Power distribution, performance changes and bioelectrical impedance properties during the preparation period of professional cyclists

Andrea Giorgi¹, Maurizio Vicini¹, Marco Bonifazi², Hannes Gatterer³

Introduction

Athletic training improves exercise performance and modifies body composition. The influence of training volume and intensity during the general preparation period on performance and body composition has not been extensively studied in cyclists. Thus, this study aimed to investigate performance changes as well as changes in the body composition and bioelectrical impedance properties during a three-month training period with varying training volume and intensity.

Methods

Eight professional road cyclists participated in the study. After a one-month off season and before starting with their seasonal preparation period, bioelectrical impedance vector analyses (BIVA) and skinfold thickness measurements (9 sites) were performed at T0, T10 (after a month from T0), T40, T68. The bioelectrical values analyzed were Reactance/height (Xc/h), Impedance(IMP). Training volume and intensity (4 zones: <100, 100-300, 300-500, >500, Metcalfe et al. 2016) as well as the Training Stress Score (TSS) were monitored at T10, T40, T68. Detailed data acquisition was done only for the last ten days during the first period. We used training data with the Training Peaks Software (Peakware LLC, Lafayette, CO, USA) and determined the functional threshold power (FTP), the functional reserve capacity (FRC) and the peak power during 5 s (P5s), 5 min (P5min), 20 min (P20min) and 60 min (P60min).

Results

Total training volume decreased from T40 to T68 (distance: 2,720±270 km to 2,060±200 km; climbing: 30,400±9324 m to 16,560±6,690 m; time: 6,142±1100 min to 3,890±90 min; external work: 63,035±10,385 J to 42,628±4,338 J; p<0.05) as well as TSS (5757±1550 AU to 3370±777 AU).

The different intensity zones are shown in Table 1. The performance parameters improved at T40 with respect to T10 (FTP: 4.97±0.44 to 5.43±0.27 watts/kg, P5s: 12.40±3.73 to 13.97±2.16, P5min: 6.16±0.44 to 6.87±0.48, P20min: 4.68±0.48 to 5.14±0.32, P60min: 3.88±0.27 to 4.19±0.24 watts/kg, p<0.05) whereas at T68 a decline was found for P5min (5.87±0.74 watts/kg), P20min (4.65±0.57 watts/kg) and P60min (3.55±0.40 watts/kg). TSS decreased at T40 to T68 (5757±1500 AU to 3370±777 AU; p<0.05). At T10, body weight (68.0±4.4 to 67.1±5.1 p<0.05) and sum of skinfolds decreased (54.5±12.5 to 43.3±10.9 mm, p<0.05) over the 4-month training period. Moreover, significant negative correlations were found between impedance and weight and external workload (IMP with Body Weight r=−0.567 p=0.004; ΔIMP with ΔKm R=−0.571 p=0.004; ΔIMP with ΔTSS r=−0.466 p=0.022).

Discussion

The present data show that the external workload decreased slightly from T40 to T68. At T10 training minutes were not analyzed as only data for 10 days have been assessed. Over the entire observational period, intensity distribution (% time in each zone) remained essentially the same, though at T40 compared to month T10 a slightly lower portion in the <100 watts zone and a slightly greater amount of >500 watts training was completed. The phase angle and the reactance that are biomarkers of muscle function (Norman et al. 2012) improved over the 68 days of training period. Interestingly, at T10, vector length tended to increase which indicates that body water content (Norman et al. 2013; Piccoli et. al. 1994) while body weight decreased. Conversely, at T40, vector length slightly decreased that indicates body water volume was restored, whereas no significant changes in body weight occurred. We hypothesize that the body fluid and weight losses from T0 are due to a negative energy balance (hypocaloric diet + increased energy expenditure). Heydenreich et al. (2017) noted that during the preparation phase the athletes often reduce their energy intake to reduce their body weight. After increasing training volume and intensity (T40), body fluid increased which is in accordance with reports showing that intensified training and increasing physical
strain leads to body fluid gains (Pollastri et al. 2016; Sawka et al. 2000). We conclude that bioelectrical impedance is a practical method to monitor body water changes in response to physical training.

<table>
<thead>
<tr>
<th>Zones</th>
<th>T10</th>
<th>T40</th>
<th>T68</th>
</tr>
</thead>
<tbody>
<tr>
<td>% training</td>
<td>volume</td>
<td>% training</td>
<td>volume</td>
</tr>
<tr>
<td>&lt; 100 watts</td>
<td>25±6</td>
<td>1184±212</td>
<td>22±5*</td>
</tr>
<tr>
<td>100 – 300 watts</td>
<td>61±7</td>
<td>3547±221</td>
<td>61±8</td>
</tr>
<tr>
<td>300 – 500 watts</td>
<td>14±7</td>
<td>918±432</td>
<td>17±6</td>
</tr>
<tr>
<td>&gt; 500 watts</td>
<td>0.2±01</td>
<td>24±14</td>
<td>0.4±0.2*</td>
</tr>
</tbody>
</table>

* significantly different from T10
# significantly different from T40

References


Key words: Power, performance

Contact email: andreagiorgi4@gmail.com (A. Giorgi)

1 Team Androni Giocattoli – Sidermec
2 University of Siena, Department of Medical, Surgical and Neuroscience
3 University of Innsbruck, Department of Sport Science