Total, regional and unilateral body composition of professional English first-class cricket fast bowlers

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Matthew J. Lees¹, Kunwar Bansil², and Karen Hind¹

¹Institute for Sport, Physical Activity and Leisure (ISPAL), Leeds Beckett University, Headingley Campus, Leeds, LS6 3QS, United Kingdom

²Yorkshire County Cricket Club, Headingley Cricket Ground, Leeds, LS6 3DP

Corresponding author: Mr Matthew Lees, BA, MSc, Institute for Sport, Physical Activity and Leisure (ISPAL), Leeds Beckett University, Headingley Campus, Leeds, LS6 3QS, United Kingdom. Tel: (+44) 07794 137606

Email: m.lees@leedsbeckett.ac.uk

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Abstract

There have been few reports of advanced body composition profiles of elite fast bowlers in the sport of cricket. Therefore, the aim of the current study was to determine total, regional and unilateral body composition characteristics of elite English first-class cricket fast bowlers in comparison with matched controls, using dual-energy X-ray absorptiometry (DXA). Twelve male fast bowlers and 12 age-matched, non-athletic controls received one total-body DXA scan. Anthropometric data were obtained as well as left and right regional (arms, legs and trunk) fat mass, lean mass and bone mineral content. Fast bowlers were significantly taller and heavier than controls (P<0.05). Relative to body mass, fast bowlers possessed greater lean mass in the trunk (80.9±3.7 vs. 76.7±5.9%; P=0.047) and bone mineral content in the trunk (2.9±0.3 vs. 2.6±0.3%; P=0.049) and legs (5.4±0.5 vs. 4.6±0.6%; P=0.003). In the arm region, fast bowlers demonstrated significantly greater unilateral differences in bone mineral content (10.6±6.6 vs. 4.5±3.9%; P=0.012). This study provides specific body composition values for elite-level fast bowlers and highlights the potential for muscle and bone imbalances that may be useful for conditioning professionals. Our findings also suggest beneficial adaptations in body composition and bone mass in fast bowlers compared with their non-athletic counterparts.

Keywords: dual-energy x-ray absorptiometry; elite sport; lean mass; body fat; bone mineral content
Introduction

Body composition analysis is a common practice in professional sport, allowing changes in anthropometric and physiological status to be monitored. A number of techniques are used to achieve this, such as skinfold kinaanthropometry, underwater hydrostatic weighing, bioelectrical impedance analysis and dual-energy X-ray absorptiometry (DXA; Duthie, Pyne, Hopkins, Livingstone, and Hooper, 2006; Walsh, Cartwright, Corish, Sugrue, and Wood-Martin, 2011; Ackland et al., 2012). Depending on the choice of technique, individual levels of fat mass, lean mass, percentage body fat, fluid status and bone mineral content can be quantified, providing useful information for coaching staff, sports nutritionists and conditioning professionals. The three-compartment model (fat mass, lean mass and bone mineral content) of body composition assessment, such as DXA, is widely recognised as a criterion technique for measuring both total (Van der Ploeg, Withers, and Laforgia, 2003; Harley, Hind, O’Hara, and Gross, 2009) and regional (Hind, Oldroyd, and Truscott, 2011) body composition. DXA has recently been used to quantify body composition characteristics in elite South African cricket players (Micklesfield, Gray, and Taliep, 2012). However to date, no study has specifically reported the body composition profiles of English first-class cricket fast bowlers using this technique.

The discipline of fast bowling in cricket is a crucial element of the sport, and teams at all levels strive to develop bowlers with the ability to generate high ball release speeds (Wormgoor, Harden, and Mckinon, 2010). Greater ball release speed reduces the reaction time and impairs the decision-making ability of a batsman (Worthington, King, and Ranson, 2013) and this may lead to a dismissal or reduction in the scoring rate (Wormgoor et al., 2010). Hence, a considerable number of studies
have sought to identify the technical aspects that define the fastest bowlers (Glazier, Paradisis, and Cooper, 2000; Portus, Mason, Elliot, Pfiztnner, and Done, 2004; Worthington et al., 2013). In terms of execution, the bowling action is initiated with a run-up to the wicket that gradually increases in speed before culminating in a final delivery stride (Ferdinands, Marshall, and Kersting, 2010). During this sequence a bowler is required to extend and rotate the trunk whilst absorbing ground reaction forces of between 3.8–9.0 times body mass at front foot contact (Hurrion, Dyson, and Hale, 2000; Stuelcken, Ferdinands, and Sinclair, 2010).

Non-DXA anthropometric profiling has shown that greater anterior-posterior chest depth and large arm and calf girths are associated with higher ball release speeds (Pyne, Duthie, Saunders, Petersen, and Portus, 2006; Stuelcken, Pyne, and Sinclair, 2007; Johnstone et al., 2014). Using DXA, Micklesfield and colleagues (2012) reported no differences in total fat mass and lean mass in elite South African fast bowlers compared to batsmen and spin bowlers. The purpose of the current study was to explore regional and unilateral as well as total three-compartment body composition in elite English first-class cricket fast bowlers, and to compare these values with age-matched, non-athletic controls.

Methods

Participants

Twelve professional male cricket fast bowlers from an English first-class county club and twelve non-athletic, age-matched controls (age 22.6 ± 4.6 vs. 21.4 ± 1.6 years, respectively; $P = 0.437$) participated in the study. For the purpose of this
study, the term ‘fast bowler’ refers to a player who would normally bowl seam up and
in normal circumstances, the keeper would stand back to take the ball, given the
greater ball velocity compared to slower bowlers (Dennis, Farhart, Goumas, and
Orchard, 2003). Controls were recruited from non-athletic university staff and
students not engaged in a structured programme of exercise. The age range of both
groups was 17.0–30.1 years for fast bowlers, and 18.0–23.8 years for controls. By
ethnicity, there were 11 Caucasians and 1 Asian participant in each sample group.
Prior to testing all participants provided their written, informed consent to take part.
Approval for the study was granted by the University Faculty Research Ethics
Committee in accordance with the guidelines of the Declaration of Helsinki.

Experimental design

Participants underwent a single total-body DXA scan (Lunar iDXA, GE Healthcare,
Madison, WI) during the preseason phase of the cricket season (January) in a
euhydrated state. Participants were instructed to wear light weight clothing and
remove all shoes and jewellery prior to testing. Height was measured using a
stadiometer (SECA Alpha, Birmingham, UK) to the nearest millimetre and body
mass was measured using calibrated electronic scales (SECA Alpha 770,
Birmingham, UK) to the nearest gram. Participants were asked to lie on the scanning
table in a supine position, with arms to the side and ankles supported with the Lunar
ankle strap. Each scan took approximately 7 minutes to obtain values for total fat
mass, lean mass, percentage body fat and bone mineral content. Bone mineral
content is the amount of bone mineral (hydroxyapatite) within a given anatomical
region, and provides one indication of bone strength. Lean mass and fat mass data
were calculated based upon the ratio of soft tissue attenuation of two X-ray energy
beams for each pixel containing a minimum amount of soft tissue but no significant
bone (Mazess, Barden, Bisek, and Hanson, 1990). Bone mineral content was then
determined from the absorption of each beam by bone.

In our laboratory, the *in-vivo* short-term precision (%CV) for total body
composition variables are 0.82% for fat mass, 0.51% for lean mass, 0.86% for
percentage body fat, and 0.60% for bone mineral content (Hind et al., 2011). All
scanning and analysis procedures were completed by the same trained operator using
the GE Lunar ENCORE software package (Version 15.0) and interpreted by an
International Society for Clinical Densitometry (ISCD) clinically certified
densitometrist. The machine was checked and calibrated on a daily basis in
accordance with the manufacturer’s recommendations.

**Statistical analyses**

All statistical analysis procedures were completed using the SPSS software package
(Version 21.0, SPSS Inc., Chicago, IL). Normality and equality of variance in the
data were assessed using the Shapiro-Wilk test, normality plots and Levene’s test
where appropriate. Descriptive statistics were used to profile each of the sample
groups, with data reported as mean ± standard deviation. For regional data both
absolute and relative values were calculated. The association between lean mass and
bone mass was determined using the Pearson product-moment correlation.

Independent samples t-tests were used to compare body size and composition
variables of fast bowlers and controls. Dependent samples t-tests were used to
compare differences in body composition between the legs (front leg vs. back leg)
and arms (non-bowling vs. bowling). In the event that a variable was found to be non-parametric, log transformation was performed. Effect size in the form of Cohen’s $d$ was reported to demonstrate the magnitude of observed differences. A variation of the effect size scale put forth by Cohen (1988) was used to classify observed effect size values as follows: 0–0.2 (trivial), 0.2–0.6 (small), 0.6–1.2 (moderate), 1.2–2.0 (large) and >2.0 (very large) (Hopkins, 2002). For effect sizes, 95% confidence intervals (95%CI) were also determined. Statistical significance for all analyses was set to $P \leq 0.05$.

**Results**

The descriptive characteristics of the fast bowlers and controls are reported in Table I. Fast bowlers were significantly taller ($P = 0.001$), heavier ($P = 0.001$) and possessed greater amounts of lean mass and bone mineral content ($P < 0.001$) compared to controls, with effects ranging from large to very large. Absolute and relative total fat mass did not significantly differ between groups, nor did body mass index. The moderately lower percentage body fat in fast bowlers was noted, despite not reaching statistical significance. Effects for body mass index and fat mass ranged from trivial to small. The correlation between total lean mass and bone mineral content was not significant in fast bowlers ($r = 0.57, P = 0.053$) but was significant in controls ($r = 0.79, P = 0.002$).
Regional differences in body composition are shown in Table II. Fast bowlers possessed significantly higher absolute lean mass and bone mineral content in the arms, legs and trunk. This was further indicated by the large to very large effect sizes observed. Absolute fat mass did not differ significantly between groups in any region. When expressed as % of regional mass, no significant differences were observed in the arms ($P > 0.05$). Although arm bone mineral content was moderately greater in fast bowlers, this effect did not reach statistical significance ($P = 0.053$). Bone mineral content was significantly higher in the legs of fast bowlers; this was concurrent with greater lean mass and bone mineral content in the trunk compared to controls. These differences also constituted moderate to large effects. In controls, significantly greater relative fat mass was observed in the trunk, demonstrating a moderate effect. No other significant differences in regional body composition were observed.

****insert Table 2 near here****

The percentage differences in unilateral body composition for both groups are given in Table III. Fast bowlers demonstrated a significantly greater difference in arm bone mineral content than controls ($P = 0.012$) and this constituted a moderate effect. A moderately greater difference in leg fat mass was observed in fast bowlers however this was not statistically significant. No other significant differences were found and this is further supported by the small/trivial effect size values observed.
In fast bowlers, when the front leg was compared to the back leg, no significant differences were found for fat mass (2.59 ± 0.47 vs. 2.63 ± 0.47 kg; $P = 0.368; d = 0.09 ± 0.21$), lean mass (11.53 ± 1.09 vs. 11.62 ± 1.30 kg; $P = 0.473; d = 0.08 ± 0.24$) or bone mineral content (800 ± 86 vs. 792 ± 97 g; $P = 0.177; d = 0.09 ± 0.14$). For the bowling arm, significantly greater lean mass (4.34 ± 0.43 vs. 4.15 ± 0.49 kg; $P = 0.021; d = 0.22 ± 0.18$) and bone mineral content (288 ± 37 vs. 257 ± 34 g; $P < 0.001; d = 0.87 ± 0.38$), were observed compared to the non-bowling arm. No significant differences in fat mass were found (0.79 ± 0.17 vs. 0.76 ± 0.14 kg; $P = 0.166; d = 0.19 ± 0.28$).

***insert Table 3 near here***

**Discussion**

To our knowledge this is the first study to present DXA-derived total and regional body composition values for elite English cricket fast bowlers. It is also the first investigation to report unilateral differences in body composition in fast bowlers and an age-matched control group.

Fast bowlers were significantly taller than controls, supporting reports elsewhere that elite fast bowlers are taller than players from other cricketing disciplines (Micklesfield et al., 2012; Johnstone et al., 2014) as well as the general male population (Health and Social Care Information Centre, 2012). Typical values in this population have ranged from 183 cm to 192 cm (Stuelcken et al., 2007; Wormgoor et al., 2010; Worthington et al., 2013). Increased standing height may be
a beneficial attribute for performance in fast bowling, given that a higher angle of
ball release may extract greater bounce from the playing surface (Stuelcken et al.,
2007).

The significantly higher body mass, absolute total and regional lean mass
found in fast bowlers indicates a more highly-developed physique (Stuelcken et al.,
2007). The only previous study to compare body mass between fast bowlers and
controls did so in 9 fast bowlers, and found no significant differences in body mass
(Micklesfield et al., 2012). However, previous research in cricket (Pyne et al., 2006)
and other throwing sports (Van den Tillaar and Ettema, 2004; Werner, Suri, Guido,
Meister and Jones, 2008) has shown that increased body mass and lean mass are
linked to both bowling velocity and throwing performance. For example, Pyne and
colleagues (2006) found that anterior-posterior chest depth, measured by
anthropometry, was one factor in a multiple linear regression analysis that showed a
sizeable relationship ($r = 0.74$) with peak bowling speed in 24 senior first-class fast
investigated the effects of anthropometry and gender on maximal overarm throwing
velocity in 20 experienced male handball players. Throwing velocity was found to
correlate with both fat-free mass ($r = 0.62$) and body mass ($r = 0.54$). These findings
are further supported by those of Werner et al. (2008) who conducted a study of ball
velocity and throwing mechanics in 54 collegiate baseball players using three-
dimensional, high-speed (240 Hz) video analysis. It was found that heavier pitchers
tended to throw faster than lighter pitchers, perhaps due to the possession of greater
lean mass and strength (Werner et al., 2008).

In our study, the observation that no significant differences in fat mass were
found between fast bowlers and controls suggests that the difference in body mass
between groups was predominantly lean mass, and this may be desirable for
performance (Van den Tillaar and Ettema, 2004; Pyne et al., 2006). Further, the
greater absolute and relative lean mass and decreased relative fat mass of the trunk
region (Table II) in fast bowlers is indicative of an optimised body composition, in
which the ratio of lean mass to fat mass is maximised, thus enhancing performance
(Van den Tillaar and Ettema, 2004; Pyne et al., 2006; Stuelcken et al., 2007). The
fact that the measurements were taken during preseason, at a time of considerable
emphasis on training and physical development (Milanese, Piscitelli, Lampis, and
Zancanaro, 2012) may have also contributed to this profile. As outlined previously,
increased levels of lean mass may be beneficial for fast bowlers to enhance bowling
velocity and accuracy (Pyne et al., 2006; Stuelcken et al., 2007; Johnstone et al.,
2014). Furthermore, the development of lean mass may be beneficial for fast bowlers
with regards to injury prevention (Stuelcken et al., 2007).

The greater total and relative bone mineral content of the legs and trunk in
fast bowlers may be indicative of the loading placed upon them, with particular
emphasis on the lower limbs and lumbar spine (Finch, Elliot, and McGrath, 1999;
Hurrion et al., 2000). It has been speculated that high levels of bone mass in fast
bowlers may be a consequence of their high lean mass (Micklesfield et al., 2012).
The ‘muscle-bone unit’ theory suggests that both muscle and bone, as highly
metabolic endocrine organs, are capable of bidirectional crosstalk via myokines and
osteokines (Cianferotti and Brandi, 2014). Thus, striated muscle can influence bone
strength (Cianferotti and Brandi, 2014). Although in our study, the correlation
between bone mineral content and lean mass was large, this did not reach statistical
significance. It is more likely that the ground reaction forces endured by fast bowlers
in the run-up and delivery stride contribute an osteogenic effect, in line with Frost's
Mechanostat theory (Frost, 1987). The Mechanostat is a negative feedback system responsible for bone modelling and remodelling, influenced by mechanical, hormonal and cell signalling mechanisms (Schoenau and Fricke, 2006). Indeed, the high-impact nature of fast bowling may itself be responsible for beneficial adaptations in bone mass and appendicular lean mass in this population (Andreoli et al., 2001; Micklesfield et al., 2012). However, it should also be noted that excessive repetitive loading of significant magnitude, such as that induced by a high bowling workload, may result in skeletal micro-trauma leading to overuse injuries such as lumbar stress fractures (Dennis, Finch, and Farhart, 2005).

The significantly greater unilateral difference in arm bone mineral content in fast bowlers may be a consequence of muscular and osseous adaptations in the bowling (dominant) arm. This has been demonstrated in other sports such as tennis and baseball as well as in collegiate throwing athletes (McClanahan et al., 2002; Whittington et al., 2009). These adaptations are likely a result of the increased muscular forces applied during bowling and throwing when compared to the non-dominant arm. For example, Glazier and colleagues (2000) found that the arm action contributed 62.2% of ball release speed, using three-dimensional biomechanical analysis. Large distraction forces are experienced at the glenohumeral joint during the early stages of the follow-through of the bowling action, requiring the appropriate dynamic stability to maintain structural integrity at the joint (Stuelcken, Ferdinands, Ginn, and Sinclair, 2010). Concurrent with the Mechanostat and muscle-bone unit theories, dynamic muscular forces generated within the bowling arm of fast bowlers may be sufficient to instigate a site-specific osteogenic response (Schoenau and Fricke, 2006). Importantly, the presence of muscle and/or bone imbalances in overhead throwing athletes may be associated with an increased risk
of injury due to functional instability and movement impairments (Wang and Cochrane, 2001; Page, 2011; Edouard et al., 2013; Mangine et al., 2014). In this study, no significant unilateral differences in body composition were found in the trunk region. By DXA, the trunk includes the complete spine and can be confounded by the sternum and rib cage. The skeletal response to long-term fast bowling in the lumbar spine would enable a more appropriate exploration of the effects of repetitive, dynamic forces at a site of frequent injury in this population (Finch et al., 1999).

**Conclusions**

To our knowledge this is the first investigation to quantify total, regional and unilateral body composition in fast bowlers using a three-compartment model. Our findings suggest that fast bowlers possess greater total lean mass and bone mineral content than non-athletic controls. Furthermore, fast bowlers demonstrated higher relative lean mass and bone mineral content in the trunk and legs. These data may provide guide values for strength and conditioning professionals and coaching personnel, particularly with consideration to development athletes in the sport of cricket. Crucially, the existence of unilateral differences in these variables by way of muscular and osseous imbalances may pose practical implications for the design of training programmes to potentially improve performance and/or reduce injury risk. Future research to prospectively investigate the relationships of bone and body composition with injury occurrence in a larger sample of fast bowlers over the course of a complete first-class season is warranted.
References


**Table I.** Anthropometric and total-body composition characteristics of fast bowlers and non-athletic, age-matched controls (mean ± standard deviation).

<table>
<thead>
<tr>
<th></th>
<th>Controls (n=12)</th>
<th>Fast bowlers (n=12)</th>
<th>p value</th>
<th>Effect size ± 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>177.3 ± 7.8</td>
<td>187.7 ± 5.8</td>
<td>0.001⁹</td>
<td>1.51 ± 0.83</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>74.4 ± 6.7</td>
<td>84.9 ± 6.6</td>
<td>0.001⁹</td>
<td>1.58 ± 0.86</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.7 ± 2.6</td>
<td>24.3 ± 2.0</td>
<td>0.545</td>
<td>0.26 ± 0.88</td>
</tr>
<tr>
<td>Fat mass (kg)</td>
<td>14.8 ± 4.7</td>
<td>14.1 ± 2.6</td>
<td>0.646</td>
<td>0.18 ± 0.80</td>
</tr>
<tr>
<td>Lean mass (kg)</td>
<td>56.5 ± 3.8</td>
<td>67.0 ± 5.8</td>
<td>&lt;0.001⁹</td>
<td>2.14 ± 0.86</td>
</tr>
<tr>
<td>%BF</td>
<td>20.5 ± 5.0</td>
<td>17.4 ± 2.9</td>
<td>0.081</td>
<td>0.76 ± 0.86</td>
</tr>
<tr>
<td>BMC (g)</td>
<td>3041 ± 304</td>
<td>3789 ± 422</td>
<td>&lt;0.001⁹</td>
<td>2.03 ± 0.85</td>
</tr>
</tbody>
</table>

⁹ denotes statistical significance at $P \leq 0.001$.

%BF percentage body fat; BMC bone mineral content; BMI body mass index
Table II. Absolute and relative regional body composition of the arms, legs and trunk in fast bowlers and non-athletic, age-matched controls (mean ± standard deviation).

<table>
<thead>
<tr>
<th></th>
<th>Controls (n=12)</th>
<th>Fast bowlers (n=12)</th>
<th>p value</th>
<th>Effect size ± 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM (kg)</td>
<td>1.6 ± 0.7</td>
<td>1.6 ± 0.3</td>
<td>0.728</td>
<td>0.14 ± 0.82</td>
</tr>
<tr>
<td>LM (kg)</td>
<td>7.2 ± 0.7</td>
<td>8.5 ± 0.9</td>
<td>0.001a</td>
<td>1.61 ± 0.88</td>
</tr>
<tr>
<td>BMC (g)</td>
<td>428 ± 42</td>
<td>545 ± 68</td>
<td>&lt;0.001a</td>
<td>2.07 ± 0.81</td>
</tr>
<tr>
<td>BM (%)</td>
<td>17.2 ± 5.4</td>
<td>14.9 ± 2.9</td>
<td>0.201</td>
<td>0.53 ± 0.83</td>
</tr>
<tr>
<td>LM (%)</td>
<td>78.0 ± 4.9</td>
<td>79.9 ± 2.9</td>
<td>0.249</td>
<td>0.47 ± 0.82</td>
</tr>
<tr>
<td>BM (%)</td>
<td>4.7 ± 0.7</td>
<td>5.2 ± 0.5</td>
<td>0.053</td>
<td>0.82 ± 0.83</td>
</tr>
<tr>
<td><strong>Legs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM (kg)</td>
<td>5.0 ± 1.6</td>
<td>5.2 ± 0.9</td>
<td>0.763</td>
<td>0.15 ± 1.02</td>
</tr>
<tr>
<td>LM (kg)</td>
<td>19.6 ± 1.8</td>
<td>23.1 ± 2.3</td>
<td>&lt;0.001a</td>
<td>1.69 ± 0.83</td>
</tr>
<tr>
<td>BMC (g)</td>
<td>1181 ± 141</td>
<td>1592 ± 183</td>
<td>&lt;0.001a</td>
<td>2.52 ± 0.84</td>
</tr>
<tr>
<td>BM (%)</td>
<td>19.2 ± 4.5</td>
<td>17.5 ± 3.0</td>
<td>0.276</td>
<td>0.44 ± 0.82</td>
</tr>
<tr>
<td>LM (%)</td>
<td>76.2 ± 4.1</td>
<td>77.2 ± 2.9</td>
<td>0.485</td>
<td>0.28 ± 0.82</td>
</tr>
<tr>
<td>BM (%)</td>
<td>4.6 ± 0.6</td>
<td>5.4 ± 0.5</td>
<td>0.003b</td>
<td>1.45 ± 0.90</td>
</tr>
<tr>
<td><strong>Trunk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM (kg)</td>
<td>7.3 ± 2.5</td>
<td>6.5 ± 1.6</td>
<td>0.366</td>
<td>0.38 ± 0.85</td>
</tr>
<tr>
<td>LM (kg)</td>
<td>26.4 ± 2.0</td>
<td>32.2 ± 3.2</td>
<td>&lt;0.001a</td>
<td>2.17 ± 0.84</td>
</tr>
<tr>
<td>BMC (g)</td>
<td>913 ± 100</td>
<td>1152 ± 194</td>
<td>0.001a</td>
<td>1.55 ± 0.85</td>
</tr>
<tr>
<td>BM (%)</td>
<td>20.7 ± 6.1</td>
<td>16.2 ± 3.6</td>
<td>0.039b</td>
<td>0.90 ± 0.85</td>
</tr>
<tr>
<td>LM (%)</td>
<td>76.7 ± 5.9</td>
<td>80.9 ± 3.7</td>
<td>0.047b</td>
<td>0.85 ± 0.84</td>
</tr>
<tr>
<td>BM (%)</td>
<td>2.6 ± 0.3</td>
<td>2.9 ± 0.3</td>
<td>0.049b</td>
<td>1.00 ± 1.00</td>
</tr>
</tbody>
</table>

* denotes statistical significance at $P \leq 0.01$.

* denotes statistical significance at $P \leq 0.05$.

*BMC* bone mineral content; *FM* fat mass; *LM* lean mass
Table III. Percentage (%) differences in unilateral body composition of fast bowlers and non-athletic, age-matched controls (mean ± standard deviation).

<table>
<thead>
<tr>
<th></th>
<th>Controls (n=12)</th>
<th>Fast bowlers (n=12)</th>
<th>p value</th>
<th>Effect size ± 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td>6.20 ± 6.11</td>
<td>3.51 ± 2.88</td>
<td>0.182</td>
<td>0.56 ± 0.84</td>
</tr>
<tr>
<td>LM</td>
<td>4.45 ± 2.90</td>
<td>4.46 ± 3.44</td>
<td>0.991</td>
<td>0.00 ± 0.81</td>
</tr>
<tr>
<td>BMC</td>
<td>4.51 ± 3.85</td>
<td>10.59 ± 6.64</td>
<td>0.012*</td>
<td>1.12 ± 0.85</td>
</tr>
<tr>
<td><strong>Legs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td>2.67 ± 2.23</td>
<td>4.34 ± 2.92</td>
<td>0.131</td>
<td>0.64 ± 0.85</td>
</tr>
<tr>
<td>LM</td>
<td>3.23 ± 2.75</td>
<td>3.01 ± 2.05</td>
<td>0.844</td>
<td>0.08 ± 0.83</td>
</tr>
<tr>
<td>BMC</td>
<td>2.38 ± 1.74</td>
<td>2.28 ± 1.66</td>
<td>0.889</td>
<td>0.06 ± 0.88</td>
</tr>
<tr>
<td><strong>Trunk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td>5.42 ± 5.89</td>
<td>5.95 ± 4.64</td>
<td>0.551</td>
<td>0.10 ± 0.34</td>
</tr>
<tr>
<td>LM</td>
<td>3.60 ± 3.02</td>
<td>3.54 ± 3.34</td>
<td>0.859</td>
<td>0.07 ± 0.81</td>
</tr>
<tr>
<td>BMC</td>
<td>4.91 ± 4.57</td>
<td>4.80 ± 4.18</td>
<td>0.890</td>
<td>0.06 ± 0.89</td>
</tr>
</tbody>
</table>

*denotes statistical significance at \( P \leq 0.05 \).

BMC bone mineral content; FM fat mass; LM lean mass