

The Load and Repetition Effects of High Volume Circuit Resistance Training Periodization on The Continuum Strength-Endurance Methodology

Yüksek Hacimli Dairesel Direnç Antrenman Periyodizasyonunun Sürekli Kuvvet-Dayanıklılık Metodolojisi Üzerindeki Yük ve Tekrar Etkileri

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Abstract

Circuit resistance training is one of the high load and short time rest regimes for maximize performance. This training condition was not performed in high volume (%60-75-90-1RM) strength-endurance continuum according to multiple set load and repetition setting, single training volume determined. The aim of the study was to investigate the load and repetition effects of high volume circuit resistance training periodization, to maximize the level of strength and endurance in muay thai athletes by providing load and repetition periodization development. Muay thai athletes 12 participated in resistance training at 75% 1RM volume and performed multiple set, relative endurance (%60-1RM), absolute endurance (%70-1RM) and potential muscle power (%85-1RM) repetition maximum trials performed during 3 weeks of periodization and 6 training sessions. The maximum strength performance outcomes were increased at (9-13% - 1RM%), whereas to low-medium-high load and repetition exercises were (<10% and rep= <7%) reported to short term circuit resistance periodization. The study outcomes promote maximal load and repetition, therefore, short-term high-volume circuit resistance training periodization was the primer strength gain and neuromuscular adaptation for improving manipulation load and repetition strategies. The periodic program may be possible to increase, strength and endurance performance level in micro session plans.

Keywords: High volume circuit, resistance training, short term periodization, muay thai athletes.

Özet

Dairesel direnç antrenmanı, performansı en üst düzeye çıkarmak için yüksek yük ve kısa süreli dinlenme rejimlerinden biridir. Bu antrenman koşulu, çoklu set yük ve tekrar ayarına göre yüksek hacimli (%60-75-90-1TM) kuvvet-dayanıklılık sürekliliğinde gerçekleştirilmedi, tek antrenman hacmi belirlendi. Çalışmanın amacı, yüksek hacimli dairesel direnç antrenman periyodizasyonunun yük ve tekrar etkilerini incelemek, yük ve tekrar periyodizasyonu gelişimi sağlayarak muay thai sporcularında kuvvet ve dayanıklılık seviyesini arttırmaktır. Muay thai sporcularından (N=11), %75 1TM hacminde direnç antrenmanına katıldı ve 3 haftalık periyodizasyon ve 6 antrenman seansı boyunca gerçekleştirilen çoklu set, relatif dayanıklılık (%60-1TM), dayanıklılık (%70-1TM) ve potansiyel kas gücü (%85-1TM) tekrarlar maksimum denemeleri gerçekleştirdi. Maksimum kuvvet performansı sonuçları (%9-13 - 1TM%) oranında artarken, düşük-orta-yüksek yük ve tekrarlar egzersizleri (<%10 ve <%7) kısa süreli dairesel direnç periyodizasyonuna sonuçlandı. Çalışma sonuçları maksimum yük ve tekrarı teşvik etti, bu nedenle kısa süreli yüksek hacimli dairesel direnç antrenmanı periyodizasyonu manipülasyon yük ve tekrarlar stratejilerini iyileştirmek için birincil kuvvet kazanımı ve nöromusküler adaptasyon ile sonuçlandı. Periyodik program mikro seans planlarında kuvvet ve dayanıklılık performans seviyesini artırmak mümkün olabilir.

Anahtar kelimeler: Yüksek hacimli dairesel antrenman, kısa süreli periyodizasyon, muay thai sporcuları.

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Introduction

Last decade, circuit or periodized resistance training used to hypertrophic responses, muscle adaptation and strength gain on maximize performance of untrained and trained individuals, worked single or multiple set and rest interval manipulation (Marx et al., 2001). In the study, single and multiple set performing compared to low and high repetition according this resistance periodized training models, noted to performance outcomes ie., strength and muscle potential adaptation (Compos et al., 2002). However, the circuit resistance training is high training volume whereas periodized model single volume and low-high repetition strategy (Kraemer et al., 2000). Indeed, performance increases, performing 3 week and long term week periodized training worked on repetition changes in single and multiple set at 10-12RM high repetition and 3-5RM low repetition (Compos et al., 2002; Marx et al., 2001; Kraemer et al., 2000). In that is training zone regimes (strength-endurance continuum), one of high load low repetition or/and low load high repetition resistance training similarly load - repetition set-up resistance training model (Schoenfeld et al., 2015; 2021). Circuit resistance training high volume not observed on zone regimes as a progression on multiple set set-up and high load training section (Kahraman & Varol, 2023). Furthermore, circuit resistance training is high load and low repetition enhance maximize strength potential contraction level and muscle power gain (Kahraman & Varol, 2023). In this condition, multiple set (3 to 5 set) performances and short time rest interval improve acute muscle potential contraction level and strength gain (Compos et al., 2002). For example, muscle contraction potential enable to strength and endurance performance forming progressive strength-endurance continuum set-ups adjust for loading changes and training volume determined on long term circuit resistance training (Marx et al., 2001). Multiple set ups on the continuum strength-endurance, are low load endurance zone (+15RM), moderate load hypertrophy zone (8-12RM) and high load strength zone (3-5RM) perform, to training stress adaptation changing of muscle load as metabolic and mechanic adaptation according to training volumes (Schoenfeld et al., 2014). Therefore, metabolic processes on low volume provide muscle 2A-B potential contraction level, while mechanic activations on high volume promote constantly 2B potential gain (Compos et al., 2002). The periodic resistance training settings, thus detect for muscle working load, repetition number and rest interval with continuum strength-endurance (Schoenfeld et al., 2021). For example, resistance training loadings are form on strength gain supporting on indicator of aimed zone level consist of periodized model training plan (Kahraman & Varol, 2024). Specifically, non-linear or linear periodization performed on 4 week and 8 week low and high repetition, however long term resistance trained reported 1RM strength increase and performance outcomes, furthermore, this training volumes enable muscle working principle as 2AB contraction adaptation (Compos et al., 2001). In this direction, continuum strength-endurance load and repetition session, according to different zone manipulation on day to day term permitted to low load high repetition and high load low repetition (Kahraman et al., 2024).

The training volumes in the zone are not similar by using the resistance loading volume obtained at the maximum number of repetitions, but similarly, the number of resistance repetitions can be rearranged according to the low and high volume of the loading (Kahraman et al., 2024). However, multiple manipulations unclear on different load set-ups with rest interval and repetition maximum to circuit resistance training session. Thus, high load low repetition or low load high repetition in generally performed on zone regimes into multiple zone and multiple sets, it is that, continuum strength-endurance strategies limited performing of repetition maximum and specific set performance (Kahraman & Varol, 2024). The reproducibility of load and repetition

manipulation promote an up-to-date method in resistance training periodization, where it is suitable for non-linear periodizations instead of fixed applications in training zones, and enhances in the short and long-term intensity and volume change, repeated training weeks can detect non-traditional resistance training level (Kahraman & Varol, 2024). Kahraman et al (2024) determined that load principle must be use set setting on rest intervals, addition loading primerly must be recommended on strength zone, hypertrophy zone and endurance zone as load and repetition principle. As this condition, non-traditional resistance training or periodized model periodization rest intervals determined on short rest 30-40s and long rest 2 to 5 min (ACSM, 2009). The strategic load performance based on percentage limitations related to rest intervals, additionally resistance zones not performed on one zone working as it is circuit resistance training periodization strategy (Kahraman & Varol, 2023), in generally not used in multiple zone working. Although, high level performance weeks are adjusted according to individual training loads, zone working in each training phase can be included in the planning of short term non-linear periodizations, but non-linear zone working principles needed for progression load and repetition working strategy. In this direction, this study aim was to load and repetition effects of high volume circuit resistance training periodization on continuum strength-endurance methodology.

Materials and Methods

Subjects

Healthy 11 muay thai subjects, were formed trained resistance group applied this study over 3 week and 6 session training day participated high volume circuit resistance training accedeed on ethic permission of Mardin Artuklu University no: (2025/2-30) The primer sample group determination provided on power analysis. The effect size of one test variable to detect sample group calculated, then account for analyzed of t-test determined actual power 0.95 and alpha error 0.05. The properties of muay thai athletes given at Table 1.

Table 1. Properties of muay thai athletes

	Mean (SD)
Age	16.54±1.63
Height	1.70±0.11
Body mass	57.36±12.38
Training experience	3.81±2.89

Experimental program

The experimental program to determine exercise condition and strength and endurance increases, performed on one exercise test protocol as strength and exercise test before high volume circuit resistance training. Firstly, anthropometric values obtained from standard measurements, then one repetition maximum test condition applied on determined exercise condition performed on reaching of 1RM-100% started in initial added 40-50% endurance zone, 70-85% hypertrophy zone and 90% strength zone repetition trials with 3-5 min intra-set interval given to all of exercise sessions provided as non-failure load accomplishment. One exercise condition specialist detected accomplish loading increase and maximum repetition sessions. One day into, one repetition maximum exercise condition after, other incrementally loading repetition protocols performed on 1-2 min intrarest interval. Then, in the all of exercises applied endurance (relative-absolute) localization on 60-70% rep trials set-up, to strength size

tested on 85% rep trial set-up into 24 hour. As provided this condition, exercise before, warm-up protocol 10 min was provided, again on the exercise sessions at 50% - 20RM used to warm-up, and then exercise tests performed into 48 hour associated resistance training day to day condition.

Circuit resistance training periodization

Over 3 week and 2 day, training high volume condition according to continuum zone repetition ranges applied to all exercise condition on strength zone (5RM), hypertrophy zone (8RM), endurance zone (15RM) determined;

WEEKLY DAY PLAN

60 – 75 – 90% = 7 SET; 1-2 min intra-rest interval;

Endurance zone: 60%1RM – 15RM warm-up; 2 set and 35 s rest interval,

Hypertrophy zone: 75%1RM – 8RM; 3 set and 40 s rest interval,

Strength zone: 90%1RM – 5RM; 1 set.

Statistical analysis

Pre condition (1.week) to post test (3.week) analyzed among compared statistical test measures. A group mean, standard deviation, descriptive analysis and T- test were resolved on using of JSAP program. As statistical descriptive measures were determined on normality values as Shapiro-wilk test, to test one hypothesis, statistical analysis tested changes of one value to determine significant differences at $p < 0.05$ (Ghasemi & Zahediasl, 2012). The descriptor effect size calculated at 0.20 small, 0.50 moderate, 0.80 large (Lakens, 2013).

FINDINGS

One repetition maximum resulted on deadlift; ($t = -10.808$; $CI = -4.77 - -1.724$; $p < 0.001$), CJShrug ($t = -4.644$; $CI = -2.229 - -0.538$; $p < 0.001$), leg press ($t = -5.164$; $CI = -2.436 - -0.645$; $p < 0.001$), and leg extension ($t = -5.913$; $CI = -2.738 - -0.797$; $p < 0.001$) in Table 2.

Table 2. 1RM outcomes

	Pre	Post	Δ
Deadlift	70.90 (24.27)	84.09 (27.00)	13.19
CJShrug	63.63 (19.63)	75.90 (25.37)	12.27
Leg press	74.63 (16.99)	81.18 (17.75)	6.55
Leg extension	61.63 (12.49)	71.54 (11.67)	9.91

Deadlift results concluded on low load ($t = -4.949$; $CI = -2.350 - -0.601$; $p < 0.001$) and repetition ($t = -2.055$; $CI = -1.256 - 0.042$; $p = 0.067$), to CJShrug ($t = -4.394$; $CI = -2.131 - -0.485$; $p = 0.001$) and repetition ($t = 0.330$; $CI = -0.495 - 0.690$; $p = 0.748$), to leg press ($t = -0.864$; $CI = -0.856 - 0.347$; $p = 0.408$) and repetition ($t = -0.277$; $CI = -0.674 - 0.511$; $p = 0.787$), to leg extension ($t = -4.633$; $CI = -2.225 - -0.536$; $p < 0.001$) and repetition ($t = -5.748$; $CI = -2.761 - -0.763$; $p < 0.001$) in Table 3.

Deadlift results concluded on medium load ($t = -8.281$; $CI = -3.712 - -1.255$; $p < 0.001$) and repetition ($t = -3.837$; $CI = -5.029 - -1.334$; $p = 0.003$), to CJShrug ($t = -$

4.219; CI%=-2.063 – -0.448; p=0.002) and repetition (t=-2.451; CI%=-8.330 – -0.397; p=0.034), to leg press (t=-5.164; CI%=-2.436 – -0.645; p<0.001) and repetition (t=-2.327; CI%=-9.788 – -0.212; p=0.042), to leg extension (t=-5.913; CI%=-2.738 – -0.797; p<0.001) and repetition (t=-2.939; CI%=-8.471 – -1.165; p=0.015) in Table 3.

Deadlift results concluded on high load (t=-9.937; CI%=-4.406 – -1.564; p<0.001) and repetition (t=-5.847; CI%=-2.711 – -0.783; p<0.001), to CJShrug (t=-4.569; CI%=-2.200 – -0.522; p=0.001) and repetition (t=-7.237; CI%=-3.279 – -1.056; p<0.001), to leg press (t=-5.135; CI%=-2.242 – -0.639; p<0.001) and repetition (t=-5.237; CI%=-2.465 – -0.660; p<0.001), to leg extension (t=-5.915; CI%=-2.738 – -0.797; p<0.001) and repetition (t=-5.928; CI%=-2.744 – -0.799; p<0.001) in Table 3.

Table 3. Maximum load and repetition outcomes

LOAD	Pre	Post	Δ	REP	Pre	Post	Δ
Deadlift				Deadlift			
60%	44.09 (20.47)	51.81 (21.24)	7.72	60%	24.27 (11.28)	27.71 (12.56)	3.44
70%	46.81 (19.40)	57.72 (19.54)	10.91	70%	15.36 (10.17)	18.54 (10.24)	3.18
85%	60.27 (20.63)	71.00 (23.14)	10.73	85%	5.54 (3.95)	9.18 (4.16)	3.64
CJShrug				CJShrug			
60%	33.63 (11.85)	44.09 (16.09)	10.46	60%	33.27 (8.34)	32.45 (7.23)	-0.82
70%	42.72 (14.72)	50.90 (18.14)	8.18	70%	23.90 (7.36)	28.27 (4.79)	4.37
85%	54.09 (16.68)	64.36 (21.63)	10.27	85%	12.45 (4.56)	19.27 (6.58)	6.82
Leg press				Leg press			
60%	50.18 (15.16)	52.00 (11.17)	1.82	60%	33.27 (11.19)	34.09 (7.35)	0.82
70%	74.63 (16.99)	81.18 (17.75)	6.55	70%	23.63 (9.38)	28.63 (5.92)	5.00
85%	63.09 (14.50)	68.72 (15.14)	5.63	85%	10.72 (4.10)	18.63 (6.86)	7.91
Leg extension				Leg extension			
60%				60%			
70%	37.45 (8.40)	45.45 (9.78)	8.00	70%	29.09 (5.12)	35.54 (3.29)	6.45
85%	61.63 (12.49)	71.54 (11.67)	9.91	85%	18.54 (4.92)	23.36 (5.59)	4.82
	51.90 (10.64)	60.36 (9.95)	8.46		7.54 (2.33)	11.36 (3.00)	3.82

Discussion

The resistance training popularities ie., periodized and non-periodized model studies on the progress resistance loads and repetitions performed to circuit resistance model for maximal performance changes generally created volume related to rest periods. In the trained population, high loading of circuit resistance training has been preferred by preparing long-term periodization (Kahraman & Varol, 2023). In this case, muscle adaptation of female wrestlers was acutely worked in 1RM strength ranges as single repetitions and increased potential muscular contraction level. Therefore, the effect of acute circuit resistance training on high strength/power potential gain can be weekly training periodization included in the non-periodized planning. Similar adaptation, long-term high resistance circuit training periodization to muscle strength significantly increased 1RM performance improve circuit resistance training sections. The load elimination section and improved (rest intervals) manipulation condition of muscle contractile sessions, to examining of performance level in muay thai athletes, provided on high volume progression training model, performing circuit resistance training is non-traditional load and repetition set-up primarily were investigated. The repetition maximum and set loading manipulation detected on multiple set and exercise condition.

This indicators of progression multiple setting sets promote high volume training intensity, therefore, the elevation load performance outcomes to trained muay thai athletes observed maximize strength and endurance gain, and potential muscle increase adaptation. The outcomes of maximize performance level of muay thai athletes reported our study, this reason performed short term low/medium/high repetition high volume circuit resistance training model. The outcomes on the repetition maximum on the low/medium/high load provided indeed training volume as detection of muscle concentric load increases, according to muscle mass increases or motor unit capacity (Campos et al., 2002). The non-traditional circuit resistance training has been performed on high load multiple sets short rest interval training models (Alcaraz et al., 2011). However, similar maximum strength results compared to traditional training was provided high strength gain on the selected load intensity levels, however, short rest intervals (35 s to 5-6RM) on circuit training increased exercise condition perform on long term periodization. This reason, indicators of maximum strength level determine muscle activation of concentric high load according on circuit training as short rest interval, and in condition performed to muscle concentric fatigue and endurance related contraction potential level to high load plan (Alcaraz et al., 2011). The traditional low load and high repetition circuit periodization methods provide muscle size adaptation and strength gain whereas high load performances at short term week periodization. Clearly, multiple sets and multi exercise condition, which in performing number of repetition on selected load set session measurements similar adaptation with selected loading performance level. Along strength gain performances or muscle size adaptation for low load circuit improve local muscular endurance, account to high load circuit limited reducing time of strength session and allowing efficiency training volume performing number of repetition and local muscular endurance (Alcaraz, Sanchez-Lorente and Blazevich, 2008). In the other condition, high load circuit resistance set (4 set) and 40 s rest interval block exercise periodization performing autoregulation resistance warm-up (ie., 10RM at 1 set, then at 50% of the 6RM) maintain maximal strength (Freitas et al., 2016). Alternative method can use for training section on daily volume change of the strength program. The implementation of circuit based training sections determined on decreases of performance level, in acute effect of high load exercise sessions provoke selected strength test outcomes, progressive exercise test outcomes, primer muscle performance output activate muscle potential fatigue (Freitas et al., 2016). Unclear of acute effect was performed on high load of circuit resistance training periodization are cleared, is that both low repetition high load and high repetition low load not seen similarly potential muscle adaptation and fatigue accumulation. However, the set and rest interval section of circuit resistance training can be change to training volume, needed for single or multiple set setting, performing to high load, short rest interval increase potential muscle performance level as fatigue and endurance (Freitas et al., 2016).

Practical Applications

Circuit high resistance high loading strength training is primarily training for sports modalities in training periodization develop maximum performance production. The common and current strength-endurance continuum methodology is effective load and repetition intensity detection. In circuit training-based strength training studies, advanced micro training periodization performing strength/hypertrophy/endurance zone regimes to training volume multiple set-section principle. The strength training is sport specific tasks appropriate non-linear periodization repeat strength performance results..

Beyanlar / Declarations

Etik Onay ve Katılım Onayı / Ethics approval and consent to participate

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During the preparation and writing process of this study, scientific, ethical and citation rules were followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive"; no falsification was made on the collected data, and this study was not sent for evaluation to any other academic publication environment.

Veri Ve Materyal Erişilebilirliği / Availability of data and material

Bu çalışmanın bulgularını destekleyen veriler, makul talepler üzerine sorumlu yazardan temin edilebilir. Veri seti yalnızca akademik amaçlar için erişilebilir olacak ve verilerin herhangi bir kullanımı, orijinal çalışmayı referans gösterecek ve katılımcıların gizliliğini koruyacaktır.

The data that support the findings of this study are available from the corresponding author upon reasonable request. The dataset will be accessible only for academic purposes, and any use of the data will recognize the original study and maintain the confidentiality of the participants.

Çıkar Çatışması / Competing interests

Yazarlar, bu makalede sunulan çalışmayı etkileyebilecek herhangi bir çıkar çatışması veya kişisel ilişkiye sahip olmadıklarını beyan etmektedirler.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Bu çalışmada yazarların katkı oranı eşittir.
All authors contributed equally to this work

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