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RELIABILITY OF PEAK FORCE AND NET IMPULSE MEASURED BY CAMPUSBOARD

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SUMMARY
Sport climbers to improve physical condition of upper limbs and performance frequently use the Campusboard. In order to establish a reliable diagnosis of strength profile for these athletes, biomechanical variables were measure with Campusboard. The objective of this study was to determine the reliability of peak force and net impulse. Thirteen male sport students (18-22 years) with dominant right hand performed the test 3 times with a rest interval of 30s. The results show excellent reliability for non-dominant and dominant hand for both variables.

INTRODUCTION
Sport climbing has become very popular over the past years [1] and different exercises and equipments have been used to improve performance and physical condition, especially the strength of the upper limbs. The commonly used Campusboard consists of a wooden base with five levels of grips in different heights and can be fixed on a wall. The climber starts the exercise hanging on the lowest grips with the elbow joint flexed and then produces a vertical impulse with the upper limbs to reach the highest possible grips. This movement technique is similar to a countermovement jump since the athlete first stretches elbow flexors muscles, thus accelerating the downward movement, which is then decelerated until the lowest positions are reached, and then starts the upward movement and acceleration.

Countermovement jump provides a reliable measurement of power as an indirect measure of performance and has been used to determine the effectiveness of training programs, athlete's physical condition and bilateral asymmetry in several sports like, football, basketball and volleyball among other [2].

Reliability refers to the reproducibility of values of a test in repeated trials on the same individuals under the same conditions. Better reliability implies better precision of single measurements and better tracking of changes in measurements in research or practical settings [3]. There are no scientific data about the reliability of biomechanical variables measured by Campusboard.

In order to establish a reliable diagnosis of strength profile, biomechanical variables were measured with this equipment. The aim of this study was to determine the reliability of peak force (PF) and net impulse (NI).

METHODS
Thirteen male sport students (non-climbers), between 18 and 22 years, performed exercise described above 3 times with a rest interval of 30s. The two lowest grips were adapted on two one-dimensional force transducers (Model Tedea Huntleigh 601), which permitted the determination of the force-time curve including the peak force and net impulse (Figure 1). Force transducers were calibrated using dumbbells with known mass (2, 10, 20, 30 and 50kg). The peak force and net impulse were registered separately for each hand at a frequency of 1 kHz and lowpass filtered at 10 Hz with a fourth-order, zerolag Butterworth filter implemented in the software DASYLab 10.0. The Statistical Package for the Social Sciences (SPSS) version 15.00 (SPSS Inc.) was used for descriptive analysis and calculus of Intraclass Correlation Coefficient (ICC 3.1).

RESULTS AND DISCUSSION
The results show excellent reliability for peak force (Table 1) and the net impulse (Table 2) for dominant and non-dominant hand, since ICC values can be interpreted as follows: ICC<0.4 – poor; between 0.4 and 0.59 – fair; between 0.6 and 0.74 – good; between 0.75 and 1.0 – excellent [4]. Despite the interpretation of ICC, results showed a slight better reliability for the dominant hand (PF = 0.94; NI = 0.87) than those obtained for the non-dominant hand (PF = 0.83; NI = 0.75). For non-climbers the handgrip strength, measured with handgrip dynamometers, exhibits less symmetry when compared with elite climbers [5]. In view of the fact that the subjects tested in present study consisted of non-climbers, the ICC values are likely to increase when elite climbers are tested with Campusboard.

The peak force of non-dominant hand (577.42 N) and dominant hand (588.87 N) are similar to results found in studies that used handgrip dynamometers to diagnose handgrip strength [5]. However, one study found values of (713.9 N) for handgrip strength using a modified dynamometer, supposedly a more specific methodology to accurately measure hand and finger strength in climbers. Once more, we expect to find higher values of peak force when elite climbers are tested with Campusboard.
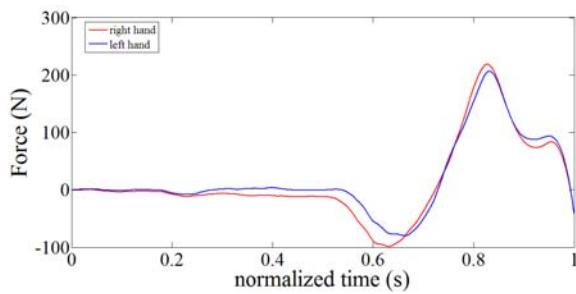
Figure 1: Force-time curves of left and right hand.

CONCLUSIONS

The use of the Campusboard proved to be an adequate equipment to determine peak force and net impulse. The reliability of other variables, e.g. rate of force development as well as bilateral differences of the biomechanical variables should be investigated in order to use this widespread training equipment as a diagnosis of strength profile for sport climbing athletes.

ACKNOWLEDGEMENTS

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Table 1: Descriptive statistics and ICC values for the peak force (PF).

PF (N)	Minimum	Maximum	Mean	sd	ICC	p value
Left hand	348.57	577.42	454.43	61.86	0.83	0.001
Right hand	347.40	588.87	452.65	66.57	0.94	0.001

Table 2: Descriptive statistics and ICC values for net impulse (NI).

NI (N.s)	Minimum	Maximum	Mean	sd	ICC	p value
Left hand	240.26	704.28	659.04	113.21	0.75	0.002
Right hand	251.88	738.87	753.86	95.31	0.87	0.001