Medicina Universitaria. 2017;xxx(xx):xxx—xxx

MEDICINA UNIVERSITARIA
www.elsevier.es/rmuanl

ORIGINAL ARTICLE

A comparison of anthropometric characteristics and somatotypes in a group of elite climbers, recreational climbers and non-climbers

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Received 24 February 2017; accepted 4 April 2017

KEYWORDS
Climbing;
Somatotype;
Anthropometric characteristics

Abstract Sport climbing has become a very popular and competitive sport. Despite growing interest in the research of climbing, there is still scant evidence regarding the adaptations it produces in the anthropometric characteristics of climbers. The objective of this study was to provide descriptive data about the anthropometric and somatotype characteristics of a group of elite and recreational climbers and compare them with a group of healthy non-climber volunteers. Twelve elite climbers (9 males and 3 females), 10 recreational climbers (7 males and 3 females), and 10 healthy non-climbers (6 males and 4 females) were assessed. Body mass, height, body mass index (BMI) and anthropometric measurements were used to obtain body fat percentage (BF%) and somatotype according to the Heath-Carter protocol. We found that females and males elite climbers (EC) have a significantly lower BF% and endomorphic component ($p < 0.05$) than non-climbers (NC). EC males also showed a significantly lower ($p < 0.05$) BMI than NC males. No differences were found between the anthropometric characteristics of EC and recreational climbers (RC); however, the EC had significantly higher mean results ($p < 0.05$) in climbing ability level and years of experience. The mesomorphic component was dominant in both groups of climbers. We concluded that EC, both males and females, are thin individuals with a predominance of musculoskeletal development, significantly less endomorphic characteristics, more ectomorphic characteristics and a lower BF% than the general population.

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http://dx.doi.org/10.1016/j.rmu.2017.05.006
1665-5796/

Introduction

Sport climbing has developed into a mainstream competitive sport and the number of participants has increased significantly since the 1970s.[1,2] In August 2016, the International Olympic Committee approved its inclusion in the Olympic Games in Tokyo 2020. It is a sport that is evolving at an accelerated rate and with the development of safety measures there has been an enormous increase in the difficultly of the routes,[3] making it more challenging for climbers to attain a high level of performance.

It is well known that athletes' body composition tends to differ from the general population and from other athletes who practice a different sport.[4] Gualdi-Russo and Zaccagni[5] stated that body shape and size are important variables, among others, that can influence an athlete's success. The identification of the body composition and somatotype of elite athletes may serve as a guide for planning and monitoring athletic training and talent selection in a certain sport.[6–8] Since the sport of climbing has become more popular, there has been an increase in research in this area. However, there is still scant scientific evidence on the somatotype of these athletes, and no consensus has been reached as to which physiological and anthropometric factors are important in determining climbing performance.[1]

Several studies have examined specific physical characteristics associated with high standard performance in the sport,[1,9–11] since there is evidence that body characteristics play an important role in determining high sporting performance.[4,12] Watts et al.[10] reported that body fat percentage (BF%) and strength to body mass ratio best predicted climbing performance. They concluded that elite climbers were extremely lean athletes with extremely low estimated BF% (4.7% and 10.7% for males and females, respectively), with a small stature and a high strength to body mass ratio. Grant et al.[9] found that elite climbers differed from recreational climbers and active non-climbers on shoulder girdle endurance, finger strength and hip flexibility. However, they found no differences in body mass, height, height:body mass ratio, BF%, arm length, and leg length. Elite male climbers in the study by Grant et al. had a greater BF% (14%) than those in the study by Watts et al., Mermier et al.,[1] reported an average BF% of 9.8% and 20.7% in male and female sport climbers. Viviani and Calderan[4] analyzed a group of top free climbers and reported a low BF% (8.3%) and an average mesomorph–ectomorph somatotype.

Since there is still little scientific information regarding the adaptation that this activity produces in the anthropometric characteristics and somatotypes of climbers, our aim was to provide descriptive data of elite and recreational climbers and compare them with an age-matched healthy non-climbing group.

Material and methods

Twenty-three experienced climbers from two local climbing organizations volunteered for this study (17 males and 6 females). They were separated into two groups based on their self-reported climbing ability.

We defined climbing ability as the most difficult self-reported ascent rated on the Yosemite decimal system (YDS) performed by lead climbing in the two years previous to the study. In order to calculate means we used the modified YDS scale, which assigns a numerical value to replace the letter grades. Letter subdivisions of the YDS were assigned values of $a = 0.00$, $b = 0.25$, $c = 0.50$, and $d = 0.75$.[11] Climbers who had lead climbed a route that was rated at least 13a by the YDS scale were categorized as elite climbers (EC) and the rest were categorized as recreational climbers (RC).

Based on these criteria, 12 climbers were EC (9 males and 3 females) and 10 were RC (7 males and 3 females). The climbers were compared to a control group made up of 10 healthy non-climber (NC) volunteers (6 males and 4 females) who did not perform any sport that demanded upper limb efforts on a regular basis.

Ethical approval was obtained from the Research Ethics Committee of the School of Medicine of the Universidad Autonoma de Nuevo Leon. Prior to the study, each volunteer provided written informed consent after receiving an oral and written description of the procedures that would be performed.

Participants were scheduled for testing on an individual basis. All participants were evaluated in a resting state and were previously instructed not to perform strenuous exercise at least one day before the study. All measurements were performed by a single investigator. Standing height was recorded using a SECA wall-mounted measuring tape (SECA m.206, Seca GmbH & Co. KG, Hamburg, Germany) with the participant barefoot and with their back against a vertical wall, registering to the nearest 0.1 cm. Body mass was measured with a body composition analyzer (InBody 3.0 SN, InBody Co., Seoul, Korea). Body mass index (BMI) was calculated by dividing the mass by the height squared.

All participants underwent anthropometry using the restrained profile established by the International Society for the Advancement of Kinanthropometry (ISAK). Skin fold thickness was measured to the nearest 0.5 mm at eight sites (biceps, triceps, subscapular, iliac crest, supraspinal, abdominal, anterior thigh and medial calf) with a calibrated Slim Guide Skinfold Caliper (Creative Health Products, Inc., Ann Arbor, MI) (constant pressure 10 g/mm^2) on the participant's right side; circumferences (relaxed arm, flexed arm, waist, hips and calves) were measured using a Lufkin metallic tape (model W696PM, Apex Tool Group, Sparks, MD), and two bone breadths (biepicondylarhumerus and femur) were measured with a CESCORF sliding bone caliper (INNOVARE 16 cm). In order to calculate the percentage of body fat, we used the Durnin and Womersley formula[13]: Density $= c - m \times \log$ (folds); where c and m are constants determined by gender and age and which were previously calculated by the authors. The logarithm is calculated from the sum of the thickness of four skin folds (biceps, triceps, subscapularis, and supra-iliac).

Once the anthropometry measurements were collected, somatotype components were calculated according to the Heath and Carter anthropometric somatotype method.[14] The following mathematical equations were made in order to obtain the three components of the somatotype:

Endomorphy: $-0.7182 + 0.1451(x) - 0.00068(x2) + 0.0000014(x3)$ in which x is the sum of the triceps, subscapular, and supraspinale folds, multiplied by (70.18/height in cm).