SPORTS PERFORMANCE

The effect plyometrics has on jump performance in football players: A literature review.

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Abstract:

Introduction: To assess the effects of plyometrics (PLY) in football to improve jump performance, a review was conducted using the data sources SPORTDiscus and Women's Studies International.
Methods: From the originally sourced 275,000 papers, 8 were obtained for this literature review, 8 experimental groups (n=81) and 8 control groups (n=74). For inclusion into this review, studies must have (i) a minimum of at least 4 weeks intervention (ii) healthy football players (iii) an amateur or elite population (iv) a control group (v) the measure of a counter movement jump (CMJ) or vertical jump (VJ).
Results: The magnitude of effect for the experimental group was small (ES = 0.52 [95% CI = 0.08-0.96], p = 0.002).
Discussion: Subgroup moderator variables were analysed (i.e Plyometric training frequency, duration, ground contacts, prescription, and the number of sessions).
Conclusion: Plyometrics does evoke increased jump performance in football players. Future studies should identify the specific correlation between how plyometrics and the dose response effects certain aspects of football performance.
Key Words: plyometrics, football, jump performance

Introduction

Football (also known as soccer) is termed the World Game and is played in every country across the globe [Mengesh et.al., 2015]. Since the inception of the men's FIFA World Cup in 1930 and the women's which was introduced in 1991, football is and will remain one of the most researched sports due to the multifaceted structure of the game. In the modern era, coaches and athletes must evolve with the demanding nature of the sport. Training adaptations have become a necessary component to enhancing physical performance across all stages of development [Beato et al., 2018].

Plyometrics (PLY) is a preferred prescription modality utilized as an effective mean to improve bone health, reduce the risk of injury [Markovic & Mikulic., 2010]; with the literature highlighting the positive effect plyometrics has on jump performance and leg strength [Ebben & Blackard., 2001; Kryeziu et al., 2019; Ozbar et al., 2014]. Sprinting (45%) and vertical jumps (16%) account for the most specific movement requirements in goal scoring situations during professional matches [Faude et al., 2012]. Due to the complex demands of the sport, research indicates that numerous factors attribute to success and the Key Performance Indicators are indicative of the constructs relating to the relevant variables in the game of football [Datson et al., 2014; Paul et al., 2015; Rein & Memmert, 2016; Smith et al., 2018, Stolen et al., 2005; Wilson et al., 2017]. In this review, the high intensity movement of jumping performance (ie. Counter Movement Jump (CMJ) and Vertical Jump(VJ) will be explored to report the findings between plyometrics training and the correlation between success on the football pitch [Arnason et al., 2004].

The effectiveness of the studies into plyometrics training themes across the literature rely largely on the prescription modality applied, (ie. Type of PLY used in a session) coupled with the prescribed volume and frequency of the bouts (ie. Number of ground contacts in a session, how many sessions per week are prescribed, high vs low impact of methodology etc.) [de Villareal et al., 2009; Adams et al., 1992; Fatouros et al., 2000; Holcomb et al., 1996; Hortobagyi et al., 1990; Luebbers et al., 2003]. Several reviews hypothesize that the longer the duration of the study (between approx. 6-14 weeks) coupled with the acute effects of the modality will produce a greater effect size when considering the outcome. Contrary to these findings, there has been evidence to suggest 4-7

weeks of PLY training can produce significant adaptation [Luebbers et al., 2003].

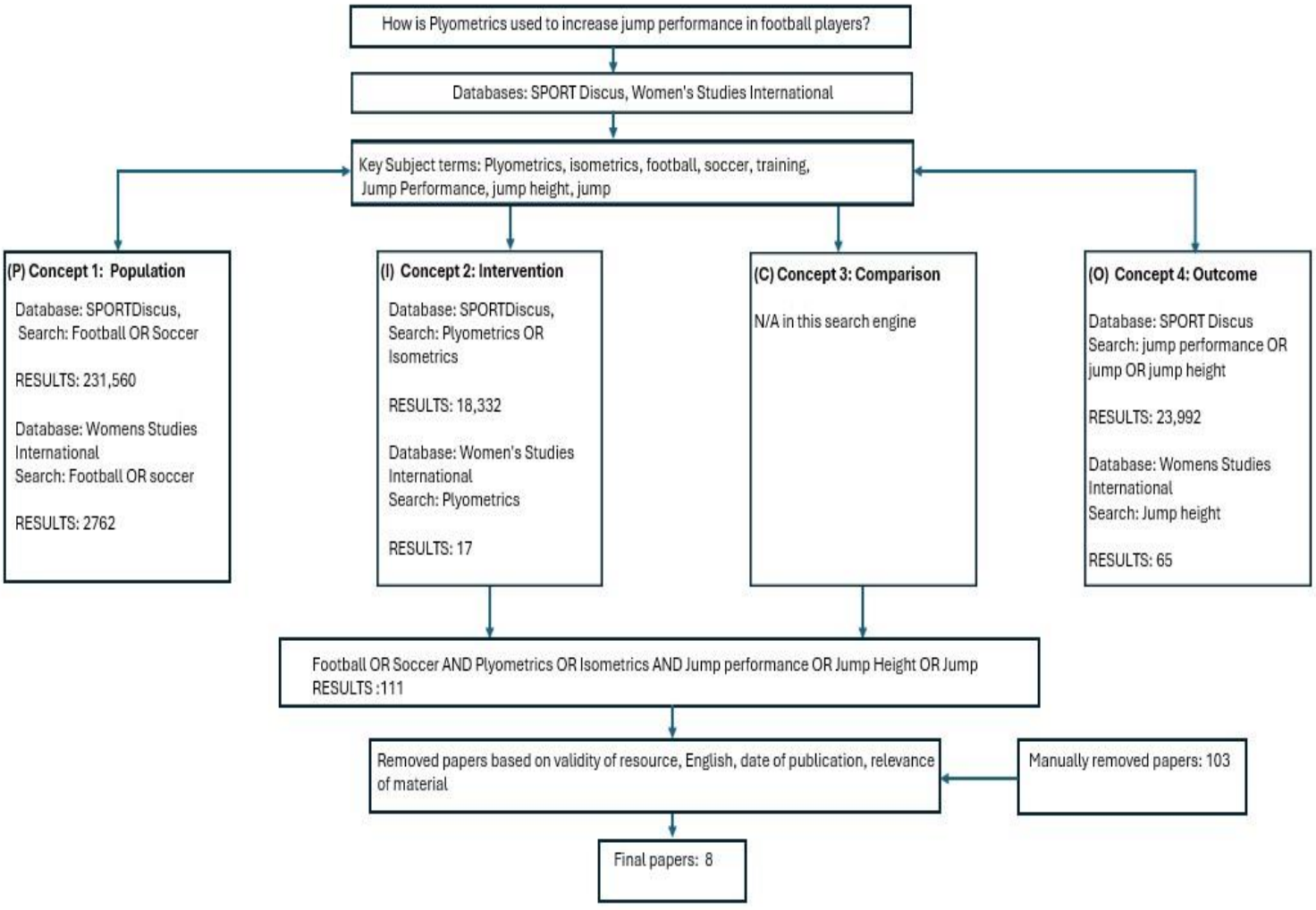
Although there are numerous publications specific to the effects of PLY on jump performance, there remains limitations around female focused studies on football specific interventions. Further, the gap in the literature when providing the effects on performance which lay outside of the standard research of PLY mechanisms when used for injury prevention [Stevenson et al., 2015; Ter Stege et al., 2014] and rehabilitation [Chmielewski et al., 2006] etc.

Current research hypothesizes that the effect which PLY training has on jump performance but may not relate to the significance or provide the reader with data to link a direct correlation specific to the demands of football. Further analysis of future studies could identify how the increase in jump performance leads to performance enhancing protocols within a match (e.g. How jump height increases the success of scoring a goal from a corner kick through heading the ball and this could be the result of x research where y resulted in effecting success). An example where the research is applicable to highlight cause and effect is hypothesized in the correlation between the effects of PLY training and the increase of Vertical Jump performance which directly relates back to the effect size increasing their average kicking distance [Rubley et al., 2011]. The limitation with providing data that hypothesizes that PLY is effective across a time span is effective, however, with the omission of how this can be applied to football as a direct indicator provides a broad context that could require further investigation for future studies.

The purpose of this literature review is to determine the cause and effect that plyometric training has on increasing jump performance in soccer players and the subsequent methods applied.

Method

Table 1. PICO Literature search engine



Results

Table 2. Control and Plyometric group intervention data.

Intervention data						
Paper	**Duration**	**Frequency**	**PG pre (cm)**	**PG post (cm)**	**CG pre (cm)**	**CG post (cm)**
Chimera et al., (2005)	6 weeks	2 sessions	17.89±2.29	18.89±2.45	18.17±2.24	18.5±2.06
Fischetti, F., et al. (2019)	12 weeks	3 sessions	33.6±5.5	36.8±5.8	32.1±6.4	32.7±5.7
Idriss, M.M., et al. (2021)	10 weeks	3 sessions	29.5 ±6.08	36.5±5.70	30.33±7.84	32.91±7.26
Nonnato et al., (2020)	12 weeks	1 session	36±4.1	36.1±4.9	37.4±3.2	35.5±4.8
Ozbar et al., (2014)	8 weeks	1 session	39.8± 4.5	46.8±2.2	35.4±4.6	37.9±3.9
Ramirez-Campillo,R.,et al.(2018)	8 weeks	2 sessions	27.4±4.3	30.1±4.7	28.8±4.9	29.9±5.1
Rubley, M.D., et al (2011)	14 weeks	1 session	39.6±8.2	47±8.1	39.4±8.3	36.8±6.2
Sedano Campo et al (2009)	12 weeks	3 sessions	25.6±1.0	28.9±0.9	26.2±0.9	25.5±1.0
Abbreviations in alphabetical order: PG: Ply group, CG: Control group						

Table 3. Control group vs Experimental group - data compilation.

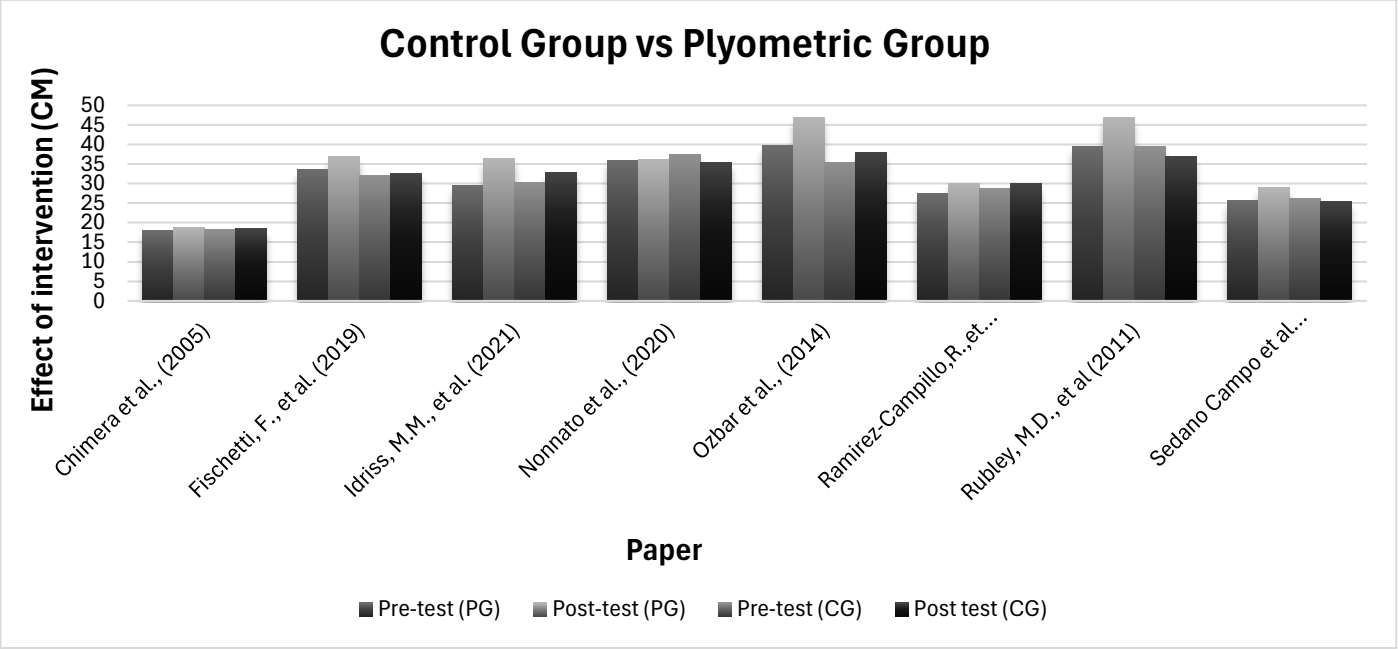


Table 4. Effect size synthesis (Cohen's d).

Effect synthesis of moderator variables (PLY group)					
Sub group (Intervention)	**Effect Size**	**Effect descriptor**	**P-value**	**Groups**	**N**
≥ 8weeks	0.76	Moderate	0.2	7	135
≤ 8 weeks	0.7	Moderate	n/a	1	20
≥ 2 sessions/week	0.66	Moderate	0.01	5	105
≤ 2 sessions/week	2.2	Large	0.08	3	50
≤ 12 weeks	0.32	Small	0.03	4	75
≥ 12 weeks	0.58	Small	0.05	4	80
Effect size (Cohen's d): trivial<2.0, small 0.2-0.6, moderate 0.6-1.2, large 1.2-2.0, very large >2.0					

Three interventions [Idriss et.al, 2021; Ozbar et.al, 2014; Rubley et al, 2011] resulted in a 15% or greater increase in jump performance. The difference in relative weight of each study in the experiment group varied from 0% to approx. 20%.

Of the 8 studies reviewed, half of the studies [Fishetti et al., 2019; Nonnato et al., 2020; Ozbar et al., 2014; Sedano-Campo et al., 2009] tested participants with between 2-3 years previous PLY training experience.

Two papers [Rubley et al., 2011; Sedano-Campo et al., 2009] reported significant kicking distance and velocity increases as an effect of PLY training by approx. 10-20%.

The average number of ground contacts per intervention were 2175, (min. 917) [Ozbar et al., 2014] and (max. 3240) [Fischetti et al., 2019; Sedano-Campo et al., 2009].

The eight studies included 8 experimental groups (Table 5), with a total of 155 participants (74 in the control groups).

Table 5. Comparative results data

Comparative Data Results Table							
Paper	**Reference**	**Aim**	**Population**	**Method**	**Pre-test**	**Post-test**	**Practical Application**
Effects of Plyometric Training on Muscle-Activation Strategies and Performance in Female Athletes	Chimera et al., (2005)	Evaluate the effect of PLY training muscle activation strategies & performance of the lower extremity during jumping exercises	Female Div 1 soccer & hockey players (18-20yrs)	6 weeks; 2 sessions per week n=20 (CG, n=9), (PG, n=11) Testing battery: VJ	**(PG) (VJ)** **17.89cm ±2.29** **(CG) (VJ)** **18.17cm ± 2.24**	**(PG) (VJ)** **18.89cm ±2.45** **(CG) (VJ)** **18.5cm ±2.06**	(CG) & (PG) had insignicant difference of 2.0% & 5.8% (PG) ES = 1.42
Lower-limb plyometric training improves vertical jump and agility abilities in adult female soccer players	Fischetti, F., et al. (2019)	Determine how explosive strength & agility are affected by a 12 week plyometric training program in elite female soccer players	Female elite soccer players; CG, age 26.7 ± 5.3yrs; PG, age 26.5 ± 6.9yrs)	12weeks/ 3sessions per week; 2 groups n=28 (CG, n=14) (PG, n=14) Testing battery :CMJ	**(PG) (CMJ)** **33.6cm ± 5.5** **(CG) (CMJ)** **32.1cm±6.4**	**(PG) (CMJ)** **36.8cm ± 5.8** **(CG) (CMJ)** **32.7cm±5.7**	Signficant change from baseline (p<0.05) PG: 9.7% CG: 2.6% (PG) ES = 1.41
Effect of plyometric training on improving vertical jump in female footballers (14-17 years old)	Idriss, M.M., et al. (2021)	Dtermine the effect of PT on improving vertical jump (VJ) in female footballers	Female footballers in the National Womens Football League Algeria (14-17yrs)	10 weeks 3 sessions per week; n=22 (CG, n=11) (EG, n=11, Testing battery : CMJ	**(PG) (CMJ)** **29.50cm ± 6.08** **(CG) (CMJ)** **30.33cm ± 7.84**	**(PG) (CMJ)** **36.5cm ± 5.70** **(CG) (CMJ)** **32.91cm ± 7.26**	Significant gains post test, (PG), (CMJ) t=5.70, p,0.05 (PG)ES =1.41
The effect of a single session of Plyometric training per week on fitness parameters in professional female soccer players	Nonnato et al., 2020	Compare the effectiveness of 12 weeks PLY training on physical performance in professional female soccer players during the season	Female second league	12 weeks, 1session per week n=16 (CG, n=8) (PG, n=8) Testing battery: CMJ	**(PG) (CMJ)** **36.0cm±4.1** **(CG)(CMJ)** **37.4cm±3.2**	**(PG) (CMJ)** **36.1cm±4.9** **(CG) (CMJ)** **35.5cm±4.8**	(PG) Insignificant Increase
The effect of 8 week Plyometric training on leg power, jump and sprint performance in female soccer players	Ozbar et al., 2014	Dtermine the effect of 8 week PLY training on leg power and jump andsprint performance in female soccer players	Professional female soccer players	8 weeks, 1session per week (n=18) CG:9, PG:9. Testing battery: CMJ	**(PG)(CMJ)** **39.8cm±4.5** **(CG) (CMJ)** **35.4cm±4.6**	**(PG) (CMJ)** **46.8cm±2.2** **(CG) (CMJ)** **37.9cm±3.9**	(PG) Significant Increases (ES = 1.4) (CMJ) (p <0.05)
Effects of different plyometric training frequencies on components of physical fitness in amateur female soccer players	Ramirez-Campillo,R.,et al.(2018)	Assess effects of plyometric jump training (PJT)in vertical jump height	Female soccer players. Age: 21*	8 weeks, 2 sessions per week n=15 CG: 7 PG: 8. Testing battery : CMJ	**(PG) (CMJ)** **27.4cm ± 4.3** **(CG) (CMJ)** **28.8cm ±4.9**	**(PG) (CMJ)** **30.1cm ± 4.7** **(CG) (CMJ)** **29.9cm ± 5.1**	Significant increase (PG) ES= 1.41
The effect of plyometric training on power and kicking distance in female adolescent soccer players	Rubley, M.D., et al (2011)	Measure the effects of low-frequency, low impact plyometric training on VJ & kicking distance	Female adolescent soccer players (age 13.4 ± 0.5yrs)	14 weeks; 1 session per week n=16 (CG, n=6), (PT, n=10) Testing battery: VJ & average kicking distance in metres	**PT (VJ) 39.6 ± 8.2** **CG (VJ) 39.4cm ± 8.3**	**PT (VJ)** **47.0cm ± 8.1** **(CG) (VJ)** **36.8cm ± 6.2**	VJ Jump height(PG) increased by 18.6% (p=0.001) (ES = 1.4) Average kicking distance increased (PG) by 21.5% (p=<0.001)
Effects of lower limb plyometric training on body composition, explosive strength and kicking speed in female soccer players	Sedano Campo et al., 2009	Examine how explosive strength, kicking speed and body composition are affected by a 12 week plyometric training program in elite female soccer players	Elite female soccer players	12 weeks, 3 sessions p/week. n= 20 (CG n= 10) (PG n= 10) Testing battery: CMJ	**(PG) (CMJ)** **25.6cm ± 1.0** **(CG)(CMJ)** **26.2cm ± 0.9**	**(PG) (CMJ)** **28.9cm ±0.9** **(CG)(CMJ)** **25.5cm ± 1.0**	(PG) Significant Increases (CMJ) (p <0.05) (PG) ES = 1.41

Abbreviations in alphabetical order: CG Control group,CMJ Counter movement jump, ES Effect size (n) Sample size PG Plyometric group, VT Vertical jump

Discussion

The aim of this literature review was to assess the cause and effect that PLY training has on jump performance for football players. The database search returned approx. 275,000 possible research papers with a broad context of Plyometric training interventions across all possible fields. From there, 111 papers were identified where jump performance and football were specifically highlighted, and of those 34 papers found to be relevant, 8 papers were chosen for this literature review. The literature provided resounding evidence to suggest that PLY training has a significant impact on jump performance for football athletes when comparing with a control group. This finding is consistent with the review papers which conclude PLY training enhances explosive lower limb power [Rubley et al., 2011; Beato et al., 2017; Sedano Campo et al., 2009; Idriss et al., 2022; Fischetti et al., 2019].

The benefits of PLY training hypothesize the effect of neural and elastic adaptations in the development of the stretch shortening cycle [Malisoux et al., 2006; Weiss et al., 1998], hence the effect of a reduced ground reaction capability when performing CMJ to generate maximum force [Idriss et al., 2022]. The physiological response to Ply training must be observed as a variable within itself for the improvement of jump performance in football players [Ramirez et al., 2020]. However, the dose response of PLY training; (frequency, duration, ground contacts per session and sessions per week) are factors that could highlight the direct link in the studies effecting jump performance with the intervention applied. Moderator variables were used (table 6) to explore these effects.

Plyometric interventions with a frequency of two or more sessions per week [Chimera et al.,2005; Fischetti et al., 2019, Idriss et al., 2021, Ramirez et al., 2018, Sedano-Campo et al., 2009] produced a moderate effect on jump performance (ES = 0.66), and sessions less than 2 per week [Nonnato et al., 2020; Ozbar et al., 2014, Rubley et al., 2011] produced a large effect size (ES = 2.2). It should be noted that in the study of [Ozbar et al., 2014 and Rubley et al., 2011] the large effect size may be due to a higher-than-average fitness level, given that the pre-test jump performance was at an advanced level.

In this review a broad range of participants were analyzed across varying skill levels from amateur to elite athletes. In the study of (Ozbar et.al, 2014) these participants were of elite level and had 2 years previous PLY training experience [table 6], whereas in the study of (Rubley et al., 2011) the participants were amateur athletes. In these cases, both studies in the Ply group had significant Effects (ES = 1.4). The interventions were 12 and 14 weeks respectively with one session per week (Table 2). Both studies provide evidence in the literature concurrent with other findings which concur structured and intensive ply programs enhance jump performance. However, for the study of (Nonnato et.al, 2020) where the subjects were professional football players, this study was conducted for 12 weeks with one session per week. In this intervention the allocated time for the session was 20-25mins, the effect of the CMJ in this study was 0.1cm. Of note, the above studies where the prescription lasted 60min (one session per week), the response was significant.

In relation to duration, programs that lasted 12 weeks or longer [Fischetti et al, 2019; Nonnato et al,2020; Rubley et al., 2012; Sedano-Campo et al., 2009] produced a small effect (ES 0.58), and those that lasted less than 12 weeks also provided a small effect (ES 0.32). As follows, in the meta-analysis [Moran et al., 2019] on the effects of PLY training in female youth ($p < 0.05$) there was significant effect for programs 8 weeks or longer (ES = 1.04) compared with programs less than 8 weeks (ES = 0.24). In longer interventions it could be assumed that greater and intensified PLY stimuli attribute to increased physiological adaptation of the mechanical variables [Markovic & Mikulic, 2010; Piirainen et al., 2014; Ramirez-Campillo, Alvarez et al., 2018]. With relevance, program interventions that were 10 weeks or longer effected a mean value of 2221 jumps in comparison to programs that lasted 10 weeks or less that effected a mean value of 1389 jumps, ≈ 60% difference. Overall, the literature highlights that PLY program duration, frequency, ground contacts per session and the design of the intervention prescription are some of the moderator variables.

Regarding program design and the point of efficacy, in the study of [Fischetti et al., 2019] the design, training

procedures and PLY drills applied were thoroughly explained for the expectation of gaining maximum performance results. In the study of [Idriss et al., 2021 & Nonnato et al., 2022] although the PLY training protocol was explained, and the level of detail was sufficient to enact the intervention, the methods applicable to the expectation of the effect could be an area of improvement in future research for this topic.

There may be lacking evidence for interventions regarding PLY training and its effects specific to football, (particularly for adolescent females and women) [Nonnato et al.,2020; Rubley et al., 2011], however, two papers reported a strong correlation between PLY training with increased kicking speed and distance [Rubley et.al, 2011; Sedano Campo., 2009]. In the study of amateur adolescent female footballers where the dose was a low intensity and 14 weeks in duration (1 session PLY per week), the PLY group recorded a 21.5% increase for average kicking distance and the control group decreased their average kicking distance [Rubley et al., 2011]. In a study conducted for elite female football players spanning a 12-week testing period (3 sessions per week), the effect was also significant with the PLY group increasing their kicking velocity by 10% and the control group decreasing their velocity [Sedano Campo et al., 2009]. This type of intervention could prove useful for future studies.

The use of PLY training has been noted as being a relatively modern approach to increasing jump performance across numerous sports [Ramirez-Campillo, Alvarez et al., 2018]. As such, there remains limitations regarding the effect PLY has on jump performance, albeit current studies highlight that there is an effect and that mostly the effect is substantial. Therefore, future studies should conduct their findings based off the moderator variables that provide substantiated evidence. That being; frequency, duration, modality, and intensity, all of which correlate to the dose-response provided in the program parameters.

Table 6. Characteristics of PJT programs

Comparative program data table									
Paper	**Reference**	**PJT**	**Freq**	**Duration**	**Intensity**	**BH (cm)**	**NTJ**	**TP**	**SPT**
Effects of Plyometric Training on Muscle-Activation Strategies and Performance in Female	Chimera et al., (2005)	WD	2	6	Moderate	45	1810	OS	N/A
Lower-limb plyometric training improves vertical jump and agility abilities in adult female	Fischetti, F., et al. (2019)	WD	3	12	High	50,60	3240	IS	Yes
Effect of plyometric training on improving vertical jump in female footballers (14-17 years old)	Idriss, M.M., et al. (2021)	ID	3	10	Moderate	N/A	N/A	IS	N/A
The effect of a single session of Plyometric training per week on fitness parameters in professional female soccer players	Nonnato et al., (2020)	WD	1	12	Basic-moderate	10,20,30	1348	IS	Yes
training on leg power, jump and sprint performance in female soccer players	Ozbar et al., (2014)	WD	1	8	Basic-moderate	N/A	917	IS	Yes
Effects of different Plyometric training frequencies on components of physical fitness in amateur female soccer players	Ramirez-Campillo,R.,et al.(2018)	WD	2	8	Moderate	30,40	1440	IS	No
The effect of plyometric training on power and kicking distance in female adolescent soccer	Rubley, M.D., et al (2011)	WD	1	14	Low Intensity	15, 25, 30	1056	IS	No
Effects of lower-limb plyometric training on body composition, explosive	Sedano Campo et al., (2009)	WD	3	12	High	50,60	3240	IS	Yes

Abbreviations described in alphabetical order. BH: Box height, Freq: Frequency, ID:Insufficently described IS: In season OS: Off season PJT: Plyometric Jump Training

NTJ: Number of total jumps, SPT: Participant with previos PT experience TP: Training period, TPLY: Type of PJT drill used :WD: Well described

Conclusion

In conclusion, PLY training is an effective measure to increase jump performance in football players. However, limitations exist in the current literature with the need of further studies to provide evidence of how the use of PLY training effects jump performance specific to football skills.

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