Periodisation Strategies: A Meta-Analysis Unravelling the Impact on Optimising Athletic Peak Performance

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ABSTRACT

The present study aimed to identify the impact of various periodisation approaches used in training athletes and to identify the effect size of the periodisation technique in improving athletes' peak performance before the main event. Inclusion criteria comprised recruitment of all those studies in which the effects of periodisation training were identified on athletes' peak performance. Various databases such as Google Scholar, Pedro, MEDLINE, Cochrane Library, EMBASE, and Web of Science were searched by independent reviewers using the MeSH terms including 'interval training', 'aerobic exercise', 'periodisation,' 'peak performance', and 'athletes'. A sample size of n = 121 participants included in six studies were analysed in which the effects of periodisation methods of training among athletes were estimated for improving their peak performance by assessing jump height and speed, pool effects in the form of random, and fixed effect model were provided to depict cumulative results of all the included studies. In achieving optimisation in athletes' peak performance, inculcating the concept of periodisation is a practical approach. While incorporating periodisation in training, models of training principles must be given ardent importance.

Key Words: *Exercise training, Sports, Athletes, Periodisation, Peak performance.*

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INTRODUCTION

Periodisation is an approach to enhance athletic performance before the main event.[1] Multiple periodisation strategies have been applied in modern-day athletic training and sports practices to change athletes' attitude towards training and improve enthusiasm.[1,2] Periodisation is a concept that involves a gradual increase in training volume and a decrease in training intensity that lasts for several weeks and even up-to months, leading to the peak performance phase.[3,4] This strategy is mainly used to improve strength and power among athletes who are particularly associated with weightlifting, sprinting, and other similar sporting activities that require sudden bouts of energy.[5,6] Various forms of periodisation for athletic training since then have been established, including block periodisation, reverse periodisation, and linear periodisation, with one thing common among them, and that is to achieve peak performance in athletes before the final event.[7-9] Periodisation can easily be performed by varying training volumes and intensities during off-season training session camps organised for athletes and is guided with the impression of preparing athletes for an upcoming event.[10]

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As the traditional periodisation approach is based on high-volume and low-intensity training with a progressive increase in training intensities and decrease in volume, the modern approach is based on the concept of intensities and low-volume training.[11] According to the modern periodisation technique, the reverse approach prevents athletes from associated high-intensity training injuries that they may encounter during the training season while moving close to the main events. Besides that, for the training of sports events like swimming and rowing and improving muscular endurance, studies have suggested that the reverse periodisation approach has yielded better results.[12] Moreover, an essential key factor for the athletic training is efficiency, and studies have also found the reverse periodic training approach as a time-effective one.[13]

The basic principle behind the concept of periodisation is as same as the principles of training: Overloading, specificity, intensity, and volume. The only approach is to use these principles cyclically to achieve peak athletic performance.[14] Variations in the parameters of frequency, intensity, time, and type (FITT) can bring changes in periodisation to prevent fatigue and over-reaching daily and weekly. They, hence, can contribute vitally to achieve the peak performance.[15] As the peak performance is an important indicator to identify the optimal functioning of athletes to perform at the highest level, the training to achieve peak performance before actual events increase the chances of an athlete performing well in the main events. Therefore, the present study has aimed to identify the impact of various periodisation approaches used in the training of athletes and to identify the effect size of the periodis-

ation technique in improving athletes' peak performance before the main event.

METHODOLOGY

Various databases such as Google Scholar, PeDro, MEDLINE, Cochrane Library, EMBASE, and Web of Science were searched by independent reviewers using the MeSH terms such as 'interval training', 'aerobic exercise', periodisation', 'peak performance', and 'athletes' to obtain studies on effects of periodisation in training methodology.

Inclusion criteria comprised the recruitment of all those studies in which the effects of periodisation training were identified on athletes' peak performance for speed tests and jump length. All studies meeting the inclusion criteria and conducted from 2010 to 2023 were included. Two reviewers used the predetermined method to find studies. The meta-analysis was performed according to the Guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Figure 1).

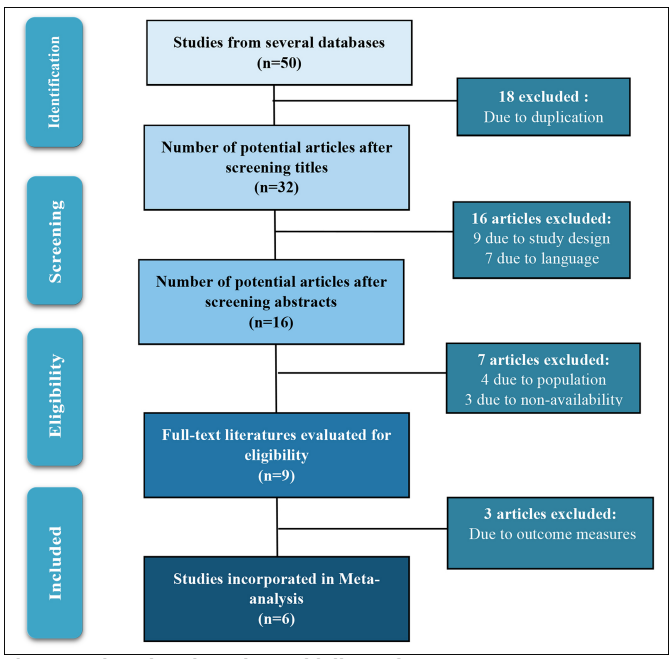

Figure 1: Flow chart based on guidelines of PRISMA.

Trials based on training protocol other than the basic concept of periodisation training, articles not available in the English language, and studies for which open accesses were not reachable even after emailing the corresponding authors, were excluded from this meta-analysis. A data mining form was designed to extract study information, such as author's name, publication year, targeted population, and treatment duration (Table I).

The Cochrane tool's parameters were used for risk of bias assessment of included studies.[16] Allocation was performed based on randomisation and concealing, blinding (participation and outcome) data assessment (incomplete and selective reporting), and biases of other types based on the author's judgement.

MedCalc statistical software version 20.112 was used for quantitative analysis. The continuous measure analysis was performed to determine the pooled effect based on the standardised mean difference (SMD) at 95% CI. The effect size was estimated using Cohen's rule of thumb, which categorised an effect size on three parameters: A small effect size if the values of SMD lied within the range of 0.2 to 0.5; moderate if the values found within the range of 0.5 to 0.8, and larger if the values found to be greater than 0.8. The level of heterogeneity and value of I^2 was used in order to interpret based on random and fixed effect models ($I^2 \leq 50$ fixed effect, $I^2 \geq 50$ random effect).

RESULTS

A total of n = 50 articles were retrieved in the initial search from six databases. After screening titles, n = 18 was excluded due to duplication, and n = 32 articles were left for further evaluation. After screening the abstract, n = 15 studies were found relevant for full-text articles. Finally, after further screening, only n = 6 studies that met the inclusion criteria were included in the study.

A sample size of n = 121 participants included in six studies were analysed in which the effects of periodisation methods of training among athletes were estimated in improving their peak performance by assessing jump height and speed and pool effects in the form of random and fixed effect models were provided to depict cumulative results of all the included studies.

The analyses of the findings revealed a positive increase in the cumulative effect of vertical jump height as estimated on SMD = 1.537 on random effect model I^2 = 90.28%. The increase in the cumulative jump height as observed by the studies was found to be significant (p = 0.039), hence suggesting a positive impact of the periodisation method of training protocol in improving the peak performance in the form of vertical jump height among athletes (Table II, Figure 2a).

The findings revealed a non-significant effect (p = 0.56) periodisation training in improving speed (SMD = -0.105), hence suggesting that the periodisation method of training had no significant difference in improving speed among athletes. Moreover, the test for heterogeneity suggests a low percentage of inconsistency (I^2 = 20.98%) among the studies and therefore, fixed effect was used to interpret the cumulative effects of the findings for the speed test (Table III, Figure 2b).

Judgement of risk of biased analysis on the guidelines of Cochrane based on the author's judgement was performed as illustrated in Table IV. The randomisation sequence analysis suggested that all the six studies revealed a low risk of biasness.[17-22] All studies under this parameter revealed a low risk of biasness as per the author's judgement.[17-22] Three studies considered the participant's blinding,[18-20] whereas two studies reflected high risk,[21,22] and one study showed unknown risk of blinding.[17] No study showed any bias towards incomplete outcome data.[17-22] All studies reflected low bias risk towards reporting selection bias.[17-22]

Table I: Description of studies incorporated for the purpose of meta-analysis.

Author and year of publication	Sample size	Target population	Age range/ average age in years	Intervention		Outcome
				Intervention Group	Control Group	
Ishida *et al.*[17] 2021	CG = 8 EG = 9	Soccer players	19.6 ± 1.6 years	Block periodisation	Active individuals	Speed test
Clemente *et al.*[18] 2019	CG = 13 EG = 11	Triathlon athletes	27.7 ± 5.7 years	Traditional periodisation	Physically active individual	Jump length speed test
Harries *et al.*[19] 2018	CG = 10 EG = 8	Rugby union athletes	15 - 18 years	Linear periodisation	Undulating periodisation	Jump length speed test
Barbalho *et al.*[20] 2018	CG = 11 EG = 12	Soccer players	18 - 20 years	Block periodisation	Conventional soccer training	Jump length speed test
da Silva *et al.*[21] 2016	CG = 7 EG = 8	Skydivers athletes	18 - 50 years	Daily non-linear periodisation	Control Group	Jump length speed test
Bartolomei *et al.*[22] 2014	CG = 12 EG = 12	Rugby athletes	24.2 ± 3.1 years	Block periodisation	No periodisation	Jump length

EG, Experimental group performed interval training exercises. CG, Control group performed continuous exercises or no exercises.

Table II: Analysis of fixed and random effects model on SMD for vertical jump height.

Study	N1	N2	Total	SMD	SE	95% CI	t	p	Weight (%)	
									Fixed	Random
Clemente *et al.*[18]	11	13	24	0.00452	0.396	-0.816 to 0.825			30.49	21.44
Harries *et al.*[19]	8	10	18	1.378	0.507	0.304 to 2.452			18.58	20.61
Barbalho *et al.*[20]	12	11	23	5.994	0.971	3.975 to 8.014			5.06	16.32
da Silva *et al.*[21]	8	7	15	1.503	0.559	0.296 to 2.711			15.26	20.18
Bartolomei *et al.*[22]	12	12	24	-0.141	0.395	-0.960 to 0.677			30.62	21.44
Total (fixed effects)	51	53	104	0.747	0.218	0.313 to 1.180	3.419	0.001	100.00	100.00
Total (random effects)	51	53	104	1.537	0.734	0.0813 to 2.992	2.094	0.039	100.00	100.00
Test for heterogeneity										
Q	41.1707									
DF	4									
Significance level	p <0.0001									
I^2 (inconsistency)	90.28%									
95% CI for I^2	80.22 to 95.23									

Table III: Analysis of fixed and random effects model on SMD for speed test.

Study	N1	N2	Total	SMD	SE	95% CI	t	p	Weight (%)	
									Fixed	Random
Ishida *et al.*[17]	9	8	17	0.422	0.467	-0.573 to 1.417			17.89	18.39
Clemente *et al.*[18]	11	13	24	-0.193	0.397	-1.015 to 0.629			24.79	23.72
Harries *et al.*[19]	8	10	18	-0.685	0.466	-1.672 to 0.303			17.96	18.45
Barbalho *et al.*[20]	12	11	23	-0.424	0.407	-1.270 to 0.423			23.52	22.79
da Silva *et al.*[21]	8	7	15	0.519	0.496	-0.553 to 1.591			15.84	16.65
Total (fixed effects)	48	49	97	-0.113	0.197	-0.505 to 0.279	-0.571	0.569	100.00	100.00
Total (random effects)	48	49	97	-0.105	0.223	-0.547 to 0.338	-0.470	0.640	100.00	100.00
Test for heterogeneity										
Q	5.0619									
DF	4									
Significance level	p = 0.2810									
I^2 (inconsistency)	20.98%									
95% CI for I^2	0.00 to 66.59									

Table IV: Assessing risk of bias using a Cochrane collaboration's tool.

Study	Random allocation	Allocation concealment	Participants blinding	Outcome assessment blinding	Incomplete outcome data	Selective reporting
Ishida *et al.*[17] 2021	+	+	?	?	+	+
Clemente *et al.*[18] 2019	+	+	+	+	+	+
Harries *et al.*[19] 2018	+	+	+	+	+	+
Barbalho *et al.*[20] 2018	+	+	+	+	+	+
da Silva *et al.*[21] 2016	+	+	-	-	+	+
Bartolomei *et al.*[22] 2014	+	+	-	-	+	+

−, Bias at high risk. +, Low risk bias. ?, Unknown risk of bias.

To identify publication biased Egger's and Beggs's tests were performed separately for each of the two outcomes that were the vertical jump and speed test that revealed a publication bias among the studies for the vertical jump test where the values of Egger test were found significant p <0.0004 (Intercept = 10.51, 95% of CI, 8.58-12.44, Figure 2c) and for speed test no publication biases were observed among the studies (p = 0.3, Intercept = 5.97, 95% of CI -12.25 to 24.20, Figure 2d).

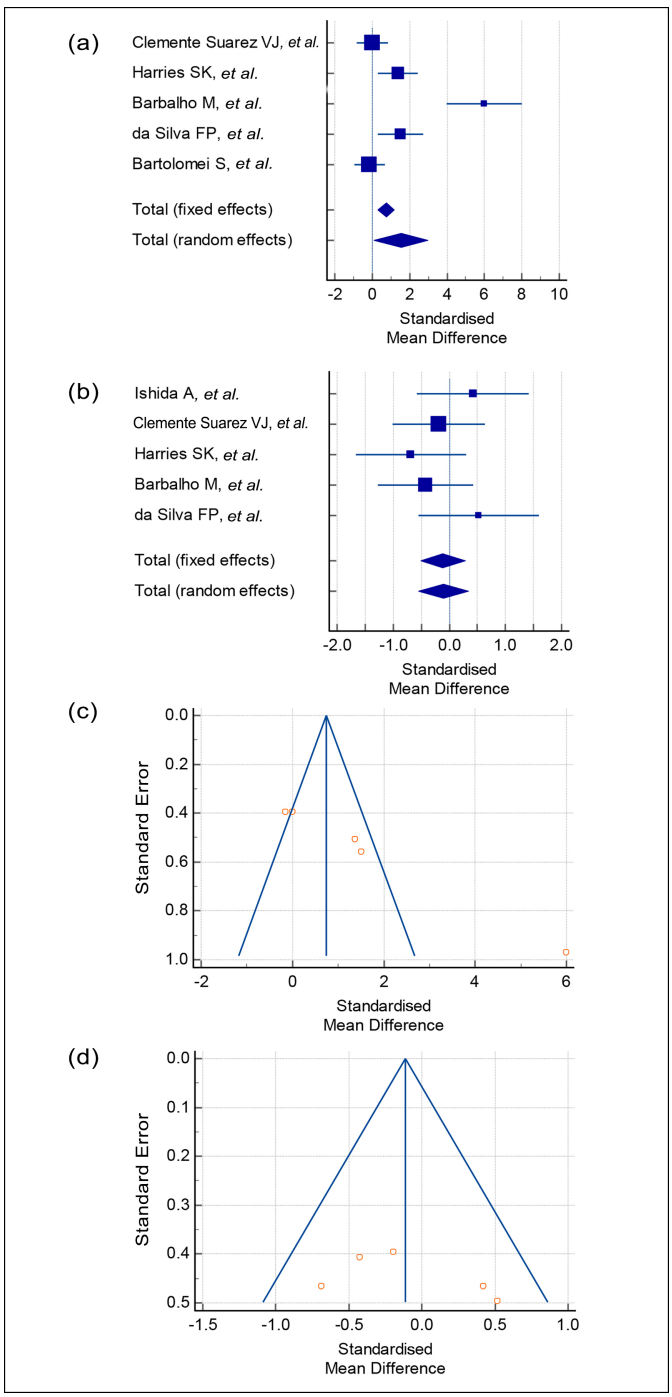

Figure 2: (a) Forest plot showing effect size for vertical jump. (b) Forest plot showing effect size for speed test. (c) Funnel plot showing publication bias for vertical jump test. (d) Funnel plot showing publication bias for speed test.

DISCUSSION

The findings of the current meta-analysis have revealed that the periodisation approach during athletes' training has an influential role in improving the peak performance, yet not all factors of peak performance can significantly increase while incorporating the periodisation approach. In this meta-analysis, the authors have identified the impact of various forms of periodisation techniques including linear, traditional, reversed, and block periodisation training approaches, in improving vertical jump heights and speed. It was found that the periodisation training approach has a significant impact (p = 0.039) on vertical jump height. In contrast, no significant SMD difference (p = 0.56) between the experimental and control groups has been observed on the peak performance of the speed-test. The findings, hence, suggested the fact that although periodisation is considered an approach to improve peak performance in athletes yet, optimisation at all the levels of athletic events cannot be guaranteed.[17-22] The individual exploration of the studies included in the current meta-analysis has revealed that in the peak performance of improving vertical jump height, the periodisation has shown positive effects however, funnel plot revealed publication bias in two of the included studies,[20,22] where one of the studies has shown a positive SMD = 5.9 (95% of CI 3.975 to 8.014) beyond 95% of CI of funnel plot towards the right side of the arm 20, and second study has shown an SMD = -0.14 (95% of CI -0.960 to 0.677) crossing the limits of left arm of the forest plot favouring controlled over the experimental group.[22] A study by Balrbalho *et al.*, depicting a significant increase (p <0.005) in vertical jump height in comparison to the control group could be due to the reason that periodisation was focused on resistance training protocol that has greatly increased muscular power; therefore author's in the study has specifically found an increase in vertical jump height and no improvement in sprint velocity and agility.[20] As the focus of periodisation in this study was mainly to improve the muscular strength over muscular endurance, the same has been depicted in the study's findings.[20] The second study in the vertical jump group that has shown a publication bias was Bartolomei *et al's* study. The findings of this study have favoured control over experiment and the possible reason could be the methodology of the study in which one group has been trained with the concept of linear progression and the second group has maintained the same volume and intensity, thereby shadowing the concept of continuous progression; therefore, the study has shown certain conflicting findings.[22] In estimating the peak performance of athletes in terms of speed test, all the studies that are included in the analysis have shown findings within the range of 95% publication bias, as observed in the funnel plot, with no significant effect in SMD, hence suggesting similar results with I^2 = 20.98% inconsistency.[17-21] Although the concept of periodisation in the training of athletes is a crucial component in achieving optimisation in peak performance, it must be noted that it should be specific to sporting events as periodisation lacks the principle of specificity and other characteristic

features of the principle of training would yield no results beyond wasting of time and energy of athletes and trainers.

CONCLUSION

The findings of this meta-analysis have revealed that in achieving optimisation in the peak performance of athletes inculcating the concept of periodisation is an effective approach and while incorporating periodisation in training, models of principles of training must be given ardent importance to get the effective results.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
KY: Drafting and framework, acquisition of the data, and analysis.
AK: Interpretation and critical revision for the important intellectual content.
Both authors approved the final version of the manuscript to be published.

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