Physiological Versus Psychological Evaluation in Taekwondo Elite Athletes

Erika Casolino, Cristina Cortis, Corrado Lupo, Salvatore Chiodo, Carlo Minganti, and Laura Capranica

Purpose: To anticipate outstanding athletic outcomes, the selection process of elite athletes simultaneously considers psychophysiological and technical parameters. This study aimed to investigate whether selected and nonselected athletes for the Italian national taekwondo team could be discriminated by means of sport-specific performances and psychophysiological responses to training. Participants: 5 established Italian national athletes and 20 elite Italian taekwondo black belt athletes (9 women, 16 men; age 23.0 ± 3.1 y; body mass 67.0 ± 12.1 kg). Methods: To update the Italian national-team roster, the 20 elite athletes participated in a 1-wk selection camp (7 training sessions). Selected athletes (n = 10) joined established national athletes during the following 3-wk national training period (7 training sessions/wk). During the 1-wk selection camp, differences (P < .05) between selected and nonselected athletes in performances, heart-rate responses, blood lactate accumulation [La], subjective ratings of perceived exertion (session RPE), and mood were examined. During the 3-wk national training period, differences (P < .05) in mood between selected and established national athletes were investigated. Results: With respect to nonselected athletes, selected athletes responded better to training in terms of session RPE (P = .047) and [La] (P = .046). No difference in performance and mood between subgroups emerged. After the 3-wk national training period, differences (P = .035) emerged for confusion, with decreases in the established national athletes and increases for recently selected athletes. Conclusions: Session RPE and [La] seem to be more effective than psychological measures in discriminating between elite taekwondo athletes. Evaluation of mood could be effective in monitoring athletes’ response to national training.

Keywords: selection process, POMS, session-RPE, heart rate, blood lactate

The selection of elite athletes is a complex process affected by several factors that vary in relation to the specific nature of the sport discipline. Studies of taekwondo have indicated that elite athletes need specific anthropometric characteristics1–4 and mental skills5,6 and high levels of explosive power and anaerobic capacity4,7–14 combined with high technical and tactical proficiency.1–3,15 However, it remains to be determined the extent to which such variables discriminate elite athletes during a selection process. This issue is critical for coaches, who could benefit from relevant information to direct their decision in establishing a taekwondo team roster, especially when the selection process is limited in time. In Italy, to update the national team made up of athletes with established international experience (ie, Olympic Games, European and World Championships), a 1-week selection camp is organized at the beginning of the precompetitive season to include new members chosen from the pool of athletes who have recently achieved national success.

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on the mental health of athletes reports low scores on the negative POMS scales and high scores on the positive vigor-activity scale, reflecting the desired iceberg profile. Furthermore, significant decreases in the positive scale and increases in the negative ones are thought to reflect maladaptations to intense taekwondo training or competitive stress. Because the validity of POMS in discriminating between successful and unsuccessful athletes has been questioned, especially when the instrument is administered during a selection process that is short in duration and perceived as unfair due to a lack of clear criteria, there is a need to ascertain whether the POMS could be a valid tool for selecting potential national taekwondo athletes. In general, elite athletes undergo training volumes and competition schedules more demanding than those experienced by their subelite counterparts. This may be particularly relevant during a national-team selection process when athletes have to endure intense training and still maintain competitive sharpness.

Taekwondo training can include a variety of activities, and a thorough selection process should be based on several sessions to evaluate athletes’ acute and chronic adaptations. In general, national taekwondo athletes undergo training volumes and competition schedules more demanding than those experienced by their elite counterparts. This may be particularly relevant during a national-team selection process, when athletes who have obtained recent achievement at the national level have to be able to endure the intense training of those with established international experience. Actually, athletes can inherently integrate the physiological and psychological stress they experience during exercise, perceiving the same external load differently depending on their fitness and skill level. Operationally, an athlete’s rating of perceived exertion (RPE) represents a practical method to measure subjective evaluations of internal training load. Furthermore, when one multiplies the subjective RPE value by the duration of the training session (ie, session RPE), it is possible to quantify the load perceived during several taekwondo training sessions. Therefore, one can hypothesize that session RPE could be considered a discriminating factor to verify whether athletes are capable of sustaining a period of intense training. In fact, measures of performance combined with disturbances in mood state and altered RPE have been suggested as valid indicators of maladaptation to training.

Because no study has simultaneously considered the influence of different variables during the selection process of taekwondo athletes, this investigation was designed to verify whether selected and nonselected athletes for the Italian national team could be discriminated on the basis of sport-specific (ie, sprint, jump, and sport-specific circuit) performances and psychophysiological (ie, RPE and POMS) responses to training. We hypothesized that, with respect to their nonselected counterparts, selected athletes would have better athletic performances, perceive training as less intense, and show a better mood profile.

Methods

Participants

The institutional review board of the University of Rome Foro Italico approved the within-subjects experimental design, which included 5 established Italian national taekwondo athletes and 20 elite black belt athletes (9 women, 16 men; age 23.0 ± 3.1 y, body mass 67.0 ± 12.1 kg) who provided a written informed consent.

The 20 elite athletes had been ranked among the first 3 positions in their weight category at the Italian Taekwondo Championship and had at least 5 years of previous training consisting of at least three 2-hour sessions weekly. The 5 established national athletes had solid and successful experience at international (ie, 4 medalists at the European and World Championships) and Olympic (ie, 1 silver medalist and 1 semifinalist) levels and at least 10 years of previous national training consisting of at least seven 2-hour sessions per week.

Procedures

Because no coach would allow a researcher to influence his or her training plan, this study was designed to explore sport-specific and psychophysiological variables actually included during the selection period. Thus, the testing procedures were explained in details and athletes were ensured anonymity of results and to be free to withdraw at any time. The experimental period included 2 phases with a 6-day recovery between: (1) a 1-week selection camp organized to define 10 new entries to join 5 established national athletes for the Italian national team and (2) a 3-week national training period for the 10 selected and 5 established athletes. Regardless of gender and weight category, athletes underwent the same training plan under the supervision of the national coach and physical trainer. According to the coach’s training program, the selection camp included 7 sessions (duration 40–105 min) with different training objectives, as well as evaluations of the athletes’ anaerobic and sport-specific performances, RPE, and POMS (Table 1). When the national-team roster had been defined, potential national athletes were retrospectively divided into those who made the team (selected: n = 10) and those who did not (nonselected: n = 10) for further analysis. Before and after this 3-week period, athletes already included on the national roster and newly selected ones were administered the POMS questionnaire. All subjects participating in the study were already familiar with the testing protocol, which had been routinely administered during their taekwondo season.

Anaerobic Performance

During the first training session of the selection camp, the 20 potential national athletes were administered 3 anaerobic tests: countermovement jump (CMJ), squat jump (SJ), and 10-m sprint. For each test, participants were allowed 3 trials, with a 2-minute recovery period. The best trial was used for analysis. Before testing
athletes underwent a 20-minute standardized taekwondo warm-up during which they carried out jogging, basic technical exercises, and stretching at a moderate intensity. To measure any change in anaerobic performance over time in selected athletes, after the 3-week national training period they were also administered CMJ and SJ tests, whereas the 10-m sprint was not performed because it was not included in the coach’s plan.

During the jumps, the athletes were required to keep their hands on their hips, and jump height was evaluated by means of an optical acquisition system (Optojump, Microgate, Udine, Italy), which measures with 10^{-3}s resolution air and ground-contact times. Dual infrared reflex photoelectric cells system (Polifemo, Microgate, Udine, Italy) positioned 10 m apart were used to measure running speed. Athletes began from a standing start with the front foot 0.5 m from the first timing gate.

Specific Taekwondo Circuit Training

After a 20-min standardized warm-up, specific taekwondo circuit training (3:40 min:s) was administered to evaluate the functional taekwondo capability of selected and nonselected athletes. During this circuit training, athletes performed CMJ, skipping (SK), and roundhouse kicks (RK) in 3 different stations (Figure 1). RK was performed by powerfully kicking a pad, and SK performance was considered valid when the athletes touched with their knees a pad positioned at hip height. Heart-rate (HR) responses were recorded (Team System, Polar, Kempele, Finland) with a sampling frequency of 5 seconds, and the number of CMJ, SK, and RK performed during each of the 3 stations was recorded. According to the literature, the highest HR value observed during a simulated match is considered the individual HR_{peak}. Thus, percentages of individual’s HR_{peak} have been used to evaluate the cardiovascular stress (ie, time spent at HR >85% of individual HR_{peak}). At rest and after 3 minutes of recovery, blood lactate concentration [La] was measured in capillary blood using dry chemistry (Accutrend Lactate Analyzer, Roche, Basel, Switzerland). Finally, session RPE was calculated.

Profile of Mood State

To evaluate individual mood state, the Italian version of the 58-item POMS questionnaire was administered at the beginning (W-PRE) and end (W-POST) of the 1-week selection camp and at the beginning (T-PRE) and end (T-POST) of the 3-week national training period (Figure 2). Athletes completed the POMS questionnaire between 7 and 8 AM. They were asked to describe the intensity of their feelings (“How do you feel right now”) on a 5-point Likert scale (ie, not at all = 0, somewhat = 1, moderately so = 2, very much so = 3, and very very much so = 4). To prevent possible confounding factors, athletes completed the W-POST questionnaire unaware of the selection outcome.

A 30-minute rest at the end of each training session, the potential national athletes were asked to rate the intensity of their training by means of the category-ratio CR-10 scale, which is based on verbal anchors (ie, from rest to maximal) that translate the athlete’s perception of effort into a numerical score of 0 to 10. This individual RPE was multiplied by the duration (ie, min) of training to calculate the session RPE.

Table 1 Training Objectives and Evaluations of the Experimental Period During the 1-Week Selection Camp

<table>
<thead>
<tr>
<th>Training session</th>
<th>Mode of training</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>technical/tactical</td>
<td>CMJ, SJ, sprint, POMS, RPE</td>
</tr>
<tr>
<td>2</td>
<td>technical/tactical</td>
<td>RPE</td>
</tr>
<tr>
<td>3</td>
<td>aerobic</td>
<td>RPE</td>
</tr>
<tr>
<td>4</td>
<td>strength</td>
<td>RPE</td>
</tr>
<tr>
<td>5</td>
<td>specific endurance</td>
<td>RPE</td>
</tr>
<tr>
<td>6</td>
<td>recovery</td>
<td>RPE</td>
</tr>
<tr>
<td>7</td>
<td>specific TKD circuit</td>
<td>RPE, HR, POMS, [La]</td>
</tr>
</tbody>
</table>

Abbreviations: CMJ, countermovement jump; SJ, squat jump; POMS, Profile of Mood State; RPE, rating of perceived exertion; TKD, taekwondo; HR, heart rate; [La], blood lactate.

Figure 1 — Schematic representation of the specific taekwondo circuit training performed by potential national athletes during the fifth session of the 1-week selection camp. Abbreviations: CMJ, countermovement jump; SK, skip; RK, roundhouse kick.
Statistical Analysis

Statistical significance was accepted with an alpha level of $P \leq .05$. Data are presented as mean ± SD unless stated otherwise. To control for gender-related training adaptations, differences between male and female athletes were considered for all the studied parameters. A multivariate analysis of variance (MANOVA) was applied to verify differences in anaerobic performance (ie, CMJ, SJ, 10-m sprint) between selected and nonselected athletes in relation to gender. Moreover, a MANOVA for repeated measures with condition (W-PRE and T-POST) as a within factor and gender as a between factor was used to determine differences in selected athletes’ CMJ and SJ performances.

To estimate the cardiovascular stress during the specific taekwondo circuit training, a 2 (gender: female vs male) × 2 (subgroup: selected vs nonselected) ANOVA was applied. A 2 (gender: female vs male) × 2 (subgroup: selected vs nonselected) × 2 (condition: rest vs 3-min postexercise) ANOVA was performed to verify differences in athletes’ [La] in relation to the specific taekwondo circuit training. To evaluate athletes’ overall circuit-training performance, CMJ (cm), SK (n), and RK (n) were converted to Z scores and summed. Then, a 2 (gender: female vs male) × 2 (subgroup: selected vs nonselected) ANOVA was applied. A 2 (gender: female vs male) × 2 (subgroup: selected vs nonselected) × 7 (training sessions) ANOVA was used to ascertain differences for session RPE values, considering subgroup and gender as between factors and condition as a within factor. If the overall $F$ test was significant, post hoc Fisher protected least-significant-difference comparisons with Bonferroni corrections and Cohen effect size (ES) were used. An ES $<0.2$ was considered trivial, from 0.3 to 0.6 small, $<1.2$ moderate, and $>1.2$ large.

Results

At the beginning of the 1-week selection period, anaerobic performance showed a main effect only for gender (CMJ: $F_{1,19} = 33.173$, $P < .0001$, ES = 3.07; SJ: $F_{1,19} = 27.632$, $P < .0001$, ES = 2.59; 10-m sprint: $F_{1,19} = 77.950$, $P < .0001$, ES = 4.33), with better values for men than their female counterparts (Table 2).

Despite no difference emerging for subgroups, selected athletes tended to perform higher jumps and faster 10-m sprints than their nonselected counterparts. At the end of the 3-week national training period, selected athletes maintained gender differences (CMJ: $F_{1,8} = 11.236$, $P = .010$, ES = 2.81; SJ: $F_{1,8} = 8.777$, $P = .0181$, ES = 2.35). A difference for condition ($F_{1,8} = 5.321$, $P = .0499$) emerged only for SJ, with lower T-POST performances (F: 27.3 ± 2.7 cm; M: 38.6 ± 6.2 cm) with respect to W-PRE values (F: 27.9 ± 4.4 cm; M: 40.7 ± 6.8 cm). In particular, reductions were 98.6% ± 5.5% for female athletes and 95.0% ± 3.2% for male athletes.

The specific taekwondo circuit training posed very high cardiovascular stress (Figure 3). No difference between gender and subgroups emerged for the occurrence of HR >85% of individual HRpeak (52.4% ± 21.0%) or session RPE (198.0 ± 58.7 AU) values. Regardless of gender, higher ($F_{1,8} = 147.70$, $P < .0001$, ES = 4.74) postexercise [La] values (10.32 ± 2.46 mmol/L) with respect to resting values (1.81 ± 0.61 mmol/L) were found, with a significant condition × subgroup interaction ($F_{1,8} = 5.55$, $P = .046$, ES = 1.53). In particular, postexercise [La] was higher for nonselected athletes than for their selected counterparts (Figure 4). Performances (ie, CMJ, SK, RK) during the circuit training showed a gender difference ($F_{1,9} = 8.52$, $P = .027$, ES = 1.71), with positive
values for men and negative values for women (Figure 5). In particular, absolute values of performances maintained a difference ($F_{1,9} = 75.30, P < .0001, ES = 4.19$) only for CMJ (Table 3). However, when the 15-second CMJ performances were expressed relatively to the athletes’ CMJ recorded at the beginning of the 1-week selection camp, no difference emerged for gender (F: 66.1% ± 4.4%; M: 69.5% ± 5.5%).

No gender-related difference emerged for session RPE or POMS values. Session RPE during the selection week (Figure 6) showed differences for training sessions ($F_{6,96} = 16.48, P < .0001$) and subgroups ($F_{1,16} = 4.62,

Table 2  Anaerobic Performance at the Beginning of the 1-Week Selection Camp in Relation to Gender and Selection Outcome, Mean ± SD

<table>
<thead>
<tr>
<th>Gender</th>
<th>Selection outcome</th>
<th>Countermovement jump (cm)</th>
<th>Squat jump (cm)</th>
<th>10-m sprint (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>selected</td>
<td>28.8 ± 3.7</td>
<td>27.9 ± 4.4</td>
<td>2.12 ± 0.07</td>
</tr>
<tr>
<td></td>
<td>nonselected</td>
<td>26.4 ± 1.8</td>
<td>23.7 ± 2.1</td>
<td>2.15 ± 0.07</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>27.4 ± 2.8*</td>
<td>25.5 ± 3.7*</td>
<td>2.14 ± 0.06*</td>
</tr>
<tr>
<td>Male</td>
<td>selected</td>
<td>42.4 ± 7.1</td>
<td>40.7 ± 6.8</td>
<td>1.85 ± 0.06</td>
</tr>
<tr>
<td></td>
<td>nonselected</td>
<td>39.3 ± 2.7</td>
<td>35.8 ± 3.7</td>
<td>1.92 ± 0.04</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>41.0 ± 5.6</td>
<td>38.4 ± 6.0</td>
<td>1.89 ± 0.06</td>
</tr>
</tbody>
</table>

*Differences (P < .0001) for gender.

Figure 3 — Heart rate (HR) and blood lactate [La] responses of a selected athlete relative to the specific taekwondo circuit training (3 min, 40 s). Dashed lines indicate HR_{peak} (ie, 198 beats/min) recorded during a simulated combat and 85% of individual HR_{peak}.

Figure 4 — Means and SDs of blood lactate [La] values of selected and nonselected athletes collected before (rest) and after (3 min) the specific taekwondo circuit training. Difference in postexercise [La] supports the data in Figures 3 and 4 relative to nonselected athletes’ experiencing training harder than the selected subgroup. *Difference (P < .0001) between conditions. #Difference (P < .05) between subgroups.
Figure 5 — Mean Z scores relative to countermovement-jump (CMJ), skip (SK), and roundhouse-kick (RK) performances during the specific taekwondo circuit training in relation to gender. *Difference ($P < .0001$) for gender.

Table 3  Countermovement-Jump, Skip, and Roundhouse-Kick Performance During the Specific Taekwondo Circuit Training in Relation to Gender and Selection Outcome, Mean ± SD

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group</th>
<th>Countermovement jump (cm)</th>
<th>Skip (n)</th>
<th>Roundhouse kick (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>selected</td>
<td>20.5 ± 0.7</td>
<td>69.7 ± 5.2</td>
<td>34.4 ± 3.7</td>
</tr>
<tr>
<td></td>
<td>nonselected</td>
<td>17.3 ± 1.0</td>
<td>63.5 ± 1.7</td>
<td>30.0 ± 0.4</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>18.9 ± 2.0*</td>
<td>66.6 ± 4.7</td>
<td>32.2 ± 3.3</td>
</tr>
<tr>
<td>Male</td>
<td>selected</td>
<td>28.7 ± 1.9</td>
<td>76.7 ± 9.9</td>
<td>35.3 ± 0.9</td>
</tr>
<tr>
<td></td>
<td>nonselected</td>
<td>26.2 ± 1.6</td>
<td>71.9 ± 1.0</td>
<td>33.1 ± 4.5</td>
</tr>
<tr>
<td></td>
<td>total</td>
<td>27.4 ± 2.1</td>
<td>74.3 ± 6.8</td>
<td>34.2 ± 3.2</td>
</tr>
</tbody>
</table>

*Differences ($P < .0001$) for gender.

Figure 6 — Means and SDs of daily session-rating-of-perceived-exertion values for selected and nonselected athletes during the 1-week selection camp. *Difference ($P < .0001$) between training sessions. #Difference ($P < .05$) between subgroups.
with higher values for nonselected athletes (256.7 ± 64.3 AU) than for selected ones (200.8 ± 28.7 AU). Athletes’ mood resembled the desired iceberg profile during both the 1-week selection camp (Figure 7) and the 3-week national training period (Figure 8). During the 1-week selection camp, only the tension subscale showed a difference for condition ($F_{1,22} = 14.239, P < .001$) and its interaction with subgroup ($F_{2,22} = 4.410, P = .025$). Post hoc analysis maintained differences between conditions for both selected ($P = .0017, ES = 1.17$; Figure 7[a]) and nonselected ($P = .032, ES = 0.63$; Figure 7[b]) subgroups, with higher W-PRE (selected: 6.4 ± 2.8 pt; nonselected: 6.4 ± 4.7 pt) values than W-POST (selected: 3.3 ± 2.5 pt; nonselected: 3.7 ± 3.8 pt) ones. At the end of the 3-week national-training period, 2 selected athletes voluntarily withdrew because of organizational problems. Regardless of gender, during this experimental period only the vigor subscale showed a reduction for condition ($F_{1,11} = 9.402, P = .011, ES = 0.42$), with higher T-PRE (20.7 ± 4.5 pt) values than T-POST (18.5 ± 5.9 pt) ones. In addition, a subgroup × condition interaction ($F_{1,11} = 5.803, P = .035, ES = 0.59–0.78$) emerged for confusion, with established athletes showing a decrease from T-PRE (3.6 ± 2.3 pt) to T-POST (2.4 ± 1.7 pt) but the newly selected athletes presenting the opposite trend (T-PRE: 3.0 ± 1.9 pt; T-POST: 4.4 ± 1.7 pt).

**Figure 7** — Means and SDs of precamp (W-PRE) and postcamp (W-POST) Profile of Mood State subscales of (a) selected and (b) nonselected athletes during the 1-week selection camp. *Differences ($P < .001$) between conditions.

**Figure 8** — Means and SEs of the Profile of Mood State subscales of established and selected athletes before (T-PRE) and after (T-POST) the 3-week national training camp. *Differences ($P < .05$) between conditions.
Discussion

To our knowledge, this is the first study that simultaneously considered the influence of different variables during the selection process of national-team-level taekwondo elite athletes, without any manipulation of the actual training plan of the coach. Despite gender differences emerging for absolute values of anaerobic performances, no difference in training adaptation emerged between male and female athletes for session RPE, POMS, HR, [La], or jump values expressed relatively to the athletes’ best performances. Therefore, any observation made was considered related to the selection process, independently from athlete gender. The findings highlight a trend for selected athletes to have more suitable sport-specific characteristics than their counterparts and to experience the selection and training process as less physically stressful. Remarkably, POMS showed a relative insensitivity in discriminating between elite athletes.

Anaerobic Evaluation

Compared with previous studies on elite taekwondo athletes,5,7 better CMJ and SJ performances were observed, with no significant differences between selected and nonselected subgroups. Considering that explosive lower limb power is believed to be a fundamental prerequisite in taekwondo6,8 and crucial for the execution of kicking techniques,7 it seems reasonable not to expect statistical differences between athletes who successfully compete at national level. Furthermore, the strict criteria for inclusion ensured a homogeneous group but limited its sample size, which might have affected the statistical significance.36 However, at the very elite level, small differences in performances can have a tremendous impact on athletic outcome. Therefore, it is possible to acknowledge the coach’s capability to discriminate athletes with better jumping and sprinting performances.

Specific Taekwondo Circuit Training

The high occurrence of HR >85% HRpeak and the high [La] measured at the end of the specific taekwondo circuit training support a relevant involvement of anaerobic metabolism, which could enhance athletes’ physical performance.28 Despite the fact that [La] values observed at the end of the circuit training were comparable to those reported after specific exercises and official and simulated taekwondo competitions in elite athletes,8,10–13 time spent at HR >85% of individual HRpeak was lower than that reported during official10,11 and simulated12 competitions. These findings mirror the differences in time structure (3:40 min:s) and activity:rest ratio (1:1) of the specific taekwondo circuit training and a regular taekwondo match.37,38 For [La], a difference emerged between subgroups, with highest concentrations found in nonselected athletes. These findings mirror those relative to the session RPE, with nonselected athletes perceiving the training as harder than their selected counterparts. Thus, it is possible to speculate that selected athletes have a higher capability to sustain heavy training stimuli than those who did not make the national team.

During the circuit training overall (ie, summed Z scores of CMJ, SK, and RK), performances showed a gender difference, mainly attributable to CMJ. In considering the lower jump capability of female athletes with respect to their male counterparts, it is interesting to note that gender-related differences were not maintained when 15-second CMJ performances were expressed relative to athletes’ CMJ recorded at the beginning of the 1-week selection camp. Furthermore, the lack of difference in total number of SK and RK executions supports the hypothesis that the administered circuit training was suitable for both female and male athletes.

Session-RPE

Several authors8,10 have claimed that in competitive settings elite athletes tend to report lower RPE values than their actual HR responses. In the current study, athletes’ perception of effort resembled the cardiac activity. This discrepancy could be ascribed to different conditions between the closed-skill–specific taekwondo circuit training and the open-skill competition, where high levels of attentional focus on the opponent’s actions may induce athletes to perceive their efforts as less intense.10 Actually, session RPE succeeded in discriminating between subgroups, except for the strength training (fourth training session, Figure 5). Assuming that fitness and skill levels and psychosocial factors can influence RPE,28,39 the session RPE confirmed its validity for elite athletes32 and proved to be a useful tool in discriminating their capability to sustain intense training.

POMS

The POMS data reported show the desired iceberg profile for all athlete subgroups, during both the selection camp and the training period. According to the literature,40 no gender difference emerged in the POMS of elite taekwondo athletes after an intense training period. Although it was not possible to retrospectively discriminate between successful and unsuccessful athletes based on POMS results, a decrease of tension-anxiety values between W-PRE and W-POST was observed for both subgroups. This finding mostly likely reflects the anxiogenic nature of the selection contest, where athletes are asked to perform their best but often without exactly knowing the selection criteria applied. In fact, anxiety-producing situations are characterized by being only partially controlled and by uncertainty about the outcome.41 Although the sample studied was homogeneous in skill and conditioning (ie, years of experience, achievements),42 the POMS was not sensitive enough to detect differences within a group of high-level athletes.
due to situational variables such as the duration of the event (ie, 1-wk training camp). Moreover, as reported by Rowley et al., it is plausible to hypothesize that, given the item transparency, athletes may have manipulated their responses toward a “desirable” answer, countering any potential difference between the subgroup profiles. In fact, making the national team, besides being an important career achievement, has an important economical impact on athletes’ lives (social desirability). On the other hand, the POMS questionnaire has been widely used as a tool to monitor athletes’ response and adaptation to training in different sports and has been shown to respond coherently in relation to training load and athlete expertise. In particular, Martin et al. reported how vigor and fatigue are related to athletes’ physical and physiological status and, thus, are sensitive to high-intensity training periods. Consequently, the decrease in vigor scores observed after the 3-week training camp could reflect athletes’ effort to cope with the exercise load imposed. The unchanged fatigue scores, despite the drop in vigor level, could reflect their capability to still respond positively to training stimuli, except for selected athletes’ SJ performances after the 3-week period. Furthermore, the increase in confusion-bewilderment scores of the selected athletes might be related to the new condition (ie, training mode and times, group dynamics, dietary habits) resulting from making the national team.

**Practical Applications and Conclusions**

The current study highlights the effectiveness of the session-RPE and physiological measurements in distinguishing between elite taekwondo athletes. Although HR response showed no difference between selected and nonselected athletes, its trend is in agreement with results obtained from [La] and session-RPE measurements. Moreover, as both selected and nonselected athletes were already highly fit at the time of the national-team selection, it was not possible to underline differences between the 2 subgroups by means of anaerobic performances (ie, jump and sprint tests), which are fundamental taekwondo prerequisites. Thus, it appears reasonable to infer that selection of taekwondo elite athletes should rely on sport-specific tailored physical tests, integrating the relative information with that gathered from physiological measurements. In addition, the POMS was not suitable to discriminate between athlete subgroups, but it showed its effectiveness in monitoring response to training in relation to athletes’ expertise level.

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