



# The Effect of Training Intensity on VO<sub>2</sub>max in Young Healthy Adults: A Meta-Regression and Meta-Analysis

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## Introduction

For more than 30 years, VO<sub>2</sub>max has been known to be an excellent predictor of premature death. To date, the most effective way to increase VO<sub>2</sub>max is cardiovascular training (1). Its improvement, if only a MET (metabolic equivalent to 3.5 ml O<sub>2</sub> / kg / min), increases the chances of disease survival from 10% to 25%. Prescription of optimal intensity to promote VO<sub>2</sub>max gains is therefore very important.

The purpose of this study is to conduct a meta-analysis to measure the effect of training intensity on the increase in VO<sub>2</sub>max. Table 1 summarizes the characteristics of the selected studies, which were separated into 3 groups of average intensities: 68%, 87% and 167% VO<sub>2</sub>max.

## Results

Although some researchers suggest that in order to improve the VO<sub>2</sub>max, it is necessary to maximize the time spent at intensities close to the latter, the authors of the present study have discovered that whatever intensity is chosen, the improvements in aerobic capacity are, in average of 4.1 ml O<sub>2</sub> / kg / min. There is therefore no optimal intensity that predicts the improvement of VO<sub>2</sub>max (Table-2). Such results completely change the established paradigms of aerobic training.

Note in table 2 that the most intense sessions are also the shortest, that the weekly training frequency (rounded) is 3 sessions / week for groups doing interval training compared to 4 sessions / week for continuous training groups (see Table 1). If we divide the improvement of the VO<sub>2</sub>max by the number of minutes of total efforts (improvement / (duration of the study x training frequency x duration of the periods of efforts)), we note that there is 6x plus of gain with the training of very high intensity (HIIT type) than with those made at the lowest intensities.

Considering that one of the reasons most often mentioned by the active population to abandon an exercise program is that of lack of time and that with 6x less investment of time we obtain the same cardiovascular gains, these results come to give a definite advantage in HIIT.

## Limitations

This meta-analysis looked at the analysis of several studies by comparing intensity levels based on improvements in VO<sub>2</sub>max. What the authors did not take into account is the energy expenditure made in each of the sessions. It is possible to believe that a session of medium / long duration generates a greater caloric expenditure than a HIIT type session where working time is very short and rest very long. We can therefore wonder if the results of this meta-analysis would have been the same if we compared sessions according to their caloric expenditure.

Another limitation comes from the duration of studies; 4 to 8 weeks. If the protocols had lasted longer (eg 6 months), would we have seen a capping of improvements for either group? The question remains unresolved.

## Conclusion

Intensity is not as important a parameter as one might have thought for improving aerobic capacity.

## Practical applications

In light of this conclusion, which does not provide more precise VO<sub>2</sub>max gain intensity, coaches should plan sessions based on client preferences, the diversification of training methods, regular periodization and the availability of training. stimulating challenges in order to keep their customers motivated.

Table 1: Characteristics of training for all the studies and group.

Group	No.	Type of training		Study Duration (weeks)	Training Frequency (days / week)	Intensity (% of VO <sub>2</sub> max)	Session Duration (minutes)	Improvement Rate
		Continuou s	Intervals					
1	14	13	1	6,0	3,7	68 (60-70)	45	238 min/ml
2	13	2	11	6,9	3,2	87 (80-92,5)	20,5	113 min/ml
3	13	0	13	6,2	3,1	167 (100-250)	8,5 <sup>#</sup>	40 min/ml
Tous	40	15	25	6,4	3,3	105 (60-250)	19	98 min/ml

*Note: No.: number of studies. Intensity: presented as an average (range of exercise intensities). Duration of session: represents the time of effort of a session excluding warm-up, recovery intervals and the return to calm. Rate of improvement: minutes of effort / ml. improvement. # significantly different (p <0.05) from group 1*

Table 2: Results on Improvement of VO<sub>2</sub>max for Each Group

Group	VO <sub>2</sub> max* pretest	VO <sub>2</sub> max* post-test	Improvement*
1	44,4	48,6	4,2
2	51,4	55,4	4,0
3	43,2	47,3	4,1
Tous	46,6	50,7	4,1

*\*(ml d'O<sub>2</sub>/kg/min)*