

Effect of two tapering strategies on endurance-related physiological markers in athletes from selected training centres of Ethiopia

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ABSTRACT

Objective We aimed to investigate the effects of two tapering strategies on specific endurance-related performance markers in some selected athletic training centres of Ethiopia.

Methodology Thirty-seven young distance runners (mean age: 20±1.97 years; mean training period: 2.43±0.603 years) were randomly assigned to high-intensity low-volume (HILV) and high-intensity moderate-volume (HIMV) taper groups. Training frequencies were five times per week conducted for 2 weeks in both groups. At baseline and after 2 weeks of the taper intervention, the average red blood cell (RBC) count, haemoglobin (Hgb) concentration and haematocrit percentages (Hct) of the participants were measured and analysed using a complete blood count (sysmix) instrument.

Results Using a parallel-group design, we investigated the effects of the two tapering strategies (HILV and HIMV), and positive changes were observed in the endurance-related physiological traits of RBC count, Hgb concentration and Hct percentages regardless of the amount of volume reduced during the 2-week taper period. Comparisons of the two strategies did not reveal significant differences between the taper groups.

Conclusion Taper strategies characterised by HILV and HIMV training load have beneficial effects on the improvement of endurance performance. Reduction of training load-training volume did not affect endurance performance, instead these could induce extra adaption of the body physiology.

INTRODUCTION

The usual hard training, competition and wider knowledge on progressive overload training regimens severely influence contemporary training and recovery methods in athletes.¹ Nowadays, it is difficult for athletes, coaches and researchers to find the best strategies to increase performance. When the body is unable to adapt to the given training load, a condition called overtraining syndrome might develop, which contributes a lot to this intolerance.² Non-training stress in the form of environmental and lifestyle stressors,

What are the new findings?

- ▶ Both the high-intensity low-volume and high-intensity moderate-volume tapering strategies have beneficial effects on the performance improvement of endurance athletes.
- ▶ As long as the training intensity was kept high enough, above the race pace level, the reduction of training volume did not affect endurance performance.
- ▶ Reduction of training volume up to three-fourths of the pretaper volume is more effective than reduction by half percentages.

How might it impact on clinical practice in future?

- ▶ The findings from this study might help coaches and athletes in facilitating the adaptation process and in preventing overtraining syndrome.

such as examination and relationship stress, may also contribute to the development of overtraining syndrome.^{3,4} Thus, overtraining syndrome is a response to an accumulation of both training and non-training stress.

Most of the reports state that overtraining is mainly caused by insufficient recovery periods after a long exhaustive training.⁵ Every strategy done before a major competition is intended to boost performance by reducing the cumulated effects of fatigue, which could be attained through reduction of training load.^{6,7} Thus, exercise scientists are looking for different alternative training interventions, recovery methods and dietary intake to achieve peak performance of an athlete.⁸

Tapering is among the possible strategies used by most athletes and their coaches which facilitates the extra-adaptation process without getting too tired or detrained. It is



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defined as short periods of reduction in athletes' training load prior to a major competition.^{9,10} It is a strategy recommended by different exercise physiologists, researchers, training expertise and scholars.¹¹ Overtraining might occur in competitive athletes unless they taper for one up to four weeks.¹² Poor tapering, characterised by a reduction in training intensity or a long period of reduction in training volume for more than 28 days, results in detraining.¹³ Each of these situations may result in athletes missing their peak time, thus compromising optimal performance and undoing an otherwise.

A well-designed taper could enhance athletic performance by initiating physiological and psychological adaptations.¹⁴ A scientifically designed taper intervention programme mainly focuses on the reduction of training volume, maintaining or increasing of intensity. All these helps to improvement in performance ranges from 0.5% to 6%,¹⁵ although care should be taken while reducing the training loads and taper practice and it should be designed systematically.

The decrease in training load can be accomplished by reducing the number of practices (frequency), the intensity of workouts (intensity) and the volume of training performed in a given session (volume, ie, distance, time or repetition), and by varying the length of the taper or duration.¹² However, the reduction of training load that employed for a variable segments of time mainly done with the expense of the training volume, but not the training intensity, depending on individuals' profiles of fatigue level and their adaptation.¹⁶ Volume could be reduced systematically, but training intensity remains high for trained athletes.¹⁰ The reduction in training load, especially the training volume, enables athletes to have enough recovery time, which aids in supercompensations.¹⁷ A brief, high intensive training programme also provides sufficient stimuli to prevent detraining,^{10–16} although there is no commonly agreed tapering (load reduction) formula. Some consider a reduction of 60%–70% of the training volume is appropriate in improving endurance performance without causing detraining symptoms,¹³ while others suggest a minimum of 70% of the training load is needed to maintain training-induced maximal oxygen uptake.¹⁸ Banister *et al*¹⁹ also reported that there was a recorded performance improvement after 31% reduction in training volume.

Thus, the incoherent research findings, opinions and practices that we observe, hear and see about tapering might create some confusion among coaches and athletes. Due to these facts, coaches, athletes and sports experts face difficulties, think that this tapering might cause detraining in case it is applied incorrectly,¹⁵ and are uncertain about the best performance-peaking strategies. Most of the issues associated with tapering were related to the lack of confidence among coaches and athletes as it is the most feared strategies to achieving peak performance.²⁰ Arguments were mostly on (1) the amount of training load to be reduced and (2) the method of

reduction (stepwise or a progressive), which could influence the effectiveness of the taper.¹⁹

Based on the researchers' experience (observation and discussion), coaches did not have well-organised and proofed understanding of the importance and strategies of proper tapering, as result they give less attention to its implementation. Of course it is a wise decision not to fully accept or doubt a research finding done outside of the situations they live and have, since it may not be effective in Ethiopian situations. This research study investigates and compares the effects of two tapering strategies on specific endurance-related performance markers in selected athletic training centres (ATC) in Ethiopia.

METHODS

Location/Areas of the study

The centres of attention were two ATCs (Maychew and Tenta) found in the Tigray and Amhara regional states of Ethiopia at an altitude of 2860 m and 2679 m above sea level and 625 km and 520 km far, respectively, from Addis Ababa, the capital city of Ethiopia.

Sample and sampling techniques

Thirty-seven competitive endurance athletes from the two ATCs volunteered to participate in this study. The total population (Census sampling) was used because they are few in numbers and all are taken as a sample. Athletes who are going to be in competitions, have minimum training experience of 2 years, engage in training regularly for the last 3 months, free from illness or injury conditions, and have weekly training load that comprises 20–30 miles could be included. Those who cannot fulfil the above criteria were excluded.

Design of the study

A quasi-experimental design was used with parallel-group setting. Participant athletes were assigned to the high-intensity low-volume (HILV) and high-intensity moderate-volume (HIMV) taper intervention groups using block (gender-based) randomisation techniques. Pre-post test data collection methods were used.

Data analysis

Initially, the data were tested for assumptions of normality using the Shapiro-Wilk and Kolmogorov tests and confirm normal distribution. The demographic characteristics of the participant athletes were assessed and analysed using descriptive statistics. Independent t-test was used to compare baseline differences between groups, and paired t-test and analysis of covariance (ANCOVA) were used to analyse the changes and differences, respectively. Results were reported using mean±SD and mean difference (MD). The level of significance was set at $\alpha=0.05$ ($p<0.05$). SPSS V.20 was used for all analyses.

RESULTS

No significant differences ($p>0.05$) were observed between the two groups (as seen in [table 1](#)) in their

Table 1 Baseline RBC, Hgb and Hct% using independent t-test

Variables	Group	n	M	SD	t	df	P value
Pretest RBC	HILVt	20	5.11	0.31	-0.082	35	0.935
	HIMVt	17	5.12	0.31			
Pretest Hgb	HILVt	20	15.23	0.90	0.549	35	0.586
	HIMVt	17	15.09	0.62			
Pretest Hct	HILVt	20	43.80	3.22	-0.246	35	0.807
	HIMVt	17	44.04	2.62			

Difference is significant at $p < 0.05$.

HILVt, high-intensity low-volume taper group; HIMVt, high-intensity moderate-volume taper group; Hct, haematocrit percentages; Hgb, haemoglobin concentration; M, mean; RBC, red blood cell count.

baseline scores prior to the taper intervention at $\alpha = 0.05$ level. Possible changes that occurred after the taper might be because of the taper programme.

According to the paired t-tests analysis (table 2), significant differences were seen ($p < 0.05$) within each taper group. This means both strategies, the HILV and HIMV taper strategies, had significant effects on athletes' red blood cell (RBC) counts with MD=0.43 at $t(19)=2.5$ ($p=0.004$) for the HILV group and MD=0.30 at $t(16)=4.10$ ($p=0.001$) for the HIMV group; haemoglobin (Hgb) concentrations with MD=0.93 at $t(19)=4.11$ ($p=0.001$) for the HILV group and MD=0.72 at $t(16)=2.43$ ($p=0.027$) for the HIMV group; and haematocrit (Hct) percentages with MD=2.72 at $t(19)=2.48$ ($p=0.023$) for the HILV group and MD=2.54 at $t(16)=2.50$ ($p=0.024$) for the HIMV group at $\alpha = 0.05$ level.

Post-test score differences between groups were also checked using ANCOVA (as seen in table 3), which helped to covariate (control) variations in the post-test values due to the differences (training periods, age, sex) within participants. There were no significant differences ($p > 0.05$) between groups at $\alpha = 0.05$ level.

DISCUSSION

The HILV and HIMV taper methods involve maintenance of intensity high enough above the race pace level and reductions of volume up to 75% and 50% of

the pretaper training volume, respectively. Physiological endurance performance markers were assessed in each group at baseline and immediately after the 2-week taper interventions. Positive MDs were observed in both groups with RBC MD=0.43 and M=0.30, Hgb MD=0.39 and M=0.72, and Hct MD=2.72 and M=2.54 for the HILV and HIMV taper groups, respectively. Significant changes ($p < 0.05$) were observed within the group in endurance performance markers (RBC, Hgb and Hct) after the 2-week taper in both groups at $\alpha = 0.05$ level. The changes within the HILV taper group occur as a consequence of adequate reductions in the training volume (75%) during the high intensive training sessions, which may assist in better physiological adaptations. This is consistent with other studies such as by Pyne *et al.*¹⁴ which revealed that endurance performances were improved after a reduction of training volume but not intensity and frequency. Similar results by Bosquet²¹ and Neary *et al.*¹ had prompted fundamental physiological adaptation after a reduction in training volume and maintenance of intensity. Shepley *et al.*¹⁰ made comparative study with three groups—HILV taper, low-intensity moderate-volume taper and rest-only taper—on middle-distance runners and concluded that blood volume, red cell volume and running time to fatigue were optimised only with the HILV taper.

The HIMV taper group also showed significant changes after the taper. This findings aligned with Seiler²² and

Table 2 Paired (pre and post) differences between intervention groups

Groups	Variables	Pre	Post	MD	t	df	P value
		M \pm SD	M \pm SD				
HILVt	RBC	5.08 \pm 0.33	5.50 \pm 0.37	0.43	2.50	19	0.004
	Hgb	15.23 \pm 0.90	16.16 \pm 0.97	0.93	4.11	19	0.001
	Hct	43.80 \pm 3.22	46.52 \pm 3.48	2.72	2.48	19	0.023
HIMVt	RBC	5.15 \pm 0.28	5.45 \pm 0.41	0.30	4.10	16	0.012
	Hgb	15.09 \pm 0.62	15.81 \pm 0.97	0.72	2.43	16	0.027
	Hct	44.04 \pm 2.62	46.57 \pm 3.66	2.54	2.50	16	0.024

Difference is significant at $p < 0.05$.

HILVt, high-intensity low-volume taper group; HIMVt, high-intensity moderate-volume taper group; Hct, haematocrit percentages; Hgb, haemoglobin concentration; M, mean; MD, mean difference; RBC, red blood cell count.

Table 3 Differences between groups in post-test RBC (ANCOVA)

Variables	Group	n	M	SD	df	F	P value	Partial η^2
RBC	HILVt	20	5.50	0.37	1,34	0.104	0.749	0.003
	HIMVt	17	5.45	0.41				
Hgb	HILVt	20	16.16	0.97	1,34	0.996	0.334	0.031
	HIMVt	17	15.81	0.97				
Hct	HILVt	20	46.51	3.48	1,34	0.010	0.923	0.000
	HIMVt	17	46.57	3.66				

Difference is significant at $p < 0.05$.

ANCOVA, analysis of covariance; HILVt, high-intensity low-volume taper group; HIMVt, high-intensity moderate-volume taper group; Hct, haematocrit percentages; Hgb, haemoglobin concentration; M, mean; RBC, red blood cell count.

stated that a short period of high intensive training bouts in combination with high proportion of volume or long training duration is beneficial in further improving endurance performance. When comparing the HILV and HIMV taper strategies, there were no statistically significant differences ($p > 0.05$) between the groups at $\alpha = 0.05$. Reductions of the pretaper training volume might have an effect on performances regardless of the amount of reduction. An encouraging finding conducted by Houmard *et al.*¹³ revealed that performance was unaffected by the reduction in training volume up to 70%; however, a long period of training volume reduction of more than 28 days could cause symptoms of detraining. During the taper period, training volume must be reduced^{25 26} and training frequency could be reduced or maintained¹⁶ to improve performance. Endurance performance improved after a reduction of training volume¹⁴ but not intensity.^{1 23}

In general, as long as the training intensity is kept high, there are no large discrepancies in performance whether the volume and frequencies were reduced for a short period of time.^{25 27 28} In most of these studies performance was maintained or improved after a reduction of training volume during the week(s) before a major competition. Tapering improves the performance of athletes regardless of the relative differences in the amounts of volume reduced.^{26 29}

However, MDs were observed in all physiological markers (RBC, Hgb and Hct traits) between the groups. This may be because of the differences in the amount of training volume reduced or the reduction patterns. Optimal reductions in training volume could help to improve performance than too little or too much.¹⁹ Training components such as frequency, volume, duration, intensity and type of taper performed have an impact on the body's adaptations and its responses to a peak performance.²⁴ Shepley *et al.*¹⁰ also conducted a comparative study with emphasis on the amount of volume with 62% reduction and 90% reduction practised for 7 days and found that the 90% volume reduction group improved from the previous best time by 22%. However, maximum care is needed not to reduce high amounts of volume for an extended period of time, as it may cause detraining.¹² Comparative studies done by Mujika²⁸ and

Padilla²⁹ emphasised on the 50% and 75% reductions in training volume in middle-distance runners and showed that performance was not significantly enhanced by either tapering protocol, although the 75% reduction group showed better improvement as compared with the other groups. In another research work by Mujika¹⁵ with emphasis on three volume reduction designs—20%, 41%–60% and greater than 60% reduction—improvement in performance was observed with the high (>60%) volume reduction taper group than the moderate (41%–60%) or low (20%) volume reduction groups. Comprehensive studies reported by Bosquet *et al.*¹² and Havanloo³⁰ boldly confirmed that large gains in endurance performance were attained when the intensity was maintained or kept high, but volume and frequency might be reduced even up to 85% and not more than 20%, respectively.

CONCLUSION

Tapering has beneficial effects on the improvement of endurance performance regardless of the amount of volume reduced. Significant changes were observed following the HILV and HIMV taper interventions. Large gains in performance improvements expressed with greater MDs were attained in the HILV taper group than in the HIMV taper group. However, no statistically significant differences were observed between the two groups (HILV and HIMV taper).

Contributors AAJ developed the preliminary ideas and was involved in every procedure of the entire study. SM was involved in editing, modifying and shaping the research work. MA and DM initiated the study design and helped in conducting the primary statistical analysis. All authors contributed to the refinement of the study protocol and approved the final manuscript.

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REFERENCES

1. Neary JP, Martin TP, Quinney HA. Effects of taper on endurance cycling capacity and single muscle fiber properties. *Med Sci Sports Exerc* 2003;35:1875–81.
2. Meehan H. The over-training syndrome: what exactly is this phenomenon? What causes it? How can occurrence be minimised? Heidi Meehan explains Descartes publishing LTD. *The coach J* 2002;41–6.
3. Kentta G, Hassmen P. Over-training and recovery: a conceptual model. *Sports Medicine* 1998;26:25–39.
4. Meehan HL, Bull SJ, James DVB. *The role of non-training stress in the development of the over-training syndrome. Paper presented at the annual conference of the British Association of Sport and Exercise Sciences*, 2001.
5. Zatsiorsky VM. *Biomechanics in sport. performance enhancement and injury prevention. encyclopedia of Sport medicine IOC Medical Commission*. Jonkopping University, Blackwell Science, 2003.
6. Kentta G, Hassman P, Raglin JS. Training practices and overtraining syndrome in Swedish age group athletes, *International Journal of Sport medicine* 2001;22:1–6.
7. Matos NF, Machado D. Overtraining and burnout in young English athletes. *GoregthiemeVelag kg Riidigerstradle 14/70469, Stuttgart* 2010.
8. Mujika I. *Tapering and peaking for optimal performance*. Universities of Basque country united states of America, Human kinetics IL-61825-5076 800-747-4457, 2009
9. Brannstrom A, Rova A, JG Y. Effects and mechanisms of tapering in maximizing muscular power. horizon research publishing. *Sport and Art* 2013;1:18–23.
10. Shepley B, MacDougall JD, Cipriano N, et al. Physiological effects of tapering in highly trained athletes. *J Appl Physiol* 1992;72:706–11.
11. Bompa TO, Haff GG. *Periodization theory and methodology*. human kinetics, 2009. Available: www.HumanKinetics.com
12. Bosquet L, Berryman N, Dupuy O, et al. Effect of training cessation on muscular performance: a meta-analysis. *Scand J Med Sci Sports* 2013;23.
13. Houmard JA, Scott BK, Justice CL, et al. The effects of taper on performance in distance runners. *Med Sci Sports Exerc* 1994;26.
14. Pyne DB, Mujika I, Reilly T. Peaking for optimal performance: research limitations and future directions. *J Sports Sci* 2009;27:195–202.
15. Mujika I, Goya A, Padilla S, et al. Physiological responses to a 6-d taper in middle-distance runners: influence of training intensity and volume. *Med Sci Sports Exerc* 2000;32:511–7.
16. Neary JP, Martin TP, Reid DC, et al. The effects of a reduced exercise duration taper programme on performance and muscle enzymes of endurance cyclists. *Eur J Appl Physiol Occup Physiol* 1992;65:30–6.
17. Calder A. *Recovery strategies for sport performance. workbook. applied sport knowledge Pty LTD*. Australian Institute of Sport, 2005.
18. Hickson RC. Interference of strength development by simultaneously training for strength and endurance. *Eur J Appl Physiol Occup Physiol* 1980;45:255–63.
19. Banister EW, Carter JB, Zarkadas PC. Training theory and taper: validation in triathlon athletes. *Eur J Appl Physiol Occup Physiol* 1999;79:182–91.
20. Baker J, Cobley S, Fraser-Thomas J. What do we know about early sport specialization? not much! *High Ability Studies* 2009;20:77–89.
21. Bosquet L, Montpetit J, Arvisais D, et al. Effects of tapering on performance: a meta-analysis. *Med Sci Sports Exerc* 2007;39:1358–68.
22. Seiler S. What is best practice for training intensity and duration distribution in endurance athletes? *Int J Sports Physiol Perform* 2010;5:276–91.
23. Houmard JA, Johns RA. Effects of taper on swim performance. practical implications. *Sports Med* 1994;17:224–32.
24. Spilsbury KL, Fudge BW, Ingham SA, et al. Tapering strategies in elite British endurance runners. *Eur J Sport Sci* 2015;15:367–73.
25. Grivas GV. *The effects of tapering on performance in elite endurance runners: a systematic review. International journals of Sport science*. Trikala, Greece: Department's f physical education and sport science, University of Thessaly, 2018.
26. Mujika I, Padilla S. Scientific bases for pre-competition tapering strategies. *Med Sci Sports* 2003;35:1182–7.
27. Mujika I. *Intense training: the key to optimal performance before and during the taper*. Scandinavian journal of medicine & science in sport. John Wiley & Sons, 2010.
28. Mujika I, Goya A, Padilla S, et al. Physiological responses to a 6-d taper in middle-distance runners: influence of training intensity and volume. *Med Sci Sports Exerc* 2000;32:511–7.
29. Padilla P, Pyne DB, Mujika I, et al. Physiological changes associated with the pre-event taper in athletes with the pre-event taper in athletes. *Journal of sport medicine* 2004.
30. Hovanloo F, Ebrahim K, Alizadeh R, et al. The effects of two tapering methods on physical and physiological factors in amateur soccer players. *World Journal of sport science* 2012 2012;6:194–9.