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BRIEF REPORT

Athletic Profile of Highly Accomplished Boulderers

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Objective.—Bouldering is a discipline of rock climbing completed at low height. Despite its popularity, scientific description of this sport remains sparse. This study aims to characterize the athletic profile of highly accomplished boulderers.

Methods.—Twelve male highly accomplished boulderers (age 25.3 ± 4.9) were matched for age (± 5 yr), height (± 5 cm), and body mass (± 5 kg) to 12 nonclimbing aerobically trained controls. Body composition was determined by dual energy x-ray absorptiometry. Handgrip and climbing specific finger strength were assessed by dynamometry. Shoulder girdle and abdominal muscle endurance were assessed by isometric tests. Data were mostly analyzed by *t*-tests with an adjusted alpha level for multiple comparisons. Ethical approval was received from the School of Sport, Health and Exercise Sciences, Bangor University, Bangor, UK.

Results.—Body composition was similar between the groups, apart from increased bone mineral density in climbers' forearms (1.1 ± 0.1 vs. 1.0 ± 0.1 g $\cdot$ cm^2, $t_{(22)} = 2.798$, $p = 0.010$). Hand grip strength and climbing specific finger strength were greater in climbers (eg, finger strength: 494 ± 64 vs. 383 ± 79 N, $t_{(22)} = 3.740$, $p = 0.001$), but handgrip and abdominal endurance were similar between the groups. In contrast, endurance of the shoulder girdle was substantially greater in boulderers (58 ± 13 vs. 39 ± 9 s, $t_{(22)} = 4.044$, $p = 0.001$).

Conclusion.—Highly accomplished boulderers were characterized by handgrip and finger strength better than that of nonclimbing controls and superior to that of previously investigated elite climbers. In contrast, boulderers' body composition and core endurance were similar to that of controls (who were aerobically trained). These characteristics provide an athletic profile of highly accomplished boulderers, and hence identify possible targets that with further investigation may aid athlete selection and training program design.

Key words: body composition, bouldering, climbing, hand strength, upper body, muscle strength

Introduction

Bouldering is a discipline of rock climbing that involves completion of short climbing tasks termed "boulders" or "problems." These are performed close to the ground on either natural rock or artificial walls. With a minimal chance of serious injury and no requirement for extensive technical equipment and knowledge, bouldering is the most accessible of climbing disciplines, in which the most difficult climbing techniques are realized.

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Participation in bouldering is substantial and escalating.[1] Bouldering competitions are organized at regional, national, and international levels, and are completed on artificial walls where steepness and hold spacing and size are varied to alter difficulty. In International Federation of Sport Climbing competitions, bouldering generally consists of 3 rounds: qualification (consisting of 5 boulders), semifinal (4 boulders), and final (4 boulders). Each boulder is normally compromised of 4 to 8 handholds, and a successful ascent typically requires 1 minute or less to complete. Multiple attempts are allowed within a 4 or 5 minute period, and 4 to 5 minutes of rest are allowed between each boulder.[2]

Whether climbing for competition or recreation, it is necessary to determine the athletic profile of elite performers to optimize physical performance in this emerging sport. This information may identify possible phys-

Table. Demographic, anthropometric, and body composition data of highly accomplished boulderers and non-climbing controls (mean ± *s*)

	Boulderers	*Controls*	*Statistical significance*	*Effect size*
Age (yr)	25.3 ± 4.9	22.7 ± 2.5	$t_{(16)} = 1.688$, $p = 0.110$	$d = 0.66$
Height (cm)	177.7 ± 4.9	181.5 ± 5.9	$t_{(22)} = -1.719$, $p = 0.100$	$d = -0.67$
Mass (kg)	70.2 ± 6.2	73.4 ± 9.7	$t_{(19)} = -0.942$, $p = 0.358$	$d = -0.39$
Body mass index (kg/m^2)	22.3 ± 2.0	22.2 ± 2.5	$t_{(22)} = 0.027$, $p = 0.979$	$d = 0.001$
Activity level (h/week)	12.3 ± 3.1	13.1 ± 4.8	$t_{(22)} = 0.310$, $p = 0.657$	$d = -0.19$
Lean mass (kg)	57.8 ± 4.6	59.5 ± 5.9	$t_{(22)} = -0.762$, $p = 0.454$	$d = -0.31$
Lean mass index (kg/m^2)	18.3 ± 1.2	18.1 ± 1.4	$t_{(22)} = 0.487$, $p = 0.631$	$d = 0.20$
Fat mass (kg)	8.6 ± 3.5	10.4 ± 5.3	$t_{(22)} = -0.970$, $p = 0.342$	$d = -0.39$
Fat mass index (kg/m^2)	2.7 ± 1.2	3.1 ± 1.6	$t_{(22)} = -0.697$, $p = 0.493$	$d = -0.29$
Fat mass (%)	12.1 ± 4.3	13.8 ± 5.6	$t_{(22)} = -0.837$, $p = 0.412$	$d = -0.34$
Total body BMD (g/cm^2)	1.29 ± 0.11	1.25 ± 0.07	$t_{(22)} = 1.106$, $p = 0.281$	$d = 0.45$
Arm BMD (g/m^2)	1.10 ± 0.12	0.97 ± 0.12	$t_{(22)} = 2.798$, $p = 0.010$*	$d = 1.00$

Statistical significance refers to results from independent *t* test; effect size refers to Cohen's *d*; activity level refers to time spent on primary activity; BMD, bone mineral density; *statistically significant difference between groups. The Bonferroni adjusted alpha level for the 2 bone measures = 0.025.

iological targets that future studies may confirm are useful for athlete selection and to guide training program design.[3] Data obtained from the related discipline of sport climbing suggest that the ideal athletic profile for rock climbing is small stature, low body mass, low body fat, high upper body strength to body mass ratio, high dynamic and isometric muscular endurance, high upper body power, and moderate to high aerobic fitness.[3,4] However, sport climbing is characterized by longer climb ascent times of 2 to 7 minutes, and route length up to 18 m. In contrast, bouldering routes are shorter, and in competitions have a maximum height of only 3 m.[2] Natural and artificial bouldering routes are also described as being more strenuous, powerful,[5] and require intense intermittent effort.[6] Thus the activity profile of bouldering is different from that of sport climbing, and boulderers may possess a different athletic profile. At present, scientific description of the participants of this climbing discipline is sparse.

The aim of this study was to characterize the physiological profile of highly accomplished boulderers. Specifically, body composition, muscular strength, and isometric endurance were determined to describe this population. Results were compared prospectively to similarly active but non-climbing controls. Based on observations made of climbers from other disciplines,[3,4] we hypothesized that, when compared to aerobically trained athletes, highly accomplished boulderers would: (1) possess enhanced forearm strength relative to body mass; (2) be more resistant to forearm fatigue; (3) have similar body fat; and (4) posses enhanced shoulder girdle and trunk endurance.

Methods

Following institutional ethical approval (School of Sport, Health and Exercise Sciences, Bangor University) and with informed consent, 12 male highly accomplished boulderers, defined as achieving an outdoor bouldering grade of Fontainebleau 7b (on a scale from 4 to 8c+, equivalent to Union Internationale des Associations d'Alpinism metric scale ~grade 10) on at least 5 occasions including once within the last 2 months were case-control matched to 12 non-climbing controls (Table 1, upper half). All boulderers had taken part in the sport of bouldering regularly for at least 4 years, and bouldering was their primary (> 90% of climbing time) climbing discipline. Controls participated in non-upper-body dominant aerobic sports including running, cycling, and football.

During the winter season, participants presented rested, hydrated, and 2-hour fasted. Body composition was determined by technician-blinded dual energy x-ray absorptiometry (QDR 1500, Hologic Inc, Bedford, MA, USA). After warm up, maximal hand grip strength of both hands was assessed using a Takei handgrip dynamometer (5001 Grip-A, Takei Scientific Instruments, Tokyo, Japan). Climbing specific finger strength of the dominant hand only was also determined using a novel finger flexor dynamometer. A simple base plate was designed and manufactured from wood to stabilize a standard handgrip strength dynamometer (5001 Grip-A, as above) in a horizontal position (see http://www.bangor.ac.uk/sport/documents/fingerdynamometer.ppt) level with the 12th rib. Only the distal phalanx could be