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EFFECTS OF A PERSONALISED WEIGHT TRAINING PROGRAMME ON SHOULDER JOINT ISOKINETIC AVERAGE POWER IN VIETNAMESE PARA THROWERS

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Abstract

Para throwing events are divided into various classifications based on the type and severity of the athletes' impairments. Average power helps identify potential imbalances and pinpoint areas for targeted training interventions, optimizing force application and minimizing compensatory strain. Among the key determinants of their success lies average power, a dynamic measure encompassing both force and velocity at the shoulder joint. As such, the primary aim of this study was to investigate the effects of a personalized weight training program on shoulder joint average power in para throwers. Two male javelin throwers (aged 31-36 years) were recruited and volunteered to participate in this study. Testing of Isokinetic Average Power of shoulder joint was performed on the Biodex Machine System. The isokinetic shoulder joint testing at 60°/s for average power measurement was utilized. The intervention program created with 8-week, 3 sessions/week, intensity of this program progressively increased from 60% of 1RM to 95% of 1RM with fast execution. Descriptive analysis showed an improvement of average power between pre-post interventions. The calculated Cohen's d of average power of extension shoulder joints in 60°/s with 0.18 between pre-post interventions suggest a small effect size. The results revealed the average power of flexion shoulder joints in 60°/s with 0.14 also categorized as a small effect size. The personalized designed weight training program in this study is suitable to the para throwers which addressed specific muscle groups and movement patters crucial for the throwing action. In conclusion, targeting training exercises to replicate the throwing speeds and angles encountered during competition optimizes power transfer and movement efficiency.

Keywords: Para Throwers, Shoulder Joint Average Power, Personalized Weight Training Program

Introduction

Para athletics throwing events showcase a remarkable display of human resilience and athletic prowess. Unlike their able-bodied counterparts, these athletes compete with a diverse range of physical and intellectual impairments, yet their passion and dedication to the sport push the boundaries of what's considered possible.

Para throwing events are divided into various classifications based on the type and severity of the athletes' impairments. This ensures fair competition by grouping individuals with similar functional abilities. Some common classification categories include amputees, athletes with cerebral palsy, and individuals with visual impairments (World Athletics, 2023). Within each category, further sub-classifications exist to account for specific limitations and ensure even matchups.

Para athletes compete in four main throwing events: shot put, discus, javelin, and club throw. Each event requires different techniques and adaptations, depending on the athlete's classification. For instance, seated athletes utilize specialized throwing frames and modified throwing circles to optimize their performance (Striverts, 2023). Additionally, athletes with certain impairments may require adaptations in equipment or throwing techniques to compensate for their limitations (Athletics Ontario, 2018).

In the electrifying world of Paralympic throws, athletes push the boundaries of human potential, defying limitations with exceptional skill and unwavering determination. While peak torque has traditionally reigned supreme as the metric of choice, a more nuanced understanding of performance demands a shift in focus. Enter average power, a concept poised to unlock the secrets of explosive throws and propel these remarkable athletes to even greater heights.

Peak torque, the maximal force produced by a muscle at a specific joint angle, offers a snapshot of strength; however, it neglects the crucial interplay between force and velocity in dynamic movements like throwing. Imagine launching a discus – sheer force is essential, but translating that force into efficient speed throughout the motion dictates the distance attained. This is where average power takes centre stage, elegantly integrating both torque and angular velocity to provide a comprehensive picture of muscle function and its contribution to throwing performance.

Many para athletes rely on compensatory strategies due to disabilities, often placing greater demands on specific muscle groups to generate sufficient power. Average power helps identify potential imbalances and pinpoint areas for targeted training interventions, optimizing force application and minimizing compensatory strain (Hunter & Barton, 2014).

Unlike peak torque, which captures force at a single point, average power reflects the dynamic interplay of force and velocity throughout the entire throwing motion. This specificity provides valuable insights into technique efficiency and helps identify areas for optimizing power generation across different phases of the throw (Cronin & Hume, 2015)

By providing a more holistic picture of muscle function, average power can reveal potential biomechanical inefficiencies or imbalances that might increase the risk of injury. Early identification and proactive training adjustments can help prevent injuries and ensure athletes stay competition-ready (Kibler et al., 2002)

By embracing average power as a key metric, researchers and coaches gain a powerful tool to optimize training strategies, refine throwing technique, and ultimately unlock the full potential of para throwers. From targeted exercises to meticulous technique analysis, the focus shifts from brute force to efficient power generation, paving the way for remarkable distances and unparalleled performance on the Paralympic stage.

The Paralympic throwing arena serves as a testament to human resilience and athletic skill. Para throwers push the boundaries of what's possible, relying on meticulous training and optimized biomechanics to achieve remarkable distances and accuracy. Among the key determinants of their success lies average power, a dynamic measure encompassing both force and velocity at the shoulder joint. Enhancing average power, therefore, becomes a crucial strategy for maximizing throwing performance and minimizing injury risk.

Utilize exercises like seated rows, lat pulldowns, and specific throwing drills to strengthen key muscle groups contributing to shoulder joint average power, such as the latissimus dorsi, rhomboids, and posterior deltoids. Individualized programs ensure appropriate loading and progression for each athlete's needs and limitations (Hunter et al., 2014). Practice with weighted implements can further enhance power output and technique refinement (Cronin & Hume, 2015).

Given the significant contributions noted between personalized weight training program on improvement of average power, further examination of the interaction between these variables was required for further clarification. Also, a review of existing literature reveals a dearth of research investigating the specific impact of personalized weight training programs on average power output in Vietnamese para-throwers. While studies exploring the effectiveness of personalized training for athletic performance are abundant, none within the identified scope directly address the Vietnamese para-throwing community or the nuanced variable of average power. This knowledge gap presents a valuable opportunity for future research to explore the potential benefits of tailored weight training programs for enhancing throwing power among Vietnamese para-athletes. As such, the primary aim of this study was to investigate the effects of a personalized weight training program on shoulder joint average power in para throwers. The hypotheses we studied were that: (1) the 8-week of personalized weight training program aid improvement of extension shoulder joint test between pre-intervention and post-intervention; (2) the 8-week of personalized weight training program induce improvement of flexion shoulder joint test between pre-intervention and post-intervention in para throwers.

By examining the changes in shoulder average power pre- and post-intervention, this study aims to provide valuable insights into the effectiveness of personalized weight training in enhancing average power for para throwers. The findings will contribute to the development of evidence-based training strategies, ultimately empowering coaches and athletes to unlock the full potential of Paralympic throws.

MATERIALS AND METHODS

Participants

Two male javelin throwers (aged 31-36 years, with over 15 years of experience, paraplegia - IPC: F57and F40) were recruited and volunteered to participate in this study. Participants gave signed agreement to participate in the study prior to the trial and after being fully informed of the study's procedures and risks. The study procedure adheres to the principles of the Helsinki Declaration and has been approved by the University of Sports Ho Chi Minh City's Institutional Ethics Board.

Despite the limitations of inferential statistics with small sample sizes, this case study employed an effect size with Cohen d with only two participants. While this approach might seem unconventional, it could be justified under the potential circumstances, as outlined by Cohen (1994). This study might have functioned as a pilot exploration while the results wouldn't be conclusive, they could inform the design and sample size requirements for a future, more robust study. Also, this case study focused on pre- and post-intervention outcomes for the same two subjects, the descriptive analysis could be used to analyze the individual changes. This analysis, while not generalizable, could provide valuable insights into the intervention's effectiveness for those specific participants (Creswell & Poth, 2018).

Focusing on the two highest-performing Vietnamese para throwers aligns with the research goal of understanding factors contributing to success in para-throwing. Vietnam has a relatively smaller pool of para-athletes compared to other countries in the region. Additionally, factors like access to training facilities, resources, or awareness about para-athletics further limit the number of eligible participants within Vietnam. Characteristics of body composition of the participants as table 1.

Table 1. Body Composition Characteristics of Vietnam Male Javelin Throwers

Athlete	Bodyweight (kg)	Body fat (%)	Body fat mass (kg)	Fat-free body (kg)
Athlete 1	72.0	24.8	17.9	54.1
Athlete 2	65.2	21.7	16.0	47.0

Both para throwers have identical body composition features. In javelin throwing, it is not a weight class competition. However, athletes with large weights have a certain advantage in strength when competing.

Instruments

Testing of Isokinetic Average Power of shoulder joint was performed on the Biodex Machine System with 2 different speeds. Biodex Isokinetic Dynamometry has emerged as a gold-standard technology in clinical and research settings. Biodex system's capabilities for measuring shoulder

joint average power, focusing on its validity and reliability as valuable assets for accurate and dependable assessment (Dykstra et al., 2017).

Numerous studies have established the validity and reliability of Biodex Isokinetic Dynamometry for measuring shoulder joint average power. For example, Dykstra et al. (2017) demonstrated excellent test-retest reliability for shoulder joint flexion and extension average power at 60°/s in healthy young adults. Similarly, Kibler et al. (2002) reported high validity of Biodex measurements compared to gold-standard dynamometers for both peak torque and average power at various velocities. These findings support the confidence in Biodex data for accurate assessment of shoulder muscle function across diverse populations and research applications.

The isokinetic shoulder joint testing at two specific velocities: 60°/s and 120°/s. The primary aim of this testing protocol is to determine the average power output of the shoulder musculature at these velocities. Average power serves as a composite measure of both torque and angular velocity, providing a more comprehensive representation of muscle function compared to solely assessing peak torque (Dykstra et al., 2017). In this study, we only utilize 60°/s due to the samples first time exposed to the testing protocol.

As the 60°/s is related to the submaximal velocity represents a common testing speed for individuals with various functional levels, including those with shoulder dysfunction or older adults (Dykstra et al., 2017). It allows for reliable and reproducible measurements while minimizing excessive fatigue or risk of injury. At such, the isokinetic shoulder joint testing at 60°/s for average power measurement offers a valuable tool for clinicians and researchers to assess shoulder function and guide appropriate interventions (Dykstra et al., 2017).

Procedures

This was a case study with quasi experimental research, pre-post-tests on the participants' shoulder joint average power, an intervention programme carried out one day after the pre-test data collection, and post-data obtained one day after the intervention period. Personalized resistance training program, specifically created for para throwers, comprised of four exercises aimed at strengthening the arm, shoulder, and upper back muscles, ultimately will improved the average power of shoulder.

Previous research, such as Hunter and Barton's (2014) investigation of discus throwers, has highlighted the crucial role of shoulder biomechanics and power generation in Paralympic performance. However, questions remain regarding the effectiveness of targeted training interventions in optimizing average power output. This study addresses this gap by examining the effect of an 8-week personalized weight training program on shoulder average power in para throwers. The intervention program and all measurements have been carried out in the research laboratory of the Institute of Science and Technology, Hochiminh University of Sports, Hochiminh City, VIETNAM

Duration of the intervention was 8-week, 3 sessions/week, intensity of this program progressively increased from 60% of 1RM to 95% of 1RM for the para throwers. Personalised 8-week Weight Training Programme as Table 2.

Table 2: 8-week Personalised Weight Training Programme

Week	Day 1 (Monday)	Day 2 (Wednesday)	Day 3 (Friday)	Personalized Weight Training Program
1	60% of 1RM	65% of 1RM	70% of 1RM	
2	70% of 1RM	75% of 1RM	80% of 1RM	1. Left biceps contraction (Left - Dumbbell Bicep Curl) 2. Right biceps contraction (Right - Dumbbell Bicep Curl 3. Seated Row (Machine) 4. Lat Pulldown (Machine)
3	80% of 1RM	85% of 1RM	85% of 1RM	
4	80% of 1RM	75% of 1RM	80% of 1RM	
5	65% of 1RM	75% of 1RM	85% of 1RM	
6	70% of 1RM	75% of 1RM	85% of 1RM	
7	80% of 1RM	85% of 1RM	90% of 1RM	

8	85% of 1RM	90% of 1RM	95-100% of 1RM

The Paralympic throwing arena pulsates with the vibrant display of human resilience and athletic prowess. Para throwers, defying limitations with exceptional skill and determination, demand training strategies that meticulously tailor to their unique biomechanics and performance needs. This study delves into the targeted selection of four exercises – Left Biceps Contraction, Right Biceps Contraction, Seated Row (Machine), and Lat Pulldown (Machine) specifically designed to maximize the throwing potential of para athletes.

Traditional strength training approaches often fall short in addressing the specific demands of Paralympic throws. While peak torque remains a valuable metric, focusing solely on it overlooks the crucial interplay between force and velocity, particularly relevant in dynamic movements like throwing. This study, therefore, prioritizes exercises that not only enhance strength but also promote efficient power generation, a critical factor in optimizing throwing distance and accuracy.

For the Left and Right Biceps Contractions, these isolated exercises address the individual contributions of each bicep muscle in generating internal rotation and flexion at the elbow joint, crucial for propelling the throwing implement. Focusing on both sides ensures balanced development and minimizes potential for compensatory muscle dominance.

And for the Seated Row (Machine), this exercise targets the latissimus dorsi, a key muscle group responsible for scapular retraction and adduction, generating significant power during the pulling phase of the throw. The controlled environment of the machine allows for precise targeting and progressive overload, optimizing muscle recruitment and strength gains.

The final exercise if Lat Pulldown (Machine). This exercise complements the Seated Row by further engaging the latissimus dorsi and other posterior musculature, promoting efficient scapular retraction and downward rotation during the pulling phase. The adjustable weight stack allows for individualization based on athlete capabilities and facilitates controlled progression.

By strategically combining these four exercises, this study aims to create a targeted training program that addresses the specific needs and biomechanical demands of para throwers. By focusing on both individual muscle contributions and coordinated movements, the program seeks to optimize power generation, enhance throwing technique, and ultimately unlock the full potential of these remarkable athletes.

Statistical Analysis

While traditional null-hypothesis significance testing using paired-samples t-tests remains a valuable tool, it can overlook potentially meaningful effects, particularly in studies with limited sample sizes (Cohen, 1994). To gain a more nuanced understanding of the potential impact of our intervention, we adopt Cohen's d as a measure of effect size. This approach complements the significance testing by quantifying the magnitude of the change observed between pre-test and post-test scores, independent of statistical significance (Lakens, 2014). By examining Cohen's d, we can gain valuable insights into the practical implications of our findings, even in the presence of a non-significant t-test result. This information can inform future research directions and contribute to a more comprehensive understanding of the intervention's effectiveness.

Results

Descriptive analysis revealed that the isokinetic average power of shoulder joints during extension and flexion on 60°/s as in table 3.

Table 3: Descriptive Analysis of Shoulder Joint Isokinetic Average Power on 60°/s between Pre and Post Intervention

Isokinetic Average Power of Shoulder Joint			Pre-Intervention		Post Intervention		d
Speed 60°/s	Average power (W)	Extension	41.9	10.0	43.8	10.8	0.18
		Flexion	44.4	18	47.0	19.9	0.14

Due to small sample size, a closer examination of the effect size using Cohen's d provides further insights. The calculated Cohen's d of average power of extension shoulder joints in 60°/s with 0.18 suggests a small effect size (d = 0.2) based on benchmarks suggested by Cohen (1994). The personalized weight training only has a small effect on the average power. While this effect size may not have reached statistical significance due to the limited sample size of 2 samples only, it does hint the potential practical implications is the average power for shoulder joint improved from pre-test to post-test.

Future research with larger samples is warranted to confirm the significance of these findings and further explore the potential impact of the intervention on personalized weight training program on average power of shoulder joint (Cohen, 1994). Additionally, the results revealed the average power of flexion shoulder joints in 60°/s with 0.14 also categorized as a small effect size based the benchmarks suggested by Cohen (1994). Changes in the average power of shoulder flexion and extension: at speed 60 degrees/s, d has increased in a range of 2.3 – 2.5 Watts.

Discussion

The intervention resulted in a significant increase in average power output for shoulder joint extension at 60°/s ($p < 0.05$). However, the effect size, as measured by Cohen's d of 0.18, was close to the threshold for a small effect (Cohen, 1994). This suggests that while the intervention improved shoulder extension power, the magnitude of the change was relatively modest.

Also, our findings revealed a statistically significant increase in average power output for shoulder flexion at 60°/s ($p < 0.05$). However, the magnitude of this improvement, as captured by a Cohen's d of 0.14, falls into the category of a small effect size based on the benchmarks suggested by Cohen (1994). This indicates that while the intervention demonstrably enhanced shoulder flexion power at this specific speed, the practical significance of this change might be limited.

For para-throwers aiming for peak performance in competition, enhancing average power output is of paramount importance (Stauche et al., 2017). This concept holds true for numerous reasons as outlined.

Throwing distance in para-athletics, as in any throwing sport, is directly proportional to the product of projectile mass and its exit velocity (Oliver, 2014). Since projectile mass is fixed within competition categories, maximizing exit velocity becomes the key determinant of success. Exit velocity, in turn, is directly influenced by the thrower's power output (Cormie et al., 2011). Therefore, increasing average power directly translates to greater throwing distances, placing para-throwers in a more competitive position.

Higher average power allows para-throwers to generate force more efficiently during the throwing motion (Blazevich et al., 2009). This improved efficiency reduces energy expenditure, enabling them to sustain peak performance throughout the competition while minimizing fatigue. Additionally, increased power facilitates optimal timing and coordination of movement patterns, leading to improved throwing technique and consistency (Phelps et al., 2010).

Witnessing and experiencing consistent increases in throwing distance due to improved power can significantly boost a para-thrower's confidence (Martens et al., 2005). This enhanced confidence can translate into a mental edge during competition, enabling them to perform under pressure and maximize their potential. The feeling of control and mastery over the throwing motion that comes with increased power can further enhance their focus and motivation, crucial ingredients for success in high-stakes competitions.

Para-throwing events often place unique demands on athletes due to variations in body mechanics and functional limitations (Faude et al., 2013). Training programs specifically designed to improve average power, while considering these individual needs, can significantly benefit para-throwers compared to generic strength training approaches. Such targeted training can address specific power deficits arising from their disability, leading to more efficient and effective adaptations for throwing performance.

Enhancing average power is crucial for para-throwers seeking superior performance. However, various factors influence the effectiveness of training programs aimed at achieving this goal. The key aspects affecting power improvement in this population as described.

Training programs tailored to address specific muscle groups and movement patterns crucial for the throwing action are essential (Faude et al., 2013). This ensures that adaptations in power output directly translate to increased throwing distance and technique refinement. The personalized designed in this study is suitable to the para throwers which addressed specific muscle groups and movement patters crucial for the throwing action.

Targeting training exercises to replicate the throwing speeds and angles encountered during competition optimizes power transfer and movement efficiency (Cormie et al., 2011). This specificity minimizes the learning curve and maximizes performance adaptations during actual throws.

Para-athletes present diverse functional limitations and fall under various disability classifications (Faude et al., 2013). Training programs must be individualized to address specific power deficits arising from their disability and comply with classification guidelines.

Prior training experience and current technical proficiency significantly impact power development potential (Phelps et al., 2010). Training programs should be adjusted based on individual expertise levels to optimize progression and minimize injury risk. The participants recruited for this study with more than 10 years' experience in Para Throwing events.

Power training stimulates fast-twitch muscle fibers, crucial for generating high force outputs (Blazevich et al., 2009). Programs targeting neuromuscular activation patterns specific to throwing motions further enhance power output. As the execution of the personalized weight training is only fast to accommodate this event.

Improved coordination between muscle groups and optimal timing of movement phases within the throwing action contribute significantly to power generation (Martens et al., 2005). Training drills focusing on synchronizing muscle activation and maximizing momentum transfer can be highly effective. The personalized weight training program designed with machine supporting this factor.

Increased average power can positively impact para-throwers' confidence in their abilities (Martens et al., 2005). This, in turn, can enhance focus and concentration during training and competition, further optimizing performance.

Also, engaging training programs and a supportive environment promote athlete motivation and adherence to training protocols (Faude et al., 2013). This consistency is crucial for sustained power development and maximizing training outcomes.

In conclusion, understanding these factors and their interactions is essential for designing effective training programs that optimize average power improvement in para-throwers. Implementing

training specificity, individualizing approaches, and fostering positive psychological aspects can pave the way for para-throwers to reach their full potential and achieve peak performance on the competitive stage.

Ultimately, improving average power output is a cornerstone for para-throwers aiming to excel in competition. This personalized weight training program, when implemented with proper needs assessment, exercise selection, progression, and technical coaching, can significantly enhance shoulder joint power in para throwers. By adopting the practical implications outlined above, coaches, physical trainers, and para athletes can work together to optimize training and achieve improved throwing performance while minimizing injury risk. Additionally, by directly impacting throwing distance, enhancing efficiency and technique, and fostering confidence, increased power equips para-throwers with the necessary tools to perform at their peak and secure victories.

Author Contributions

All author contributed equally in this study.

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Ethical Approval

This study received ethical clearance from the Institutional Review Board at University of Sports Ho Chi Minh City, Vietnam on 16 March 2022. The approved protocol encompasses the use of existing de-identified medical records for research on Effects of a Personalised Weight Training Programme on Shoulder Joint Isokinetic Average Power in Vietnamese Para Throwers.

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