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Research Article

Effect of Training Periodisation on Anthropometric Variables of Men and Women Elite Indian Wushu Taolu Players

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Abstract

Training periodisation is a systematic approach to organising training into distinct phases, each with specific goals to optimise performance and avoid plateaus by managing fatigue and varying training intensity and volume over time. This structured method helps prevent overtraining by incorporating essential rest and recovery periods, which support physical adaptation and reduce injury risk but also impact key anthropometric and body composition parameters—vital for assessing an athlete's physical status and tailoring training programs effectively by influencing body composition metrics such as fat mass (FM), total body fat percentage (TBF), fat-free mass (FFM), skeletal muscle mass (SMM), and bone mass (BM), which are essential markers of an athlete's physical readiness and development. This study aimed to examine the effect of periodisation through the four training phases on anthropometric and body composition variables in elite Indian men and women Wushu Taolu players. Thirty elite Wushu Taolu athletes (20 men and 10 women) were monitored over four training phases: General Preparatory Phase (GPP), Specific Preparatory Phase (SPP), Pre-Competitive Phase (PCP), and Competitive Phase (CP) of their training macro-cycle. The study followed a longitudinal observational design with repeated measures and statistical analysis to determine changes across training stages and between genders. This study demonstrates a positive response to training periodisation, highlighting its effectiveness in optimising body composition and physical preparedness in elite Taolu Wushu players. The reductions in total body fat percentage (TBF) and increases in skeletal muscle mass (SMM) across men and women players indicate that periodisation supports targeted improvements in athletic metrics critical to performance. The relatively stable body mass, alongside gains in fat-free mass (FFM), particularly in men players, further underscores the benefits of a structured training approach, confirming that training periodisation effectively enhances body composition while managing fatigue and avoiding overtraining.

Keywords: Training Periodisation, Anthropometric Variables, Wushu Taolu, Elite Athletes, Body Composition

Introduction

Wushu is a comprehensive form of traditional Chinese martial art [1]. The performance aspect of Wushu is represented by Taolu, which uses choreographed forms to highlight the practitioner's talent and the discipline's extensive past [2,3]. Focusing on accuracy, fluidity, and creative expression complements the combat-focused Sanda. Empty-Hand Forms of Taolu encompasses a range of movements that show stances, kicks, strikes, and jumps. Practitioners perform these sequences to demonstrate their technical mastery, control, and balance. In Weapon Forms of Taolu, traditional weapons like the staff (gun), sword (jian), and saber (dao) are also used in Taolu practices. In Chinese martial arts, these displays showcase fighting prowess and the aesthetic and cultural value of traditional weapons. Practitioners are judged in Taolu competitions based on several standards that represent both artistic expression and technical skill. Fluidity and control are crucial for exhibiting seamless transitions between movements, while technical proficiency is evaluated on the precision and accuracy of the techniques used. Since competitors must demonstrate their strength and quickness throughout their routines, speed and power are also essential. Furthermore, judges take into account the practitioner's poise and expression, as well as the overall quality of the performance, which results in an engaging demonstration of martial arts [3-5].

Macrocycle periodisation is a long-term training approach, typically lasting several months to a year, divided into preparatory, competitive, and transition phases. Each phase targets specific goals like building strength, endurance, or skill. This structured method helps athletes peak at the right time, supports performance modelling through data analysis, and informs the timing and type of fitness tests. It also helps prevent overtraining, enhances recovery, and improves motivation. Overall, periodisation optimises training and performance outcomes [6]. Monitoring this cycle is crucial for athletes.

Multiple studies confirm that systematic periodisation impacts body composition, primarily by reducing fat mass and increasing skeletal muscle mass over time [7]. Some important anthropometric markers of an athlete's physical condition are body mass, body fat percentage, skeletal muscle mass, and fat-free mass. These factors are utilised to track training progress and preparedness in addition to influencing biomechanical efficiency and movement economy [8]. Agility, power-to-weight ratio, and technical execution are all closely linked to the ideal body composition in combat sports, such as Wushu [9]. Because of hormonal and physiological variations, men and women athletes frequently react differently to similar training loads. Although both sexes can increase their muscle mass and decrease their body fat percentage, the rate and degree of change differ, with men often exhibiting more noticeable hypertrophic reactions [10].

Periodised training has been shown to be beneficial in several sports, but little research has been done on how it affects Indian Wushu competitors, especially when looking at gender-comparative studies. Coaches and sports scientists may be able to create more efficient, customised training plans if they better understand how organised training affects anthropometric characteristics in both men and women athletes across training phases.

In order to evaluate the impact of training periodisation on important anthropometric and body composition metrics during four training phases in elite Indian men and women Wushu Taolu players, the current study was conducted. By offering evidence-based insights into gender-specific adaptations to structured training, this study aims to close the gap in the literature and eventually contribute to more advanced training techniques in Indian martial arts.

Materials and Methods

Since it tackles explicitly the practical difficulties elite Indian Wushu Taolu athletes experience in maximising their physical preparedness for important national and international events, this study qualifies as applied research. The study intends to provide practical insights that enhance the physical conditioning and preparation of athletes competing in events like the Asian Games, World Wushu Championships, and National Games of India by concentrating on the effects of structured training periodisation on anthropometric and body composition variables. The main goal is to convert periodisation theory into research-based training methods that improve the physical characteristics required for elite Taolu performance.

Through the use of an experimental research methodology, training stages were methodically carried out and observed throughout an entire macro-cycle. This study exclusively focuses

on Taolu experts, focusing on both men and women athletes, rather than comparing various event groupings (such as Sanshou and Taolu). The General Preparatory Phase (GPP), Specific Preparatory Phase (SPP), Pre-Competitive Phase (PCP), and Competitive Phase (CP) were the steps that participants followed in a systematic order. Body mass, BMI, fat mass, total body fat percentage, fat-free mass, skeletal muscle mass, and bone mass were among the anthropometric and body composition data that were documented at each stage. This design provides a strong foundation for assessing how well macro-cycle planning shapes important physiological variables by allowing the evaluation of cause-and-effect links between periodised training and physical changes.

Thirty top-tier Indian Wushu Taolu athletes—ten women and twenty men—actively participating in national competitions, were the subjects of the study. The selection of participants was based on their representation in national or inter-university championships and their regular involvement in accredited training programs. Men and Women participants averaged (mean ± Standard deviation) years, respectively, 22.35 ± 2.94, 21.8 ± 3.99 years.

To provide a thorough examination of this combative sport, both men and women national-level Wushu players were included in this study. The 19-28 age range has been established as the inclusionary range. In order to collect data from people who are often at the prime of their athletic careers and going through important developmental and performance periods, this particular age group was chosen. Additionally, athletes and their coaches have given their express agreement to take part in the study, guaranteeing that the participant and their support networks have been fully informed of and supportive of the research involvement. A minimum condition for National degree participation was to be at least five years of training age in order to ensure that participants had an appropriate level of experience and expertise. By ensuring that the sample included athletes with significant experience and participation in competitive Wushu, this criterion enhanced the validity and comprehensiveness of the study's conclusions.

The study eliminated athletes who were not actively participating in the authorised camps or training sessions, did not fall within the age range, or had not gained the necessary amount of competitive experience.

To uphold ethical standards and guarantee the integrity of the research process, participants who were unable to give consent or whose coaches did not consent were also eliminated. Using these standards, the study concentrated on a specific appropriate group of Wushu athletes, improving the precision and relevance of the findings.

A longitudinal observational research design was employed, wherein athletes were evaluated across four structured phases of a complete training macro-cycle: General Preparatory Phase (GPP), which focused on developing a broad physical base through aerobic conditioning, flexibility, and general strength training. Athletes engaged in bodyweight exercises, dynamic stretching, and fundamental Wushu techniques to enhance stamina, agility, and motor control. Specific Preparatory Phase (SPP) emphasises Wushu-specific skill refinement, including advanced Taolu routines and weapon techniques. Training included plyometric drills, technical precision work, and form execution to improve coordination, balance, and explosive power. Pre-Competitive Phase (PCP) simulated competition scenarios to build psychological readiness and strategic execution. Athletes practise full routines under fatigue, engage in mock contests, and participate in tactical sessions combined with high-intensity interval training (HIIT) and Competitive Phase (CP), mainly focused on maintaining peak performance with reduced training volume but sustained intensity. Emphasis was placed on recovery, mental preparation (e.g., visualisation), technical sharpening, and regeneration strategies such as stretching and proper nutrition.

Results and Discussion

Understanding these changes can help tailor training programs to optimise performance and reduce fatigue, particularly during the crucial competitive phase, as described in Table 2. The data in Table 2 outlines the descriptive statistics for anthropometric components measured during four training phases (General preparatory phase or GPP, Specific Preparatory Phase or SPP, Pre-competitive Phase or PCP, and Competitive Phase or CP) of the training macrocycle for both men and women Taolu Wushu players. This table provides insights into changes in various parameters, including age, standing height, body mass and basal metabolic rate (BMI) across different training phases. The age of Taolu men was consistent at 22.35 years with a standard deviation (SD) of 2.94

across all phases. Their standing height remained stable at 167.9 cm with an SD of 4.53. Body mass slightly fluctuated, increasing from 60.14 kg in GPP to 60.27 kg in SPP, then decreasing to 59.86 kg in PCP and 59.41 kg in CP, with standard deviations (SD) of 4.6, 4.35, 4.01, and 3.99, respectively. The Basal Metabolic Rate (BMI) of the Taolu men remained relatively constant, averaging 21.36 kg/m^2 with SD 1.87 in GPP and declining slightly to 21.08 kg/m^2 with SD 1.4 in CP. Despite being modest, these decreases show an improvement in lean body composition, which is probably due to increased muscle mass and/or fat loss, as evidenced by later body composition data. The modest rise in body mass (60.27 kg) during SPP might be the result of hypertrophic adaptations prior to the subsequent decline in fat mass. Improved strength-to-weight ratio and metabolic efficiency, which are essential for dynamic and acrobatic Taolu performances, are reflected in the declining trend in BMI.

S No.	Variables	Equipment
1	Standing Height (m)	Analog Stadiometer
2	Body Mass (kg)	Tanita DC-430MA III
3	TBF (%)	
4	SMM (%)	
5	Bone Mass (kg)	
6	BMI (kg/m^2)	Formula by WHO

Table 1: Parameters, Equipment used for Monitoring during Phases of Training Macro-cycle.

Event	Gender	Training Phase	Age (in Years)	Standing Height/ ht.(cm)	Body Mass/wt. (kg)	Basal Metabolic Rate/BMI (kg/m^2)
Taolu	Men	GPP	22.35 ± 2.94	167.9 ± 4.53	60.14 ± 4.6	21.36 ± 1.87
		SPP	22.35 ± 2.94	167.9 ± 4.53	60.27 ± 4.35	21.41 ± 1.74
		PCP	22.35 ± 2.94	167.9 ± 4.53	59.86 ± 4.01	21.25 ± 1.55
		CP	22.35 ± 2.94	167.9 ± 4.53	59.41 ± 3.99	21.08 ± 1.4
	Women	GPP	21.8 ± 3.99	157.1 ± 4.53	51.98 ± 4.86	21.02 ± 1.1
		SPP	21.8 ± 3.99	157.1 ± 4.53	51.84 ± 4.91	20.96 ± 1.12
		PCP	21.8 ± 3.99	156.7 ± 4.22	51.08 ± 4.77	20.76 ± 1.16
		CP	21.8 ± 3.99	157.1 ± 4.53	51 ± 4.82	20.62 ± 1.1
GPP - General Preparatory Phase SPP - Specific Preparatory Phase PCP - Pre-Competitive Phase CP - Competitive Phase						

Table 2: Descriptive Statistics for Anthropometric Components Estimated during All Four Training Phases (GPP, SPP, PCP and CP) of Training Macro-cycle for Men and Women Taolu Wushu Players (n = 30).

The age of Taolu women consistently averaged 21.8 years with a standard deviation (SD) of 3.99 throughout all phases. Their standing height remained stable at approximately 157.1 cm with an SD of 4.53. Body mass decreased from 51.98 kg in GPP to 51.84 kg in SPP, further declining to 51.08 kg in PCP and ending at 51 kg in CP, with standard deviations (SD) of 4.86, 4.91, 4.77, and 4.82, respectively. The Basal Metabolic Rate (BMI) showed a slight decline from 21.02 kg/m^2 with SD 1.1 in GPP to 20.62

kg/m^2 with SD 1.1 in CP. The decreased trend across phases indicates consistent improvements in body composition, even if the decreases in body weight and BMI were not as noticeable as those seen in men athletes. Despite gender-based variations in hormonal and metabolic responses, this pattern highlights how well the periodised training approach works to produce desired physiological adaptations in both sexes.

The anthropometric shifts that have been observed are consistent with the periodisation concepts that are frequently used in combat sports, where players tend to improve their body composition as they move from training to competition. The steady decrease in body mass and BMI points to deliberate power-to-weight ratio optimisation, which is essential for Taolu Wushu's explosive and technical movements. The comparatively small changes in body mass (1.21% for men and 1.89% for women) suggest that weight control techniques are being adequately managed, which may reduce non-functional mass while maintaining muscle integrity. As weight-cutting techniques used in weight-category combat sports can vary from 5 to 10% of body mass, which is in contradiction to this strategy [11,12]. Our study's moderate weight modifications are more in line with the regulated periodisation techniques that are detailed in their examination of Chinese Wushu Taolu athletes. Our results on gender differences—women athletes show somewhat more relative weight loss than men athletes. These discrepancies might be the result of gender-specific training responses or physiological adaptations unique to the sport, as some of the studies have also observed in other combat sports [13,14].

The declining variability in men's BMI values during training phases points to a convergence towards an ideal competitive body composition as athletes get closer to competition. This decrease in anthropometric variation might be a fine-tuning process that maximises both the biomechanical efficiency and aesthetic presentation that are essential to Taolu success.

In contrast to more drastic weight-loss strategies used in other combat sports, the slight adjustments made in our study probably maintain proper energy availability, which is a crucial factor that emphasises preserving performance and health [15-18]. These alterations' gradual character is consistent with some research, which showed that, when appropriately managed, moderate weight loss does not negatively affect athletic performance [19]. These results emphasise the normal size and pattern of anthropometric changes that accompany a planned training macro-cycle in elite performers, which is helpful information for coaches and sports scientists working with Taolu Wushu athletes.

The data in Table 3 outline the descriptive statistics for parameters of body composition estimated during all four training phases (GPP, SPP, PCP and CP) of training Macro-cycle for men and women Taolu Wushu players. For Taolu men, fat mass decreased from 7.21 kg (± 2.32) in GPP to 4.98 kg (± 1.14) in CP, with total body fat percentage dropping from 11.83% (± 3.19) to 8.34% (± 1.68) across the training phases. Fat-free mass showed a slight increase from 52.93 kg (± 3.27) in GPP to 54.43 kg (± 3.44) in CP. Skeletal muscle mass fluctuated, peaking at 31.23 kg (± 2.09) in CP. Bone mass remained stable at approximately 2.89 kg (± 0.2) throughout. In Taolu women, fat mass decreased from 11.13 kg (± 1.19) in GPP to 9.91 kg (± 1.23) in CP, while total body fat percentage dropped from 21.4% (± 1.04) to 19.44% (± 1.51) over the phases. Fat-free mass exhibited minor fluctuations, with averages of 40.85 kg (± 3.82) in GPP and 41.09 kg (± 4.0) in CP. Skeletal muscle mass varied, reaching 23.06 kg (± 2.48) in CP, while bone mass remained consistent at around 2.43 kg (± 0.32). Taolu men's SMM% progressed to 52.6%, and women's increased from 43.25% to 45.17%, indicating improved muscle composition with stable bone mass. Overall, these findings highlight that Taolu Wushu players undergo significant changes in body composition, characterized by reduced fat mass and increased muscle mass across training phases. These adaptations suggest optimized training programs that enhance physical performance, especially leading into competition, providing valuable insights for coaches and trainers in refining training strategies.

Training periodisation for Wushu athletes efficiently optimises body composition parameters, resulting in improved performance, as demonstrated by statistical analyses employing Kruskal-Wallis and Pearson correlation tests. These techniques attest to the fact that organised training cycles greatly enhance the physical characteristics associated with competitive performance. For each of the four training phases—General Preparatory Phase (GPP), Specific Preparatory Phase (SPP), Pre-Competitive Phase (PCP), and Competitive Phase (CP)—the graph displays changes in body

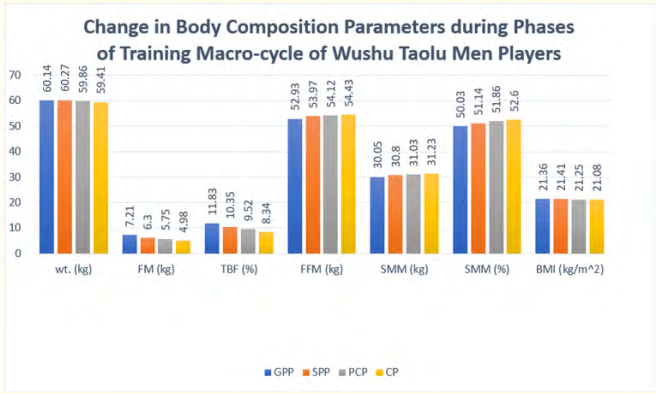

Figure 1: Changes in Men Athletes' Body Compositions through the Phases of Training Macro-cycle.

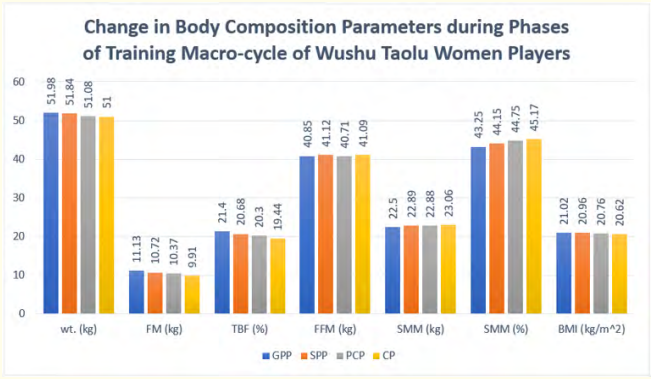

Figure 2: Changes in Women Athletes' Body Compositions through the Phases of Training Macro-cycle.

Event	Gender	Training Phase	Fat Mass/FM (kg)	Total Body Fat/TBF (%)	Fat-Free Mass/FFM (kg)	Skeletal Muscle Mass/ SMM (kg)	Skeletal Mus-cle Mass/ SMM (%)	Bone Mass/ BM (kg)
Taolu (n = 30)	Men (n = 20)	GPP	7.21 ± 2.32	11.83 ± 3.19	52.93 ± 3.27	30.05 ± 2.11	50.03 ± 2.22	2.89 ± 0.2
		SPP	6.3 ± 1.96	10.35 ± 2.7	53.97 ± 3.34	30.8 ± 2.16	51.14 ± 1.59	2.91 ± 0.21
		PCP	5.75 ± 1.67	9.52 ± 2.38	54.12 ± 3.16	31.03 ± 2.04	51.86 ± 1.72	2.92 ± 0.2
		CP	4.98 ± 1.14	8.34 ± 1.68	54.43 ± 3.44	31.23 ± 2.09	52.6 ± 1.75	2.92 ± 0.2
	Women (n = 10)	GPP	11.13 ± 1.19	21.4 ± 1.04	40.85 ± 3.82	22.5 ± 2.38	43.25 ± 0.87	2.43 ± 0.32
		SPP	10.72 ± 1.13	20.68 ± 0.94	41.12 ± 3.91	22.89 ± 2.28	44.15 ± 1.07	2.43 ± 0.32
		PCP	10.37 ± 1.06	20.3 ± 0.95	40.71 ± 3.87	22.88 ± 2.38	44.75 ± 0.69	2.39 ± 0.32
		CP	9.91 ± 1.23	19.44 ± 1.51	41.09 ± 4	23.06 ± 2.48	45.17 ± 0.96	2.42 ± 0.33
GPP - General Preparatory Phase SPP - Specific Preparatory Phase PCP - Pre-Competitive Phase CP - Competitive Phase								

Table 3: Descriptive Statistics for Parameters of Body Composition Estimated during All Four Training Phases (GPP, SPP, PCP and CP) of Training Macro-cycle for Men and Women Taolu Wushu Players (n = 30).

composition for the Taolu men and Taolu women Wushu athlete groups. Weight (Wt.), total body fat (TBF), fat-free mass (FFM), skeletal muscle mass (SMM), bone mass (Bm), and body mass index (BMI) are important metrics that are monitored. Each of these metrics shows unique patterns during the macro-cycle stages.

Athletes' adjustment to the varying demands of each phase is demonstrated by the weight changes. In combat sports, weight is usually tracked to ensure it matches performance objectives. TBF reduction is frequently targeted in order to improve athletic performance, especially as athletes move from GPP to CP. Better power-to-weight ratios, which are essential in combat sports, are correlated with lower TBF. Muscle growth and general fitness are shown by both metrics. In order to enhance strength and endurance, increases in FFM and SMM are typically targeted during the preparatory stages, peaking prior to the competition. As a result of the constant support needed for physical activity during the training periods, bone mass stays comparatively constant. BMI changes are a generalised measure of changes in body composition, following general weight patterns. For Wushu athletes, the four-phase macro-cycle enables strategic body composition control. Achieving optimal performance during the competition phase requires understanding how each phase affects weight, body fat, muscle mass, and other metrics. Adjustments for Body Fat and Weight: Combat athletes strive to maximise their body fat and weight in order to maintain strength and improve their speed and agility. Taolu athletes exhibit notable drops in TBF from the GPP to CP in the graph. This is in line with research, which stresses that maintaining lean mass and reducing body fat must be balanced in combat sports in order to sustain physical strength and performance effectiveness [20]. Athletes with optimal body composition measurements, such as reduced TBF, also tend to have superior physical capacities, such as strength and endurance, which are crucial in combat scenarios [21]. Muscle Mass Development: Throughout the preparation stages, especially from the GPP to the PCP, where the emphasis is on building strength and functional muscle for improved performance, increases in FFM and SMM are evident. Some studies show that combat sports require a balance between muscular growth and endurance, which affects the athletes' power-to-weight ratio, and are consistent with this tendency [22]. Skeletal muscle and fat-free mass are important, as maintaining muscle mass is essential when losing weight, particularly as one approaches the competitive stage [23]. The idea that having well-developed skeletal muscle mass improves performance in explosive, dynamic sports like Wushu is supported by the SPP and PCP, which place an emphasis on raising FFM and SMM while lowering body fat. Impact of Phases on Body Composition: The GPP places a strong emphasis on general conditioning, which is demonstrated by modest gains in muscle mass and a decrease in the proportion of body fat in all athlete groups. More noticeable changes occur during the SPP and PCP phases, with a focus on increasing muscle mass and decreasing body fat, both of which are essential for performance optimisation. Weight stabilisation and muscle mass maintenance with little body fat are characteristics of the PCP to CP transition, as seen in the graph. This supports the study which shows that combat athletes frequently use regulated weight loss techniques to maximise their preparedness for competition without compromising the integrity of their muscles [24].

Conclusion

This study shows that elite Wushu Taolu athletes' body composition may be efficiently optimised through systematic training periodisation. Men competitors had notable gains in body fat percentage (11.83% to 8.34%) and fat mass (7.21 kg to 4.98 kg), while improving their fat-free mass (52.93 kg to 54.43 kg). Women athletes also benefited from lower body fat percentages (21.4% to 19.44%) and fat mass (11.13 kg to 9.91 kg), as well as higher percentages of skeletal muscle mass (43.25% to 45.17%). In contrast to severe weight-cutting, which is typical in combat sports, the mild weight alterations (1.21% for men and 1.89% for women) indicate a more regulated approach that may better preserve muscular integrity while maximising power-to-weight ratios, which are essential for Taolu performance.

Future studies ought to look at long-term adaptations over several competitive seasons, link anthropometric changes to particular performance metrics, incorporate hormonal and metabolic evaluations, examine the effects of nutritional interventions, track recovery indicators, compare the effects of periodisation across various combat sports, use cutting-edge measurement technologies, and investigate psychological correlates of changes in body composition. Given that women athletes exhibited differing rates of adaptation than men athletes, coaches ought to employ gender-specific, organised, four-phase

periodisation programs. Instead of focusing on drastic weight loss, programs should encourage gradual, moderate weight control (1-2% body weight). To ensure that training responses are adequate, it is crucial to regularly check important variables, especially TBF%, SMM%, and FFM. Nutritional strategies should be in line with training phases, with a focus on protein for building muscle and careful energy management for body composition optimisation. For elite Wushu Taolu performance, these results offer evidence-based recommendations for periodised training that maximises body composition.

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