

Assessment of hand grip strength in Mexican boxers by training phase

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Abstract

Background and Study Aim:

Boxing bouts are explosive by nature as they include components of speed and power in order to be effective. If a boxer cannot produce power, his performance will be limited. This was the paramount motivation to perform a study on the evolution of the gripping strength in both hands as an indirect indicator of upper limb strength, since this is a major factor in the medical control of boxing matches.

Material/Methods:

22 Mexican high performance fighters were studied by body weight divisions (lightweight, middleweight and heavy-weight) and their strength was assessed by training phase (general, special and competitive). The Relative Strength Index was also assessed, since it took body weight into consideration, thus assisting us to medically control training in this sport, a matter on which there is little reference in the literature. For the statistic analysis a student t test was conducted to evaluate the variables of right hand strength as compared to the left hand's, as well as to the remaining variables by training phases. Moreover, we conducted a Variance Analysis (ANOVA) in order to ascertain if there was a statistical difference between divisions concerning all the variables studied.

Results:

Values found in hand-grip strength in both hands were lower than those reported for elite boxers internationally. We also ascertained a mathematical statistically non-significant increase in hand-grip strength in both hands across the entire sample, for which we recommend improving strength training in upper limbs. There was a mathematical increase with a significant statistic difference for most of the variables studied in the middleweight division by training phase, proving that these boxers were better trained concerning their upper limb strength.

Conclusions:

There was also a mathematical increase with significant statistic difference for the overall boxer group studied by phases in regard to the Right Relative Strength Index. We recommend it as a suitable indicator for controlling strength in boxers.

Key words:

boxing • isometric strength • hand-grip

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BACKGROUND

Boxing – sport of fighting with the fists, especially according to rules requiring the use of boxing gloves and limiting legal blows to those striking above the waist and on the front or sides of the opponent.

Most **boxing** bouts are explosive in nature as they include certain components of power and speed to be effective. If a fighter cannot produce force its performance will be diminished [1–3].

Hand-grip dynamometry constitutes an indirect muscle-strength indicator for upper limbs when there is no “special dynamometer” available to analyze blow power as well as the overall weight of blows stricken during a given time period [2,4,5].

Hand-grip strength – the maximum force applied by the hand to hold an object.

Several studies [5–8] posit that **hand-grip strength** is one of paramount indicators for medical control in boxing training.

Moreover, the dynamics of change in manual dynamometry in athlete's mirrors modifications in excitability of the Central Nervous System and the sporting shape is inordinately influenced by this state of excitability of the CNS [9]. The maximum work capability is also ensured when there is an optimal CNS excitability level, so that dynamometric measurements enable to ascertain patterns, increment and decline of this excitability objectively and elicit the corresponding conclusions benefiting the training of athletes [9].

Ozolín [9] posits that during the competitive phase there must be a 1 to 2 kg increase in hand-grip dynamometry over the average values obtained earlier, so that they correspond to a suitable CNS excitability to ensure an optimal athletic performance.

Muscular isometric dynamometry consists in a suite of tests to measure muscle power in groups whose main joints perform agonistic functions. The goal is to correlate magnitudes obtained by executing actions in which these muscle groups are involved and in which the amount of strength is decisive; so, the type of force employed corresponds to the **isometric strength** of the maximum effort which doesn't result in changes in muscle length [10–13].

The tests to determine strength related to body weight can evaluate in absolute or relative terms. It's advisable to conduct them in sports in which there are competitions carried out by weight divisions, and boxing is one of them [10]. For practical reasons, dynamometric measurement results are undertaken in kilograms (mass measurement units), but the measurement unit, in strict sense, is the Newton (1 kg mass weights 9.8 N) [10].

The objective of this research is to distinguish the evolution of isometric hand-grip strength by training phase in Mexican boxers who belong to the National and Juvenile boxing teams. We'll also assess a Relative Strength Index [14] that takes the athletes' body weight into consideration.

We undertake this due to the importance of the strength quality in boxing matches, according to various authors [1,2,4] and for the indirect orientation of upper limb strength, which this evaluation of isometric hand-grip strength gives us, for it is one of the paramount indicators concerning boxing [7].

Moreover, we wish to discover the tendencies in CNS excitability changes by analyzing the evolution of the

hand-grip and to correctly assess this excitability, in order to improve training and to accomplish better results at a competitive level.

MATERIAL AND METHODS

This research was conducted on 11 Mexican high performance boxers belonging to the National Boxing Team as well as 11 from the Juvenile Boxing Team.

The study was carried out by sorting the variables by training cycle (general, special and competitive) and by boxing divisions (lightweight, middleweight and heavyweight) so to obtain a specific characterization.

The divisions were grouped as follows:

Lightweight (includes the 48, 51, 54 and 57 kg divisions).

Middleweight (includes the 60, 64, 69 and 75 kg divisions).

Heavyweight (includes the 81, 91 and over 91 kg divisions).

Right and left hand-grip measurements were made using a UK-made Harpenden manual dynamometer graduated for kilograms. Three measurements were made for each hand, with a 30-seconds resting time between each measurement.

The boxer stood with upper limbs hanging and with the hand in an intermediate position between pronation and supination. The measurement was conducted after a warm-up session by flexing fingers and wrists and rotating wrists.

Moreover, we obtained the relative strength of the hand-grip of both hands in relation to the athletes' body weight, by applying the following formula [14]:

$$\text{Relative Strength Index} = \frac{\text{Hand-grip strength (right and left) in kg}}{\text{Boxer weight in kg}}$$

For the statistical analysis we used the SPSS-IBM suite to obtain median and standard deviation. Furthermore, student t tests were conducted to ascertain whether there was a significant statistic difference when comparing right- and left-hand variables. We also conducted variance analysis (ANOVA) to determine whether there was any significant statistic difference in the variables among the three divisions under study. Results are featured in Tables and Figure.

Isometric strength – the maximum amount of force that can be exerted against a resistance by static contraction of the involved muscles.

Table 1. General indicators of mexican high performance boxers in competitive phase.

| Indicators | X | SD |
|-----------------------|--------|-------|
| Age in years | 20.10 | 2.16 |
| Sporting age in years | 5.57 | 1.71 |
| Height (cm) | 173.20 | 10.18 |
| Weight (kg) | 67.95 | 16.73 |

RESULTS

In the analysis of sporting age (Table 1) we see that, compared to groups of similar boxers in the international literature [1,7,15] this sample is smaller due to the difficulty in keeping the National Team boxers for a long period of time before they turn pro. The remaining parameters are within the normal range reported in the international literature on boxing [1,7,15–19].

When comparing hand-grip strength values in both hands in Mexican boxers, we saw that they were lower than in other countries, as can be seen in Figure 1.

Analyzing the Right and Left Relative Strength Index (RSI) (Table 2) we observed that for the Lightweight and Heavyweight divisions, as the cycle progressed, the incremental tendency was not clear-cut (hetero-chronic), since only the index grew from General to Special phase,

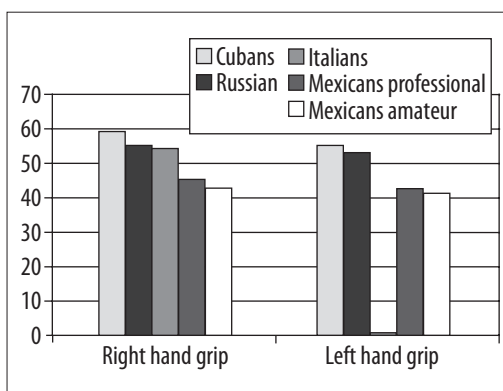


Figure 1. Comparison of hand grip strength in right and left hands of high performance boxers by country.

and in the Competition phase diminished afterwards, all without significant statistical difference.

In the case of the Middleweight division and the entire group of boxers, the tendency from one training phase to the next was incremental with a significant statistical difference in the case of the Right Relative Strength Index, as can be clearly seen in Table 2.

In the analysis of the Left Relative Strength Index (RSI), although in the Middleweight division and the overall boxers' group there is an incremental tendency from one phase to the next, only in the former there is a significant statistical difference.

Table 2. Performance of right and left relative strength indexes (RSI) of overall boxers by divisions according to training phase and their comparison.

| Weight divisions | General | | Special | | Competition | | Comparison | | |
|--|---------|------|---------|------|-------------|-------|------------|---------|-------------|
| | X | SD | X | SD | X | SD | General | Special | Competition |
| Right RSI | | | | | | | | | |
| Lightweight | 64.68 | 6.60 | 69.52 | 6.85 | 69.36 | 10.21 | ns | ns | ns |
| Middleweight | 61.08 | 4.96 | 65.81 | 7.15 | 74.92 | 5.83 | ** | *** | *** |
| Heavyweight | 60.58 | 9.10 | 63.80 | 5.90 | 61.60 | 10.73 | ns | ns | ns |
| Total boxers | 62.11 | 7.03 | 66.38 | 6.81 | 68.63 | 10.40 | ** | ** | ** |
| Left RSI | | | | | | | | | |
| Lightweight | 65.04 | 5.38 | 66.36 | 6.26 | 65.05 | 9.63 | ns | ns | ns |
| Middleweight | 61.43 | 6.99 | 63.88 | 4.35 | 71.99 | 5.35 | ** | ** | ** |
| Heavyweight | 57.47 | 9.36 | 59.99 | 7.78 | 57.10 | 10.70 | ns | ns | ns |
| Total boxers | 61.31 | 7.77 | 63.41 | 6.58 | 64.11 | 10.29 | ns | ns | ns |
| Comparison between right and left RSI | | | | | | | | | |
| Lightweight | ns | | ns | | ns | | | | |
| Middleweight | ns | | ns | | ns | | | | |
| Heavyweight | ns | | ns | | ns | | | | |
| Total boxers | ns | | ns | | ns | | | | |

* α=0.001; ** α=0.003; *** α=0.008.

Table 3. Comparison of rsi strength indicators in Mexican boxers by divisions according to training phase.

| Stages indicators | General | Special | Competition |
|-------------------|----------------|----------------|----------------|
| Right hand grip | SD (L) (M) (H) | SD (L) (M) (H) | SD (L) (M) (H) |
| Left hand grip | SD (L) (M) (H) | SD (L) (M) (H) | SD (L) (M) (H) |
| Right RSI | NSD | NSD | SD (L) (M) (H) |
| Left RSI | NSD | NSD | SD (L) (M) (H) |

SD – Significant difference; NSD – Non-significant difference.

Furthermore, in the analysis of the Left Relative Strength Index (RSI) the Middleweight division also evolved positively with increments from one phase to the next with significant statistical difference.

We also observed that in both hands the Relative Strength Index (RSI) diminished as the divisional weight increased. This is logical if we consider that the formula to determine this index is based on body weight (in its ratio denominator), as we can see very well in Table 2.

Comparing the Right Relative Strength Index with the Left, there was no significant statistical difference in all the boxers under study, although the Right Relative Strength Index values overall were slightly higher in the Special and the Competition phases, for the entire sample group and the assorted divisions; unlike General phase, whose values are slightly higher than the Left RSI values by divisions, excepting the overall boxers group whose Right RSI values were higher. This can be seen in Table 2.

In Table 3 we found that after a variance analysis conducted to ascertain whether there was any significant statistical difference between assorted divisions (lightweight, middleweight and heavyweight), this was the case in left and in right-hand hand-grip; this didn't happen with the Right and Left RSI, since there were only significant differences among the three divisions in the competitive phase.

DISCUSSION

We will first discuss the strength indicators for both hands, which gave us a notion of the way this feature has been developing in the upper limbs, which is crucial to a proper boxing performance.

In the right hand-grip strength analysis by divisions we saw that in the Lightweight and Heavyweight divisions there is no clear incremental tendency from one phase to the next, though there is a slight increase in General to Special phase and then a decline in Special to Competition phase, without any significant statistic difference; yet Competition period values are higher than

General period values, maybe due to a lack of proper training of the right upper limb.

We must underscore positive changes and a clear incremental tendency from one phase to the other, with a significant statistic difference in the Middleweight division.

Regarding the left hand we see that in the Lightweight and Heavyweight divisions the incremental tendency is not clear-cut, since the increment from General to Special phase is slight without any significant statistical difference; the evolution of this variable is deficient in these athletes and we believe this is due to poor left-upper limb training, somewhat that we cannot be careless about in boxers.

Here we also have to underscore the difference in the MIDDLEWEIGHT division in which positive changes with clear incremental tendencies from one phase to the other with significant statistical difference.

In dynamometric analysis of hand-grip strength in the boxers' both hands we saw a incremental tendency from one phase to the next, but without significant statistical difference, and an improved evolution by divisions yet results cannot be called excellent.

When we analyze the Table 4 we are also able to observe that hand-grip values for both hands by divisions increase as weight is gained in all phases.

Comparing right and left-hand-grip strength results we saw no significant statistical difference. These reached maximum 4.36% values in Competition period, which were expected since there shouldn't be any significant difference in opposite hand strength values, for there must be a balance between those values, as we found in the boxers we studied, as seen in Table 4.

We also found that right hand-grip strength was higher in all divisions across the entire Special and Competition phases; at General phase it didn't happen that way and we observed higher values in the left hand in the Lightweight and Middleweight divisions, while at this phase the Heavyweight division and the totality of the

Table 4. Hand grip performance in right and left hands of boxers by divisions and training phase and its comparison.

| Weight divisions | General | | Special | | Competition | | Comparison | | |
|---|---------|------|---------|------|-------------|------|------------|---------|-------------|
| | X | SD | X | SD | X | SD | General | Special | Competition |
| Right hand grip | | | | | | | | | |
| Lightweight | 36.12 | 3.64 | 38.37 | 4.17 | 36.46 | 7.38 | ns | ns | ns |
| Middleweight | 41.62 | 2.32 | 44.00 | 3.58 | 48.12 | 3.87 | * | * | ** |
| Heavyweight | 52.25 | 8.37 | 55.00 | 6.41 | 53.50 | 7.57 | ns | ns | ns |
| Total boxers | 43.33 | 8.59 | 45.79 | 8.45 | 46.02 | 9.56 | ns | ns | ns |
| Left hand grip | | | | | | | | | |
| Lightweight | 36.25 | 1.66 | 36.62 | 3.85 | 34.26 | 7.38 | ns | ns | ns |
| Middleweight | 42.00 | 5.55 | 42.87 | 4.05 | 46.37 | 4.10 | ns | * | * |
| Heavyweight | 49.62 | 9.00 | 52.00 | 9.54 | 50.75 | 9.37 | ns | ns | ns |
| Total boxers | 42.62 | 8.13 | 43.83 | 8.87 | 43.89 | 9.96 | ns | ns | ns |
| Comparison between right hand and left hand grip | | | | | | | | | |
| Lightweight | ns | | ns | | ns | | | | |
| Middleweight | ns | | ns | | ns | | | | |
| Heavyweight | ns | | ns | | ns | | | | |
| Total boxers | ns | | ns | | ns | | | | |

* $\alpha=0.03$; ** $\alpha=0.001$.

boxer group presented higher right hand values too. We believe this is due to the fact most boxers in the sample were right-handed (90.91%).

Recapitulating, we saw that there was no incremental tendency in the Lightweight and Heavyweight boxers under study, as the hand-grip strength cycles in both hands, although this tendency in the entire sample is not significant.

Only in the Middleweight division there was a clear incremental tendency, but the variation was higher than 2 kg. in Competition period, thus proving a higher-than-suitable CNS excitability in this training phase.

So, the use of isometric dynamometry in fingers as part of the medical control of boxers showed a poor neurophysiologic adaptation in all of the athletes under study, which forced us to recommend training routines in order to try to achieve a suitable CNS excitability.

Results obtained through the dynamometric evaluation of the hand-grip in the whole boxer group and in the assorted divisions, along with the values obtained for hand-grip in Mexican boxers are lower than those reported for elite boxers and combat sport at an international level [4,6,7,15,20–22], but within normal limits [23,24], which makes us recommend improving upper limb training in Mexican amateur athletes if we strive to have better prepared competitors and thus attain better results in the competitive arena.

Mathematical increase in hand-grip strength of the right hand in all boxers, as well as the significant increase in values across the Middleweight boxers, along with a drop in body weight in athletes, due to loss of lipids as the date of the big fight approached, we believe that it contributed to a suitable variation in the Relative Strength Index.

After analyzing these results, we infer the likelihood of resorting to this Relative Strength Index (RSI), therefore, we can deduct the importance of studying the hand-grip strength in both hands in boxers, by the assorted divisions to which they belong.

CONCLUSIONS

1. We ascertained a mathematical statistically non-significant increase in hand-grip strength in both hands across the entire sample.
2. Values found in hand-grip strength in both hands were lower than those reported for elite boxers internationally.
3. Non-optimal values in hand-grip strength in both hands concerning competitive phase proved a poor neurophysiologic adaptation to training among the athletes under study
4. There was a mathematical increase with a significant statistic difference in the Right Relative Strength

Index in the entire boxer sample by training phase, thus suggesting that this could be a major indicator for strength control in boxers.

5. At the Middleweight division all of the studied variables tended to grow and showed a significant statistical difference, proving that its boxers were better trained concerning upper limb strength.
6. The existence of a significant statistic difference in hand grips strength values between the Lightweight, Middleweight and Heavyweight divisions, showed

the importance of studying this variable in boxers by divisions.

Recommendations

- I. We recommend improving strength training in Mexican boxers' upper limbs.
- II. We suggest performing dynamometric assessments in hand grips by training phase to control the CNS excitability state in boxers and thus to accomplish better competitive results.

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