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Football training improves lean body mass in men with prostate cancer undergoing androgen deprivation therapy

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Androgen deprivation therapy (ADT) remains a cornerstone in the management of patients with prostate cancer (PCa) despite adverse effects on body composition and functional parameters. We compared the effects of football training with standard care in PCa patients managed with ADT (> 6 months). Fifty-seven men aged 67 (range: 43–74) were randomly assigned to a football group (FG, $n = 29$) or a usual care control group (CON, $n = 28$). The primary outcome was change in lean body mass (LBM) assessed by dual-energy X-ray absorptiometry scanning. Secondary outcomes included changes in knee-extensor muscle strength (one repetition maximum), fat percentage, and maximal oxygen uptake (VO_{2max}). Mean heart rate during training was 137.7 (standard deviation 13.7) bpm or 84.6 (3.9)% HRmax. In FG, LBM increased by 0.5 kg [95% confidence interval (CI) 0.1–0.9; $P = 0.02$] with no change in CON (mean group difference 0.7 kg; 95% CI 0.1–1.2; $P = 0.02$). Also, muscle strength increased in FG (8.9 kg; 95% CI 6.0–11.8; $P < 0.001$) with no change in CON (mean group difference 6.7 kg; 95% CI 2.8–10.7; $P < 0.001$). In FG, VO_{2max} increased (1.0 mL/kg/min; 95% CI 0.2–1.9; $P = 0.02$) and fat percentage tended to decrease (0.7%; 95%CI 1.3–0.0; $P = 0.06$), but these changes were not significantly different from CON. In conclusion, football training over 12 weeks improved LBM and muscle strength compared with usual care in men with prostate cancer receiving ADT.

Prostate cancer (PCa) is the second most frequent malignancy in European men and the most common noncutaneous cancer in Danish men (The Danish Cancer Registry, 2012; Ferlay et al., 2013). PCa growth depends on androgen stimulation, and androgen deprivation therapy (ADT) has become a cornerstone in PCa management, with 50% of patients receiving ADT (Gregory et al., 2001; Meng et al., 2002). ADT reduces serum testosterone to castrate levels via surgery (orchiectomy) or pharmaceuticals, i.e., luteinizing hormone-releasing hormone-agonists (LHRHa; Sharifi et al., 2005). ADT reduces tumor growth and is associated with an array of adverse effects including loss of lean body mass (LBM; 2–4%), increases in fat mass (FM; 2–11%), reduced bone mineral density (BMD), increased risk of fractures, and declines in physical ability and quality of life (Lubeck et al., 2001; Galvao et al., 2008; Alibhai et al., 2010; Haseen et al., 2010).

Trial Registration: ClinicalTrials.gov: NCT01711892

Exercise has been suggested as a possible means to counteract the adverse effects of ADT. Previous studies have provided evidence that exercise may improve LBM, cardiorespiratory fitness, and functional task performance in patients undergoing ADT (Gardner et al., 2014). While these findings are encouraging, a low level of physical activity in this patient group remains a challenge. A recent study found that only 41% of a PCa population met the official physical activity guidelines and those treated with ADT were significantly less physical active than those treated with radiotherapy alone (Chipperfield et al., 2013). Thus, the introduction of innovative interventions reflecting male cancer survivors' need for action-orientated activities likely to stimulate long-term adherence is of importance (Adamsen et al., 2001). Recent studies have shown that recreational football induces beneficial and sustainable musculoskeletal, metabolic and cardiovascular adaptations in healthy untrained young men (Krustrup et al., 2009), middle-aged men with hypertension (Andersen et al.,

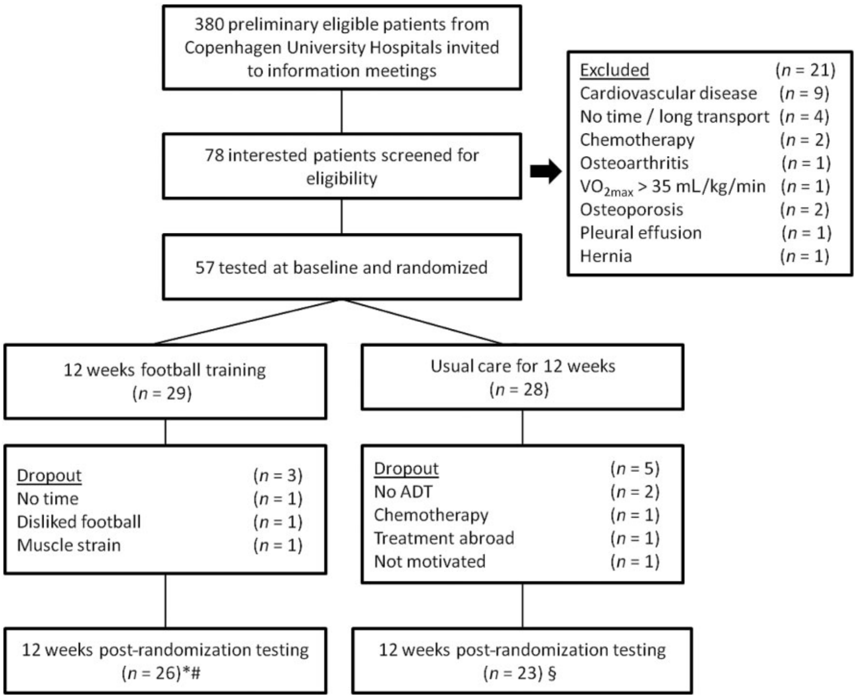

Fig. 1. CONSORT diagram. *Two participants in FG underwent post-baseline assessments except the sit-stand-test after 8 weeks intervention due to injury. #Data from one participant's DXA scan were not included in the analysis due to development of a lymph edema in the left leg caused by a progressing lymph node metastasis in the left inguinal region. §One participant in CON did not undergo the DXA scan, sit-to-stand, and 1RM test at 12 weeks due to work obligations.

2010; Krustrup et al., 2013), middle-aged men with type 2 diabetes (Schmidt et al., 2013), and elderly untrained men (Helge, 2014).

Accordingly, we designed the "FC Prostate" randomized controlled trial (RCT) to evaluate the effects of 12 weeks of football training on body composition, cardiovascular risk profile, bone health, glucose tolerance, physical performance, and patient reported outcomes in men with PCa managed with ADT (Uth et al., 2013). In the present paper, we present data on the effect on LBM (primary outcome), body fat percentage, maximal oxygen uptake (VO_{2max}), muscle strength, and sit-to-stand performance. Analyses of additional measurements included in the study are ongoing and the results will be published elsewhere.

Methods

Study design and population

The present study was an RCT in men with advanced or locally advanced PCa allocated to a football intervention group or a usual care waiting list control group. The overall design and methodology have been described in details previously (Uth et al., 2013). In brief, patients presenting at Copenhagen Prostate Cancer Center, Copenhagen University Hospital, Rigshospitalet, or the Department of Urology, Frederiksberg Hospital, Denmark aged < 76 years managed with ADT, i.e., LHRHa, or surgical castration, for at least 6 months were eligible. Main criteria for exclusion were cardiovascular disorders, osteoporosis, and activity limiting pain from bone metastases. The study was approved by the Danish National Committee on Biomedical Research Ethics for the Capital Region (registration number H-3-2011-131) and written informed consent was obtained from all participants before any study procedures were undertaken. The study flow is presented in Fig. 1.

Randomization and blinding

After successful completion of all baseline assessments, participants were randomized 1:1 to the football intervention group (FG) or the usual care control group (CON). All data were entered into a web server after collection and were not available to study personnel at subsequent tests. At the termination of the study, a statistician blinded to treatment assignment performed all analyses before disclosing any study outcome data to the study coordinator and researchers involved in the study.

Treatment arms

Intervention group

Participants in the FG performed football for 12 weeks two to three times weekly on a natural grass pitch at The Department of Nutrition, Exercise and Sports, University of Copenhagen. In adverse weather conditions (i.e., < 5 °C or heavy rain) training was performed indoors on a wooden floor. All training sessions were supervised by an experienced instructor. During the first 4 weeks, the football training consisted of two weekly sessions, which started with 15 min of warm-up exercises (running, dribbling, passing, shooting, balance, and muscle strength exercises) followed by 2 × 15 min of 5–7 a-side small-sided games. In weeks 5–8, the duration of each session increased to 3 × 15-min games after the warm-up, and in weeks 9–12, there were three weekly training sessions of the same duration.

Control group

Participants in CON were encouraged to maintain their baseline physical activity level and were offered 12 weeks football training after the assessment period had been completed.

Study assessments

All assessments took place at baseline and after 12 weeks. Participants were instructed to avoid intake of medication, caffeine, and vitamins, and to abstain from tobacco use for 12 h prior to the tests and to avoid strenuous physical activity for 48 h prior to all examinations.

Primary study outcome

The primary study outcome was change in LBM determined by whole-body dual-energy X-ray absorptiometry (DXA)-scan (iDXA, Lunar Corporation, Madison, Wisconsin, USA) performed in the morning after an overnight fast.

Secondary study outcomes

Body composition

Assessment of android, gynoid, and total body fat mass was derived from the whole-body DXA scan. Height was measured by a stadiometer, body weight was measured with a digital platform scale and body mass index (BMI) was calculated [weight in kg/(height in m)^2]. Waist circumference was measured around the abdomen at the level of the belly button, and the hip circumference was measured at the widest part of the hips and hip-to-waist ratio was calculated (Price et al., 2006).

VO_{2max}

Two hours after consuming a normal breakfast, participants conducted a submaximal walking test on a treadmill and an incremental test to exhaustion on a cycle ergometer. The submaximal test consisted of 4 min of walking on a treadmill at 4.5 km/h to determine oxygen uptake, respiratory exchange ratio (RER) and heart rate (HR) during an activity similar to that of daily living. After 4 min of passive rest, the incremental cycle test started with 4-min cycling at 40 W, with a self-chosen cadence in the range of 70–90 rpm. The load was increased by 20 W each min until volitional exhaustion. Oxygen uptake, RER, and ventilation were determined by pulmonary gas exchange measurements (MasterScreen CPX, Viasys Healthcare, St Paul, Minnesota, USA). The physiological criteria for approval of the VO_{2max} test were RER ≥ 1.05 and leveling off on the VO_2 curve with an increase of < 1 mL O_2/min/kg (Rowland, 2005). HR was determined in 5 s intervals throughout the incremental test by a Polar Team System chest belt (Polar Electro Oy, Kempele, Finland). VO_{2max} and maximal heart rate (HR_{max}) were defined as the highest oxygen uptake and HR values obtained over 30- and 15-s periods, respectively.

1 repetition maximum (1RM) test

The maximal dynamic concentric muscle strength for the knee extensors was assessed in a knee-extensor resistance machine with the 1RM test measured in 2.5 kg intervals. After a standardized warm-up, the test load started at 15 kg and the resistance was gradually increased until failure. The rest periods between the attempts were 30 s long. The maximum weight lifted through a full range of motion was recorded as 1RM (Taaffe et al., 1999).

Sit-to-stand test

The sit-to-stand test was performed using a chair fixed to the ground with a seat 45 cm above the ground. Participants were instructed to sit in the middle of the chair, back straight, arms crossed over their chest, feet flat on the floor. A mechanical contact in the seat was connected to a computer that automatically counted the number of rises. Correct standing technique was demonstrated first slowly, then quickly. Participants were allowed to practice for two to three repetitions before the start of the test. On the signal "go," participants were asked to stand and then return to the seated position, as many times as possible in 30 s (Jones et al., 1999).

HR during football training

Participants wore HR monitors (Polar Electro Oy, Kempele, Finland) in weeks 2–3 and weeks 11–12 to determine the HR response and the time in various HR zones (HR distribution) in order to evaluate the intensity level of the football training.

Adherence and adverse events

Attendance and reasons for nonattendance of training sessions (e.g., muscle soreness, injury, in- or outpatient visits to the hospital) were recorded in a training log book. Serious adverse events occurring during training were reported immediately to the Unit for Patient Safety in the Capital Region of Denmark.

Sample size calculation and data analyses

To detect a 0.7 kg difference in LBM between the randomization groups, assuming a standard deviation (SD) of 1.0 kg, 34 patients were needed in each group with a significance level (two-sided) of 5% and a power of 80% (Uth et al., 2013). Statistical analyses were performed using Statistical Analysis Systems (SAS) version 9.2. Continuous data are reported either as means and SDs or as medians and interquartile ranges. Baseline comparisons across randomization groups are based on either two-sample *t*-tests, using Welch's *t*-test whenever variances differ significantly, or Kruskal–Wallis tests. Categorical data are reported as proportions and compared across randomization groups using Fisher's exact test. The primary outcome is reported as a two-sample *t*-test comparing change scores in the two randomization groups. Significance level was set at 0.05. The secondary outcomes are reported as means and SDs and as change scores with corresponding 95% confidence limits. Furthermore, two-sample *t*-tests are reported for the secondary outcomes.

Results

Patient characteristics

The groups were well balanced following randomization, although participants in CON were taller than participants in FG ($P = 0.01$). Bone metastases were present in 11 participants, of which seven were allocated to FG. Metastases located to the pelvic, hips, or lower extremities were found in five participants in FG. None of these participants presented with symptomatic disease that would disqualify them from training as judged by the treating physician. Participant characteristics at baseline are presented in Table 1. Participants in FG who completed pre- and post-intervention assessments attended a mean of 20.6 (SD 8.0) of the 28 training sessions, corresponding to an attendance rate of 76.5% (SD 24.2).

Table 1. Baseline characteristics of participants

Variables	Football mean ± SD/n (%)/median (IQR)	Usual care mean ± SD/n (%)/median (IQR)	P-value
Demographic profile			
Age (years)	67.1 ± 7.1	66.5 ± 4.9	$P = 0.72$*
Completed university or college	14 (50.0%)	16 (61.5%)	$P = 0.63$†
Employed full time	7 (25.0%)	8 (30.8%)	$P = 0.88$†
Married or cohabitant	22 (78.6%)	23 (88.5%)	$P = 0.47$†
Medical profile			
Weight (kg)	83.4 ± 11.6	89.0 ± 11.9	$P = 0.08$*
Height (cm)	177.0 ± 5.7	180.8 ± 5.4	$P = 0.01$*
BMI (kg/m^2)	26.6 ± 3.2	27.6 ± 2.8	$P = 0.24$*
Cancer stage grouping			
≥ T3 n	19 (70.4%)	21 (80.8%)	$P = 0.53$†
Presence of nodal metastasis	4 (13.8%)	9 (34.6%)	$P = 0.11$†
Presence of bone metastasis	7 (24.1%)	4 (15.4%)	$P = 0.51$†
Gleason score at diagnosis	7.8 ± 1.1	7.9 ± 1.0	$P = 0.86$*
PSA level at diagnosis	18 (10–39)	28 (15–43)	$P = 0.63$‡
Radical prostatectomy	3 (10.3%)	5 (19.2%)	$P = 0.45$†
Previous radiation	16 (55.2%)	9 (34.6%)	$P = 0.18$†
ADT time (days)	376 (285–833)	560 (283–1049)	$P = 0.65$‡
Time since diagnosis (days)	453 (374–2077)	671 (383–1359)	$P = 0.74$‡
Behavioral profile			
Self-reported leisure-time physical activity level			
Sedentary	2 (7.1%)	1 (3.9%)	
Walking or cycling for pleasure	12 (43.9%)	9 (34.6%)	$P = 0.44$†
Regular physical activity (≥ 3 h/week)	12 (42.9%)	16 (61.5%)	
Intense physical exercise (≥ 4 h/week)	2 (7.1%)	0 (0.0%)	
Current smoker	7 (25%)	6 (23.1%)	$P = 1.0$†

**t*-test pooled variance.
†Fisher's exact test.
‡Kruskal–Wallis test.
ADT, androgen deprivation therapy; BMI, body mass index; IQR, interquartile range; PSA, Prostate-specific antigen; SD, standard deviation.

HR response during football training sessions

Mean HR during football training based on four training sessions in weeks 2–3 and weeks 11–12 was 137.7 (SD 13.7) bpm corresponding to 84.6 (SD 3.9) % of individual maximal HR. The time spent in HR zones < 70%, 70–80%, 80–90%, and 90–100% was 4.6% (SD 4.3), 20.0% (SD 14.9), 48.7% (SD 13.8), and 26.8% (SD 22.2) of total training times, respectively. There was no difference in mean HR in weeks 2–3 compared with mean HR in weeks 11–12 [137.6 (SD 14.5) and 137.8 (SD 13.8) bpm; $P = 0.89$]. Likewise, there were no significant differences in the HR distribution for the football training in the first and last phase of the intervention period (Fig. 2).

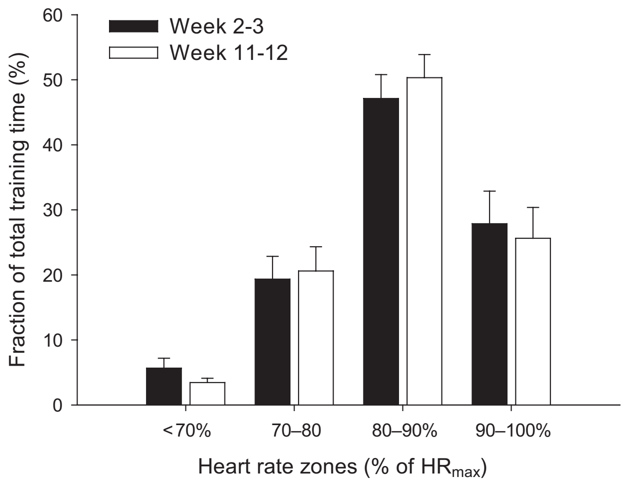

Fig. 2. Heart rate distribution during football training expressed in percentage of training time in selected heart rate zones in weeks 2–3 (black bars) and weeks 11–12 (white bars). Data are presented as means ± standard error of the mean.

Primary outcome

The difference in change scores in total LBM at 12 weeks was 0.7 kg (95% CI 0.1 to 1.2; $P = 0.02$) in favor of FG (Fig. 3(a)).

Secondary outcomes

Body composition

There was no difference in changes between FG and CON for hip-to-waist ratio ($P = 0.56$), android FM ($P = 0.20$) or gynoid FM ($P = 0.64$) but a trend was seen for fat percentage (mean difference –0.7; 95%CI –1.5 to 0.2; $P = 0.08$; Fig. 3(b)). Table 2 lists body composition end points.

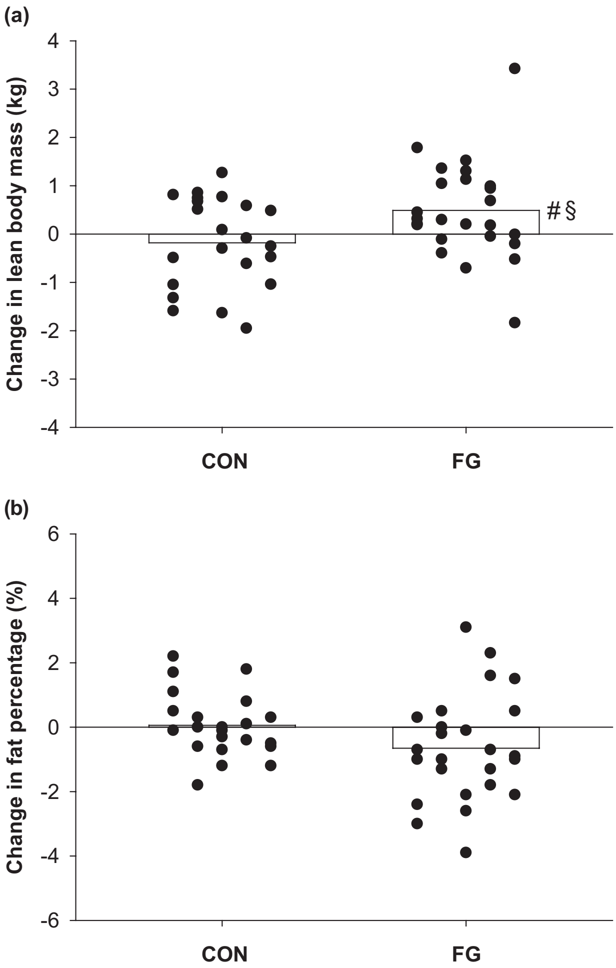

Fig. 3. Changes in lean body mass (a) and fat percentage (b) over a 12-week intervention period with football training (FG) or usual care (CON) for prostate cancer patients undergoing androgen deprivation therapy. Average group changes as well as individual changes are presented. #Denotes significant within-group changes. §Denotes significant between-group differences.

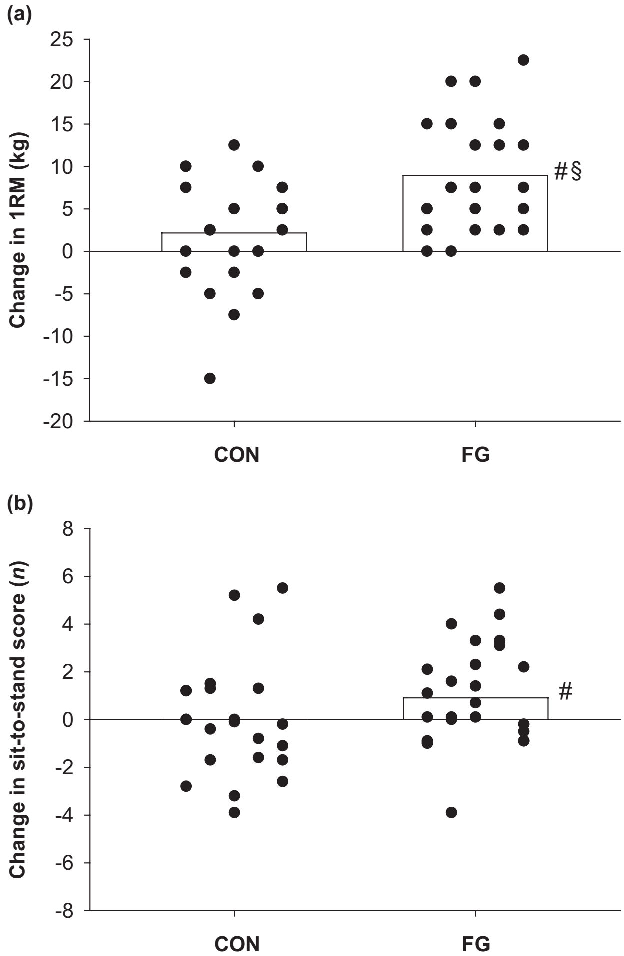

Fig. 4. Changes in knee-extensor muscle strength (1RM, a) and sit-to-stand scores (b) over a 12-week intervention period with football training (FG) or usual care (CON) for prostate cancer patients undergoing androgen deprivation therapy. Average group changes as well as individual changes are presented. #Denotes significant within-group changes. §Denotes significant between-group differences.

Physical performance

Muscle strength for knee extensors (1RM) increased in FG ($P < 0.001$) with no change in CON ($P = 0.13$) and a mean difference of 6.7 kg (95% CI 2.8–10.7; $P < 0.001$) in favor of FG (Fig. 4(a)). In FG, an improvement was observed in the sit-to-stand test score (1.4 repetitions; 95% CI 0.36–2.50; $P = 0.01$) and VO_{2max} (1.0 mL/kg/min; 95% CI 0.2–1.9; $P = 0.02$) but these changes were not significantly different from CON (Fig. 4(b)). Table 2 lists physical capacity end points.

Adverse events

In FG, two participants had a fracture of the fibula bone (session 1 and 16, respectively). Also, one participant had a partial rupture of an Achilles tendon (session 3), and one participant had an ankle sprain in training session 16. All four recovered fully from these injuries after conservative treatment. Additionally, one participant withdrew from the study after a quadriceps muscle strain. In one of the participants who had a fibula fracture, a diagnosis of peripheral neuropathy was revealed in the medical treatment following the fracture and the participant was therefore excluded from the intervention but re-tested at 12 weeks and the data were included in the analysis. Three of the injured participants resumed football training after appropriate recovery time.

Discussion

This is the first randomized controlled study to evaluate the effects of football training compared with standard care in men with PCa managed with ADT for > 6 months. The most important findings were that the 12-week intervention resulted in an improved LBM in the football group compared with the usual care controls, in combination with an increase in knee-extensor muscle strength. These results emphasize that PCa patients

Table 2. Body composition and functional capacity absolute values and changes after the 12-week intervention

Variable	Baseline Mean	Baseline SD	12 Weeks Mean	12 Weeks SD	Change score Mean	Change score 95% CI	Change score *P*	Group difference in mean change score (FG vs CON) Mean	Group difference 95% CI	Group difference *P*
Lean mass, kg										
Football	53.1	5.9	54.0	5.2	0.5	0.1 to 0.9	0.02	0.7	0.1 to 1.2	0.02
Control	56.7	5.5	56.8	5.1	−0.2	−0.6 to 0.2	0.38			
Fat mass, kg										
Football	27.6	7.5	26.3	7.0	−0.6	−1.4 to 0.1	0.08	−0.6	−1.5 to 0.2	0.14
Control	30.0	7.7	29.7	6.2	0.0	−0.5 to 0.5	0.95			
Fat mass, %										
Football	32.6	5.8	31.7	5.6	−0.7	−1.3 to 0.0	0.06	−0.7	−1.5 to 0.2	0.08
Control	32.9	5.2	32.9	4.0	0.1	−0.4 to 0.5	0.78			
1 RM (kg)										
Football	62.8	15.0	71.7	18.8	8.9	6.0 to 11.8	< 0.001	6.7	2.8 to 10.7	< 0.001
Control	71.7	16.9	73.9	16.0	2.2	−0.7 to 5.0	0.13			
Sit-to-stand (repetitions)										
Football	20.0	6.0	21.5	6.3	1.4	0.4 to 2.5	0.01	1.2	−0.3 to 2.8	0.11
Control	22.1	4.9	22.3	5.5	0.2	−0.9 to 1.3	0.72			
VO_{2max} (mL O_2/kg/min)										
Football	27.2	4.6	28.7	5.2	1.0	0.2 to 1.9	0.02	0.7	−0.6 to 2.0	0.29
Control	26.4	3.4	26.9	3.0	0.3	−0.7 to 1.4	0.50			

Mean (SD) at both time points are based on available data. Mean change is based on 12-week score minus baseline score and may not precisely reflect this difference given that mean change is calculated only on data from participants assessed at both time points.
1RM, one repetition maximum; CI, confidence interval; SD, standard deviation; VO_{2max}, maximal oxygen uptake.

managed with ADT can obtain positive adaptations in body composition and muscle strength after a short-term football intervention.

The present study showed a high attendance rate and revealed a high exercise intensity during football training for the PCa patients. The HR recordings collected over several training sessions during the intervention period revealed average HRs of 85% of individual HR_{max} and more than 25% of the training time with HRs above 90% of HR_{max}. Another 25% of the time was spent with HRs below 80% of HR_{max}. These HR values are similar to values obtained during football training for healthy 70-year-old men with and without prior experience with football as well as middle-aged untrained men with hypertension and type 2 diabetes (Krustrup et al., 2013; Schmidt et al., 2013; Andersen et al., 2014), which emphasizes that football training is an intense interval activity also for PCa patients managed with ADT. Considering that mean and peak HRs were around 140 and 160 bpm, respectively, during football training but only around 100 bpm during physical activities that are usually performed in everyday life, like walking at 4.5 km/h and cycling at 40W (data not shown), it is clear that the football training constitutes an extraordinary training stimulus for the participants.

The observation of an increase in LBM is accordance with the findings of Galvão et al. (2010), who reported that a combination of resistance and aerobic exercise reversed loss of LBM after 12-week intervention in men with PCa receiving ADT for > 2 months. Similarly, Alberga et al. (2012) found that a 24-week resistance exercise intervention preserved LBM in men receiving ADT while decreases were seen in both an aerobic exercise group and a control group. A recently published randomized pilot study indicated that resistance exercise may also be well tolerated and improved LBM in men with bone-metastatic PCa (Cormie et al., 2013). Loss of LBM during ADT has been widely reported (Haseen et al., 2010) and has been linked to reduced mobility and function (Clay et al., 2007). We therefore believe that the improvement in LBM resulting from the present football intervention may be clinically important. In direct relation to the increase in LBM, the football group participants had a marked increase in knee-extensor muscle strength compared with the control subjects. Likewise, a within-group improvement was observed in functional capacity as evaluated by the sit-to-stand test. These training adaptations can benefit the PCa patients during everyday life activities as well as during physical training.

Also of importance, VO_{2max} improved significantly from baseline to 12 weeks in the football group, although this was not significantly different from the changes in the control group. However, even modest improvements in oxygen uptake may be of importance since better peak oxygen uptake is a strong independent predictor of survival in healthy adults (Kodama et al., 2009) and PCa patients undergoing ADT have previously been shown to have reduced aerobic capacity (Galvao et al., 2008). Moreover, football training resulted in a borderline reduction in fat percentage compared with usual care. This finding is in line with findings by Segal et al., which indicated that resistance training prevented an increase in body fat (Segal et al., 2009). Since adiposity is a common adverse effect related to ADT (Hamilton et al., 2011) causing secondary morbidity, e.g., cardiovascular disease and type 2 diabetes (Keating et al., 2006), we consider this finding to be of potential clinical relevance. It is, however, essential for the preservation of the favorable effects that the men maintain the activity long term. So far, a qualitative investigation (Bruun et al., 2014) from the present study suggests that the participants regarded football training as a welcome opportunity to regain control and acquire a sense of responsibility for own health without assuming the patient role.

Three serious adverse events occurred during football training, i.e., two fibula fractures and one partial Achilles tendon rupture. These injuries were managed with conservative treatment and the participants recovered fully. As no bone metastases were present in the fractured bones, these injuries are regarded as accidental and unrelated to metastatic disease. While serious injuries are a source of great concern, the potential debilitating effects of physical inactivity on body composition, physical capacity, and subsequent risk of morbidity must be weighed against potential training related hazards. In order to prevent musculo-skeletal events, future interventions offering football training to men with prostate cancer undergoing ADT should consider an adaption period of combined strength-, balance-, and football skill training prior to actual football games, such as the FIFA 11+ exercises (Junge et al., 2011). However, given the nature of the football activity involving physical contact between players, an uneven playing surface, and unexpected moves by teammates, opponents, and the ball, the risk of injuries related to training is not completely avoidable.

The present study has several important limitations including unblinded assessment personnel and a lower than expected recruitment rate. Furthermore, the study population was relatively heterogeneous regarding age and treatment duration and there was possibly a case of selection bias, as the present study appealed to participants motivated for exercise. It should also be noted that the football group, on average, had received ADT for approximately 6 months less than the control group. Although this was not statistically significant and both groups had received treatment for more than a year, the football group may have been subject to further deterioration during the intervention period compared with the control group. Strengths of the study include the novelty of football as a cancer rehabilitation modality, assessment of clinically relevant outcomes with validated measures, and inclusion of patients with a substantial disease burden underrepresented in exercise trials.

In summary, 12 weeks of football training is an effective intervention to improve lean body mass and muscle strength in men with prostate cancer during androgen deprivation therapy.

Perspectives

Accumulating evidence suggests that exercise may ameliorate adverse effects related to androgen deprivation treatment of PCa (Gardner et al., 2014). The present study adds to existing knowledge by showing that football training improves clinically relevant outcomes and thus may be considered as a recommendable alternative to traditional rehabilitation interventions. However, pragmatic studies devoted to the examination of the effectiveness of football training in a natural setting (i.e., community-based, local football clubs) are warranted in order to establish the generalizability and dissemination potential of football in prostate cancer survivorship care.

Key words: Rehabilitation, cancer survivorship, muscle mass, body fat percentage, 1RM, VO_{2max}, side effects, soccer.

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