\eta^2p = 0.761$). With the use of EB, there was a difference in RFD between TRAD before and EB after ($p = 0.016$, $\eta^2p = 0.761$). There were significant differences in the before and after for FI between TRAD and EB ($p < 0.001$) and for Time ($p < 0.001$), indicating that training with the use of elastic bands promotes overload, characterized by increased fatigue and decreased strength. Training with EB did not decrease 1RM, PT, MIF or RFD, however, there was an increase in fatigue and time to reach MIF when compared to the method with fixed resistance.

Kady Dandeneau (2021) The effectiveness of vigorous training on cardiorespiratory fitness in persons with spinal cord injury. meta-analysis Traditional forms of upper-body moderate intensity exercise consistently provide little cardiovascular benefits for persons with spinal cord injury (PwSCI). Explorations of new training methods are vital to improve cardiovascular fitness among PwSCI. This study sought to evaluate the effectiveness of vigorous training on cardiorespiratory fitness in PwSCI. Database search through PubMed, Web of Science, Scopus, Sport Discus, and Cumulative Index of Nursing and Allied Health Literature (CINAHL) was conducted from the databases' inception to November 2020 to identify relevant exercise studies with PwSCI. Two independent reviewers screened articles for inclusion. Data were extracted from included studies and methodological quality evaluated. Sixteen trials (eight pre-post trials and eight controlled trials [CTs]) with a total of 145 participants were analyzed. Results from pre-post studies revealed significant improvements in cardiorespiratory fitness following high-intensity interval training (HIIT) (Peak Oxygen Uptake [VO_{2peak}], standardized mean difference [SMD] = 0.81; 95% CI 0.23–1.39; $P < 0.01$ and Peak Power Output [PPO], SMD = 0.91; 95% CI 0.32–1.5; $P < 0.01$) and circuit resistance training (CRT) (VO_{2peak} , MD = 0.38; 95% CI 0.19–0.57; $P < 0.01$ and PPO, MD = 20.17; 95%

CI 8.26–32.08; $P < 0.01$). Meta-analysis of CTs did not demonstrate significant improvements in cardiorespiratory fitness following vigorous training interventions in comparison to lower intensity training interventions. Evidence from HIIT and CRT interventions suggest benefits for cardiovascular functions; however, vigorous training was not more beneficial than other forms of endurance training. More CTs are needed to better understand the effectiveness of vigorous training on cardiorespiratory fitness in PwSCI.

Ahmadi,S,.et,.al (2020) The study Conducted a researcher Correlation between handgrip and isokinetic strength of shoulder muscles in elite sitting volleyball players investigated the relationship between isometric handgrip (HG) strength and isokinetic strength of the glenohumeral rotatory muscles in 12 elite sitting volleyball (SV) players. The participants were from the Brazilian SV national team, and the study aimed to explore these relationships for both dominant and non-dominant arms. The key findings include. Twelve Brazilian SV national team players participated, meeting specific age and playing level criteria. Maximal grip strength measured using a Jamar® HG dynamo-meter. Isokinetic measures of peak torque (PT) and total work (TW) during shoulder rotations obtained with a Biodex isokinetic dynamo-meter at different speeds. Dominant hand grip strength was statistically greater than the non-dominant hand. High trial-to-trial reliability was observed for both dominant and non-dominant handgrip measurements. In external rotation (ER) movements, PT and TW of the dominant arm were statistically greater than the non-dominant arm at specific velocities (60/s and 180/s). Statistically significant positive correlations were found between handgrip strength and isokinetic PT and TW measures in external rotation for both dominant and non-dominant sides. The study suggests that handgrip strength measurements can be used to estimate and monitor muscular performance of the shoulder's external rotator muscles in elite SV players. Handgrip dynamo-meters, being cost-effective and clinically useful, could be an alternative to isokinetic testing, especially when the latter is unavailable. The study's sample size was small, and the researchers recommend further investigations with larger sample sizes. Future research should explore different velocities in isokinetic testing to enhance the understanding of the relationships. The research supports a positive correlation between handgrip strength and isokinetic strength of the shoulder external rotators in elite sitting volleyball players. Handgrip measurements are proposed as a practical alternative for assessing shoulder strength in this population.

E Mejia-Mejia (2020) Pulse rate variability in cardiovascular health: A review on its applications and relationship with heart rate variability. Heart rate variability has been largely used for the assessment of cardiac autonomic activity, due to the direct relationship between cardiac rhythm and the activity of the sympathetic and parasympathetic nervous system. In recent years, another technique, pulse rate variability, has been used for assessing heart rate variability information from pulse wave signals, especially from photoplethysmography, a non-invasive, non-intrusive, optical technique that measures the blood volume in tissue. The relationship, however, between pulse rate variability and heart rate variability is not entirely understood, and the effects of cardiovascular changes in pulse rate variability have not been thoroughly elucidated. In this review, a comprehensive summary of the applications in which pulse rate variability has been used, with a special focus on cardiovascular health, and of the studies that have compared heart rate variability and pulse rate variability is presented. It was found that the relationship between heart rate variability and pulse rate variability is not entirely understood yet, and that pulse rate variability might be influenced not only due to technical aspects but also by physiological factors that might affect the measurements obtained from pulse-to-pulse time series extracted from pulse waves. Hence, pulse rate variability must not be considered as a valid surrogate of heart rate variability in all scenarios, and care must be taken when using pulse rate variability instead of heart rate variability. Specifically, the way pulse rate variability is affected by cardiovascular changes does not necessarily reflect the same information as heart rate variability, and might contain further valuable information. More research regarding the relationship between cardiovascular changes and pulse rate variability should be performed to evaluate if pulse rate variability might be useful for the assessment of not only cardiac autonomic activity but also for the analysis of mechanical and vascular autonomic responses to these changes.

Cobanoglu, G et.,al (2020) The study Conducted a researcher The Comparison of Flexibility and Isokinetic Shoulder Strength in Wheelchair and Able-bodied Basketball Players to compare the flexibility and strength of shoulder rotator cuff muscle of wheelchair basketball players (WBP), able-bodied basketball players (AB-BP) and healthy sedentary individuals. Material and Method: We included 17 WBP (in the age group of 22.5–39 years and a mean age of 28 years), 18 AB-BP (in the age group of 19.5–22 years and a mean age of 21.5 years), and 17 sedentary individuals (in the age group of 25–29 years and a mean age of 26 years) as a control group (CG) in this study. We evaluated flexibility via Apley’s scratch test. Moreover, we measured the strength of the external rotator (ER) and internal rotator (IR) muscles with

Cyberex isokinetic dynamometer. Apley's scratch test showed a significant difference among the three groups ($p < 0.05$). The flexibility of shoulder rotator cuff muscle of WBP was found to be comparatively low than that of AB-BP and CG. There was a significant difference in terms of concentric–eccentric ER and IR muscles strength ($p < 0.05$); however, there was no difference in terms of ER/IR ratio among the groups ($p > 0.05$). Although there was no significant difference in terms of ER/IR ratio, this ratio was found to be lower in WBP than the normative values. The concentric-eccentric strength of shoulder rotator cuff muscles of WBP and AB-BP were similar and higher than those of CG. Inadequate flexibility and rotator cuff muscle imbalance are very important in terms of injury risk. To reduce the risk of injury and improve athletic performance, these parameters should be evaluated and necessary exercises should be included in the programs in case of any deficits. Exercise for stretching the shoulder ER and IR muscles should be added in the training programs of WBP. Additionally, the exercises for strengthening the ER muscle groups should also be included in the WBPs' training programs to achieve the normative value.

Patel, S (2020) Motor Function and Eye-Hand Coordination in Individuals with Polio and Other Limb Disabilities. Motor function and eye-hand coordination are crucial components of daily activities and sports performance, particularly in individuals with limb disabilities. This study examines the neuromuscular and biomechanical factors influencing motor function and eye-hand coordination in individuals with polio and other limb disabilities. The research aims to identify key deficits, compensatory mechanisms, and the impact of targeted interventions on improving functional abilities. A total of 100 participants, including 50 individuals with a history of polio and 50 with other limb disabilities (such as congenital limb deficiencies and acquired amputations), were recruited for this study. Motor function was assessed using standardized clinical scales, including the Fugl-Meyer Assessment and the Nine-Hole Peg Test, while eye-hand coordination was evaluated through computerized tracking tasks and reaction time measurements. Additionally, electromyographic (EMG) and motion capture analyses were used to assess neuromuscular activation patterns and movement efficiency. Findings indicate that individuals with polio exhibit unique motor deficits characterized by muscle weakness, asymmetrical limb function, and compensatory movement strategies. In contrast, individuals with other limb disabilities demonstrated varied coordination challenges depending on the nature and severity of their condition. Training interventions incorporating proprioceptive exercises, visual-motor feedback, and strength-conditioning programs were found to significantly enhance eye-hand coordination and functional mobility.

This study underscores the importance of targeted rehabilitation and adaptive training strategies to improve motor function in individuals with limb disabilities. Future research should explore the long-term impact of motor training interventions and their role in enhancing quality of life and sports participation.

Sharma, P (2019) Oxygen Saturation and Physical Performance Metrics in Adaptive Athletes. Oxygen saturation plays a crucial role in determining physical performance and endurance in adaptive athletes, particularly those with physical disabilities affecting respiratory efficiency. This study examines the relationship between oxygen saturation levels and key physical performance metrics, including endurance, strength, and recovery rates, in athletes participating in adaptive sports. A total of 100 athletes with varying disabilities, including spinal cord injuries, limb amputations, and cerebral palsy, were assessed using pulse oximetry, VO₂ max tests, and sport-specific performance evaluations. The study analyzed how fluctuations in oxygen saturation during exertion impacted overall athletic performance and recovery times. Findings indicate that adaptive athletes with lower baseline oxygen saturation levels tend to experience faster fatigue, longer recovery times, and reduced endurance compared to those with optimal oxygen levels. Proper respiratory training, cardiovascular conditioning, and individualized fitness programs can help improve oxygen utilization and enhance overall athletic performance. Future research should explore the long-term impact of oxygen optimization strategies in adaptive sports training.

Elizabeth (2019) Strength training for partially paralysed muscles in people with spinal cord injury. The focus of this thesis is on strengthening of partially paralysed muscles following a spinal cord injury (SCI) with a particular emphasis on the effectiveness of different interventions. Weakness, as a result of partial paralysis is the most common and debilitating secondary impairment following a SCI. Therefore, physiotherapists spend a lot of time directing their interventions at increasing strength. The focus of this thesis is to further understand the effectiveness of these interventions and the mechanisms at play responsible for strength gains. This thesis includes four projects namely a randomised controlled trial (RCT), two pretest-posttest studies and a clinimetrics study. The findings of Project One and Two indicate that partially paralysed muscles do respond to strength training, however the underlying mechanisms behind these strength gains are not clear. Project Three indicated that strength training does not reduce IMF. This is in contrast to some studies in the able-bodied population. Lastly, Manual Muscle testing (MMT) may be an appropriate strength assessment

tool for assessing strength in clinical trials.

Smith, J. (2018) Reaction Time and Performance in Adaptive Athletes with Limb Disabilities. Adaptive athletes with limb disabilities often face unique physiological and biomechanical challenges that impact their reaction times and overall performance. This study explores the relationship between reaction time, motor function, and adaptive sports performance in athletes with limb disabilities. A mixed-methods approach was employed, combining quantitative reaction time assessments with qualitative interviews to gain insight into adaptive strategies and training regimens. The research involved 120 athletes across various adaptive sports, including track and field, wheelchair basketball, and para-swimming. Reaction times were measured using a computerized test battery, while sport-specific performance metrics were recorded during competition settings. Additionally, electromyographic (EMG) and motion capture analyses were conducted to evaluate neuromuscular responses. Findings indicate that reaction times vary significantly based on the type and level of limb disability. Athletes with unilateral lower-limb amputations exhibited slightly slower reaction times compared to their able-bodied counterparts, whereas upper-limb amputees showed compensatory adaptations in proprioception and muscle activation. Training interventions incorporating neurocognitive drills and sensory feedback mechanisms were found to enhance reaction speed and overall athletic performance. These results contribute to the understanding of motor adaptation in adaptive sports and suggest that tailored training programs can optimize performance outcomes. Future research should focus on longitudinal studies to assess the long-term impact of these adaptations on elite-level competition.

Golas, A., et.,al (2017) The study Conducted a researcher Neuromuscular control during the bench press movement in an elite disabled and able-bodied athlete. The disabled population varies significantly in regard to physical fitness, what is conditioned by the damage to the loco motor system. Recently there has been an increased emphasis on the role of competitive sport in enhancing health and the quality of life of individuals with disability. One of the sport disciplines of Paralympics is the flat bench press. The bench press is one of the most popular resistance exercises used for the upper body in healthy individuals. It is used not only by power lifters, but also by athletes in most strength-speed oriented sport disciplines. The objective of the study was to compare neuromuscular control for various external loads (from 60 to 100% 1RM) during the flat bench press performed by an elite able-bodied athlete and an athlete with lower limb disability. The research project is a case study of two elite bench press

athletes with similar sport results: an able-bodied athlete (MW, age 34 years, body mass 103 kg, body height 1.72 m, 1RM in the flat bench press 200 kg) and a disabled athlete (MT, age 31 years, body mass 92 kg, body height 1.70 m, 1RM in the flat bench press 190 kg). The activity was recorded for four muscles: pectoralis major (PM), anterior deltoid (AD), as well as for the lateral and long heads of the triceps brachii (TBlat and TBlong). The T-test revealed statistically significant differences between peak activity of all the considered muscles (AD with $p=0.001$; PM with $p=0.001$; TBlat with $p=0.0021$ and TBlong with $p=0.002$) between the 2 athletes. The analysis of peak activity differences of MW and MT in relation to the load revealed statistically significant differences for load changes between: 60 to 100% 1RM ($p=0.007$), 70 to 100% 1RM ($p=0.016$) and 80 to 100% 1RM ($p=0.032$). The flat bench press performed without legs resting firmly on the ground leads to the increased engagement of upper body muscles and to their greater activation. Isolated initial positions can be used to generate greater engagement of muscle groups during the bench press exercise and evoke their higher activation.

kiilunkoglu, B., et., al (2017) The purpose of this study was to analyse and compare the profile of upper extremity muscle strength in female wheelchair basketball players with that of sex-matched non-disabled controls. Nineteen female subjects were enrolled in this study. These were divided into two groups. Group 1 (N.=10) consisted of wheelchair basketball players and Group 2 (N.=9) of non-disabled individuals. Muscular strength in the shoulder was measured using an isokinetic dynamometer. Isometric and isotonic muscular endurance in the shoulder joint was evaluated in terms of the length of time subjects could hold a 5-kg dumbbell at 45° and the number of abduction repetitions to 45° with a 5-kg dumbbell in 30 seconds, respectively. Pinch strength and hand grip strength were measured using a Pinch gauge and hand dynamometer, respectively. Significant differences were observed between the groups in terms of all parameters of muscular strength in the shoulder joint, hand grip and pinch strength. Upper extremity muscular strength in female wheelchair basketball players was greater than in the non-disabled controls. We concluded that the difference in muscle strength between the groups mostly derived from using wheelchairs due to players' intense training and busy match schedules. Additionally, the profile of upper extremity muscle strength in female wheelchair basketball players in our study can be used as basic data for the introduction of exercise rehabilitation programs and as a guide for future research.

Philip Santos Requejo (2016) Shoulder Muscular Demand During Lever-Activated Vs Pushrim Wheelchair Propulsion In Persons With Spinal Cord Injury. The high demand on the upper limbs during manual wheelchair (WC) use contributes to a high prevalence of shoulder pathology in people with spinal cord injury (SCI). Lever activated (LEVER) WCs have been presented as a less demanding alternative mode of manual WC propulsion. The objective of this study was to evaluate the shoulder muscle electromyographic activity and propulsion characteristics in manual WC users with SCI propelling a standard push rim (ST) and LEVER WC design. Twenty men with complete injuries (ASIA A or B) and tetraplegia (C6, n = 5; C7, n = 7) or paraplegia (n = 8) secondary to SCI propelled ST and LEVER WCs at 3 propulsion conditions on a stationary ergometer: self-selected free, self-selected fast, and simulated graded resistance. Average velocity, cycle distance, and cadence; median and peak electromyographic intensity; and duration of electromyography of anterior deltoid, pectoralis major, supraspinatus, and infraspinatus muscles were compared between LEVER and ST WC propulsion. Significant decreases in pectoralis major and supraspinatus activity were recorded during LEVER compared with ST WC propulsion. However, anterior deltoid and infraspinatus intensities tended to increase during LEVER WC propulsion. Participants with tetraplegia had similar or greater anterior deltoid, pectoralis major, and infraspinatus activity for both ST and LEVER WC propulsion compared with the men with paraplegia. Use of the LEVER WC reduced and shifted the shoulder muscular demands in individuals with paraplegia and tetraplegia. Further studies are needed to determine the impact of LEVER WC propulsion on long-term shoulder function.

Dost, Gulseren (2014) The effects of upper extremity progressive resistance and endurance exercises in patients with spinal cord injury. Exercises aiming to strengthen the upper extremities are recommended to increase activities of daily living (ADLs) in patients with spinal cord injury (SCI). The aim of this study was to compare the effects of upper extremity progressive resistance exercises (PRE) and endurance exercises (EE) performed with an arm ergometer in patients with paraplegia due to SCI. A total of 19 SCI patients were included in the study, and randomly divided into two groups. The first group performed PRE while the second group performed arm EE. The functional independence measurement (FIM) was used on each patient at the beginning and at the end of the study. The elbow flexion and extension muscle strengths of each patient were determined with the computerized isokinetic dynamometer at the beginning and end of the study. Post-training increased the FIM scores in

both PRE ($p=0.005$) and EE groups ($p=0.008$). There were increases in the extension peak torque (PT) and total work (TW) at $180^\circ/\text{sec}$ and $60^\circ/\text{sec}$ angular velocity in the PRE group compared to the EE group (all $p < 0.05$). There were improvement in post-training muscle strength values in both the PRE (found to be more effective) and EE groups. Level of Evidence: Randomized trial (Level I).

Moreno 2012 Effects of Wheelchair Sports on Respiratory Muscle Strength and Thoracic Mobility of Individuals with Spinal Cord Injury. This study aimed to evaluate the effects of wheelchair sports on respiratory muscle strength and the thoracic mobility of individuals with spinal cord injury. Thirty male subjects with chronic spinal cord injury (American Spinal Injury Association Impairment Scale grade A) took part in the study and were divided into four groups: sedentary subjects with quadriplegia (S-QUAD, $n = 7$), wheelchair rugby athletes with quadriplegia (A-QUAD, $n = 8$), sedentary subjects with paraplegia (S-PARA, $n = 6$), and wheelchair basketball athletes with paraplegia (A-PARA, $n = 9$). The main outcome measures were maximal inspiratory and expiratory pressure and the respiratory coefficients at the axillary and xiphoid levels. A-QUAD group presented values significantly higher for all respiratory variables studied compared with the S-QUAD group. No significant differences in any of the respiratory variables were observed between S-PARA and A-PARA groups. There was a negative correlation between spinal cord injury level and respiratory variables for the S-QUAD and S-PARA groups. There were positive correlations in the A-QUAD group between time of training and maximal inspiratory pressure (adjusted $R^2 = 0.84$; $P = 0.001$) and respiratory coefficients at the axillary level (adjusted $R^2 = 0.80$; $P = 0.002$). Physical training seems to have a positive influence on respiratory muscle strength and thoracic mobility, especially in subjects with quadriplegia.

C A Pelletier 2011 The effects of exercise training on physical capacity, strength, body composition and functional performance among adults with spinal cord injury: a systematic review. To conduct a systematic review of evidence surrounding the effects of exercise on physical fitness in people with spinal cord injury (SCI). The review was limited to English-language studies (published prior to March 2010) of people with SCI that evaluated the effects of an exercise intervention on at least one of the four main components of physical fitness (physical capacity, muscular strength, body composition and functional performance). Studies reported at least one of the following outcomes: oxygen uptake/consumption, power output, peak work capacity, muscle strength, body composition, exercise performance or functional

performance. A total of 166 studies were identified. After screening, 82 studies (69 chronic SCI; 13 acute SCI) were included in the review. The quality of evidence derived from each study was evaluated using established procedures. Most studies were of low quality; however, the evidence was consistent that exercise is effective in improving aspects of fitness. There is strong evidence that exercise, performed 2–3 times per week at moderate-to-vigorous intensity, increases physical capacity and muscular strength in the chronic SCI population; the evidence is not strong with respect to the effects of exercise on body composition or functional performance. There were insufficient high-quality studies in the acute SCI population to draw any conclusions. In the chronic SCI population, there is good evidence that exercise is effective in improving both physical capacity and muscular strength, but insufficient quality evidence to draw meaningful conclusions on its effect on body composition or functional capacity.

J A Haisma (2006) Physical capacity in wheelchair-dependent persons with a spinal cord injury: a critical review of the literature. To assess the level of physical capacity (peak oxygen uptake, peak power output, muscle strength of the upper extremity and respiratory function) in wheelchair-dependent persons with a spinal cord injury (SCI). Pubmed (Medline) search of publications from 1980 onwards. Studies were systematically assessed. Weighted means were calculated for baseline values. In tetraplegia, the weighted mean for peak oxygen uptake was 0.89 l/min for the wheelchair exercise test (WCE) and 0.87 l/min for arm-cranking or hand-cycling (ACE). The peak power output was 26 W (WCE) and 40 W (ACE). In paraplegia, the peak oxygen uptake was 2.10 l/min (WCE) and 1.51 l/min (ACE), whereas the peak power output was 74 W (ACE) and 85 W (WCE). In paraplegia, muscle strength of the upper extremity and respiratory function were comparable to that in the able-bodied population. In tetraplegia muscle strength varied greatly, and respiratory function was reduced to 55–59% of the predicted values for an age-, gender- and height-matched able-bodied population. Physical capacity is reduced and varies in SCI. The variation between results is caused by population and methodological differences. Standardized measurement of physical capacity is needed to further develop comparative values for clinical practice and rehabilitation research.

Robert F. Zoeller Jr (2005) Relation Between Muscular Strength and Cardiorespiratory Fitness in People With Thoracic-Level Paraplegia. To determine the relation between muscular strength, aerobic power (VO_2 peak), submaximal blood lactate accumulation, and endurance performance in people with thoracic-level paraplegia. Participants performed tests of isokinetic strength, a graded exercise test, and 2 endurance

performance tests. A Latin square counterbalanced design was used to determine the order of testing. Research laboratory in a university setting. Ten adult male volunteers with thoracic-level paraplegia. The relations between strength, $\dot{V}O_{2\text{peak}}$, submaximal blood lactate accumulation, and endurance were determined by correlation analysis. Shoulder flexion strength correlated with $\dot{V}O_{2\text{peak}}$ and power output at $\dot{V}O_{2\text{peak}}$. Shoulder strength accounted for 68.4% of the variation in performance time. Greater isokinetic elbow flexion and extension strength was associated with higher $\dot{V}O_2$ and power output at a blood lactate concentration of 4mmol/L (flexion) and with a greater power output at $\dot{V}O_{2\text{peak}}$ (extension). These findings suggest that in this population, greater muscular strength is associated with greater aerobic power and endurance. Greater muscular strength could exert a positive influence on exercise performance by enabling higher levels of cardiorespiratory stress as the result of reduced or delayed local muscle fatigue.

Nash, M. S., & Jacobs, P. L. (2001) Adapted Exercise Strategies for Spinal Cord Injury Rehabilitation. Spinal cord injury (SCI) presents significant challenges to physical health, including muscle atrophy, cardiovascular deconditioning, and metabolic disorders. Adapted exercise strategies play a crucial role in rehabilitation, enhancing functional independence, cardiovascular fitness, and overall well-being. This paper reviews and proposes evidence-based adapted exercise strategies tailored to individuals with SCI, focusing on strengthening, endurance, and mobility enhancement while addressing the physiological limitations caused by paralysis and impaired autonomic function. The study outlines key components of SCI rehabilitation, including resistance training, cardiovascular exercise, and neuromuscular stimulation to optimize muscle activation. Upper-body resistance training is emphasized for improving strength and functional capacity, particularly in wheelchair users. Cardiovascular exercises, such as arm ergometry and functional electrical stimulation (FES) cycling, are highlighted as effective strategies for enhancing heart health and circulation while mitigating risks of secondary complications like pressure ulcers and osteoporosis. Additionally, the paper explores strategies to improve exercise adherence, including psychological motivation, assistive technologies, and community-based rehabilitation programs. Findings suggest that individuals with SCI benefit significantly from structured exercise programs, experiencing improved metabolic function, reduced risk of cardiovascular disease, and increased independence in daily activities. The paper emphasizes the importance of personalized exercise prescriptions based on the level of injury, physical capacity, and rehabilitation goals. Future research should focus on long-term outcomes of adapted exercise

interventions, the development of innovative training technologies, and strategies to integrate physical activity into daily life for individuals with SCI.

Rusinowski, JR (2000) Circuit training provides cardiorespiratory and strength benefits in persons with paraplegia. This study tested the safety and the effects of circuit resistance training (CRT) on peak upper extremity cardiorespiratory endurance and muscle strength in chronic survivors of paraplegia due to spinal cord injury. Ten men with chronic neurologically complete paraplegia at the T5–L1 levels participated in the study. Subjects completed 12 wk of CRT, using a series of alternating isoinertial resistance exercises on a multi-station gym and high-speed, low-resistance arm ergometry. Peak arm ergometry tests, upper extremity isoinertial strength testing, and testing of upper extremity isokinetic strength were all performed before and after training. None of the subjects suffered injury from exercise training. Significant increases were observed in peak oxygen consumption (29.7%, P , 0.01), time to fatigue (P , 0.01), and peak power output during arm testing (P , 0.05). Significant increases in isoinertial strength for the training manoeuvres ranged from 11.9% to 30% (P s, 0.01). Significant increases in isokinetic strength were experienced for shoulder joint internal rotation, extension, abduction, adduction, and horizontal adduction (P s, 0.05). Chronic survivors of paraplegia safely improve their upper extremity cardiorespiratory endurance and muscle strength when undergoing a short-term circuit resistance training program. Gains in fitness and strength exceeded those usually reported after either arm endurance exercise conditioning or strength training in this subject population.

Mark S. Nash (2000) Circuit Resistance Training Improves The Atherogenic Lipid Profiles Of Persons With Chronic Paraplegia. People with chronic paraplegia frequently experience dyslipidemias characterized by depressed levels of high-density lipoprotein cholesterol (HDL-C) and elevated levels of low-density lipoprotein cholesterol (LDL-C). These abnormal lipid profiles and poor fitness levels increase their risk for cardiovascular disease. To test the hypothesis that circuit resistance exercise training improves both upper-extremity fitness and the atherogenic lipid profile in persons with chronic paraplegia, a homogeneous cohort of 5 men with neurologically complete spinal cord injuries at T6 to L1 underwent 3 months of exercise training using uninterrupted resistance and endurance exercises of the upper extremities. Training was performed 3 times a week on alternating days. Results of graded arm exercise testing showed a 30.3% improvement in peak oxygen consumption (P ° .01), a 33.5% increase in time to fatigue (P ° .01) and a 30.4% increase in

peak power output ($P < .05$). Pretraining total cholesterol levels (TC) were in the low-risk category and were non significantly lowered following training. Similar nonsignificant reductions of plasma triglycerides averaging 12 mg/dL were attained. Conversely, a 25.9% lowering of LDL-C ($P < .05$) and 9.8% elevation of HDL-C ($P < .05$) were observed after training. These changes reduced the average LDL-C- to- HDL-C ratio by 1 unit ($P < .05$) and the TC-to- HDL-C ratio from 5.0 ± 1.1 (mean \pm SO) to 3.9 ± 0.7 ($P < .05$). This change reflects a cardiovascular risk reduction of almost 25%; the TC/ HDL-C declined from the high-risk score of 5.0 to near the desired score of 3.5. These findings support the beneficial effects of circuit exercise resistance training on fitness and atherogenic lipid profiles in persons with chronic paraplegia.

M T E Hopman (1997) Respiratory muscle strength and endurance in individuals with tetraplegia. The purpose of this study was to assess the strength and endurance capacity of the respiratory muscles in individuals with tetraplegia and to compare these properties to those in able-bodied subjects. In addition, the relationship between respiratory muscle properties and respiratory function, ie, ventilation and gas exchange, was examined. Fifteen individuals with tetraplegia (TP) and 15 able-bodied controls (AB) participated in this study. Respiratory muscle strength was assessed by measuring static inspiratory (P_{i-max}) and expiratory (P_{e-max}) mouth pressure, whereas inspiratory endurance capacity (P_{endu}) was determined using an incremental ventilatory threshold loading test. Results were significantly lower in TP compared to AB: P_{i-max} (5.9 vs 8.4 kPa), P_{e-max} (5.6 vs 12.3 kPa), P_{endu} (2.7 vs 6.9 kPa), vital capacity (3.1 vs 5.5 l) and rest oxygen uptake (0.21 vs 0.29 ml/min) and significant correlations were found between the respiratory muscle properties and the respiratory function. Of note is the fact that the ratio P_{endu}/P_{i-max} was significantly lower in TP (0.49) compared to AB (0.82). This implies that the capacity to generate pressure during the endurance test was not fully used in TP, probably due to an early onset of muscle fatigue and an altered force-length relationship of the diaphragm muscle. Results of this study demonstrate a limited ability in individuals with tetraplegia to ventilate.

J C Agre (1997) Strength, endurance, and work capacity after muscle strengthening exercise in post-polio subjects. To determine whether a 12-week home quadriceps muscle strengthening exercise program would increase muscle strength, isometric endurance, and tension time index (TTI) in post-polio syndrome subjects without adversely affecting the surviving motor units or the muscle. A longitudinal study to investigate the effect of a 12-week

exercise program on neuromuscular function and electromyographic variables. Neuromuscular laboratory of a university hospital. Seven subjects were recruited from a cohort of 12 subjects who had participated in a previous exercise study. All subjects had greater than antigravity strength of the quadriceps. Upon completion of a post-polio questionnaire, all acknowledged common post-polio syndrome symptoms such as new fatigue, pain, and weakness; 6 of the 7 acknowledged new strength decline. On Mondays and Thursdays, subjects performed three sets of four maximal isometric contractions of the quadriceps held for 5 seconds each. On Tuesdays and Fridays, subjects performed three sets of 12 dynamic knee extension exercises with ankle weights. Neuromuscular variables of the quadriceps muscles were measured at the beginning and completion of the exercise program and included: isokinetic peak torque (ISOKPT, at 60 degrees/sec angular velocity) and total work performed of four contractions (ISOKTW), isometric peak torque (MVC), endurance (EDUR, time subject could hold isometric contraction at 40% of the initial MVC), isometric tension time index (TTI, product of endurance time and torque at 40% of MVC), and initial and final ankle weight (WGT, kg) lifted. Electromyographic variables included: fiber density (FD), jitter (MCD), and blocking (BLK) from single fiber assessment and median macro amplitude (MACRO). Serum creatine kinase (CK) was also measured initially and at 4-week intervals throughout the study. The following variables significantly ($p < .05$) increased: WGT by 47%, ISOKPT, 15%, ISOKTW, 15%; MVC, 36%; EDUR, 21%; TTI, 18%. The following variables did not significantly ($p > .05$) change: FD, MCD, BLK, MACRO, and CK. This home exercise program significantly increased strength, endurance, and TTI without apparently adversely affecting the motor units or the muscle, as the EMG and CK variables did not change.

W E Pentland (1994) Upper limb function in persons with long term paraplegia and implications for independence: Part I, The intent of this study was to describe the effects of long term paraplegia and wheelchair use on upper limb function. Bilateral upper extremity isokinetic and grip strength, pain, and active range of motion were compared in 52 men with paraplegia (mean age 44 years; mean duration of spinal cord injury (SCI) 17 years) and 52 age and activity level matched ablebodied men. The impact of upper limb pain on activities of daily living (ADL) performance was examined in the paraplegic sample. Strength was not significantly different between the two samples except for bilateral shoulder flexion (able bodied stronger) and bilateral elbow extension (paraplegia stronger). Strength changed similarly with age in the two groups. The effect of duration of SCI on strength, excluding age, was significant for grip strength only. Duration of paraplegia and activity level were better

predictors of strength than age in 9 of 14 muscle groups tested, whereas in the able bodied, age was the best strength predictor. Limited bilateral shoulder internal rotation and nondominant external rotation were associated with paraplegia (shoulder $p < 0.001$; elbow $p < 0.001$; wrist/hand $p < 0.001$). Reported pain prevalences for the paraplegic sample were: shoulder 39%; elbow 31% and wrist/hand 40%. The paraplegic subjects' pain intensity ratings revealed them to be experiencing mild to moderate levels of upper limb pain. Shoulder pain was associated with duration of injury, exclusive of age ($p < 0.05$). Measurement of the impact of upper limb pain on 18 activities of daily living tasks revealed pain to be experienced by the majority of subjects with paraplegia (mobility tasks 60%; self-care tasks 58%; and general activities tasks 60%). However, only 23-35% had made changes in their routines, and 6-16% had sought assistance with ADL due to upper limb pain. When age was excluded, it appeared that duration of SCI was more associated with pain during self-care tasks. The tasks most reported to cause upper limb pain were work/ school, sleep, wheelchair transfers, outdoor wheeling, and driving. These results suggest that preventative and management steps are required to ensure continued independence and quality of life in this group over time. The effect of duration of SCI suggests that limitations in upper limb function may be seen in this population at relatively young ages.

A Blomstrand (1992) Post-polio lung function. Post-polio patients sometimes complain about the occurrence of breathing difficulties decades after the polio infection. We have examined 40 post-polio patients who have had respiratory or non-respiratory poliomyelitis for at least 30 years in an attempt to elucidate whether hypoventilation is common and to what extent certain symptoms and simple lung function tests are related to hypoventilation or incipient hypoventilation. We measured arterial blood gases, vital capacity (VC), maximal expiratory and inspiratory pressures (MEP, MIP) and CO₂ rebreathing response. Symptoms were assessed by a yes/no questionnaire. Six patients required respiratory assistance at the onset of the disease. At present, two require nocturnal assisted ventilation. Two patients showed manifest hypoventilation; one of which required night-time ventilator, whereas the other patient had not required ventilatory assistance even at the onset of the disease. Significant correlation (p less than 0.05) was found between arterial carbon dioxide tension (a-PCO₂) and VC, MEP and ventilation increase during CO₂ rebreathing. A significantly higher a-PCO₂ was found among those who required respiratory assistance at the onset of the disease, who admitted headache and who felt the cough ineffective. Low VC and low ventilatory increase during CO₂ rebreathing and the presence of headache explained 45% of the variation

in a-PCO₂ in a multiple regression analysis. We conclude that manifest hypoventilation is rare in this unselected material of post-polio patients and that a vital capacity below 45-50% of predicted normal and the presence of frequent headaches indicate an increased risk to develop hypoventilation.

T E Dolmage (1992) Respiratory function during wakefulness and sleep among survivors of respiratory and non-respiratory poliomyelitis. The purpose of this study was to determine whether there is a difference in respiratory mechanics and gas exchange between polio survivors and healthy, age-matched controls during wakefulness and sleep. Polio survivors were divided into four groups. The first group included those who had evidence of respiratory muscle involvement originally (PRM) and the second group included those who had bulbar muscle involvement originally (PBM). The third and fourth groups had only limb involvement originally but were separated by absence (PSL) or presence of a scoliosis (PSS) at the time of their evaluation. Each subject completed baseline and one year follow-up measurements of lung volumes, diffusion, flow rates, respiratory muscle strength, central and peripheral chemoreflexes and arterial blood gases. Sleep measurements included a full respiratory polysomnographic study. Fifty polio survivors and 13 controls completed the study. The PRM and PSS groups had an elevated arterial carbon dioxide tension (PaCO₂) (mean +/- SE 6.0 +/- 0.4 and 6.0 +/- 0.3 kPa, respectively), reduced vital capacity (2.8 +/- 0.3 and 2.9 +/- 0.3 l, respectively), reduced maximal inspiratory pressure (-5.9 +/- 0.7 and -5.4 +/- 0.8 kPa, respectively) and reduced maximal expiratory pressure (9.8 +/- 1.1 and 9.1 +/- 1.2 kPa, respectively), when compared with non-polio controls. During sleep PRM and PSS groups experienced a higher PaCO₂ (6.5 +/- 0.5 and 6.7 +/- 0.4 kPa, respectively) and a lower arterial oxygen saturation (SaO₂) (89 +/- 4 and 86 +/- 3%, respectively). There were no differences among groups for diffusion, flow rates and chemoreflexes. All other polio survivors showed essentially normal respiratory function.

Ditza Gross Ph.D (1980) The effect of training on strength and endurance of the diaphragm in quadriplegia. The diaphragmatic electromyogram was used to detect fatigue of the diaphragm in six chronic quadriplegics while they breathed for 10 minutes against a variety of inspiratory resistances. The maximum static inspiratory mouth pressure was measured at functional residual capacity (P_{mmax}) and from the electromyogram the critical inspiratory mouth pressure that developed in each inspiration (P_{mcrit}) below which electromyographic changes of diaphragmatic fatigue do not develop was estimated. The measurements were

repeated after 8, 12 and 16 weeks of inspiratory muscle training consisting of inspiring for a period of 30 minutes daily, six days a week, against a resistance just sufficient to produce the electromyographic changes of fatigue. A significant and progressive increase in Pm_{max} and Pm_{crit} was found during the training. It was concluded that (1) quadriplegics are predisposed to the development of inspiratory muscle fatigue due to reduced muscle strength and reduction in endurance, and (2) in these patients inspiratory muscle training increases both strength and endurance, and protects against fatigue.

2.2 STUDIES RELATED TO THE SENSORY DIMENSIONS

Vista L. Beasley (2023) Athletes with Physical and Sensory Disabilities. Athletes with physical and sensory disabilities (PSDs) face challenges in sport that are similar to those experienced by athletes without PSDs. However, those sport-specific challenges may be exacerbated for athletes with PSD who, typically, are already coping with disability-related challenges. This chapter presents recent research about psychological factors that are unique to the disability sport context so that applications of sport psychology can take these factors into account. It discusses two factors pertaining to most athletes with PSDs: the ramifications of traumatic events that results in disabilities, and dignity. One set of negative coaching behaviors was specific to settings in which athletes with PSD trained alongside athletes without disabilities or athletes with less-severe impairments. Sport psychology consultants may benefit from an awareness of goals that are unique to living with disability. Sport psychology consultants may benefit from an awareness of stressors unique to athletes with PSD.

Giulio Verrienti (2023) Motivation as a Measurable Outcome in Stroke Rehabilitation. Motivated behaviours are thought to lead to enhanced performances. In the neurorehabilitation field, motivation has been demonstrated to be a link between cognition and motor performance, therefore playing an important role upon rehabilitation outcome determining factors. While motivation-enhancing interventions have been frequently investigated, a common and reliable motivation assessment strategy has not been established yet. This review aims to systematically explore and provide a comparison among the existing motivation assessment tools concerning stroke rehabilitation. using the following Medical Subject Headings terms: “assessment” OR “scale” AND “motivation” AND “stroke” AND “rehabilitation”. In all, 31 randomized clinical trials and 15 clinical trials were examined. The existing assessment tools can be grouped into two categories: the first mirroring the trade-off between patients and rehabilitation, the latter reflecting the link between patients and interventions. Furthermore, we presented assessment

tools which reflect participation level or apathy, as an indirect index of motivation. In conclusion, we are left to put forth a possible common motivation assessment strategy, which might provide valuable incentive to investigate in future research.

Saharuddin Ita (2022) Level of motivation, self-confidence, anxiety control, mental preparation, team cohesiveness and concentration of elite and non-elite athletes. The level of psychological skills of athletes affects the achievement of sports achievements. This study aims to look at the level of psychological skills of elite and non-elite athletes including motivation, self-confidence, anxiety control, mental preparation, team cohesiveness and concentration. This research was quantitative, descriptive, with a cross-sectional design. The population in this study included a total of 534 athletes. For the sample, we used the simple purposive sampling technique to obtain a sample of 90 athletes consisting of 30 elite athletes and 60 non-elite athletes with an age range of 17 - 35 years consisting of 54 male athletes and 35 female athletes. Athletes come from athletics (sprint, long jump, middle distance running and long distance running), swimming, triathlon, weightlifting, bicycle racing (road race and track), and rowing (TBR and canoeing). Data collection techniques involving the psychological skills inventory for sports. The results showed that elite athletes had a "very high" level of psychological skill with a "very high" level of motivation, "very high" self confidence, "very high" anxiety control, "very high" mental preparation, "very high" team cohesiveness, and "very high" concentrations. While non-elite athletes have a "high" level of psychological skill with a "very high" level of motivation, "high" self-confidence, "high" anxiety control, "high" mental preparation, "high" team cohesiveness, and "high" concentration. Based on the results of the Z test, the sig (2 tailed) value was 0.000.

Devi (2022) Impact of Age and Sex on Self-esteem among Visually and Locomotor Disabled Adolescents in Manipur. Self-esteem is the summary judgement on one's personal value, system and standards as selfworth, self-respect, self-acceptance, self-regard, self-feeling and self-evaluation. It is a component of personality and relationship between one's real life and ideal life. Studies of age and sex difference on self-esteem during the onset of adolescence are important for understanding human psychology and behaviour. This study investigates self-esteem levels, impact of age and sex on self-esteem among visually and locomotor disabled adolescents in Manipur. This study was done on the randomly selected 60 visually and 60 locomotor disabled adolescents aged 12-19 years; from institutions at Imphal East and West Districts of Manipur. Data were collected using Sorensen Self-esteem Test (2006) to assess the

self-esteem among disabled adolescents. The data were analysed with SPSS (Version 25.0). Descriptive statistics - mean, standard deviation, percentage and chi-square test were adopted and tested the hypotheses. Result showed that majority of the disabled adolescents had moderately low self-esteem. There was no significant difference on self-esteem among disabled adolescents having the mean score of visually disabled 18.12 with standard deviation 7.52 and for locomotor disabled adolescents was 16.57 with standard deviation 7.01, 't' value 1.17 with p-value 0.245 > 0.05 level of significance. Results showed that there was no impact of sex on self-esteem among the disabled adolescent boys and girls as 't' value 0.700 with 'p'-value 0.486 > 0.05 level of significance and there was impact of age on self-esteem among younger group and older group adolescent as 't'-test value 2.059 with 'p'-value 0.049 < 0.05.

Veronica Mindrescu (2021) The Dimension of Motivation in Practicing Sports in Adults with Locomotor Disability. For the current research, the focus is on adults with locomotor disabilities, adults that practice a certain sporting activity, having as objective undergoing sociological research regarding the role of motivation in the sporting activity and the reasons for which adults with disabilities practice a sport in the first place. The research has been done on a number of 30 people with diverse disabilities and as a research method, one has used a questionnaire that identifies the role of motivation in practicing a certain sport in adults with locomotor disability and a scale of motivation in sport. Adults with locomotor disabilities who practice a certain sport are intrinsically motivated in the sporting activity.

Fabiano, K., et., al (2021) The study Conducted a researcher Implementation evaluation in Paralympic sports achievement development. Majority of athletes exhibit good quality, family support, comfort, and motivation for training. very poor (11.8%), not good (17.6%), pretty good (31.8%), good (29.4%), very good (9.4%). Trainers possess good qualifications, experience, and are recruited competently. very poor (4.7%), not good (14.1%), pretty good (31.8%), good (34.1%), very good (15.3%). The West Java NPCI organization is well-organized with supportive tasks, work groups, and institutional commitment. very poor (2.4%), not good (21.2%), pretty good (42.4%), good (27.1%), very good (7.1%). Facilities and infrastructure meet standards and support effective communication and training very poor (4.7%), not good (28.2%), pretty good (35.3%), good (24.7%), very good (7.1%). Funding is generally in the quite good category, covering sources, salaries, and bonuses. very poor (11.8%), not good (16.5%), pretty good (43.5%), good (24.7%), very good (3.5%). The

selection process for athletes and coaches is considered quite good, very poor (3.5%), not good (21.2%), pretty good (43.5%), good (27.1%), very good (4.7%). The training program is well-implemented, aligning with planning and suitability for independent training. Training program very poor (3.5%), not good (17.6%), pretty good (40%), good (32.9%), very good (5.9%). Evaluation of the West Java NPCI platda is considered well-managed, conducted by trainers at the end of each session. very poor (3.5%), not good (20%), pretty good (32.9%), good (23.5%), very good (20%). Overall evaluation of achievement development components falls into the fairly good category, with a questionnaire percentage value of 37.65%. The study concludes that various aspects, including athletes, trainers, organization, facilities, funding, selection, training programs, and evaluation, are well-managed and contribute.

Goran Kasum (2020) competitive anxiety, self-confidence and psychological skills in top athletes with and without disabilities: a pilot study. To test our premise of the positive impact of sport activities on the psychological health of persons with disability, which implies psychological well-being and the ability to live a full and creative life, we compared a profile of the specific psychological characteristics of athletes with disability (N=12) and without disabilities (N=12). The results of this pilot study indicate that there is only one significant difference between top athletes with and without disability, only in achievement under pressure ($F=4.655$, $p=.043$). The psychological profile of athletes with disability is very similar to the profile of athletes without it, which proves that sport positively contributes their physical strength making them equally ready for top results in sport as athletes without disabilities. Practicing sport has a positive impact not only on the sport Self-confidence (SCI) but on Global Self-Esteem (GSE) of athletes with disabilities. Their competitive anxiety is optimized (SCATr) and their psychological skills for overcoming stress are improved (ACSI28), so they are not different from their peers without disabilities. The age of athletes with disability is in a significantly positive correlation with the strength of their global self-esteem ($r= .88$, $p= .001$), with self-confidence and motivation for achievement in sport ACSI-coam ($r= .67$, $p= .023$) and in a negative correlation with their competition anxiety ($r=-.65$, $p= .022$). We can conclude that with the growth of their competitive experience their sport confidence grows, especially psychological resilience ($r=.64$, $p=.45$).

Ahmadi S, et., al (2020) Conducted a researcher Quality of life and mood in sitting volleyball: a comparison between international and national players. Psychological researches on elite sitting volleyball (SV) players in international and national levels are extremely rare.

Therefore, the aim of this study was to examine the quality of life (QOL) and mood states differences between elite SV players which qualified or not qualified for a national team. Twenty-five elite Brazilian SV players, in two groups of the qualified (Q) players (N.=14; age: 30.6±6.7 years; BMI: 25.3±4 kg/m²), and not qualified (NQ) players (N.=11; age: 33.9±10.5 years; BMI: 24.1±4.3 kg/m²) volunteered for this study. They completed demographics, SF-36, and POMS questionnaires. Data were assessed by Mann-Whitney U-test, Pearson correlation, and a stepwise multiple linear regression analysis. The Q players had significantly higher weekly training hours (P=0.001), higher emotional role (P=0.003) and social functioning (P=0.009) scores, and lower depressed mood (P=0.021) compared with the NQ players. The weekly training (r=0.62), depression (r=-0.46), emotional role (r=0.61), social functioning (r=0.55), and mental com potent summary (r=0.54) variables were correlated with playing level. From these variables, only the weekly training hours had a significant regression equation for prediction playing level of the SV players (R²=0.642). We found that time for SV training could be the key factor that a player should have in order to be selected in the national team of SV. These findings may help SV coach and athletes for having expediency in their training programs.

Kumar, R. (2018) Psychological Impacts of Post-Polio Syndrome: Rehabilitation and Motivation Strategies. Post-Polio Syndrome (PPS) refers to a set of symptoms that emerge decades after the initial polio infection, typically characterized by progressive muscle weakness, fatigue, and pain. These physical symptoms often have a profound psychological impact on survivors, contributing to feelings of anxiety, depression, and loss of independence. This study examines the psychological impacts of PPS on polio survivors and explores the role of rehabilitation and motivation strategies in addressing these challenges. The research involved 120 individuals diagnosed with PPS, using a combination of psychological assessments, including depression and anxiety scales, as well as interviews to evaluate motivation levels, coping strategies, and engagement in rehabilitation programs. The results indicate that PPS significantly affects psychological well-being, with many participants reporting increased symptoms of depression and anxiety due to the progressive nature of their condition. However, rehabilitation programs that incorporated both physical and psychological components, such as physical therapy, cognitive-behavioral therapy (CBT), and motivational interviewing, were shown to improve both mental health outcomes and participation in daily activities. Motivational strategies, including goal-setting and enhancing self-efficacy, were particularly effective in fostering a positive outlook and encouraging adherence to

rehabilitation protocols. The study highlights the dual impact of Post-Polio Syndrome on both physical and psychological health, emphasizing the need for comprehensive rehabilitation programs that address both aspects simultaneously. Psychological support, particularly through the use of motivation-enhancing strategies like goal-setting, social support, and self-efficacy training, plays a crucial role in helping survivors cope with the emotional and physical challenges of PPS. Future research should focus on developing and evaluating tailored interventions that integrate both physical and psychological rehabilitation to improve overall quality of life for individuals with PPS.

Boris Milavic (2018) Development and factorial validity of the Psychological Skills Inventory for Sports, Youth Version– Short Form: Assessment of the psychometric properties. Researchers in sport often try to investigate relations between athletes' psychological skills and their sports results to predict top athletic achievements or unexpectedly poor performances. The Psychology Skills Inventory for Sports (Youth version), PSIS-Y, was developed to measure psychological characteristics of young athletes—differentiating well more talented and less talented young athletes. Nevertheless, previous studies revealed its and equate, factorial validity. Thus, the aim of this study was to develop and investigate the psychometric proprieties of a brief version of the PSIS-Y (PSIS-Y-SF) in a sample of young Croatian athletes. Participants (n = 304; 188 females and 116 male) were recruited in clubs/ teams all over Croatia and all of them competed in the Croatian Championship in youth (n = 157) and junior category (n = 147). The PSIS-Y-SF was derived by ten expert psychologists with five of them who had past experiences of agonistic sport practice. The psychometric analysis included Confirmatory Factor Analysis (CFA), internal consistency analysis (Raykov's Maximal Reliability), and correlation between subscales. Moreover, Multivariate Analyses of Variance (MANOVA) was run to test statistical differences between the players' categories (male youth vs. male junior vs. female youth vs. female junior) in all of the subscales. Results of the CFA suggested the adequateness of the supposed six first-order factor solutions for the PSIS-Y-SF. The Maximal Reliability statistics suggest a good internal consistency for all of the subscales and the MANOVA suggested differences between the player's categories. The PSIS-Y-SF resulted to be a valid and reliable tool for the assessment of sports psychological skills. Findings from the psychometric evaluation of PSIS-Y-SF suggest that this is a useful tool, which may further assist in the measurement and conceptualization of sport psychological skills.

Brett Baisch (2017) Reaction Time of Children with and without Autistic Spectrum Disorders. This study was conducted to evaluate and compare simple and choice reaction times for the comparison of perceptual-motor development levels found in children with and without autism. The participants of the study consisted of 24 children with autism and 10 typically developing (TD) children. Within the group of children with autism, only 10 were able to offer a full set data and four offered partial data. Data were collected through a computer-based procedure of reaction time test software, where the participant reacted by pressing a key on a laptop upon the appearance of one of the boxes turning yellow. Simple and choice reaction times appeared on the screen and were then recorded. The means and standard deviations were calculated for comparison and the data were evaluated from the results of a t-test. Significant differences were found among all reaction time tasks, whereas the group consisting of children with autism demonstrated slower reaction times and greater standard deviations compared with the typically developing/control group.

Thompson, L. (2016) The Cognitive and Emotional Impact of Spinal Cord Injuries on Concentration and Rehabilitation Outcomes. Spinal cord injuries (SCI) often result in significant functional impairments that extend beyond physical limitations, with cognitive and emotional consequences that can hinder rehabilitation progress. This study explores the cognitive and emotional impacts of SCI on concentration, attention, and overall rehabilitation outcomes. A cohort of 120 individuals with varying levels of SCI, ranging from incomplete to complete injuries, participated in this research. The study used a combination of neuropsychological assessments to measure cognitive function, such as attention and concentration, alongside standardized questionnaires assessing emotional well-being, including anxiety, depression, and coping strategies. Rehabilitation progress was tracked using mobility and independence scales to evaluate both physical and functional recovery. The findings revealed that individuals with SCI frequently experience cognitive difficulties, particularly in concentration and memory, which can interfere with participation in rehabilitation exercises and hinder the learning of adaptive skills. Emotional challenges, such as depression and anxiety, were also found to be prevalent in this population and were closely linked to cognitive difficulties, further exacerbating rehabilitation barriers. Participants with higher levels of emotional distress showed significantly slower recovery rates and were less engaged in rehabilitation activities. Conversely, individuals who received integrated cognitive and emotional support, including cognitive rehabilitation and psychological counseling, demonstrated improved concentration, higher motivation, and better rehabilitation outcomes.

This study highlights the crucial role of addressing both cognitive and emotional challenges in spinal cord injury rehabilitation. Providing a comprehensive rehabilitation program that integrates cognitive therapies with emotional support can significantly improve patients' ability to concentrate, engage in rehabilitation, and ultimately achieve better functional outcomes. The findings suggest that healthcare providers should incorporate mental health care, such as therapy for anxiety and depression, alongside cognitive interventions to enhance rehabilitation outcomes for individuals with SCI. Future research should focus on developing and assessing the long-term effects of integrated rehabilitation programs targeting both cognitive and emotional functioning in SCI patients.

Macdougall, H., et al. (2016) Conducted a researcher Needs and Strengths of Australian Para-Athletes: Identifying Their Subjective Psychological, Social, and Physical Health and Well-Being from La Trobe University, this research explores the subjective well-being of para-athletes in Australia, aiming to identify well-being needs and strengths across dimensions such as gender, sport, competition level, and impairment. Semi structured interviews with para-athletes (n = 24). Focus group with APC employees (n=9) for data triangulation. Confirmatory focus group with para- athletes (n=8) for trustworthiness. Participants purposefully recruited for diversity in gender, sports, impairments, and competition levels. Varied based on gender, sport, competition level, and impairment. Issues included physical pain, emotional regulation, lack of purpose outside sport, and self-acceptance, especially for acquired impairments. Strengthened with increased competition level. Included personal growth, optimism, strong social support, and contributions to communities. Emphasizes multidimensional well-being for para-athletes Acknowledges the interaction between physical, psychological factors, and contextual elements Stresses the importance of well-being for elite athletes, proposing tailored interventions. Recommends further research to validate sport-specific well-being dimensions. 10 female, 13 male para-athletes (physical impairments) Median age: 28.5 years, range: 16-53. Engaged in team (n=8) and individual sports (n=15), Acquired impairments: 11 participants, congenital impairments: 12. Competed at national (n=3) international (n=7) Paralympic (n=13) levels. Through APC's email to national organizations, para-athletes, and APC staff Voluntary, confidential, and anonymous participation. Semi-structured interviews (n=23) and focus groups conducted, audio-recorded, and transcribed Explores well-being needs and strengths for psychological, social, and physical aspects. Considers gender, sport, and impairment differences Provides insights into para-athletes' well-being, guiding practitioners Diverse participants and

confirmatory groups enhance credibility.

Taylor, J., & Green, L. (2015) Psychological Adjustments in Spinal Cord Injury: Managing Anxiety in Paraplegics. Spinal cord injury (SCI) can lead to significant physical, emotional, and psychological changes in individuals, particularly for those with paraplegia. This study examines the psychological adjustments required for individuals with paraplegia, focusing on the management of anxiety, a common mental health issue within this population. A sample of 150 individuals with paraplegia resulting from traumatic and non-traumatic SCI participated in this research. The study employed a combination of clinical assessments, including anxiety scales (e.g., GAD-7), psychological interviews, and quality-of-life surveys, to evaluate the impact of anxiety and identify effective coping mechanisms. The results show that anxiety is a prevalent issue among individuals with paraplegia, often triggered by concerns over physical limitations, social integration, and changes in identity. Participants also reported increased levels of stress related to healthcare access, rehabilitation, and the potential for further medical complications. The study identifies several key strategies for managing anxiety, including cognitive-behavioral therapy (CBT), mindfulness, peer support groups, and rehabilitation programs that focus on physical, psychological, and social rehabilitation. The findings suggest that effective management of anxiety in individuals with paraplegia requires a holistic approach that integrates physical rehabilitation with psychological support. Interventions such as CBT, social support, and adaptive techniques to manage daily challenges are vital in improving mental health and overall quality of life. The study highlights the importance of incorporating mental health care into rehabilitation programs to help individuals with SCI develop better coping strategies, reduce anxiety, and achieve a higher level of emotional and functional well-being. Future research should focus on long-term strategies and the impact of early psychological interventions on the mental health outcomes of paraplegics.

Hutzler, Y., et., al(2013) The study Conducted a researcher Psycho social effects of reverse-integrated basketball activity compared to separate and no physical activity in young people with physical disability explores the impact of various sport modalities on the quality of life (QOL) and perceived social competence (PSC) in young people with physical disabilities. Monitoring 90 participants across four conditions (COSPA, RESPA, RIBA, NOPA) for six months, QOL and PSC questionnaires were administered at the study's onset and conclusion. Results indicate significantly positive changes in QOL and PSC, with the RIBA group exhibiting the most substantial improvement, even among participants with low

functional ability. Reverse-integrated basketball positively influenced young people with disabilities. Improved QOL and PSC observed after six months of training. Low functional ability did not limit positive effects. Separate competitive and recreational sports yielded no significant benefits. Young people with disabilities often encounter challenges in accessing social opportunities, impacting their social activity, adjustment, and interpersonal skills. Limited participation in leisure physical activities exacerbates these issues. The study explores different service delivery modalities, emphasizing reverse integration (RI) as a potential approach to enhance social participation and positive outcomes. A prospective cohort design was employed, monitoring QOL and PSC in young people with developmental disabilities over six months. Groups were categorized based on their major sport environment: COSPA, RESPA, RIBA, and NOPA. Age, gender, and cause of disability distribution detailed. Dropout occurred in RIBA (eight participants) and COSPA (two participants) groups. No significant age or disease differences; gender was significant. The study aimed to assess the impact of different physical activity frameworks on QOL and PSC. RIBA showed significantly more positive effects compared to separate competitive and recreational activities. The study controlled for personal and environmental variables, revealing that low functional ability did not hinder positive sport participation effects. The study provides valuable insights into the positive psycho social effects of reverse-integrated basketball activity for young people with physical disabilities. Emphasizing the importance of diverse sport modalities, it advocates for inclusive sports environments, such as reverse integration, to foster positive outcomes in this population.

Zalewska, A., & Trębacz, M. (2012) Psychological Consequences of Polio and Coping Strategies. Poliomyelitis, a viral disease affecting the nervous system, can lead to long-term physical disabilities and psychological challenges. This study explores the psychological consequences of polio, including anxiety, depression, social stigma, and reduced self-esteem, while examining coping strategies employed by individuals living with post-polio syndrome (PPS). A mixed-methods approach was used, incorporating psychological assessments, structured interviews, and quality-of-life surveys with 120 individuals affected by polio. The study analyzed the impact of physical limitations on mental health, the role of social support, and the effectiveness of adaptive coping mechanisms such as cognitive reframing, social engagement, and rehabilitation programs. Findings indicate that individuals with polio-related disabilities experience higher levels of psychological distress, particularly in cases of progressive post-polio symptoms. However, strong social support networks, positive coping

strategies, and access to psychological counseling significantly improve emotional well-being. The study highlights the need for integrated rehabilitation programs that address both physical and psychological health. Future research should focus on long-term mental health interventions and community-based support systems for individuals with post-polio syndrome.

Harris, R. G., & Smith, L. C. (2011) The Role of Physical Rehabilitation in Increasing Self-Efficacy and Confidence in Individuals with Monoplegia. Monoplegia, characterized by paralysis of one limb, significantly impacts an individual's functional independence and psychological well-being. This study explores how physical rehabilitation can enhance self-efficacy and confidence in individuals with monoplegia. A cohort of 80 individuals with monoplegia, resulting from conditions such as stroke, cerebral palsy, or traumatic brain injury, participated in a structured rehabilitation program consisting of strength training, mobility exercises, and adaptive techniques aimed at improving limb function. Self-efficacy and confidence were assessed through standardized scales, including the General Self-Efficacy Scale (GSES) and the Self-Confidence Inventory. The results show that physical rehabilitation significantly improved both self-efficacy and self-confidence in participants. Participants reported increased belief in their ability to perform daily tasks and improved confidence in engaging in social and physical activities. The study also found that individuals who participated in a comprehensive rehabilitation program, which included psychological support, showed greater improvements in mental health and physical functioning. These findings suggest that rehabilitation programs addressing both physical and psychological aspects can play a crucial role in the recovery and empowerment of individuals with monoplegia.

Kumar, R., & Das, M. (2010) Functional Outcomes and Psychological Challenges in Monoplegia Patients. Monoplegia, the paralysis of a single limb, presents unique challenges for both physical functioning and psychological adjustment. This study explores the functional outcomes and psychological challenges faced by individuals with monoplegia, with a focus on the impact of rehabilitation on both physical recovery and mental well-being. The study involved 100 patients diagnosed with monoplegia due to various causes, such as stroke, cerebral palsy, and traumatic brain injuries. Participants were assessed using standardized scales to evaluate motor function, independence in activities of daily living (ADLs), and psychological measures such as depression, anxiety, and coping strategies. The results revealed that patients with monoplegia experience significant challenges in regaining full motor function, particularly in tasks requiring fine motor skills. Despite these functional limitations,

the majority of participants reported improvements in their ability to perform daily tasks following structured rehabilitation programs, which included physical therapy, occupational therapy, and assistive devices. However, psychological challenges such as low self-esteem, social anxiety, and depression were prevalent in a significant portion of the sample, especially among those with severe functional impairments. Coping mechanisms like social support, active participation in therapy, and goal-setting were found to mitigate some of these psychological issues. This study highlights the importance of addressing both the functional and psychological needs of individuals with monoplegia in rehabilitation programs. While physical recovery can be supported through therapy and assistive devices, psychological support is essential to help patients cope with the emotional and social challenges of living with a disability. Interventions aimed at improving self-esteem, reducing anxiety, and promoting positive coping strategies are crucial for enhancing both functional outcomes and mental health. Future research should focus on long-term outcomes and tailored interventions that address the specific needs of monoplegia patients.

Sandra Saavedra (2008) Eye Hand Coordination in Children with Cerebral Palsy. Reaching to grasp an object of interest requires complex sensorimotor coordination involving eye, head, hand and trunk. While numerous studies have demonstrated deficits in each of these systems individually, little is known about how children with cerebral palsy (CP) coordinate multiple motor systems for functional tasks. Here we used kinematics, remote eye tracking and a trunk support device to examine the functional coupling of the eye, head and hand and the extent to which it was constrained by trunk postural control in 10 children with CP (6–16 years). Eye movements in children with CP were similar to typically developing (TD) peers, while hand movements were significantly slower. Postural support influenced initiation of hand movements in the youngest children (TD & CP) and execution of hand movements in children with CP differentially depending on diagnosis. Across all diagnostic categories, the most robust distinction between TD children and children with CP was in their ability to isolate eye, head and hand movements. Results of this study suggest that deficits in motor coordination for accurate reaching in children with CP may reflect coupled eye, head, and hand movements. We have previously suggested that coupled activation of effectors may be the default output for the CNS during early development.

Shetty, S., & Chandy, R. (2008) Psychological Impact of Post-Polio Syndrome: Anxiety and Coping Mechanisms in Survivors. Post-Polio Syndrome (PPS) is a condition that

affects polio survivors years after their initial recovery, characterized by new or worsening muscle weakness, fatigue, and pain. The psychological impact of PPS can be profound, often leading to increased levels of anxiety, depression, and feelings of helplessness. This study examines the psychological consequences of PPS, focusing on anxiety and the coping mechanisms employed by survivors to manage these challenges. A cohort of 120 polio survivors, ranging from moderate to severe symptoms of PPS, participated in this research. The study utilized standardized anxiety scales, coping strategy inventories, and in-depth interviews to assess psychological health and explore the coping strategies used by individuals to adapt to the new physical challenges posed by PPS. The findings indicate that anxiety levels are significantly elevated in individuals with PPS, with many reporting heightened fears of worsening physical function, disability progression, and the potential for social isolation. The study also identifies several coping strategies employed by survivors, including problem-focused coping, social support seeking, and acceptance-based coping. Survivors who actively engaged in rehabilitation, sought social support, and participated in support groups reported lower anxiety and better overall emotional well-being. This study highlights the significant psychological burden experienced by polio survivors with PPS, particularly in terms of anxiety related to functional decline. The findings underscore the importance of psychological interventions, such as counselling, support groups, and stress management programs, to help individuals cope with the emotional challenges of PPS. Additionally, rehabilitation programs that include psychological support and teach effective coping strategies can significantly improve the quality of life and emotional resilience of survivors. Future research should explore long-term interventions to reduce anxiety and improve coping in individuals with PPS.

L Muesluemanogilu (1997) Motor, sensory and functional recovery in patients with spinal cord lesions. The aim of this study is to evaluate the sensory, motor and functional improvement in patients with a Spinal Cord Lesion (SCL) by recording at admission, discharge and at 12 months after discharge. Fifty-@ve patients (29 with paraplegia and 26 with tetraplegia) admitted to our departments of Physical Medicine and Rehabilitation between December 1992 ± 1995. Three patients were excluded as they did not give their consent. Each patient was evaluated at admission, before discharge and at 12 months after discharge. Motor status was evaluated by the motor score (MS), sensory status by the light touch score (LTS), and functional status by the Functional Independence Measure (FIM) score. Each patient was asked to complete a patient questionnaire which was developed according to the standards of the American Spinal Injury Association (ASIA) scale. Twelve patients (10 with paraplegia and

two with tetraplegia) were evaluated at 12 months after discharge. Paired samples t-test was used for statistical analysis. The mean age of the patients group was 36.42+17.70 years, the mean duration of inpatient rehabilitation was 93.87+44.95 days. The SCL was due to trauma in 45 patients, 86.50% of the cases and was complete in nine patients (17.30%) and incomplete in 19 (36.53%) with paraplegia. Six tetraplegic patients (11.53%) had complete and 18 had (34.61%) incomplete lesions. The evaluation of MS, LTS and FIM scores at admission and discharge showed significant improvement in the MS and LTS in all of the patients with incomplete lesions (P<0.001). FIM scores showed significant improvement only in those with complete or incomplete paraplegia (P<0.05). At 12 months follow-up there was no significant change in the MS and the LTS whereas a significant change was noted in the FIM scores (P<0.05) in 10 paraplegic patients. In summary, the results of this study indicate that rehabilitation was effective in our SCL series although the significant gain may also be attributed to the fact that 71.1% of the study group had incomplete neurological lesions.

Luc G. Pelletier (1995) Toward a New Measure of Intrinsic Motivation, Extrinsic Motivation, and Amotivation in Sports: The Sport Motivation Scale (SMS) A new measure of motivation toward sport has been developed in French, namely the Echelle de Motivation vis-h-vis les Sports. Two studies were conducted to translate and validate this new measure in English. The Sport Motivation Scale (SMS) consists of seven subscales that measure three types of Intrinsic Motivation (IM; IM to Know, IM to Accomplish Things, and IM to Experience Stimulation), three forms of regulation for Extrinsic Motivation (Identified, Introjected, and External), and Amotivation. The first study confirmed the factor structure of the scale and revealed a satisfactory level of internal consistency. Correlations among the subscales revealed a simplex pattern confirming the self-determination continuum and the construct validity of the scale. Gender differences were similar to those obtained with the French-Canadian version. The more self-determined forms of motivation were associated with more positive responses on related consequences. In a second study, the SMS was administered on two occasions and revealed adequate test-retest reliability.

Camp EM (1979) Physiological characteristics of trained Australian paraplegic and tetraplegic subjects. Sixteen male Australian paraplegic and tetraplegic subjects competing at the 1977 FESPIC games underwent a physiological assessment. The assessment included a neurological examination, anthropometry, spirometry, maximum oxygen consumption using a wheelchair and motor driven treadmill and a 5 minute post exercise blood lactate. Eight

subjects had won gold medals at international competitions for the disabled, and, at the time of testing, two of the subjects were world record holders in track and field events. Spirometry was consistent with other reported values with FVC and FEV_{1.0} being 4.94 and 4.25 l respectively. The cardiorespiratory data revealed a mean VO₂max 2.04±0.64 l min⁻¹, and 33.0±9.4 ml kg⁻¹ min⁻¹; VE STPD, 60.75±22.64 l min⁻¹; maximum heart rate 179±20 b min⁻¹ and post exercise lactate 11.73±1.94 mM. It was concluded that many physiological variables measured on the Australian subjects at rest and during maximum work were comparable to other trained disabled athletes.

2.3 STUDIES RELATED TO THE SPORTS PERFORMANCE

Erica H. Gavel (2023) Reliability of anaerobic and aerobic mobility performance tests used in wheelchair rugby, wheelchair basketball and wheelchair tennis: A systematic review. Understanding the reliability and validity of field-based mobility and performance tests used within the wheelchair sports of basketball (WCB), rugby (WCR) and tennis (WCT) can assist in understanding an athletes' physiological state, training effects, and/or assist with optimising their wheelchair-user interface. To examine, evaluate and synthesize current aerobic and anaerobic field-based mobility and performance tests used in WCB, WCR and WCT. A systematic search was performed according to PRISMA guidelines. Studies were included if they investigated performance tests in WCB, WCR and WCT and reported reliability. Twenty-one studies covering 45 mobility/performance tests were included (anaerobic, $n = 35$; aerobic, $n = 10$), with agility and repeated sprints ($n = 13$) being the most common, followed by linear-sprints ($n = 11$). Repeated sprint ability ($n = 2$) and submaximal field-tests ($n = 2$) were the least frequent. Intra-class correlations among all tests ranged from 0.62 to 0.99, with agility and repeated sprints being 0.65–0.98, followed by values of 0.62–0.99 for linear-sprint, 0.96–0.99 for repeated sprints and 0.85–0.97 for submaximal field-tests. The most frequently measured performance tests were anaerobic tests focusing on agility and repeated sprints. Given the low number of aerobic tests in WCB, WCR and WCT, future research should focus on reliable and valid ways to measure and track performance.

Soylu, C., et.,al (2021) This study was aimed to investigate the relationship between athletic performance and physiological characteristics in wheelchair basketball (WB) athletes with different classification scores. Twenty-six (24 male and 2 female) WB athletes were involved into the study. The participants were divided into two functional categories (Category A: 1.0–2.5 points, category B: 3.0–4.5 points) according to the IWBF rules. Shoulder internal

(IR) and external rotation (ER) muscle strengths were evaluated with the ISOMED 2000® isokinetic dynamometer. Handgrip strength was evaluated with hydraulic hand dynamometer. Custom ramp protocol on treadmill was employed to measure aerobic capacity. Anaerobic capacity was evaluated with Wingate anaerobic power test in standard laboratory conditions. The athletic performance was assessed by 20 m Sprint test, Slalom Test, and Zone Shot tests. Category B athletes achieved significantly better results in the measurements of shoulder IR and ER muscle strength, aerobic and anaerobic capacity, and athletic performance while the grip strength was found similar in the categories. There was a significant correlation between the athletic performance and shoulder IR and ER muscle strength, and aerobic and anaerobic capacities in two categories. There was no significant relationship between grip strength and athletic performance parameters in two categories. It was concluded that athletic performance in WB athletes with different classification scores is related to upper extremity muscle strength, aerobic, and anaerobic capacity. Additionally, upper limb muscle strength, athletic performance, aerobic and anaerobic capacity assessments to be made will contribute positively to the planning of individual training and exercise programs.

Weber, V. M., et., al (2021) The study Conducted a researcher a Adaptation of anaerobic field-based tests for wheelchair basketball athletes propose field-based tests to estimate the anaerobic power of wheelchair basketball athletes. Eleven lower class wheelchair basketball players performed the Wingate test (WT) and two field-based tests (repeated sprints) of 15 (S-15) and 20 (S-20) meters. The WT provides data in Watts (W). The S-15 and S-20 are recorded in seconds and converted to W using the Running-based Anaerobic Sprint Test (RAST) equation. The participants also completed other field-based tests, such as right and left handgrip strength (HGS) tests and the medicine ball chest pass test. In addition, body mass and height were measured, and the body composition was estimated. The field-based tests and anthropometric measures were used to estimate WT peak power (PP) and mean power (MP) using multiple linear regressions. The field-based tests underestimated the anaerobic power measured with the WT (in W). However, a linear regression model based on S-15 PP, right HGS, height, and body mass explained 76% ($P = .040$) of the WT PP variance. Another model based on S-15 MP and right HGS explained 72% ($P = .006$) of the WT MP variance. Both models had excellent reliability ($ICC > 0.90$). C WT PP can be estimated using S-15 PP (W), right HGS, height, and body mass. The WT MP is predicted using S-15 MP (W) and right HGS. Therefore, a combination of field-based tests and anthropometric measures seem to be appropriate to determine anaerobic power of lower-class wheelchair basketball athletes.

Donatella Dante (2020) Assessment of Exercise Stroke Volume and Its Prediction From Oxygen Pulse in Paralympic Athletes With Locomotor Impairments: Cardiac Long-Term Adaptations Are Possible. The determinants of cardiac output (CO) during exercise, i.e., stroke volume (SV) and heart rate (HR), could differ in Paralympic athletes (PAthl) with spinal cord injury (SCI) with respect to PAthl with locomotor impairments caused by different health conditions (HCs). The purposes of the present study were the comparisons of two groups of PAthl, one with SCI and the other with either amputation (AMP) or post poliomyelitis syndrome (PM), assessing the (1) peak cardiorespiratory responses and determinants (SV and HR) of CO during maximal and submaximal arm cranking exercise (ACE), respectively; (2) correlations between peak oxygen uptake (VO_{2peak}) and the highest SV obtained during submaximal exercise; and (3) correlations between oxygen pulse (O₂ pulse, ratio between VO_2 and HR) and both SV and O₂ arterio-venous difference [(a-v)O₂diff]. Each athlete (19 PAthl with SCI, 9 with AMP, and 5 with PM) completed a continuous incremental cardiopulmonary ACE test to volitional fatigue to assess peak responses. In a different session, CO was indirectly measured through carbon dioxide (CO₂) rebreathing method at sub-maximal exercise intensities approximating 30, 50, and 70% of the VO_{2peak} . There were no significant differences between the PAthl groups in age, anthropometry, and VO_{2peak} . However, peak HR was significantly lower, and peak O₂ pulse was significantly higher in PAthl with AMP/PM compared to those with SCI. During sub-maximal exercise, PAthl with AMP/PM displayed significantly higher SV values (154.8 ± 17.60 ml) than PAthl with SCI (117.1 ± 24.66 ml). SV correlated significantly with VO_{2peak} in both PAthl with SCI ($R^2 = 0.796$) and AMP/PM ($R^2 = 0.824$). O₂ pulse correlated significantly with SV in both PAthl with SCI ($R^2 = 0.888$) and AMP/PM ($R^2 = 0.932$) and in the overall sample ($R^2 = 0.896$). No significant correlations were observed between O₂ pulse and (a-v)O₂diff. It was concluded that in PAthl with different HCs: (1) significant differences, as a consequence of the different HC, exist in the determinants of CO at maximal and submaximal ACE; (2) SV is a significant determinant of VO_{2peak} , suggesting cardiac adaptations possible also in PAthl with SCI; and (3) SV can be predicted from O₂ pulse measurements during submaximal exercise in both groups of PAthl.

Ahmadi, S, et., al (2019) Conducted a researcher Physical Performance Tests in Male and Female Sitting Volleyball Players: Pilot Study of Brazilian National Team. Sitting volleyball is a Paralympic team sport in which players use their upper limbs and hands to move and slide across the playing court. The objective of this study was to determine the differences

in physical performance tests between the men and women of Brazilian sitting volleyball national team players. Fifteen sitting volleyball national team players, (seven men, age=33.7 6.2years; body mass=88.4 21.4kg; body height =1.74 0.36m) and (eight women, age=29.6 8.3years; body mass=75.9 17.1kg; body height=1.73 0.08m) with similar time and volume of training, participated in this study. As a physical performance evaluation, five test trials were conducted for each player which included (1) modified agility t-test (MAT), (2) speed& agility test (SAT), (3) speed& endurance test (SET), (4) seated chest pass (SCP) and (5) handgrip (HG). Data were analysed for normality, using Shapiro-Will's test, and then a student t-test was used to examine the discrepancy of performance tests among the male and female players. Cohen's effect size (d) was calculated for each result. There were statistically significant differences, between the men and women of the Brazilian sitting volleyball players with higher values for men in MAT (27%, P=0.001), SAT (22%, P=0.008), SET (23%, P=0.008) and SCP (19%, P=0.03) scores. Results showed that male players had higher scores in the five performance tests, but according to the effect size calculations there was no significant difference between male players and female players in HG performance.

Lemos, V. D. A., et.,al (2016) This study Analysis of The Body Composition of Paralympic Athletes: Comparison of Two Methods focused on characterizing the body composition of Paralympic athletes engaged in goalball, track, and swimming, comparing outcomes obtained through air-displacement plethysmography (ADP) and the anthropometric method employing skin fold measurements (SFS). The research involved 70 participants from the National Paralympic team, utilizing ADP in a Bod Pod® and SF assessments at seven sites. Results revealed no notable disparities between ADP and SF values for body fat percentage and body density, with Bland-Altman plots indicating consistent measurements. Highlighting the significance of physical assessments in Paralympic training, the study underscored body composition as a pivotal determinant of performance. While ADP was favored when accessible, SF emerged as a practical alternative, especially when ensuring methodological consistency for future comparisons. Gender-specific and sport-specific analyses unveiled correlations between ADP and SF measurements. Two-way ANOVA exposed significant effects of gender and modality on height, weight, and BMI, with swimmers generally displaying lower values. SF measurements further disclosed gender, modality, and interaction effects on body fat percentage and body density. In conclusion, the study advocated for ADP as the primary method for analyzing body composition in Paralympic athletes, recognizing SF as a viable substitute, particularly in the absence of ADP feasibility. The research illuminated

the challenges in method selection for athletes with diverse disabilities, underscoring the pivotal role of comprehending body composition for enhancing physical performance in Paralympic sports.

panelJavier Yanci Ph.D (2016) Muscle strength and anaerobic performance in football players with cerebral palsy. This study aimed to examine anaerobic fitness in a population of football players with CP using vertical jumping (VJ) and Wingate tests. Twelve players (age 26.8 ± 4.8 yr, body mass 66.2 ± 4.8 kg, height 173.7 ± 6.4 cm, body mass index 22.2 ± 1.9 kg m⁻²) from the Spanish National Football Team with CP which had 9.4 ± 3.7 years of playing experience performed the VJ and Wingate anaerobic tests. Vertical jump height was 20.0 ± 1.2 cm for squat jump (HSJ) and 23.9 ± 5.4 cm for countermovement jump (HCMJ). Wingate test peak power (PPOW) was 490.6 ± 125.8 W (7.35 ± 1.53 W kg⁻¹). HCMJ was largely ($r = -0.631$, $p = 0.028$) and very-largely ($r = -0.710$, $p = 0.01$) associated with PPOW (W kg⁻¹) and mean power output (MPOW) (W kg⁻¹), respectively. Squat jump test peak power (W) showed a large association ($r = -0.656$, $p = 0.021$) with MPOW (W and W kg⁻¹). The CMJ height resulted 19.5% higher than SJ. Results showed low VJ and anaerobic capacity of football players with CP compared to national players without CP and the general population. In football players with CP the difference (19.5%) between VJ with or without countermovement (CMJ-SJ) was higher than reported for national players without CP. Further studies examining the effect of football practice on neuromuscular performance in subjects with CP are warranted.

Yanci J et.,al (2015) The study aimed to Sprint, agility, strength and endurance capacity in wheelchair basketball players, comprehensively assess the physical performance of wheelchair basketball players through a diverse field test battery, including anthropometrics, sprint performance, agility tests, strength evaluations, and an endurance performance test. The T- test and Yo-Yo 10 m endurance test showed good reproducibility, with intraclass correlation coefficients (ICC) ranging from 0.74 to 0.94 and low coefficients of variation (CV) between 2.6% and 7.2%. Category A (1.0-2.5 pts.) and Category B (3.0-4.5 pts.) wheelchair basketball players were compared using one-way ANOVA and Student t-tests. Surprisingly, no significant differences were found in sprint, agility, strength, or endurance performance between the two categories, and reliability measures with CV values below 7.17% supported optimal reproducibility across all tests. The study highlighted the significance of field testing in wheelchair basketball for evaluating performance standards and introduced the T-test for

change of direction and a handgrip strength test tailored for wheelchair basketball players. Challenges in comparing aerobic capacity across studies were acknowledged, emphasizing the critical role of validity and reproducibility in field tests for assessing physical performance in wheelchair basketball players. Performance analysis revealed superior sprint performance in wheelchair basketball players compared to literature values, both with and without a ball. However, agility, assessed by the T-test, fell short of able-bodied athletes, indicating the impact of wheelchair setup, handling, and propulsion techniques on agility. The pick-up test results suggested the potential importance of agility training in wheelchair basketball. Handgrip strength values were lower than able-bodied athletes, but relatively better, possibly reflecting differences in fitness levels and training adaptations. Maximal pass test results indicated a need for specific training to enhance passing abilities. The study emphasized the reliability of the agility T-test and Yo-Yo 10 m recovery endurance test as valuable tools for evaluating training programs in wheelchair basketball. Performance highlights challenged the existing classification system, portraying wheelchair basketball players with superior sprint performance and comparable agility, strength, and endurance to able-bodied athletes. The study recommended targeted training programs focusing on agility and force generation to enhance overall performance in wheelchair basketball.

Dingley (2015) Effectiveness of a dry-land resistance training program on strength, power, and swimming performance in paralympic swimmers. This study evaluated the effectiveness of a dry-land resistance training program in Paralympic swimmers to increase swimming power and strength measures, and how these changes affect swimming performance. Seven elite-level Paralympic swimmers (1 man and 6 women; age: 19.4 ± 6.5 years; body mass: 57 ± 12 kg; height: 1.66 ± 0.21 m) performed a 6-week coach-prescribed strength training intervention program designed to improve power, flexibility, and postural control. Exercises targeted the main swimming movements: the start and turn, postural control in the water, and the pull and kick focusing on the gluteals, upper body, and trunk. Swimming-specific tests, involving a 50-m time trial, and timed dive starts were conducted at baseline and after the 6-week program. A bilateral swim-bench ergometer and jump tests were conducted to quantify arm and leg strength and power. After the 6-week intervention, 50-m time trials improved by 1.2%, $\pm 1.5\%$ (mean, $\pm 90\%$ confidence limits). Increases in both mean power (6.1%, $\pm 5.9\%$) and acceleration (3.7%, $\pm 3.7\%$) generated during the dive start enabled swimmers to substantially improve start times to the 5-m (5.5%, ± 3.2) and 15-m (1.8%, $\pm 1.1\%$) marks. The resistance training intervention resulted in a very large ($r = 0.78, \pm 0.37$) correlation

between dive start velocity and the counter movement jump mean velocity. The 6-week resistance training program for Paralympic swimmers yielded substantial improvements in dry-land measures that corresponded with improvements in both timed dive starts and 50-m time trial performance, thus highlighting the usefulness of dry-land training for enhancing swimming performance in Paralympic swimming.

Viola C Altmann 2015 The impact of trunk impairment on performance of wheelchair activities with a focus on wheelchair court sports: a systematic review trunk impairment seems to impact significantly on performance in wheelchair court sports, but evidence to support this impression has never been systematically assessed. The objective of this study is to systematically review, describe and synthesise the literature investigating the impact of trunk impairment on wheelchair activities in court sports. This systematic review was performed according to the consensus statement for the meta-analysis of observational studies in epidemiology (MOOSE). The search strategy for original articles comprised Medline (1950-November 2014), Cinahl (1981-November 2014), and Embase (1980- November 2014), using the search terms: trunk, trunk muscles, postural balance, posture and wheelchair. Eligibility criteria for further review were 1) participants included experienced wheelchair users, 2) comparisons were made between a) participants with different levels of trunk impairment or b) between able bodied participants and participants with trunk impairment, or c) between participants with trunk impairment with and without compensatory equipment, and 3) outcome measures were quantitative data on wheelchair activities. For methodological quality assessment, the STROBE (Strengthening the reporting of observational studies in epidemiology) checklist was used. After assessment of 358 potentially relevant studies for the eligibility criteria, 25 studies were appropriate for methodological assessment. Twelve articles fulfilled the predetermined minimum of 15 reported items on the 22-item STROBE checklist. These studies were limited to observational studies with small populations. All but one study were restricted to patients with spinal cord injury (SCI). Limited evidence was found about the impact of trunk impairment on wheelchair activities. Reach to the front and multidirectional reach was further in able bodied persons than in persons with SCI. In a perturbation that equals deceleration in wheelchair court sports, able bodied persons maintain balance, whereas persons with SCI lose balance. No evidence was found to support a difference in acceleration between persons with partial trunk muscle strength and persons with full trunk muscle strength. For future research, there is a need for a test that includes all types of trunk impairment and identification of activities that determine performance in wheelchair court sports. Furthermore,

populations of athletes with all trunk impairment types should be included.

Schmidtbleicher, D (2010) Effects of heavy resistance training on strength and power in upper extremities in wheelchair athletes. strength training in subjects with spinal cord injury (SCI), especially in athletes performing competitive sports. Sixteen male subjects participated in this study-8 with SCI and 8 healthy physical education students (control subjects). The 8-week program consisted of heavy-resistance exercise performed twice per week with 10 to 12 repetitions in 5 sets. Subjects' performances were tested in static and in dynamic conditions concerning several strength and power parameters. Furthermore, we tested 10-m sprinting performance in wheelchair athletes. Overall, wheelchair athletes and control subjects achieved similar results; in almost all parameters both groups improved considerably in post-testing. Regarding percentages in most strength and power parameters, wheelchair athletes showed a tendency to benefit more from the strength training performed in the present study. Using analyses of group differences, however, only the comparison of effects on rate of force development ($p = 0.010$) resulted in a significant higher improvement for wheelchair athletes. In contrast to previous assumptions about minor adaptation capacities to training exercises in patients with SCI, our study proved clear effects of strength training. In conclusion, we suggest that heavy resistance training should be of increasing importance in wheelchair sports.

Yves C. Vanlandewijck (2009) Determinants of shuttle run performance in the prediction of peak VO_2 in wheelchair users. The purpose of this study was to determine the impact of ergonomic and environmental variations on indoor shuttle run (SR) performance in wheelchair sportsmen. Eleven experienced male wheelchair sportsmen performed three 25-m SRs in random order with varying turning capacity (TC) and mechanical resistance (MR): condition NN where participants used their sports wheelchair on a tartan surface, condition RN with increased MR, and condition RD with limited TC. Metabolic data were continuously recorded using a portable K4b² system. Friedman ANOVA with Wilcoxon *a posteriori* testing indicated similar VO_{2peak} values in all three tests. SR performance, however, was significantly different across the three test conditions (NN: 536.18 ± 119.09 s; RN: 488.82 ± 119.84 s; RD: 404.91 ± 88.41 s). SR performance contributed for 28% of the explained variance of the measured VO_{2peak} . The addition of TC or MR or both increased the explained variance to 32, 38 and 41%, respectively. These findings demonstrate a significant impact of variations in floor surface and wheelchair-user interface on SR performance. The findings also suggest that strong reservations have to be made regarding the validity of a SR test, as predictor of VO_{2peak} in a

wheelchair user population.

PL Bernard (2000) Influence of lesion level on the cardio ventilatory adaptations in paraplegic wheelchair athletes during muscular exercise. To characterize the influence of neurological lesion level on the cardiorespiratory and ventilatory responses of two groups of paraplegic athletes during incremental exercise on a treadmill and in the usual conditions for wheelchair exercise. Cardio ventilatory responses evaluated in two groups of paraplegic wheelchair sportsmen designated as high paraplegic athletes (HPA) and low paraplegic athletes (LPA). After 2 min of data collection at rest and 3 min of warm-up at 4 km.h⁻¹, treadmill speed was increased by 1 km.h⁻¹ every minute until exhaustion. During this test, ventilation and its components, as well as respiratory exchanges, were measured breath by breath (C.P.X. Medical Graphics) every minute by taking the mean of the last 20 s of each increment. Spirometric values presented no significant differences between groups. At rest, no significant difference was observed between the two groups for all cardiorespiratory and ventilatory values obtained during the treadmill test. At submaximal exercise, all variables increased with the augmentation in workload. With the exception of R, there were no significant differences in the classic cardiorespiratory parameters ($\dot{V}O_2$, $\dot{V}CO_2$, HR, $\dot{V}E$) between the two groups of paraplegics. For the ventilatory parameters, we observed significant differences between the two groups, with values of f and I_t/Trf significantly higher ($0.01 < P < 0.001$) and values of Trf and V_t significantly lower ($0.01 < P < 0.001$) for HPA *versus* LPA. We observed changes in breathing pattern, ie, in f , V_t , Trc and I_t/Trc , were significantly different between groups, with significantly higher values of f and I_t/Trc for HPA. We noted a ventilatory disturbance which was manifested by values of breathing frequency and tidal volume during exercise that were significantly different between groups. During maximal exercise, we observed no significant differences between the two groups concerning cardiorespiratory and ventilatory values. Despite the absence of significant differences, the more linear time course of the ensemble of HPA flows, the achievement of a greater number of work loads, and the higher maximal values indicate a better capacity for adaptation to exercise in the group of lower thoracic paraplegics. These results raise questions about the influence of neurological level and further research is needed to define with more precision the capacities of readaptation of the different cardiovascular and respiratory functions, as well as the training methods best adapted to the optimization of physical capacities.

Schmid (1998) physical performance and cardiovascular and metabolic adaptation of

elite female wheelchair basketball players in wheelchair ergometry and in competition Spinal cord injury leads to a pronounced reduction of cardiovascular, pulmonary, and metabolic ability. Physical activity, up to and including high-performance sports, has obtained importance in the course of rehabilitation and the post clinical phase. Thirteen elite female wheelchair basketball players from the German National Basketball Team and 10 female sedentary spinal cord-injured persons were examined in the study. Heart volume was measured by an echocardiography. All subjects underwent a graded exercise test on a wheelchair ergometer. Additionally, heart rate, lactate, and player points were measured during a competitive basketball game in wheelchair basketball players. Cardiac dimensions were larger for spinal cord-injured wheelchair basketball players (620.3 ml; 9.6 ml · kg⁻¹) in comparison with spinal cord-injured persons (477.4 ml; 8.2 ml · kg⁻¹) but did not exceed the heart volume of untrained nonhandicapped persons. In contrast, athletes with amputations or those having had poliomyelitis reached training-induced cardiac hypertrophy in relation to body mass (713.7 ml; 13.2 ml · kg⁻¹), as observed in nonhandicapped athletes. During graded wheelchair ergometry, wheelchair basketball players showed a higher maximal work rate (59.9 v 45.5 W), maximal oxygen consumption (33.7 v 18.3 ml · min⁻¹ · kg⁻¹), and maximal lactate (9.1 v 5.47 mmol · l⁻¹) without a difference in maximal heart rate and workload at AT₄ than did spinal cord-injured persons. The average heart rate during the wheelchair basketball game was 151 · min⁻¹, and the lactate concentration was 1.92 mmol · l⁻¹. Female athletes with a less severe handicap and higher maximal oxygen consumption during the graded exercise test reached a higher game level in the evaluation. During the competitive basketball game, high cardiovascular stress was observed, indicating a fast aerobic metabolism; the anaerobic lactic acid capacity played a subordinate role. Wheelchair basketball is an effective and suitable sport to enhance physical performance and to induce positive physiological adaptations.

Taylor, J., & Green, L. (2015) Psychological Adjustments in Spinal Cord Injury: Managing Anxiety in Paraplegics. Spinal cord injury (SCI) can lead to significant physical, emotional, and psychological changes in individuals, particularly for those with paraplegia. This study examines the psychological adjustments required for individuals with paraplegia, focusing on the management of anxiety, a common mental health issue within this population. A sample of 150 individuals with paraplegia resulting from traumatic and non-traumatic SCI participated in this research. The study employed a combination of clinical assessments, including anxiety scales (e.g., GAD-7), psychological interviews, and quality-of-life surveys, to evaluate the impact of anxiety and identify effective coping mechanisms. The results show

that anxiety is a prevalent issue among individuals with paraplegia, often triggered by concerns over physical limitations, social integration, and changes in identity. Participants also reported increased levels of stress related to healthcare access, rehabilitation, and the potential for further medical complications. The study identifies several key strategies for managing anxiety, including cognitive-behavioural therapy (CBT), mindfulness, peer support groups, and rehabilitation programs that focus on physical, psychological, and social rehabilitation. The findings suggest that effective management of anxiety in individuals with paraplegia requires a holistic approach that integrates physical rehabilitation with psychological support. Interventions such as CBT, social support, and adaptive techniques to manage daily challenges are vital in improving mental health and overall quality of life. The study highlights the importance of incorporating mental health care into rehabilitation programs to help individuals with SCI develop better coping strategies, reduce anxiety, and achieve a higher level of emotional and functional well-being. Future research should focus on long-term strategies and the impact of early psychological interventions on the mental health outcomes of paraplegics.

Andes Permadi (2024) The Relationship between Wrist Flexibility and Hand-Eye Coordination on Table Tennis Backhand Drive Shot Results in Disabled Table Tennis Athletes at NPC Club. This study aims to determine the relationship between wrist flexibility and hand-eye coordination on the results of backhand drive shots. This research includes quantitative research with a correlation approach. The population of this study was 20 table tennis athletes of the Lubuklinggau City NPC Club. To determine the sample, purposive sampling was used, namely active athletes as many as 16 athletes. The data analysis used is the correlation test. Based on the results of data analysis, wrist flexibility has a relationship to the results of backhand drive shots with a correlation value ($r = 0.661$), a significant relationship and a strong level of relationship. Hand-eye coordination is a relationship to the results of the backhand drive with a correlation value ($r = 0.591$), a significant relationship and a moderate level of relationship. The results of the multiple correlation test between wrist flexibility and hand-eye coordination, based on the results of the backhand drive correlation value ($r = 0.506$), show a significant relationship with a moderate level of relationship. There is a significant relationship between Wrist Flexibility and Hand-Eye Coordination in Table Tennis Backhand Drive Stroke Results.