Contribution ID: **169** Type: **Oral**

PUSH-PULL-LEG (PPL) RESISTANCE TRAINING PROGRAM ON STRENGTH, POWER, AND AGILITY AMONG VOLLEYBALL ATHLETES

Friday, October 3, 2025 11:00 AM (15 minutes)

Abstract
This experimental study examined the impact of a six-week Push-Pull-Leg (PPL) resistance training program on the strength, power, and agility of male volleyball athletes at the University of Antique. Thirty male athletes were purposively assigned to either an experimental group (n=15), which participated in PPL training three times weekly for two hours per session, and a control group (n=15) that continued their regular volleyball training regimen. Pre- and post- intervention assessments included the 1-Repetition Maximum (1- RM) Bench Press to measure upper body strength, the Vertical Jump Test for explosive lower body power, and the Southeast Missouri (SEMO) Agility Test for overall agility. Nonparametric statistical analyses revealed that the experimental (PPL) group achieved significant gains in both explosive power and agility compared to the control group, which exhibited only marginal improvements. However, maximal strength enhancements were modest and did not differ significantly between groups. These findings suggest that integrating a short-term PPL resistance training protocol with routine practice can effectively improve key volleyball-specific physical attributes, particularly explosiveness and agility, in collegiate athletes. To induce greater strength adaptations, future protocols may require a longer duration and increased progressive overload. Overall, the PPL approach demonstrates promise as a supplementary training tool for volleyball players, principally for boosting power and agility.

Keywords: Resistance Training, Push-Pull-Leg, Strength, Power, Agility, Volleyball, Athletes

1.Introduction

Elite volleyball performance depends on the integration of skill, power, agility, and strength. While skill-based and aerobic training forms the bedrock of most volleyball programs, a growing body of research highlights the necessity of structured resistance training to maximize athletic outcomes3-4. The Push-Pull-Leg (PPL) split is a resistance training model that divides training sessions into days focused on pushing, pulling, and leg exercises. This approach, popular among fitness enthusiasts, is designed to ensure comprehensive muscle development and adequate recovery. Despite its appeal, limited empirical evidence exists on its efficacy for competitive athletes, especially in volleyball where explosive vertical movements and rapid direction changes are central to success. At the University of Antique, coaching analysis revealed gaps in explosive vertical power and on-court agility areas not adequately addressed by traditional routines. Guided by the theoretical frameworks of Connectionism and Periodization theories, which stress the value of readiness, systematic progression, and repeated practice, this research aimed to determine whether a structured PPL program would improve strength, power, and agility among university-level volleyball players. The central hypothesis posited greater enhancement in all three metrics for athletes completing the PPL regimen compared to standard training.

2.Methods

2.1Research Design

This study employed a quasi-experimental design with a before and after intervention approach to determine the effects of the Push-Pull-Leg (PPL) Resistance Training Programs on purposively selected thirty male volleyball athletes from the University of Antique, actively
participating during the 2024–2025 academic year.

2.2 Participants

The participants of the study were the purposively selected thirty male Volleyball Athletes from University of Antique and were randomly divided into an experimental group (n=15) and a control group (n=15). The experimental group engaged in a PPL resistance training program spanning six weeks, with three sessions per week, each lasting two hours. Training included multi-joint compound exercises designed to target push (bench press, shoulder press), pull (barbell row, pull-ups), and leg (squats, lunges) movements, and followed a progression of load and complexity while standard volleyball training continued. The control group maintained their typical volleyball training, without added resistance sessions.

2.3 Instruments and Materials used

A Push-Pull-Leg Resistance Training Program was designed and implemented as the functional training intervention. Pre- and post-intervention assessments evaluated upper body strength using the 1-RM Bench Press (Wood, 2008), explosive power with the Vertical Jump Test (Sargent, 1921), and agility using the Southeast Missouri (SEMO) Agility Test, adapted from Kirby (1971). This structured training approach allows for balanced muscle group targeting, promoting optimal recovery and strength gains, as supported by research on split training protocols

2.4. Data Analysis

All tests were administered under standard protocols and results were categorized based on normative scales. Descriptive statistics (mean, standard deviation, mean gain) were computed, and inferential analysis used the Wilcoxon Signed Rank Test for within-group changes and the Mann-Whitney U Test for between-group comparisons, with a significance level of 0.05.

2.5 Ethical Considerations

Ethical protocols were strictly observed. An informed consent was obtained from all participating athletes, along with the consent of their coach. Approval to conduct the study and use university facilities was granted by the University President and Sports Director. Participation was voluntary, with the right to withdraw at any time. Data confidentiality was maintained, and all training sessions were safely supervised with appropriate warm-up and cool- down routines.

3.Results & Discussion

Analysis revealed clear differences between the experimental (PPL) and control groups across all measured variables. Assessment of upper body strength via the 1-RM Bench Press revealed slight, comparable improvements in both groups. The experimental group's mean increased from 0.63 (SD = 0.09) to 0.77 (SD = 0.11), while the control group improved from 0.70 (SD = 0.12) to 0.76 (SD = 0.13). Despite these gains, both means remained classified as "poor."The mean difference in improvement between the groups (0.14 vs. 0.06) was not statistically significant (p = .905), indicating that short-term PPL training did not confer a clear advantage in maximal strength development over standard volleyball training.

Lower-body explosive power, measured by the Vertical Jump Test, demonstrated substantial improvement in the experimental group. Their mean performance rose from from "above average" (M = 60.20, SD = 6.69) to "excellent" (M = 72.20, SD = 6.61), with a mean gain of 12.00. In contrast, the control group improved from 60.04 (SD = 7.90) to M= 66.93 (SD = 6.54),), a mean increase of 6.89 cm, which did not reach the "excellent" threshold. The between-group difference in power gains was statistically significant (t(28)= 2.193, p = .037), supporting the effectiveness of the PPL intervention in enhancing vertical explosive power among volleyball athletes.

Agility, assessed using the SEMO Agility Test, improved substantially in the PPL group, with mean times decreasing from 12.35 seconds (SD = 0.58) to 10.91 seconds (SD = 0.39) a shift from "average"to "good."The control group's mean improved from 12.51 seconds (SD = 0.60) to 11.30 seconds (SD = 0.52), also reflecting improvement, though to a lesser extent. The PPL group's mean gain in agility (-1.44 seconds) exceeded that of the control group (-1.21 seconds Although the experimental group showed a greater reduction in agility test times, the between-group difference was not statistically significant (p =.320). Performance on the SEMO Agility Test showed pronounced gains in the PPL group, where mean times decreased from 12.35 seconds (SD = 0.58, "average") to 10.91 seconds (SD = 0.39, "good"), resulting in an average gain of -1.44 seconds. The control group also improved, from 12.51 seconds (SD = 0.60) to 11.30 seconds (SD = 0.52), a mean gain of - 1.21 seconds. Although the experimental group showed a greater reduction in agility test times, the difference between-group was not statistically significant (p = .320). Baseline comparisons confirmed no significant differences between groups in strength, power, or agility (all p > .05), validating the comparability of groups at the outset. This strengthens confidence that the observed improvements in power and agility can be attributed to the PPL training intervention.

Indico rendering error

```
Could not include image: Cannot read image data. Maybe not an image file?
```

4.Conclusion

This study demonstrates that a structured six-week Push-Pull-Leg (PPL) resistance training program, combined with regular volleyball practice, significantly improves lower-body power and agility in male collegiate volleyball players. Gains in vertical jump and agility are attributed to the PPL's multi-joint, high-velocity exercises that enhance neuromuscular adaptation. However, no significant maximal strength improvements were observed, likely due to the program's short duration, as longer, progressively overloaded training is generally needed for strength gains in trained athletes.
Importantly, these results show that effective performance improvements can be achieved in university settings with limited equipment, highlighting the value of well-designed resistance programs. The findings support incorporating periodized PPL training into collegiate volleyball conditioning to boost explosive power and agility, while suggesting longer interventions are necessary for strength development. Future research should explore extended training durations, varying intensities, and their impact on performance, skill acquisition, and injury prevention.

Given the shared demands for explosive power and agility, this PPL approach may also benefit athletes in sports like basketball, dragon boat racing, and lawn tennis, which require rapid, multidirectional lower-body movement.

Acknowledgement

The researchers would like to thank the student athletes, panelists, validators, and all participants who generously shared their time and insights. Their support and contributions were invaluable to the success of this study.

References

Arjuna, F., Pamungkas, G., Primasoni, N., & Rahayu, T. W. (2024). The effects of 8-week strength training toward the specific preparation phase on male volleyball athletes'performance. Physical Education Theory and Methodology, 24(1), 7–15. https:// doi.org/ 10.17 309/tmfv.2024. 1.01

Doma, K., Sato, K., Wilson, J., & Scott, C. (2020). Resistance training acutely impairs agility and spike-specific performance. International Journal of Environmental Research and Public Health, 17(18), 6448. https: //doi.org/10.3390/ijerph17186448

Keoliya, A. A., Ramteke, S. U., Boob, M. A., & Somaiya, K. J. (2024). Enhancing volleyball athlete performance: A comprehensive review of training interventions and their impact on agility, explosive power, and strength. Cureus, 16(1), e53273. https: //doi.org/10.7759/cureus.53273

Lleshi, E. (2021). Performance of female volleyball players in VO2max. European Journal of Social Science Education and Research, 8(3).
Stricker, P., McCambridge, T., & Faigenbaum, A. (2020). Resistance training for children and adolescents. Pediatrics, 145(6), e20201011. https: //doi.org/10.1542/peds.2020-10

Author: Mr MONTAÑO, Gred Conrad (University of Antique)

Co-author: DEGUMA, JON KRISTOFFER (WEST VISAYAS STATE UNIVERSITY)

Presenter: Mr MONTAÑO, Gred Conrad (University of Antique)

Session Classification: Sports Science and Performance and Enhancement

Track Classification: Sports Science and Performance Enhancement