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ORIGINAL RESEARCH

Impact of Wheelchair Rugby on Body Composition of Subjects With Tetraplegia: A Pilot Study

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Abstract

Objective: To investigate the longitudinal effects of wheelchair rugby (WR) training on body composition of subjects with tetraplegia.

Design: Subjects were evaluated at baseline and after WR training.

Setting: Faculty of physical education settings.

Participants: Individuals with tetraplegia (N=13; age, 26.6±6.0y).

Interventions: Four sessions per week of WR training composed by aerobic and anaerobic activities and technical and tactical aspects of WR. The average time of intervention was 8.1±2.5 months.

Main Outcome Measures: Body composition assessed by dual-energy x-ray absorptiometry.

Results: After training, fat mass was significantly reduced in the whole body (15,191±4603 vs 13,212±3318g, P=.016), trunk (7058±2639 vs 5693±1498g, P=.012), and legs (2847±817 vs 2534±742g, P=.003). Conversely, increased bone mineral content (183±35 vs 195±32g, P=.01) and fat-free mass (2991±549 vs 3332±602g, P=.016) in the arms and reduced bone mineral content in the trunk (553±82 vs 521±86g, P=.034) were observed after training. Furthermore, no significant correlation between the duration of training and changes in body composition was detected.

Conclusions: Regular WR training increased lean mass and bone mineral content in the arms and decreased total body fat mass. Conversely, WR training was associated with decreased bone mineral content in the trunk. These results suggest that regular WR training improves body composition in subjects with tetraplegia.

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Subjects with tetraplegia usually have few sports and exercise opportunities to engage in, mainly because of their physical impairment and lack of specialized sports venues. In this sense, wheelchair rugby (WR) was developed in the 1970s aiming exclusively at the participation of people with tetraplegia, and it is currently a Paralympic sport.[1] Tetraplegia occurs when the spinal cord, at the level of any cervical vertebrae, is injured or damaged, impairing motor and sensory functions at and below this neurologic level. Subjects with tetraplegia may face physiological dysfunctions (eg, bradycardia, impaired blood venous return and thermoregulation).[2] In addition, these individuals might develop marked changes in body composition, which include reductions in fat-free mass (FFM) in lower and upper limbs and increases in visceral and subcutaneous fat deposition.[3]

In able-bodied subjects, body composition is directly related to sports performance. There is a positive correlation between higher

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Table 1 Participant information

Subject	Age, t1 (y)	TBM (mo)	TSI (y)	AIS Grade	Height (m)	Mass, t1 (kg)	Mass, t2 (kg)
1	22	10	5.3	A	1.72	65.7	66.7
2	24	9	2.8	C	1.57	57.0	56.3
3	27	8	6.2	B	1.70	55.8	57.2
4	33	8	15.0	A	1.85	75.5	72.6
5	30	10	4.0	A	1.71	62.1	61.3
6	33	10	5.6	A	1.76	62.6	63.6
7	23	9	6.0	A	1.75	62.5	61.7
8	22	3	2.0	A	1.78	58.1	56.7
9	24	3	1.0	A	1.98	64.5	63.6
10	26	11	13.0	A	1.70	62.1	64.3
11	21	8	4.4	A	1.83	76.2	67.1
12	20	8	3.4	A	1.86	64.6	62.9
13	41	8	7.6	B	1.79	67.8	68.7
Mean ± SD	26.62±6.02	8.08±2.47	7.03±4.23		1.77±0.10	64.2±6.2	63.3±4.8

NOTE. t1 is the evaluation before the beginning of the training program. t2 is the evaluation after a period of regular training.
Abbreviations: AIS, American Spinal Injury Association Impairment Scale; TBM, time between measurements; TSI, time since injury.

levels of FFM and sports performance (eg, endurance, strength, power, speed), whereas increased adiposity has a negative impact on this regard.[4] In addition, higher levels of fat mass (FM) have been related to increased metabolic disorders (eg, dyslipidemias,[5] insulin resistance,[6] cardiovascular diseases[7]).

Subjects with spinal cord injury (SCI), especially those with tetraplegia, usually exhibit both higher adiposity[3] and incidence of cardiovascular diseases,[8] in addition to lower levels of physical activity[2] when compared with able-bodied individuals. Previous reports demonstrated that physical activity may promote benefits in the SCI population by increasing aerobic power and strength[9] and preventing decreases in bone mineral density (BMD).[10] Furthermore, cross-sectional studies showed that performance of adapted sports (WR, wheelchair basketball, wheelchair handball, wheelchair tennis) was associated with reduced carotid atherosclerosis and improved cardiac diastolic function in subjects with SCI.[11,12] However, little is known about the impact of regular WR training on body composition. Therefore, the aim of this study was to examine the longitudinal effects of WR training on body composition in subjects with tetraplegia.

Methods

Thirteen men with tetraplegia, who were part of a high-level WR team (one of the main teams of the Brazilian WR Championship, first division), participated in the study. Subjects were recruited by convenience sampling and did not regularly perform physical activity before entering into the WR training program. The small number of WR teams in Brazil and the relatively low number of subjects interested in playing this sport did not allow the performance of a randomized study and the inclusion of a larger group of athletes. Exclusion criterion included any illness that might affect regular training participation, including pressure sores, cardiovascular diseases, and urinary tract and upper respiratory tract infections. Injury level and severity were assessed according to the American Spinal Injury Association Impairment Scale.[13] The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Institutional Review Board of the University of Campinas. All participants read and signed informed consent.

List of abbreviations:

BMC bone mineral content
BMD bone mineral density
DXA dual x-ray absorptiometry
FFM fat-free mass
FM fat mass
SCI spinal cord injury
WR wheelchair rugby

Evaluation of anthropometric features and analysis of body composition by dual x-ray absorptiometry (DXA) were performed before the beginning of the training program (t1) and after a period of regular training (t2). All subjects who underwent t1 were also evaluated at t2. Because of recovery of infections and/or injuries, there were differences in the time between t1 and t2 measurements. Furthermore, 2 athletes were admitted into the team during the season and therefore had a smaller period (3mo) between the measurements (table 1). The average time between t1 and t2 was 8.1±2.5 months (see table 1).

The training program (planned and conducted by team coaches) was designed to meet the demands required by WR matches. Previous data showed that during a high-level WR match, players usually cover an average distance of 4.5km and achieve average speeds of 1.22 and 1.05ms^{-1} in the first and second half, respectively.[14] To meet these requirements, our training program was basically composed by aerobic and anaerobic activities (aerobic training, aerobic circuit training, weight lifting, circuit training, 20-m sprints, and technical and tactical aspects of WR). These activities were performed over 4 sessions per week, and each session was 3 hours in duration. This training load is similar to that reported in other studies evolving elite WR players.[15,16] All participants regularly participated in the training program and attended at least 3 sessions per week, with a training average of 10.5h/wk.

DXA was assessed using a Hologic Discovery device.[a] Bone mineral content (BMC) (g), BMD (g/cm^2), FFM (g), and FM (g) were measured in the whole body and in selected regions (trunk, legs, arms). Bone area was calculated as the ratio between BMC and BMD. The measurements were performed at t1 and t2 by the same investigator, and the volunteers were fasting. Body mass (kg)