

Student Name: Mark Thomas

Student Number: 2219345

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Lecturer: Alison Connaughton

Internal Verifier: Dylan Blain

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THE EFFECTS OF POST ACTIVATION POTENTIATION ON LOWER LIMB STRENGTH AND POWER IN WELL-TRAINED INDIVIDUALS

INTRODUCTION

In many of today's sporting participants, athletes of all levels strive to achieve optimum performance levels both in a short-term manner and a longer term. One of the techniques used to achieve this is Post Activation Potentiation (PAP). PAP is also a technique now widely used by Strength and Conditioning coaches (Prieske *et al* 2020). PAP is a well-established technique that boosts muscle force production, the effect is attributed to an increased myosin light chain phosphorylation in type II muscle fibers and measured by assessing muscle twitch force following a period of muscular activity Blazevich, A.J. and Babault, N., (2019). Additionally, myosin light chain kinase facilitates the availability of additional ATP at the actin-myosin complex, which subsequently speeds up the formation of actin-myosin cross-bridges and improves the performance of explosive movements (Xenofondos *et al* 2010). Furthermore, there may be neural adaptations responsible for performance improvement during PAP (Wallace *et al* 2019).

To perform PAP, brief, high-intensity strength, or power exercises are completed a few minutes before the primary activity to boost performance (Borba *et al* 2017). Added to the short-term benefits of PAP, there may be an additional long-term benefit to performing this technique, so PAP could be applied during resistance training to enhance total work output, potentially leading to greater long-term gains (Alves *et al* 2021). This in turn can influence and improve lower limb strength and power for athletes, which is important in sports such as football (Altieri *et al* 2021), rugby (Stone *et al* 2024), track and field (Ngo and Kazmi 2024), basketball (Cao *et al* 2024), swimming (Morouco 2012), cycling (Herrero-Molleda 2024), ice hockey (Chiarlitti 2021) and volleyball (Keoliya 2024). Many of the participants of these sports will utilize PAP as a part of their pre-competition or warm up for training routines (Liu, L., Niu, X. and Zhou, Z., 2024). Studies often utilize a range of methodologies, including resistance exercises (like barbell squats, barbell hip thrusts, and barbell hang cleans), plyometric exercises (such as depth jumps, hurdle hops, and ankle jumps), and hybrid approaches that combine resistance exercises with either plyometric or sprint exercises (Krzysztofik *et al* 2021). One study observed a marked improvement in subsequent countermovement jump (CMJ) performance among rugby players after completing a plyometric exercise routine (Tobin and Delahunt 2014), while it has been found that pre-competition plyometric exercises can enhance subsequent sprint performance in athletes from both track and field, as well as hockey (Sener, T., Sozbir, K. and Karli, U., 2021). However, much of the literature contradicts this research, as Lim *et al* (2013) discovered that three different squat exercise variations did not result in significant improvements in the 30-meter sprint performance of elite athletes. This was supported by Iacono *et al* (2016) who found no significant improvement in jumping ability in young team sport athletes after performing plyometric exercises. One factor that influences the effectiveness of PAP is fatigue, therefore an adequate rest period before executing a subsequent explosive movement may be required (Rassier, D.E. and Macintosh, B.R., 2000). Training age, experience and status are additional factors that may influence the training response of PAP (Kilduff *et al* 2007), as it was noted in the same study that recreationally trained individuals with less experience demonstrated a 1–4% decrease in performance following the conditioning activity. In conclusion, much of the research suggests that the effects of PAP are mainly positive, this study will explore these in an acute adaptation and over a four-week period.

AIMS OF THE STUDY

The aim of the research to be conducted is to explore the effects of PAP after an acute dose, while over a four-week intervention, also examine the longer-term effects. More specifically, it will evaluate what effects a vertical jump (VJ) has on the performance of a heavy resistance movement such as a Leg Press, and 6 second peak power test on a Wattbike. The study will additionally investigate the influence of fatigue by collecting data from the first and third sets of the session, while excluding the second set from analysis. The rationale behind these aims is based on the literature that PAP can enhance muscle contractility and neural activation, particularly in explosive movements. The study's main hypothesis is that PAP-inducing activities such as a VJ will result in improvements in lower limb strength and power output compared to baseline performance levels. This study will contribute to the knowledge by clarifying if PAP is beneficial, and how athletes, coaches, and rehabilitators can implement PAP in training and competition settings to maximize performance improvements in the lower limbs.

METHODS

16 participants have been selected, all of which have at least two years' training experience in resistance training. The age range of the subjects is 31.9 ± 9.2 , with a height of $182.8 \pm 6.3\text{cm}$ and $85.2 \pm 8.2\text{kg}$. The participants will be selected from sporting backgrounds such as semiprofessional rugby players, endurance runners, and triathletes, 8 of which will be part of the control group. Requirements for participation are regular strength training (minimum of twice per week), experience in resistance training of at least 2 years, a minimum age of 22 and a maximum age of 41. Also, participants must have no history of orthopedic or neuromuscular injuries in the lower extremities or cardiovascular conditions or metabolic disorders. All participants will be required to sign a Pre-Activity Readiness Questionnaire. Before participating in the study, all participants will be informed about the potential risks and consequences involved and the voluntary nature of their involvement. Before the familiarization process, all participants will obtain written informed consent and privacy agreements. A familiarization session will be arranged, where the subject's 85% 1RM will be obtained, as well as their baseline 6 second peak power test output, and a discussion of the protocols and procedures will then follow. Consent will be sought to eliminate participants with injuries or concerns about the study. They will then be asked to refrain from intense activity for at least 24 hours prior to data collection and any lower limb activity for 48 hours. Participants will also be asked to consume a complex carbohydrate meal of approximately 60g of carbohydrates at least two hours before the sessions and be adequately hydrated. During the sessions,

participants will perform a low intensity warm up on the Wattbike for a duration of ten minutes, followed by a structured dynamic stretching routine. They will then perform PAP by doing 10 repetitions of VJ, 30 seconds before performing a set at 50% 1RM on the leg press to failure. The second set of 75% 1RM will not be preceded by PAP, however the final set of 85% 1RM will be preceded by PAP. Rest periods will be timed at 3 minutes. The number of repetitions will then be recorded. On the following day, the same warm up protocol will be performed before the intervention of PAP prior to a 6 second peak power test on the Wattbike. Data collection will be conducted at the same time, on the same day of the week, and within the same facility to ensure the process's reliability and consistency.

DATA ANALYSIS

The following data analysis will be used for this study: Descriptive Statistics will be collected to understand the characteristics of all participants. Age, height, weight, training age, baseline strength and power values will be collected and may be influential on the data collected. Parametric testing will be used to assess the final data, by using ANOVA (Analysis of Variation) tests will be used to evaluate the results in SPSS, following the initial collection on Excel. The key assumption here is that the data will be normally distributed. The justification for this testing is that repeated measures ANOVA is a suitable test where multiple trials are conducted, it can account for individual variability and increases statistical reliability. ANOVA can also be used to assess if performance decreases between sets due to fatigue, and how this affects the overall PAP response.

RESEARCH TIMETABLE

October: Complete Ethics Form and Proposal Document.

November/December: Initial consultation and baseline figure collection, followed by actual collection of data over a four-week period.

December/January: Write up Introduction and Aims sections of dissertation.

February: Write up Methods and Results of the study.

March/April: Write up Discussion and Conclusion.