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Review Article

The Impact of Aquatic Based Plyometric Training on Jump Performance: A Critical Review

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ABSTRACT

International Journal of Exercise Science 14(6): 815-828, 2021. There is evidence to suggest that aquatic plyometric training (APT) may be an effective and safer alternative to traditional land-based plyometric training (LPT) when training to increase jump performance. The aim of this review was to critically examine the current literature regarding the effects of APT vs. LPT on jump performance in athletic populations. Key terms were employed in five separate databases to complete the current review. Available articles were screened for inclusion and exclusion criteria to determine which studies were deemed eligible for review. Outcome measure in these studies included those assessing lower extremity power and jump performance (i.e., drop jumps, broad jumps, sergeant jumps, repeated countermovement jumps, and vertical jumps). All but one of the studies included in this critical review showed significant improvements in jump performance after LPT and APT interventions. Both LPT and APT groups experienced similar increases in jump performance and lower-body power, pre- to post-test, in the majority of the studies examined in this review. LPT and APT have the ability to improve lower extremity explosive strength and jump performance within athletic populations. Improvements in lower body power may improve overall athletic performance. Observations from this review may be used by sport coaches, strength coaches, and athletes alike to weigh the pros and cons of both forms of plyometric training. Observations from this review may also be used to weigh the pros and cons of APT over LPT in terms of reducing risk of injury.

KEY WORDS: Vertical jump, power, broad jump, athletic performance, conditioning, cross-training, injury prevention

INTRODUCTION

Lower-body plyometric training involves performing a variety of hopping, jumping and bounding drills to develop leg power (18). This type of training is frequently recommended to improve a variety of sport-related skills, such as jumping ability, speed, reactive strength, and power (3, 8, 15, 21, 22, 23). For instance, Ahmed et al. (2) reported that an eight-week plyometric training program significantly increased lower-body flexibility, lower-body muscular power and strength, linear sprint speed, agility, and cardiorespiratory fitness, in a group of 18 high-school aged basketball players. Further support of lower-body plyometric training has been reported by Datta et al. (7). In their study, the researchers suggested that a twelve-week plyometric training program significantly improved linear sprint speed, lower-body explosive power, and agility in a group of 45 intercollegiate male handball players. Although plyometric training has shown to be an effective method of improving lower-body power, it is not without risk. Performing these drills may present an increased risk of injury to the muscles and joints of the lower-body and back (2), especially during the ground contact landing phase (18).

Aquatic plyometric training (APT) is a lower impact alternative to traditional plyometric drills (9, 19, 23). The buoyant properties of water reduce the impact forces on the musculoskeletal system during the landing phase, which may serve to reduce potential injury (19). While both land-based plyometric training (LPT) and APT have been shown to increase jump performance (4, 16, 23), few studies have compared improvements between these methods. One such study conducted by Datta et al. (7) reported significantly improved linear sprint speeds and lower-body explosive power for the APT group when comparing APT to LPT after a twelve-week plyometric training program. However, a study conducted by Elbattaway et al. (10) reported no significant differences between the improvements observed in the APT and LPT group's average power, linear sprint speed, lower-body strength, and cardiorespiratory fitness after an eight-week plyometric training program. Although, when their pre- to post-assessment data was analyzed, it was reported that both groups improved their linear sprint speed, lower-body power, and lower-body strength. Understanding the differences and similarities in LPT and APT, and their impact on jumping ability may be useful when prescribing plyometric training drills in certain populations for improving performance while mitigating injury potential.

While LPT has been shown to improve jump performance it may increase risk of injury for certain athletes. Thus, the purpose of this review was to critically examine the literature regarding the effect of LPT vs. APT on jump performance among athletic populations. A three-stage search strategy was adopted and was used to examine this question. The main objective of this review was to critically appraise the methodological quality of studies examining the effects of APT in comparison to LPT on athletes' jump performance. Four key areas discussed include: (1) the effect of APT on athletes' jump performance, (2) the effect of LPT on athletes' jump performance, (3) implications of the findings attributed to athletic populations based on the level of evidence found in the eight included studies, and (4) limitations to these findings.

METHODS

Protocol

The current review adopted a similar search strategy to that reported by Joseph et al. (14), which utilized a three-stage approach to identify and obtain studies that could potentially be used in a critical review. To help formulate the search strategy, a rapid literature review was conducted on 25 March 2020. When developing key search terms, known research was examined and commonly used terms were identified and extracted to determine the final search terms for this work. The second stage consisted of entering the aforementioned search terms into the following databases: PUBMED, SPORTDiscus, Google Scholar, EMBASE, and MEDLINE. To meet the individual search strategies within each database, key search terms were modified as required (Table 1). To rule out studies that did not include humans, the 'human-only' filter was applied when available and was manually applied when the filter option was not available. This manuscript adheres to the ethical policies set by the editorial board of this journal (20).

Table 1. Databases and search terms.

Database	Search Terms
PUBMED SPORTDiscus Google Scholar EMBASE MEDLINE	("Aquatic Plyometric") OR ("Water Plyometric") OR ("Aquatic Jump Training") AND ("Vertical Jump" OR "Squat Jump" OR "Countermovement Jump") AND ("Jump Performance" OR "Jump Height" OR "Flight Time" OR "Power" OR "Velocity")

After articles were obtained using key search terms in the listed databases, duplicates were removed, and each article was screened based on the inclusion and exclusion criteria. This was initially done by screening the title and abstract of each article and determining its acceptability for potential review. Criteria for inclusion were as follows: (a) Study available in English, (b) study available in full text, (c) study was limited to human participants, (d) study involved at least two groups of participants (e.g., those performing plyometric training in water and those performing plyometric training on land), and (e) study used at least one measure of jump performance. After the title and abstract of each article was screened for this inclusion criteria, the remaining articles were screened using the criteria set for exclusion (Table 2).

Table 2. Exclusion criteria and examples of excluded studies.

Exclusion Criteria	Example
Study was not a new investigation.	Study was a critical or systematic review.
Study examined injuries of participants.	Study predicted injury rate of participants by performing vertical jumps on a jump mat.
Participants are not high school, collegiate, or professional athletes.	Study included participants who were recreationally active college students.
Participants were not performing plyometric training in an aquatic environment	Study examined the effect of LPT on jump performance.
Study did not measure at least one jump performance-based outcome measure.	Study examined the effect of APT on speed and agility.
APT group wasn't compared to a land-based training group.	Study examined the effects of traditional PT on vertical jump performance.

The critical review process in the PRISMA flow chart (Figure 1) illustrates how research articles were selected based on the inclusion criteria set forth for this critical review. In all, 202 studies were identified across five databases. Studies from the five databases were gathered and duplicates (18) were removed, resulting in a total of 184 articles eligible to be screened for inclusion criteria. After screening for inclusion criteria, 129 articles were removed, leaving 55 full-text articles to be assessed based on the exclusion criteria. Articles were excluded if an APT intervention was not implemented in the study, jump performance was not an outcome measure, participants were not high school, collegiate, or professional athletes, and if an APT group wasn't compared to a LPT group. After being assessed for exclusion criteria, 47 of the 55 studies eligible were removed, leaving eight studies for evaluation in the final critical review.

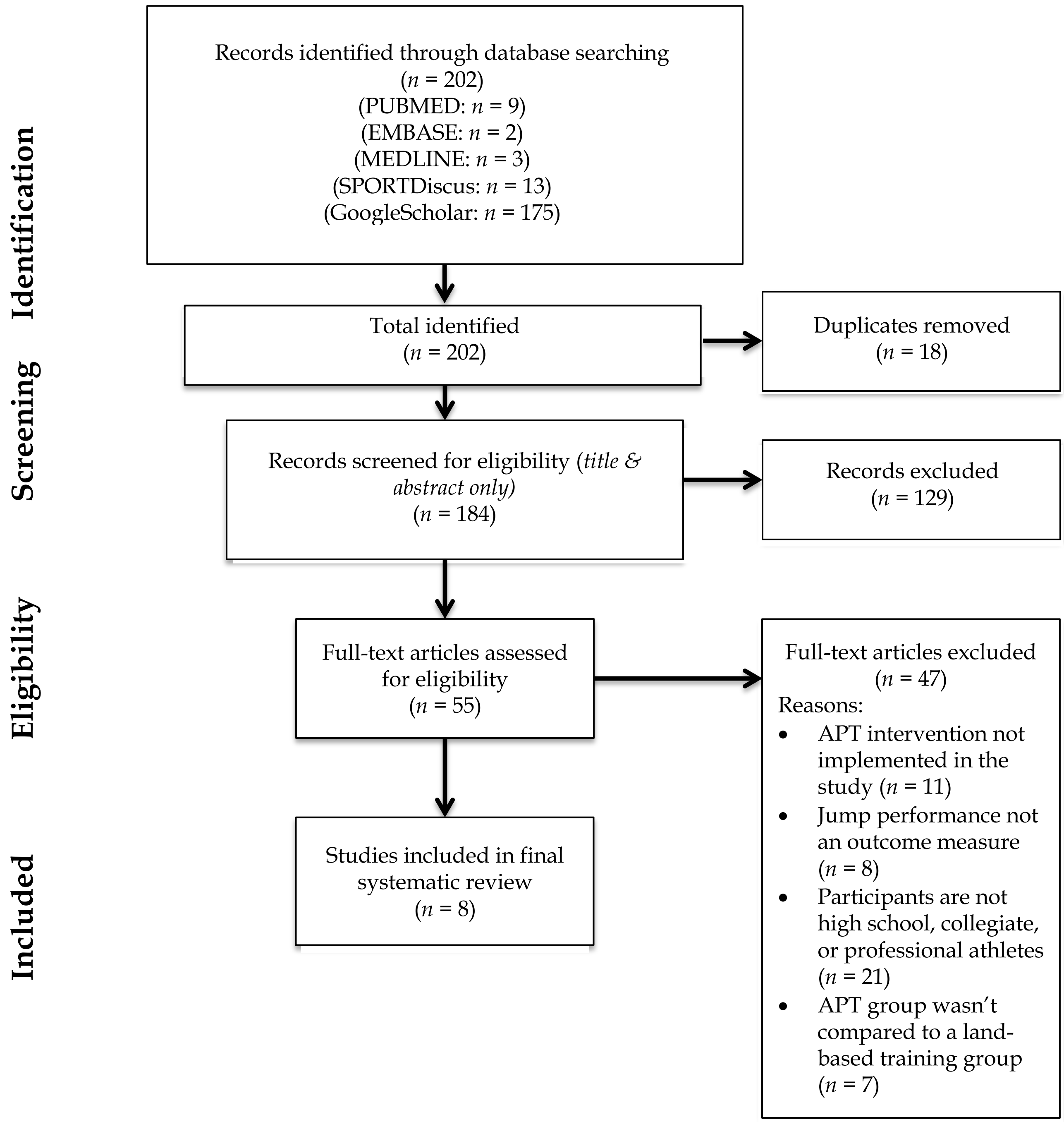

Figure 1. Systematic Search Strategy.

Of the eight studies deemed eligible for review, one was conducted in the USA (6), one in Egypt (10), one in Brazil (13), one in Iran (12), one in India (7), one in Turkey (5), one in Saudi Arabia (1), and one in South Africa (11). Five of these studies used only male participants (1, 7, 11, 12, 13), two studies used female and male participants (5, 6), and one study did not specify the sex of the participants (10). Athletes that participated in the remaining studies included: basketball (1, 5), volleyball (10, 12), soccer (13), track and field (6), and rugby (11). The aforementioned studies implemented APT programs, which ranged from six to twelve weeks in duration. LPT programs used as comparisons in these studies had similar duration and volumes of training as the APT programs utilized.

The remaining eight studies were critically appraised using the levels of evidence scale adapted from the Oxford Centre for Evidence-Based Medicine (CEBM). The CEBM was used to determine the level of evidence of each study, which can help clinicians determine the value of the reported results (17). The levels of evidence of this scale ranges from one to five with level one representing the highest quality and level five representing the lowest quality (17). Level one consists of systematic reviews of randomized controlled trials (RCTs), individual RCTs, high-quality prospective or diagnostic studies, and well-designed cost-analysis studies (17). Level two consists systematic reviews of cohort studies, well-designed individual cohort studies and outcome research (17). Level three consists of systematic reviews of case-control studies and well-designed individual case-control studies (17). Level four consists of case series, poorly designed cohort studies, and poorly designed case-control studies (17). Level five consists of anecdotal evidence, animal research, bench research, and unpublished clinical observations (17).

The CEBM is a systematic method for grading to be used in clinical practice that gives a score of quality ranging from A, B, C, D, or I, which rates how well the evidence provided from each study answers the question of interest (17). Level one evidence with consistent results receives a grade of A. A grade of B is given to level two and three with consistent evidence or level one with inconsistent evidence (17). A grade of C recommendation is given to studies that show conflicting or level 4 based evidence (17). A grade of D or I indicates that the result of the study identifies very little evidence to make a recommendation (17). This grading system shows how confident clinicians are about the results of each study and how applicable and reproducible they may be (17). Once the critical appraisal of the eight studies was completed, key data was extracted and tabled. Information extracted from these eight studies included: all authors, title of study, year of publication, purpose, design, sample, results, discussion/limitations, and future research aims if available.

The CEBM grades, indicating the level of evidence of the results of each study, as well as the outcome measures used in each study and each study's main findings related to overall jump performance are presented in Table 3. Six of the studies were given a grade of B (1, 6, 10- 13), which represents a fair level of confidence for making a recommendation. Two of the studies were given a grade of C (5, 7), which represents conflicting evidence for recommendation. A grade of B was given to studies that showed level two or three evidence, and if the results of the study were statistically significant or non-significant with little variation, which was illustrated by narrow confidence intervals and small standard deviations (17).

RESULTS

Data extracted from the studies included in the final critical appraisal are displayed in Table 3 with information on the participants, purpose, research design, results, and discussion. The outcome measurements for vertical jump performance varied across the included studies, with some studies using multiple tests and others using just one test to assess jump performance. Jump performance test used by the eight studies included: Drop jump test (13), standing broad jump (SBJ) test (10, 11), sergeant jump test (11, 12), repeated countermovement jumps test (11), and vertical jump test (1, 5-7, 10). Instruments used to assess vertical jump performance included a jump mat, Vertec vertical jump tester, and wall and chalk for the Sergeant vertical jump test. Each of the studies included used one or more of the aforementioned tests to assess jump performance before and after implementation of a six to twelve week APT vs. LPT intervention.

For the drop jump test, larger improvements in vertical jump height and ground contact time were observed in the APT group. While no significant improvements were observed pre- post-test in SBJ performance in either experimental group, the APT group showed a positive trend. Furthermore, significant improvements pre- to post-test were observed in sergeant jump performance in all three groups (APT, LTP, and CON). Although no statistical differences existed between the three groups, multiple studies provided evidence that the APT group showed the greatest improvement (% increase) in vertical jump performance. When considering repeat countermovement jump performance, LPT significantly increased pre- to post-test maximum, minimum, and average peak power values when compared to APT. Lastly, APT was reported to be equally as effect as LPT when changes in vertical jump performance was evaluated.

Fonseca et al. (13) measured vertical jump performance in the form of a drop jump test by having the participants drop from a 50-cm high bench with their hands fixed close to the hip region and upon landing on the jump mat, immediately performing a vertical jump. Results produced significant increases ($p < 0.05$) pre- to post-test in vertical jump height of both the LPT group (40.16cm vs. 46.29cm) and the APT group (36.57 cm vs. 45.93 cm). Foot contact time significantly decreased from pre- to post-test in the APT group (482.46 m/s vs. 376.19 m/s). In the inter-group comparison, a significant decrease was seen ($p < 0.05$) in foot contact time in the APT group (-106.27 m/s) when compared with the LPT group (-28.69 m/s) and control group (-4.01 m/s) in the post-test. Fonseca et al. (13) concluded that both the LPT and APT group produced significant increase pre- to post-test in vertical jump performance. However, larger improvements in vertical jump height and ground contact times were observed in the APT group.

Elbattaway & Zaky (10) and Fabricius (11) measured jump performance in the form of a SBJ test by having participants stand behind the starting line with their feet comfortably apart and subsequently jumping horizontally with a countermovement performed prior to takeoff. Upon landing, a measurement is taken from the starting line to the back of the closest heel (11). Results yielded no significant improvements pre- post-test in broad jump performance in either experimental group (LPT and APT) (11). However, the APT group demonstrated a positive trend in long jump performance from pre- to post-test by increasing performance by 3.6%. Results from Elbattaway & Zaky (10) revealed significant improvements in broad jump performance from pre- to post-test in both the aquatic experimental groups (hip- and chest-deep). However, results from Elbattaway & Zaky (10) did not reveal significant improvements in broad jump performance from pre- to post-test in the LPT group.

Table 3. CEBM grades for each study.

Reference (author/year)	Purpose	Sample	Research Design	Results	CEBM Grade
Elbattaway et al. (10)	To compare the effects of chest- and hip-deep APT and LPT on physical fitness variables among volleyball players	24 university women's volleyball players (aged 19 to 21 yrs., LPT: 20 ± 1.31 yrs.; chest-deep APT: 19.13 ± 0.83 yrs.; hip-deep APT: 20.13 ± 1.25 yrs.)	Participants were randomly divided into one of three groups: control group (LPT), chest-deep APT group, and hip-deep APT group. Pre- and post-test measurements assessed participant's body composition, speed, endurance, lower limb strength, and leg power. The intervention period consisted of training for 10-weeks, 3 days per week with a single session performed each day.	Chest-deep APT resulted in significant improvements in vertical and broad jump performance, average power, and lower limb strength.	B
Fonseca et al. (13)	To compare the effects of APT and LPT on vertical jump performance and delayed onset muscle soreness (DOMS) in soccer players	24 male soccer athletes from the youth and junior soccer teams of a soccer club in the 1st division of the state of Rio de Janerio, Brazil, who had competed for at least 2 yrs. (mean age 16.53 ± 0.5 yrs.)	Participants were randomly divided into three groups: APT group, LPT group, and control group (CG). A 6-week 2 days per week plyometric training intervention was conducted. Pre- and post-test	VJ height significantly increased ($p < 0.05$) from pre- to post-test in both experimental groups (LPT and APT). In the inter-group comparisons, a significant increase was observed ($p <$	B

			measurements on vertical jump performance were assessed using a contact platform.	0.05) in vertical jump height in the LPT and APT groups when compared with CG in the post-test.	
Fattahi et al. (12)	To compare the effect of 8-weeks of APT and LPT on biomechanical variables including agility, leg muscle strength, and vertical jump performance in young male volleyball players	45 junior male volleyball players from Alborz State of Iran (mean age 19.47 ± 2.39 yrs.)	Participants were randomly split into one of three groups: APT, LPT or CG. An 8-week plyometric training intervention was conducted. Training took place three times a week. Agility, strength, and power were assessed with a 4 x 9-m shuttle test, 1RM leg press, and vertical jump test.	No significant changes were observed in the control group in any of the variables tested. APT group showed significant differences ($p < 0.05$) in vertical jump performance (~28%), compared to the LPT (~10.5%).	B
Datta & Bharti, (7)	To examine the effects of APT and LPT on selected physical variables in intercollegiate male handball players	45 male handball players from Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat (aged 18 to 21 yrs.)	Participants were randomly placed into one of three groups: APT, LPT and CG. Each of the experimental groups participated in a 12-week intervention. Training was conducted three times per week. Pre- and post-test measurements assessed speed, explosive power, and agility.	Post Hoc Tests showed significant mean differences ($p = 0.009$) on leg explosive power among the three groups: APT group 1.93m, LPT group 1.90m, and CG group 1.87m.	C
Bavli, (5)	To compare the effects of APT and LPT on biomotorical variables among adolescent basketball players	91 male and female adolescent basketball players (mean age 16 ± 1 yrs.)	A pre-test/post-test study design was utilized in this study. Participants were randomly placed into one of three groups: APT, LPT and CG. A 12-	Statistically significant improvements ($p < 0.05$) were observed in vertical jump height in both the APT and LPT groups (APT:	C

			week plyometric intervention was performed by participants in each of the experimental groups. Training took place three times per week. Pre- and post-test measurements assessed sprint performance, vertical jump, flexibility, and leg strength.	pre- 47.2cm ± 5.2cm, post-test 51.7cm ± 5.2cm; LPT: pre- 48cm ± 9.3cm, post-test 52.6cm ± 8.8cm).	
Coleman, (6)	To examine the effects of six weeks of APT and LPT vertical jump height, velocity, initial sprint start, and muscle soreness in adolescent high school track and field athletes	26 experienced female and male track and field athletes from Monterey Trail High School (mean age APT: 15.8 ± 1 yr.; LPT: 16.8 ± 1.1 yrs.)	Participants were randomly placed into an APT or LPT group. A 6-week intervention period was implemented with training conducted twice a week. Pre- and post-test jump measurements included vertical jump height.	Vertical jump heights were comparable between the APT pre- (24.5 ± 4.06) and post-test (24.73 ± 3.9) and LPT group's pre- (23.23 ± 5.09) and post-test (23.46, ± 5.32), (p = .008).	B
Ahmed et al. (1)	To determine whether APT and LPT can improve aerobic fitness, vertical jumping ability, and physical preparation in younger basketball players	18 male junior basketball players (mean age 18 ± 0.6 yrs.)	Participants were randomly placed into one of two groups: APT and LPT groups. Both groups completed an 8-week training intervention. Training was conducted twice a week for 45 minutes. Pre- and post-test measurements assessed VO2max, 20m sprint, vertical jump, flexibility, 1RM leg press, and agility.	VJ height significantly increased (p = 0.001) from pre- to post-test in both experimental groups (APT and LPT). The APT group's vertical jump height improved (18%) compared to the LPT group (10%).	B
Fabricius, (11)	To compare the effectiveness of	52 male rugby union player	Participants were randomly placed	The LPT group significantly	B

aquatic-based and land-based plyometric programs upon selected, sport-specific performance variables in adolescent male, rugby union players	(mean age APT: 16.33 ± 0.84 yrs.; LPT: 16.23 ± 0.75 yrs.; CG: 16.41 ± 0.93 yrs.	into one of three groups: APT group, LPT group, and CG. Pre- and post-test measurements assessed agility, sprint speed, and lower body power. Participants completed a 7-week plyometric training intervention.	improved ($p < 0.05$) minimum (6.9%), maximum (5.42%), and average (5.94%) peak power values pre- to post-testing.

Fabricius (11) and Fattahi et al. (12) measured vertical jump performance via the sergeant jump test in male volleyball (age: 19.5 ± 2.4 yr) and rugby (age: 16.3 ± 0.8 yr) players. Participants performed the test by standing against a wall with their dominant shoulder and leg nearest the wall. Participants reached as high as possible and put a mark on the wall with the tip of their middle finger. After a standing reach mark was placed on the wall, they jumped as high as possible and touched the wall at the peak of their jump. The distance between the chalk mark and the original reach mark is calculated and recorded to the nearest cm. Fabricius (11) reported significant improvements pre- to post-test, in sergeant jump performance, in all three groups (APT, LTP, and CON) with no statistical differences among the three groups. However, the APT group showed the greatest improvements with a 7.88% increase in vertical jump performance. The LPT and CON group followed with increases of 7.06% and 6.69%, respectively. Results from Fattahi et al. (12) indicated a 28% increase ($p < 0.05$) in vertical performance pre- to post-test in the APT group. However, the LPT group improved vertical jump performance by 10.5% from pre- to post-test. When compared to the LPT group, Fabricius (11) concluded that APT produced higher improvements in vertical jump performance. Fattahi et al. (12) concluded that both APT and LPT have the potential to significantly increase leg power in young male volleyball players.

Fabricius (11) measured vertical jump performance in the form of a repeated countermovement jump test in a group of young male volleyball players. Participants perform this test by attaching a Fitrodyne to their waist and completing a single test of 20 continuous vertical jumps. Fatigue index calculation was also used to assess decline in power output during the test expressed as a percentage. Statistically significant pre- to post-test increases in minimum (1470.5 W ± 216.6 W vs. 1572 W ± 259.3 W), maximum (1823.4 W ± 276.5 W vs. 1922.2 W ± 315.8 W), and average (1646.3 W ± 250.6 W vs. 1744.2 W ± 274.2 W) peak power values in the LPT group were discovered. As for peak velocity measurements, the APT group produced no significant improvements in minimum velocity (1.98 m.s^{-1} ± 0.14 m.s^{-1} vs. 1.97 m.s^{-1} ± 0.17m.s^{-1}) and fatigue index score (21.75% ± 3.63% vs. 22.22% ± 3.47%) Furthermore, the LPT group decreased peak velocity fatigue rates from pre- to post-test by 5.98%.

Several studies measured jump height and performance in the form of a vertical jump test (1, 5-7, 10). Ahmed et al. (1) reported that an eight-week APT program increased vertical jump performance by 18%. This was a statistically greater improvement ($p < 0.05$) than the 10% increase seen by the LPT program (1). Similarly, Bavli (5) found significant pre- to post-test increases in vertical jump height (cm) in both the APT group (47.2 ± 5.2 vs. 51.7 ± 5.2) and the LPT group (48 ± 9.3 vs. 52.6 ± 8.8). There were no significant differences between the two experimental groups, and both experimental groups saw significantly greater improvements in vertical jump height when compared to a control group (43.7 ± 8.2 vs. 45.3 ± 8.8) (5). Coleman (6) observed no significant increases in vertical jump performance from pre- to post-test in either of the experimental groups (APT or LPT). Datta & Bharti (7) observed significantly greater improvements in vertical jump height in both the LPT (+ 0.03 meters) and APT groups (+ 0.05 meters) when compared to the control group (+ 0 meters). Datta & Bharti (7) concluded that leg power in the APT group was significantly greater than that of the LPT group and the control group. Elbattaway and Zaky (10) compared vertical jump performance of a LPT group, chest-deep APT group, and a hip-deep APT group before and after ten-weeks of PT. Significant pre- to post-test increases ($p < 0.05$) in vertical jump performance, in all three groups were observed: LPT group (55.13 ± 4.76 vs. 59.75 ± 3.62), chest-deep APT group (54.75 ± 4.92 vs. 67.88 ± 4.05), and hip-deep APT group (49.88 ± 4.45 vs. 59.62 ± 8.09).

DISCUSSION

The purpose of this review was to critically examine the current literature investigating the effects of APT vs. LPT on jump performance in athletic populations. Overall, similar pre- to post-test improvements in jump performance for both APT and LPT were observed in seven of the eight studies included in this review. Only one study reported no significant increases in jump performance after participation in either APT or LPT interventions. However, in that study greater increases in jump performance were observed by the LPT group. These findings provide strong evidence that APT is as effective as LPT at improving jump performance. Furthermore, APT may potentially reduce the risk of musculoskeletal injury for some athletes, especially those with previous lower-extremity injury. These findings may have important implications for strength and conditioning professionals who are responsible for developing training programs aimed at improving leg power.

APT and LPT interventions had similar effects on jump performance in three studies (5, 7, 10). Due to water's natural properties, APT reduces impact forces while providing additional resistance stimuli during training. Thus, APT may be useful for strength and conditioning coaches who are seeking an evidence-based cost- and time-efficient method for resistance-based team plyometric training. Additionally, APT may be beneficial for training large groups or introducing a new stimulus to well-trained athletes. Although no significant differences between groups were observed within these studies, vertical jump performance increased for both groups, which suggests that APT is equally as effective for improving jump height as LPT. However, if improving jump height is a primary objective it may be beneficial to develop lower-extremity strength first.

Similar to LPT, jump performance was also shown to significantly improve, pre- to post-test, in seven of the eight studies when an APT intervention was implemented (1, 5, 7, 10-13). Within those studies, participants generally performed two to five sets of several plyometric exercises (e.g., power skips, single- and double-leg bounding, squat jumps, etc.) for either five to ten reps or for a ten to twenty second duration (1, 5, 7, 10-13). Additionally, participants were generally given 30-120 seconds of rest between sets of plyometric exercises (1, 5, 7, 10-13). These findings may be due in large part to the resistive nature of water, which can contribute to increased force development after participating in APT, which results in improvements in jump performance. In five of the eight studies, APT yielded greater improvements in sergeant, broad, and vertical jump performance when compared to LPT (1, 10-13). However, one study reported that LPT yielded greater improvements in minimum, average, and maximum peak velocities and decreased fatigue index scores when compared to APT while the others did not observe significant differences in jump performance pre- to post-test (6, 11). The findings from the study conducted by Fabricius (11) provide evidence that the rate of force development has a greater contribution on jump performance than force development alone. Therefore, while force development greatly influences jump performance, rate of force development greatly influences lower-extremity power.

Limitations of this critical review included a potential language bias because of English only databases and search terms being used, which may have limited the number of studies eligible to be included in this review. Furthermore, this study reviewed the effect of PT on an athletic population, which may have yielded data that the general population may not replicate. Given that athletes are normally highly trained individuals, it can be assumed that significant increases in performance after exposure to a training intervention are not the result of neuromuscular adaptations, but of actual strength increases. Contrarily, significant increases experienced by untrained individuals after exposure to a training intervention may not be the result of actual strength gains, but of neuromuscular adaptations. Lastly, only two studies stated that female participants were included (5, 6). With only two of the eight studies including female participants, this may have limited the generalizability of the observations of this study to male athletes only.

In conclusion, both LPT and APT have the potential to significantly increase jump performance in athletic populations. Thus, both training modalities are capable of increasing lower-extremity explosive power, which may increase overall athletic performance. APT interventions reported significantly greater increases in jump performance when compared to LPT in two of the eight studies reviewed. However, this is not enough evidence to assume that APT is a more efficient way to improve jump performance than LPT. Overall, the majority of the included studies in this review reported similar increases in jump performance after participation in both LPT and APT interventions. APT could benefit coaches and athletes looking to utilize PT while also reducing impact forces placed upon the musculoskeletal system. Strength coaches and athletes alike may use observations made in this review to weigh the pros and cons of both types of plyometric training.

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