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The effect of training order on neuromuscular, endocrine and mood response to small-sided games and resistance training sessions over a 24-hour period

Authors: Sparkes, W ¹, Turner, AN ², Weston, M ³, Russell, M ⁴, Johnston, MJ ⁵, and Kilduff, LP ¹.

¹ Applied Sports Technology Exercise and Medicine Research Centre (A-STEM), Health and Sport Portfolio, Swansea University, Swansea, United Kingdom.

² London Sports Institute, Science and Technology, Middlesex University, London, UK.

³ Department of Psychology, Sport and Exercise, School of Social Sciences, Humanities and Law, Teesside University, Middlesbrough, UK

⁴ School of Social and Health Sciences, Leeds Trinity University, Leeds, UK.

⁵ British Athletics, University of Loughborough, Leicestershire, UK.

Corresponding author: Professor Liam Kilduff,
Applied Sports Technology, Exercise and Medicine
Research Centre (A-STEM),
College of Engineering,
Swansea University Bay Campus,
SA1 8EN
l.kilduff@swansea.ac.uk

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1 **The effect of training order on neuromuscular, endocrine and mood response to small-sided**
2 **games and resistance training sessions over a 24-hour period**

3 **Abstract**

4 Objectives: This study examined the acute effect of small-sided-game (SSG) and resistance training
5 sequence on neuromuscular, endocrine and mood response over a 24-hour (h) period.

6
7 Design: Repeated measures

8
9 Methods: Fourteen semi-professional soccer players performed SSG-training (4vs4 + goalkeepers; 6x7-
10 min, 2-min inter-set recovery) followed by resistance training 2h later (back-squat, Romanian deadlift,
11 barbell-hip-thrust; 4x4 repetitions, 4-min inter-set recovery; 85% 1 rep-max) (SSG+RES), and on a
12 separate week reversed the session order (RES+SSG). Physical demands of SSG's were monitored
13 using global positioning systems (GPS) and ratings of perceived exertion (RPE). Countermovement-
14 jump (CMJ; peak power output; jump height) and brief assessment of mood were collected before (pre),
15 during (0h) and after (+24h) both protocols. Salivary testosterone and cortisol concentrations were
16 obtained at the same time-points but with the inclusion of a measure immediately prior to the second
17 training session (+2h).

18
19 Results: GPS outputs and RPE were similar between SSG-training during both protocols. Between-
20 protocol comparisons revealed no significant differences at +24h in CMJ performance, mood, and
21 endocrine markers. Testosterone was higher at 0h during RES+SSG in comparison to SSG+RES
22 (*moderate-effect*; $+21.4 \pm 26.7$ pg·ml⁻¹; $p=0.010$), yet was similar between protocols by +2h.

23
24 Conclusions: The order of SSG and resistance training does not appear to influence the physical
25 demands of SSG's with sufficient recovery between two sessions performed on the same day. Session
26 order did not influence neuromuscular, endocrine or mood responses at +24h, however a favourable
27 testosterone response from the resistance first session may enhance neuromuscular performance in the
28 second session of the day.

29 **Key words:** Fatigue, recovery, concurrent training, training prescription.

30

31

32 **Introduction**

33 Throughout a competitive season, soccer players are required to develop and maintain multiple physical
34 qualities aligned to successful performance, including strength, power, speed, agility, aerobic capacity,
35 and repeat sprint ability, as well as engaging with technical and tactical training. ¹ As limited training
36 time often separates fixtures, the ability to concurrently develop such physical, technical, and tactical
37 qualities is pertinent to success. ² Accordingly, development of multiple physical qualities is often a
38 focus of training, with multiple sessions, each with a differing training focus, often undertaken on the
39 same day. Indeed, a recent survey of professional soccer practitioners highlighted that the majority of
40 resistance training sessions occurred in the afternoon following field-based training. ³

41
42 It is well known that the recruitment of high-threshold motor units is necessary for inducing adaptations
43 associated with strength, speed, agility and power. ⁴ Athletes may be less able to perform the movements
44 required to achieve these adaptations if fatigue and muscle damage are present. Therefore, for positive
45 adaptations to occur in the targeted physical qualities, the training stimulus should be applied in an order
46 and spacing that facilitates recovery to a point where players are able to meet the demands of each
47 training session. ⁵ Recent work in soccer has shown that whilst there is an impairment of neuromuscular
48 function immediately after a small-sided game (SSG) training session, there may be a temporary
49 recovery 2-hours later, before a further impairment after 24-hours. ⁶ Therefore it seems that after 2-hours
50 of passive recovery, the physical performance of a second intense neuromuscular training session may
51 not be impaired. However, Sparkes et al.,⁷ also found that performance of a double training day (SSG's
52 followed by resistance training 2-hours later) resulted in *small* impairments of neuromuscular
53 performance, mood score, and endocrine markers in comparison to a single training session day at +24-
54 hours. Whilst this is important for our understanding of the weekly planning of training, it is currently
55 unclear whether changing the training session order would have any influence on performance of the
56 second session of the day or the fatigue response over a 24-hour period.

57 Previous studies have examined the order effect of concurrent resistance and endurance training,^{8, 9, 10}
58 and speed and resistance training,¹¹ and have shown that manipulating the session order can impact
59 adaptations, fatigue and recovery markers. Yet to date, no studies have examined the order effect of SSG
60 and resistance training. This represents an important gap in the literature and our practical understanding
61 of how to best manipulate within-day planning, as it is currently unclear what effect this may have on
62 the either the loss or potentiation of performance experienced in the 24-hours following a double training
63 session. Given that multiple daily training sessions are often performed in soccer,³ an understanding of
64 this effect should be considered when designing and implementing soccer training programmes.
65 Therefore, the aim of this study was to compare the effects of training order on the 24-hour fatigue
66 response following a double training day in soccer players.

67

68 **Methods**

69 This study profiled two training days, one consisting of SSG training followed by resistance training 2-
70 hours later (SSG+RES), and one consisting of resistance training followed by SSG training 2-hours later
71 (RES+SSG). Each experimental protocol was completed over 24-hours on consecutive weeks. The study
72 took place midway through the 2018-19 competitive season with players being given at least 72-hours
73 rest before involvement.

74

75 Data are presented from 14 male semi-professional soccer players (age: 22.1 ± 3.1 years, mass: $79.3 \pm$
76 12.2 kg, height: 1.80 ± 0.08 m). All players were healthy, injury free and in the maintenance phase of
77 their season. In a typical microcycle, which consisted of 1 game·week⁻¹, players completed two on field
78 training sessions (1.5-2 h each) and one resistance training session (1 h). Ethical approval was granted
79 by the ethics advisory board of Swansea university. Players were informed of the risks and benefits and
80 provided written informed consent prior to participation.

81

82 Countermovement jump (CMJ), mood (BAM+ questionnaire) and saliva (testosterone and cortisol
83 concentrations) were collected before (pre), during (0h) and after (+24h) both protocols. Saliva samples

84 were also collected immediately prior to the second training session (+2h) during both protocols to
85 assess readiness to undertake the second session of the day. On arrival at the training centre (~17:00 h),
86 pre-measures were collected (saliva, BAM+, and CMJ's). The first training session began at ~17:30 h,
87 and immediately post training (0h), saliva, BAM+, and CMJ's were repeated. After 2-hours of passive
88 rest and immediately before the second training session, players repeated the saliva test, before
89 undertaking the second training session which began at ~20:30 h. The following day (+24h; ~17:00 h),
90 players repeated all measures (saliva, BAM+ and CMJ's). The following week, players repeated the
91 procedure but with the training session order reversed. Immediately after the 0h testing during both
92 protocols, players were provided with water, a banana and a protein bar (Energy: 171 kcal, Fats: 3.7 g,
93 Carbohydrate: 20 g, Sugars: 9.3 g, Protein: 14 g) and were instructed to consume only this during the 2-
94 hour period before the next session.

95

96 The SSG format used complemented the player's normal training regimes and was similar to previous
97 literature.^{6, 12, 13} After a standardized five-min warm up, consisting of dynamic stretching and short
98 sprints, players were split into four teams of five by coaching staff. The teams were organized such that
99 playing positions were balanced (e.g., one goalkeeper, defender, winger, midfielder, and striker). The
100 sport surface was a third-generation artificial grass pitch and players wore their normal soccer boots.
101 Players competed against another team for 6-blocks of 7-min (overall work-time: 42-min) with 2-min
102 between each game allowed for players to drink water and passively rest. Pitch size was 24 m by 29 m
103 and full-sized goals with goalkeepers were used; only data from outfield players was collected. Players
104 were allowed unlimited touches of the ball and the aim was to win each individual SSG repetition.

105 The content of the lower body resistance training session was selected to include exercises the players
106 were familiar with, whilst also being within the guidelines for strength development.^{11, 14} Specifically,
107 the session consisted of 4-sets of 4-repetitions of the parallel back squat, Romanian dead lift, and barbell
108 hip thrust, all at 85% of 1-repetition maximum (RM), with 4-min recovery between sets and exercises.
109 Each exercise was preceded by 2-sets of 4-repetitions at 50% and 70% of 1-RM as a warm up. Prior to
110 test involvement, each participant performed a 3-RM testing session of all three exercises, which

111 occurred exactly 1-week prior to testing. Using the 3-RM data, 1-RM was estimated using a prediction
112 equation.¹⁵ The session was supervised by an accredited strength and conditioning coach to ensure
113 appropriate technique throughout.

114

115 A portable force platform (Type 92866AA, Kistler) was used to measure lower body power via a CMJ
116 (with arms akimbo). Two CMJ's were completed after a standardized warm-up. The vertical ground
117 reaction forces were used to assess peak power output (PPO) from previously reported methods.¹⁶ This
118 data was converted into relative PPO ($W \cdot kg^{-1}$) by dividing PPO by the player's body mass. Jump height
119 (JH) was calculated by multiplying the velocity at each sampling point by time (0.005 s). It was then
120 defined as the difference between vertical displacement at take-off and maximal vertical displacement.
121 Test-retest reliability (intraclass correlation coefficient) for PPO, and JH were 0.89 and 0.84,
122 respectively. The coefficient of variation (CV) for PPO and JH were 2.3% and 3.2%, respectively.

123

124 At all time-points, 2 ml of saliva was collected by passive drool into sterile containers. Saliva samples
125 were stored at $-20^{\circ}C$ for seven days until assay. After thawing and centrifugation (2000 rpm x 10-
126 minutes), the saliva samples were analysed in duplicate for testosterone and cortisol concentrations
127 using commercial kits (Salimetrics LLC, USA). The minimum detection limit for the testosterone assay
128 was 6.1 pg.ml with an inter-assay CV of 5.8%. The cortisol assay had a detection limit of 0.12 ng.ml
129 with inter-assay CV of 5.5%. Testosterone to cortisol (T/C) ratio was determined by dividing
130 testosterone by cortisol.

131

132 Mood state was assessed using a modified version of the brief assessment of mood questionnaire
133 (BAM+).¹⁷ This 10-item questionnaire is based on the Profile of Mood State assessment and consists
134 of a scale where players mark on a 100-millimetre scale how they feel at that moment in time. Scale
135 anchors ranged from 'not at all' to 'extremely'. The questions assess the following mood adjectives:
136 anger, confusion, depression, fatigue, tension, alertness, confidence, muscle soreness, motivation and
137 sleep quality. The scores were totalled up by giving the 6 unfavourable questions (anger, confusion,

138 depression, fatigue, tension and muscle soreness) a positive value, and the 4 favourable questions
139 (alertness, confidence, motivation and sleep quality) a negative value. The original total mood score
140 ranged from -40 – 60, before adding 40 to each score so that the scale ranged from 0 – 100, with 0
141 indicating the best mood and 100 indicating the worst.^{6,17} The BAM+ questionnaire has been shown to
142 be an effective tool for monitoring the fatigue and recovery cycles in elite athletes.¹⁷

143

144 The physical demands of the SSG's were assessed both objectively and subjectively. Using Borg's
145 CR10 scale,¹⁸ players were asked to give an RPE on a scale of 1–10. This was obtained 10-min after the
146 end of the SSG's. RPE has been shown to have high correlations ($r= 0.75–0.90$) with heart rate-based
147 methods of training load across various team sports.¹⁹ A limitation of the current study is that heart rate
148 was not directly monitored. Time-motion analysis data was collected via 10 Hz GPS units embedded
149 with 100 Hz tri-axial accelerometers (OptimEye X5, Catapult Innovations, Melbourne, Australia),
150 which have shown to hold an acceptable level of reliability and validity when tracking player
151 movements.²⁰ Each unit was attached to the upper back of players using a specifically designed vest
152 garment. The data was downloaded and processed automatically using Catapult Sports software
153 (Openfield, Catapult Innovations, Melbourne, Australia). The high-speed running (HSR) threshold was
154 defined as the total distance (m) covered at a velocity $\geq 5.5 \text{ m}\cdot\text{s}^{-1}$ and was set in line with previous work
155 in soccer time-motion analysis.⁶ Player load [PlayerloadTM] is defined as the sum of gravitational forces
156 on the accelerometer in each individual axial plane (anteroposterior, mediolateral and vertical), and has
157 been reported previously in soccer time-motion analysis.^{6,21}

158

159 Results are reported as mean \pm SD. Data were collated using Microsoft Excel (Microsoft Corporation,
160 US) where descriptive statistics and graphical interpretations were derived. Statistical analysis was
161 carried out using a Statistical Package for the Social Sciences (version 19; SPSS Inc., Chicago, IL) with
162 the significance level set at $p<0.05$. Following screening of data for normality and homogeneity of
163 variance, the effects of time and order of training were assessed using a two-way (time-point and
164 protocol) repeated measures analysis of variance test. Where significant F values for time or interaction

165 between protocols were identified ($p < 0.05$), a post hoc pairwise comparison test with Bonferroni
166 correction was applied to determine where the significant differences occurred. Effect sizes (ES), using
167 Cohen's d , were calculated using a custom-made spreadsheet, with the following thresholds for
168 interpretation: *trivial* < 0.2 , *small* $0.2 - 0.6$, *moderate* $0.6 - 1.2$, *large* $1.2 - 2$.²² A paired T-test was
169 used to determine if there were any significant differences in the physical demands (GPS and RPE) of
170 the SSG's during both protocols.

171

172 **Results**

173 Physical metrics for total distance (SSG+RES, 4659 ± 611 m; RES+SSG, 4660 ± 583 m), HSR
174 (SSG+RES, 65 ± 16 m; RES+SSG, 58 ± 13 m), PlayerloadTM (SSG+RES, 470 ± 72 AU; RES+SSG,
175 465 ± 75 AU) and RPE scores (SSG+RES, 7.3 ± 1.0 AU; RES+SSG, 7.6 ± 1.1 AU) were similar between
176 SSG sessions during both protocols ($p > 0.05$).

177

178 There was a significant time effect on mood score ($F = 4.117$, $p = 0.028$). During the SSG+RES protocol,
179 mood score was significantly increased at 0h (see table 1), before returning to near pre-values at +24h.
180 Mood score did not significantly change from pre-values during RES+SSG ($p > 0.05$). There was no
181 interaction effect between protocols ($F = 1.460$; $p = 0.251$). For JH, analysis revealed that there was a
182 significant effect of time ($F = 10.986$; $p = 0.000$). During RES+SSG, JH was significantly reduced at 0h
183 (see table 1), before returning to near pre-values again at +24h. Analysis revealed there was no
184 significant interaction effects between protocols ($F = 4.122$; $p = 0.052$). For PPO, there was a significant
185 effect of both time ($F = 5.877$; $p = 0.008$), and interaction between protocols ($F = 5.695$; $p = 0.009$). Post
186 hoc analyses revealed that during RES+SSG, PPO was significantly impaired at 0h, before returning to
187 near pre-values at +24h (see table 1). PPO remained similar to pre-values during SSG+RES. Further
188 analyses revealed significantly reduced PPO at 0h during RES+SSG in comparison to SSG+RES,
189 however these differences were similar at +24h (see figure 1 and table 1).

190

191

*** TABLE 1 ***

192

193 Analysis revealed that there was a significant time effect on testosterone ($F= 5.471, p= 0.003$), whereby
194 during both protocols, concentrations remained similar to pre-values at all time-points with the
195 exception of +2h (see table 2). There was a significant interaction between protocols for testosterone
196 ($F= 5.196, p= 0.004$), where further analysis revealed that there was a greater elevation in testosterone
197 at 0h during RES+SSG in comparison to SSG+RES (see figure 1 and table 2). Both protocols had a
198 significant time effect on cortisol ($F= 11.665; p= 0.000$) and the T/C ratio ($F= 15.333; p= 0.000$). Further
199 analyses revealed that during both protocols, cortisol concentrations remained similar to pre-values at
200 all time-points with the exception of +2h (see table 2). There were no significant interaction effects
201 between protocols for both cortisol ($F= 0.814; p= 0.494$) and the T/C ratio ($F= 0.877; p= 0.462$).

202

203 *****TABLE 2 *****

204

205 *****FIGURE 1 *****

206

207 **Discussion**

208 To our knowledge, this is the first study to examine the influence of manipulating the order of SSG and
209 resistance training on acute neuromuscular, endocrine and mood responses over a 24-hour period. The
210 primary study findings was that while comparisons between the two training days revealed significant
211 differences in PPO, testosterone, and cortisol on the same day, there were no significant differences
212 between protocols after a 24-hour recovery period. A secondary finding was that the order of resistance
213 and SSG training did not appear to affect the objective or subjective physical demands of the SSG's.

214

215 The current study found that the GPS and RPE outputs of the SSG's were similar between protocols,
216 suggesting that physical performance and intensity of SSG's is not dampened when preceded by a
217 resistance training session earlier in the day. Therefore, it seems likely that in well-trained athletes, the
218 +2h time-point represents a time-frame prior to the initiation of inflammatory process but after metabolic
219 recovery, during which the athlete can undertake additional training.^{6, 23, 24} This supports previous work

220 which reported performance of a speed training protocol was maintained 2-hours after a resistance
221 training session in academy rugby union players.¹¹

222

223 Both measures of neuromuscular function (PPO and JH) decreased immediately (0h) after the resistance
224 session during RES+SSG but not the SSG session during SSG+RES (see table 1 and figure 1). It may
225 seem curious that the SSG's did not significantly impair both jump variables immediately in this study,
226 however the *small* decreases in JH were similar to previous work with exactly the same SSG protocol
227 in professional soccer players.⁶ Whilst peripheral fatigue may result from simultaneous failure at a
228 number of sites, for a specific task such as a CMJ, a particular site may be primarily responsible for a
229 loss in muscle force production, a concept referred to as task dependency fatigue.²⁵ Due to the exercise
230 selection in the current study, specifically the back squat, it could be that the targeted musculature shares
231 similar movement patterns to a CMJ, therefore accumulated more task dependant fatigue than the SSG
232 session, which was primarily running, cutting, tackling and kicking. Secondly, it is well known that
233 repetitive high-force activities are a primary source of peripheral fatigue, therefore it is possible that the
234 greater intensity of the muscle contractions in the resistance training session (85% 1-RM) resulted in
235 greater neuromuscular fatigue than the SSG's. However, by +24h, there were no significant differences
236 between protocols, suggesting that the order of SSG and resistance training does not influence the
237 neuromuscular response at 24-hours post.

238 Immediately after the first session during both protocols, testosterone, cortisol and the T/C ratio did not
239 significantly change from pre-values. However, one interesting finding is that comparisons between
240 protocols showed that the changes in testosterone were *moderately* and significantly higher at 0h after
241 the resistance session in comparison to the SSG session (see table 2 and figure 1). This supports previous
242 literature suggesting that performance of a resistance training session may alleviate the normal circadian
243 declines in testosterone throughout the day.²⁶ Given that previous work has observed this effect of
244 morning strength training on afternoon performance,²⁶ it is interesting that we may see this pattern in
245 the current study considering the time that the sessions were performed (17:30 and 20:30 hours).
246 Considering the evidence that changes in testosterone concentrations can moderate or support the

247 performance capacity of the neuromuscular system through various short-term mechanisms (e.g. second
248 messenger signalling, lipid/protein pathways, neural activity, behaviour, cognition, motor system
249 function, muscle properties and energy metabolism),²⁷ altering this rate of decline may potentially create
250 an environment later in the day when the ability to generate strength, speed and power is enhanced.^{11,}
251 ^{26, 28} By +24h, testosterone had returned to near pre-values in both protocols (table 2 and figure 1).

252

253 **Conclusion**

254 In summary, session order did not significantly influence neuromuscular, endocrine or mood responses
255 at +24h, however a favourable testosterone response from the resistance first session could potentially
256 enhance neuromuscular performance in the second session of the day. Additionally, the order of SSG
257 and resistance training sessions does not appear to influence the perceived effort or physical demands
258 of SSG's, when sufficient recovery is given between two sessions performed on the same day.

259

260 **Practical implications**

- 261 • Those responsible for designing concurrent training programs should consider allowing
262 sufficient recovery (i.e ≥ 2 hours) between sessions when programming multiple daily training
263 sessions.
- 264 • The order of small-sided games and resistance training does not appear to influence fatigue and
265 recovery markers on the following training day (+24h).
- 266 • Prescribing a resistance training session earlier in the training day could alleviate the circadian
267 decline in testosterone production, which could contribute to a maintenance in performance of
268 a second training session later in the day.

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271

272

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Figure Legends

303 Figures 1 A-F. Mean±SD mood (A), jump height (JH) (B), relative peak power output (PPO) (C),
304 testosterone (D), cortisol (E) and testosterone to cortisol ratio (T/C) (F) responses to each protocol
305 (SSG+RES vs RES+SSG). Effect sizes are shown above the figure for the between protocol differences
306 between each time point and pre-values. Asterisk (*) indicates a significant difference between
307 protocols.

Table 1. Mean (\pm SD) fatigue marker changes between time-points. Statistical inferences (p values and effect sizes) are shown for both the within and between protocol differences (SSG+RES vs RES+SSG).

| Variable | | Time-point | | | | | |
|--|---------------------|------------------|---------|----------|------------------|---------|----------|
| | | Pre – 0h | p value | <i>d</i> | Pre – 24h | p value | <i>d</i> |
| Mood Score (AU) | SSG+RES | 8.6 \pm 9.1 | 0.011 | 0.72 (M) | 5.3 \pm 11.1 | 0.291 | 0.44 (S) |
| | RES+SSG | 3.2 \pm 11.4 | 0.930 | 0.24 (S) | 4.0 \pm 8.5 | 0.316 | 0.29 (S) |
| | Protocol difference | -5.3 \pm 11.2 | 0.098 | 0.52 (S) | -1.4 \pm 14.8 | 0.738 | 0.14 (T) |
| JH (cm) | SSG+RES | -2.2 \pm 3.1 | 0.061 | 0.4 (S) | -2.6 \pm 4.9 | 0.210 | 0.49 (S) |
| | RES+SSG | -4.1 \pm 2.6 | 0.000 | 0.67 (M) | -1.3 \pm 2.0 | 0.075 | 0.25 (S) |
| | Protocol difference | -1.9 \pm 3.3 | 0.052 | 0.68 (M) | 1.2 \pm 5.4 | 0.408 | 0.33 (S) |
| CMJ Relative PPO (W·Kg ⁻¹) | SSG+RES | -0.84 \pm 2.75 | 0.836 | 0.12 (T) | -1.95 \pm 3.81 | 0.233 | 0.31 (S) |
| | RES+SSG | -3.53 \pm 2.48 | 0.000 | 0.50 (S) | -1.56 \pm 2.30 | 0.075 | 0.25 (S) |
| | Protocol difference | -2.69 \pm 3.30 | 0.009 | 1.03 (M) | -0.37 \pm 4.19 | 0.747 | 0.12 (T) |

SSG+RES, Small-sided games followed by resistance training, RES+SSG, resistance training followed by small-sided games

SD, standard deviation; SSG, small-sided game; RES, resistance training; AU, arbitrary units; ES, effect size.

Effect sizes (ES, *d*); T, *trivial*; S, *small*; M, *moderate*.

Table 2. Mean (\pm SD) endocrine marker changes between time-points. Statistical inferences (p values and effect sizes) are shown for both the within and between protocol differences (SSG+RES vs RES+SSG).

| Variable | | Time-point | | | | | | | | |
|--|---------------------|--------------------|---------|----------|--------------------|---------|----------|--------------------|---------|----------|
| | | Pre – 0h | p value | <i>d</i> | Pre – 2h | p value | <i>d</i> | Pre – 24h | p value | <i>d</i> |
| Testosterone (pg.ml ⁻¹) | SSG+RES | -4.4 \pm 32.5 | 1.000 | 0.07 (T) | -48.0 \pm 35.9 | 0.001 | 0.89(M) | -1.3 \pm 71.8 | 1.000 | 0.02 (T) |
| | RES+SSG | 17.0 \pm 25.3 | 0.157 | 0.27 (S) | -33.2 \pm 34.3 | 0.019 | 0.59 (S) | -14.0 \pm 62.0 | 1.000 | 0.24 (S) |
| | Protocol difference | 21.4 \pm 26.7 | 0.010 | 0.73 (M) | 14.9 \pm 27.6 | 0.065 | 0.42 (S) | -12.7 \pm 32.4 | 0.166 | 0.19 (T) |
| Cortisol (ug.dl ⁻¹) | SSG+RES | -0.066 \pm 0.279 | 1.000 | 0.30 (S) | -0.310 \pm 0.192 | 0.000 | 1.89 (L) | -0.065 \pm 0.208 | 1.000 | 0.36 (S) |
| | RES+SSG | -0.057 \pm 0.217 | 1.000 | 0.31 (S) | -0.251 \pm 0.178 | 0.001 | 1.72 (L) | -0.033 \pm 0.173 | 1.000 | 0.21 (S) |
| | Protocol difference | 0.009 \pm 0.175 | 0.845 | 0.04 (T) | 0.059 \pm 0.100 | 0.052 | 0.32 (S) | 0.032 \pm 0.104 | 0.264 | 0.17 (T) |
| T/C Ratio (AU) | SSG+RES | 102.6 \pm 216.9 | 0.602 | 0.52 (S) | 322.1 \pm 237.7 | 0.001 | 1.73 (L) | 35.7 \pm 117.7 | 1.000 | 0.35 (S) |
| | RES+SSG | 112.9 \pm 115.0 | 0.017 | 0.73 (M) | 261.8 \pm 232.4 | 0.006 | 1.41 (L) | -11.0 \pm 98.6 | 1.000 | 0.10 (T) |
| | Protocol difference | 10.4 \pm 170.5 | 0.823 | 0.06 (T) | -60.4 \pm 212.8 | 0.308 | 0.26 (S) | -46.6 \pm 109.2 | 0.134 | 0.43 (S) |

SSG+RES, Small-sided games followed by resistance training, RES+SSG, resistance training followed by small-sided games

SD, standard deviation; SSG, small-sided game; RES, resistance training; AU, arbitrary units; ES, effect size.

Effect sizes (ES, *d*); T, *trivial*; S, *small*; M, *moderate*; L, *large*.

