

## **Is the ratio between finger/wrist flexor and extensor strength the same in climbers as in healthy non- climbers?**

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### **Abstract**

Unlike flexion there are no population norms for extension strength and no research into the likelihood of flexor/extensor muscle imbalance as a cause for overuse syndromes. The study aims to investigate the strength of the wrist and finger flexors and extensors in a population of climbers and a healthy non-climbing group and to establish whether there is a 'normal' ratio and whether climbers are outside of this.

30 'elite' climbers and 30 non-climbers were each tested first for grip strength using a dynamometer. Extensor strength measurement was achieved by building a custom-made device.

The non-climbing control group were within national averages for flexion strength and had a mean flexor strength of 38.81kg (range; 18.67kgs – 68.67kgs) and an average flexor/extensor strength ratio of 3.08 ( $p>0.05$ ) with no significant difference between hands or due to demographic variables of gender, height or weight (see table 1). The climbing group were up to 12% stronger with a mean flexor strength of 44.68kg (range; 23.33kgs – 67.33kgs) but also demonstrated an average flexor/extension strength ratio of 3.08 ( $p>0.05$ ). The 10 strongest flexion readings between both participant groups, however did demonstrate a significantly increased ratio of 3.45.

It can be postulated that the population 'norm' for flexor/extensor strength ratio is 3.08 and that very few climbers train beyond this 'safe' limit. Individuals with a particularly strong grip may demonstrate flexor/extensor imbalance.

Mots-clés: IRCRA2018; Escalade; Chamonix, Force de prise,

### **Abstrait**

Contrairement à la flexion, il n'y a pas de normes de population pour la force d'extension et aucune recherche sur la probabilité d'un déséquilibre du muscle fléchisseur / extenseur comme cause des syndromes de surutilisation. L'étude vise à étudier la force des fléchisseurs et des extenseurs du poignet et des doigts chez une population de grimpeurs et un groupe sain non grimpeur et à établir s'il existe un rapport «normal» et si les grimpeurs sont en dehors de cela. 30 grimpeurs «élites» et 30 non-grimpeurs ont chacun été testés en premier pour la force de préhension à l'aide d'un dynamomètre. La mesure de la résistance de l'extenseur a été réalisée en construisant un dispositif sur mesure.

Le groupe témoin non grimpeur se situait dans les moyennes nationales pour la résistance à la flexion et avait une force fléchie moyenne de 38,81 kg (18,67 kgs - 68,67 kg) et un ratio moyen de fléchisseur / extenseur de 3,08 ( $p > 0,05$ ) sans différence significative entre les mains ou en raison de variables démographiques de genre, taille ou poids (voir tableau 1). Le groupe grimpeur était jusqu'à 12% plus fort avec une force moyenne de fléchisseur de 44.68kg (23.33kgs - 67.33kgs) mais démontrait également un ratio moyen de flexor / extension de force de 3.08 ( $p > 0.05$ ). Les 10 lectures de flexion les plus fortes entre les deux groupes de participants ont toutefois montré un ratio significativement augmenté de 3,45.

On peut postuler que la «norme» de population pour le ratio force des fléchisseurs / extenseurs est de 3,08 et que très peu d'alpinistes s'entraînent au-delà de cette limite «sûre». Les personnes ayant une adhérence particulièrement forte peuvent présenter un déséquilibre fléchisseur / extenseur.

## INTRODUCTION

Studies on the effects of climbing on the muscles in the arm focus on the role of the *flexors*; the gripping muscles. The role of the extensors is often discussed and it is consensus that specific reciprocal training should be engaged in to maintain the balance between these muscles. This study looks into the specifics of strength of the extensors and whether there is an imbalance. Gripping is a prime function of the hand, no more clearly demonstrated than in the sport of rock climbing, however the role of the extensor muscles in gripping is fundamental but little data is available. Unlike flexion there are no population norms for extension strength and no research into the likelihood of flexor/extensor muscle imbalance as a cause for overuse syndromes.

## PURPOSE

The study aims to investigate the strength of the wrist and finger flexors and extensors in a population of climbers and a healthy non-climbing group. It also aims to establish whether there is a 'normal' ratio and to ascertain whether climbers are outside of this.

## METHODS

30 'elite' climbers and 30 non-climbers were each tested first for grip strength using a dynamometer. Grip strength was taken in standing with the dynamometer held at the side, not contacting the body with the elbow at 90°. Three measurements were taken with a 10 second rest between each one. Extensor strength measurement was achieved by building a custom-made device with a Tanita® (Illinois, USA) Body Composition Analyzer TBF-300 on a weight only setting – as a set of scales. Standard gym weights were placed onto a specially designed base, which would safely support the weights and transfer the force to the weight belt device.

## RESULTS

The flexors for both groups were, on average 107% stronger in the dominant hand; the climber's flexion average for the dominant hand 45.40Kg compared to 43.96Kg for the non-dominant hand and the control's average dominant strength was 40.12Kg compared to 37.5Kg (Table 1).

	Control Group						Climbing Group					
	Full data		Female		Male		Full data		Female		Male	
<b>Age</b>	34.97		35		34.93		32.8		31.6		33.4	
<b>Height</b>	172.6		166.2		179.9		172.15		163.85		176.3	
<b>Weight</b>	79.54		71.9		88.3		68.51		61.91		71.82	
	LH	RH	LH	RH	LH	RH	LH	RH	LH	RH	LH	RH
<b>Flex</b>	37.5	40.12	28.31	30.5	48	50.12	43.96	45.4	30.67	32.93	50.6	51.63
<b>Ext</b>	12	14.03	8.67	10.59	15.8	17.97	14.2	15.15	10.15	10.9	16.23	17.28
<b>Ratio</b>	3.2	3	3.38	3.02	3.05	2.88	3.1	3	3.04	3.07	3.19	3.01

There were no significant differences between the means of age, height and weight and all strengths tests for either group but the control group did demonstrate a greater range of strength measurements for all variables. There was no statistically significant difference between the weights of the two groups ( $p= 0.368$ ) (Table 1).

There was no significant difference between the groups right hand strength (flexion  $p=0.1$ , extension  $p=0.396$ , ratio  $p=0.592$ ) however the left-hand flexion and extension measurements were statistically significant ( $p= 0.044$  &  $0.036$  respectively) although the ratio between these two measurements was not statistically significant ( $p=0.72$ ).

The overall ratio of flexor strength to extensor strength for the control group not differentiating between variables for gender, height, weight or age was 3.0825 and the climbing group 3.0775, which gives an overall population ratio of 3.08 regardless of whether individuals are climbers or non-climbers.

## DISCUSSION

The study demonstrated effective gathering of population norms for forearm flexor/extension strength ratios. The equipment was easy to source and use and proved a reliable method of measurement. Although the use of a dynamometer has been shown to lack specificity for testing grip strength of climbers [8] there are other tests that have been devised looking at the particular issue of climber's grip. Nevertheless, this study is not intended to look at grip but to compare one muscle group with another i.e. flexors with extensors. Thus, using the dynamometer is relevant and as a test of absolute flexor strength will give an appropriate comparison to the test for absolute extensor strength.

The difference of 7% in flexion strength between dominant and non-dominant hands of both groups supports the findings of Grant [1] who identified a difference of 7.99% in climbers although a larger difference in non-climbers of 11.73% for their inner range grip average. The difference between the females and males in our study were not as significant as found by Grant [1] with only a 2% difference between male and female in the control and a 4% difference between the male and female climbers.

Extension strength followed a similar pattern to flexion strength with an increase in strength corresponding to an increase in flexion strength.

Despite the differences between overall strength of participant groups and the significant difference with non-dominant strength the difference between ext/flex ratios were not statistically significant (all  $p$  values  $> 0.05$ ).

According to the measurements collected from these participants there is *no difference between the finger and wrist extensor/flexor strength ratio between climbers and non-climbers*. This proves that climbing also trains the extensors, which is obvious analysing the hand position while gripping. To apply full strength to the grip when loading the finger flexors a degree of extension in the radiocarpal joint is beneficial [3]. Nevertheless, it is hypothesised that a shift of the extensor/flexor ratio up or down may be the origin of insertion tendinopathies of the finger flexor or extensors [2,4].

Another finding of the study is that if only the 10 strongest flexion measurements (4 from non-climbers, 6 from climbers) all of which were above 60Kg, were compared with their corresponding extensor strength the result

shows that the average extensor/flexor ratio is 3.43; significantly beyond the 'norm' as defined in this study. If the 10 weakest flexion measurements, all of which were below 27Kg (8 from non-climbers, 2 from climbers) were compared with their corresponding extensor strength the results show that there was an average ratio is 3.15; *not* significantly abnormal but also *not* diametrically opposed to the stronger participants. This is as would be expected if the ratio directly corresponded with a *significant increase in strength* and not just strength differences where weaker individuals would show a ratio of less than the norm of 3.08. This may be evidence to support physiological change in the very strongest of examples but does not, necessarily prove a link with climbing as 4 out of 10 of this sample were non-climbers. Further measurements with climbers who are symptomatic for medial or lateral epicondylitis are necessary to evaluate whether this ratio is different in those.

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