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Monitoring Postmatch Fatigue During a Competitive Season in Elite Youth Soccer Players

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Context: Countermovement jump (CMJ) and perceived wellness measures are useful for monitoring fatigue. Fatigue indicators should simultaneously show sensitivity to previous load and demonstrate influence on subsequent physical output; however, these factors have not been examined.

Objective: To explore the efficacy of CMJ and wellness measures to both detect postmatch fatigue and predict subsequent physical match output in elite youth soccer players.

Design: Cross-sectional study.

Patients or Other Participants: Sixteen soccer players (18 ± 1 years) from 36 English Football League Youth Alliance League fixtures.

Main Outcome Measure(s): Physical match outputs (total distance, high-speed running, very high-speed running, and accelerations and decelerations [AD]) were recorded using a 10-Hz global positioning system and 200-Hz accelerometer device during competitive match play. The CMJ height and perceived wellness were assessed weekly and daily, respectively, as indirect indicators of fatigue. Four subunits of wellness (perceived soreness, energy, general stress, and sleep) were measured using customized psychometric questionnaires.

Results: Simple linear regression showed that match AD predicted energy ($R^2 = 0.08$, $P = .001$), stress ($R^2 = 0.09$, $P < .001$), and total wellness ($R^2 = 0.06$, $P = .002$) at 2 days postmatch. The CMJ ($R^2 = 0.05$, $P = .002$), stress ($R^2 = 0.08$, $P < .001$), sleep ($R^2 = 0.03$, $P = .034$), and total wellness ($R^2 = 0.05$, $P = .006$) measures at 5 days prematch predicted AD during the subsequent match.

Conclusions: The CMJ and wellness measures may be useful for detecting postmatch fatigue. Wellness scores, but not CMJ, at 5 days prematch influenced subsequent match output and therefore may be used to plan and periodize training for the upcoming microcycle.

Key Words: accelerations, countermovement jump, fatigue, periodization, training load

Key Points

- Countermovement jump height and perceived wellness fluctuated in response to match output, whereas only perceived wellness influenced subsequent match output.
- The associations between fatigue indicators and match loads and outputs were weak; thus, changes should be interpreted in the context of a holistic athlete-monitoring system.

Competitive soccer match play induces significant fatigue lasting for up to 72 hours, and yet, soccer players are often required to compete on several occasions within a 7-day period.[1] Unsurprisingly, an imbalance between training and competition stresses, alongside an insufficient recovery period, has been shown to increase the risk of illness and injury and, in some cases, lead to overtraining syndrome.[2] As a consequence, the importance of monitoring individual physical "load"[3,4] and fatigue status[5] and quantifying the physical demands of soccer competition[6] has increased in recent years. Indirect measures of "neuromuscular function," such as jump tests that incorporate the stretch-shortening cycle, and athlete self-report measures, such as subjective wellness questionnaires, have been used in team-sport settings as part of a pragmatic monitoring and testing toolset.[5] In a recent meta-analysis,[1] researchers reported that countermovement jump (CMJ) performance and perceived wellness were reduced immediately after and for up to 72 hours after soccer-specific exercise, highlighting the potential significance of such tools for monitoring recovery from soccer-specific exercise.

Global positioning software (GPS)-derived physical outputs, such as total distance (TD) covered, high-speed distance, and acceleration and deceleration characteristics, allow coaches to more accurately estimate physical load.[3] For example, despite constituting only 12% of distance travelled, high-speed characteristics have received significant attention during competitive performance analysis.[6] This is likely because high-speed actions often dictate the most important moments of soccer competition.[6] Contemporary models of periodization promote a balance of recovery and physical load to maximize the training stimuli and optimize competitive performance.[7] Within each microcycle, higher training loads are prescribed such that sufficient recovery is permitted after a previous match and before a subsequent match, whereas technical and recovery sessions are prescribed on the days in close proximity to a match as a means to prevent a significant accumulation of fatigue.[7] However, despite the prescribed load, player-specific characteristics (ie, the player- and position-specific demands of sessions and recovery responses) require individualized modifications to the periodized plan.[2,8] Indeed, an excessive training load without sufficient recovery can increase the injury risk and reduce physical match outputs and, hence, competitive performance.[8,9] Consequently, identifying fatigue status at the beginning of a microcycle is essential to individualize the planning and periodization of training within a given cycle.[5]

The influence of fatigue status, as measured by CMJ[9,10] and perceived wellness,[11,12] on subsequent physical match output has previously been assessed. For example, Cormack et al[9] found that players in a fatigued state maintained TD and high-speed running (HSR) but had a reduced contribution of vertical acceleration to an accelerometer-derived "player-load," likely because of an impaired ability to sprint, accelerate, and decelerate. However, most earlier investigators[9,10] have compared physical match outputs of soccer players in a fatigued versus nonfatigued state without accounting for differences in the magnitude of fatigue. Furthermore, previous authors[9–11] measured fatigue status on days proximal to a match and, thus, did not consider incorporating fatigue measures at the start of a microcycle to determine subsequent weekly and per-session training load prescriptions.

As adolescence is a stage of growth encompassing rapid changes in physical, physiological, and psychological development, adolescent athletes may respond differently to a given training load compared with adults as well as those in their own peer group.[4] Earlier researchers[13] reported a high prevalence of nonfunctional overreaching in elite male youth soccer players. Additionally, a consensus statement from the International Olympic Committee[14] called for more data to inform evidence-based practices relating to minimizing the injury risk and enhancing wellbeing in youth athletes. Therefore, further examination is warranted to advance our understanding of the training load-recovery cycle in this population.[4,14]

Authors have suggested that fatigue indicators should simultaneously show sensitivity to previous load and demonstrate influence on subsequent training or match output[5,9]; however, these factors have largely been assessed in isolation.[9,15,16] Thus, the purpose of our study was to explore the efficacy of CMJ and wellness measures to both detect postmatch fatigue and observe subsequent physical match output in elite youth soccer players. We hypothesized that CMJ and perceived wellness would be sensitive to previous match load and predictive of subsequent physical match output.

METHODS

Participants

Sixteen outfield under-18 academy youth soccer players (age = 18 ± 1 years, height = 1.78 ± 0.54 m, mass = 70.2 ± 5.9 kg) from the same team competing in the English Football League Youth Alliance League provided written informed consent. All participants were briefed with a detailed explanation of the aims and requirements of the investigation, as well as any potential risks. For those under the age of 18 years, parental or guardian consent was also acquired. Players were assigned an outfield playing position by the head technical coach. Playing positions were central defenders (n = 2), wide defenders (n = 3), central midfielders (n = 6), wide midfielders (n = 4), and strikers (n = 1). All procedures were approved by the Ethics Committee of Sport and Health Sciences (University of Exeter).

Table 1. Sample Weekly Microcycle Demonstrating the Timing of Fatigue Monitoring Relative to Match Day (MD)

MD Code	Day	Fatigue Monitoring
MD+2/–5	Monday	Wellness and countermovement jump
MD–4	Tuesday	Wellness
MD–3	Wednesday	Wellness
MD–2	Thursday	Wellness
MD–1	Friday	Wellness
MD	Saturday	Wellness
MD+1	Sunday	Wellness

Experimental Design

Data from 36 weekend matches were collected during the competitive season from August 2017 to April 2018. Up to 5 substitutions were allowed during each match. Only data from athletes who played a full match were included for that week. If a player had an extended break from match play (eg, due to injury or nonselection), those data were removed from analysis until the athlete returned to regular match play. The total number of individual match observations was 211, and the mean number of observations per player was 13.2 ± 5.4. The CMJ tests were performed weekly, during each microcycle (Table 1), and wellness questionnaires were completed daily throughout the study period. Data were analyzed 2-fold, such that physical match outputs were used to predict fatigue status at 2 days postmatch (MD+2; prospective analysis), whereas fatigue status 5 days at prematch (MD–5) was used to predict subsequent match output (retrospective analysis). This design allowed for a concurrent assessment of the efficacy of CMJ and wellness measures to both monitor postmatch fatigue and predict subsequent match outputs. Players took part in normal team training throughout the study, as prescribed by the coaching and medical staff, which was in line with a weekly periodization model, as previously described.[7]

Match Output Variables

We measured match output variables using portable 10-Hz GPS devices with an embedded 200-Hz accelerometer (models Polar Team System and Polar Electro Oy). The 10-Hz GPS devices have demonstrated an acceptable level of validity and reliability in a team-sport setting when researchers assessed the speed of movement during intermittent exercise.[17] For each match, participants wore a chest strap with the GPS device located over the sternum. The GPS device was switched on 15 minutes before the warmup and switched off immediately after competition. Data from warmups and during half-time were excluded from the current study. Players wore the same GPS device

Table 2. Descriptive Statistics (Mean ± SD) for Physical Match Output Variables According to Playing Position[a]

Position	Total Distance, m	High-Speed Running, m	Very High-Speed Running, m	Accelerations and Decelerations, n[a]
Central defender (n = 45)	10 229 ± 433	1735 ± 282	603 ± 137	239 ± 43
Wide defender (n = 36)	10 882 ± 510	2111 ± 313	873 ± 173	217 ± 29
Central midfielder (n = 82)	11 340 ± 936	2214 ± 487	751 ± 250	217 ± 35
Wide midfielder (n = 33)	11 150 ± 687	2585 ± 456	1272 ± 251	264 ± 40
Striker (n = 15)	10 804 ± 705	2662 ± 295	1299 ± 160	264 ± 35
Total (n = 211)	10 957 ± 840	2184 ± 498	860 ± 322	232 ± 41

[a] n = No. of player observations.

for each match to prevent interdevice measurement error.[17] The measures of physical match output were (1) TD, (2) HSR (m $\geq$15 km·h^{-1}), (3) very high-speed running (VHSR; m $\geq$19 km·h^{-1}), and (4) accelerations and decelerations (AD; total number of AD $\geq$2 m·s^{-2}).

Countermovement Jumps

The CMJ performance was determined via jump height and measured using a standardized jump mat (Probotics Inc). Jump height was calculated from flight time using the following equation:

$$h = \frac{(f^2 \times g)}{8}$$

where h = jump height, f = flight time, and g = gravitational acceleration.

After a standardized warm-up (5-minute cycle at 125 W), participants completed 5 CMJs separated by 60-second rest periods using a standardized protocol. They were asked to stand on the jump mat with their feet parallel and approximately shoulder-width apart. Players were instructed to jump as high as possible, while maintaining hands on hips throughout, and complete a maximal vertical jump. The CMJ depth was self-selected. Using this experimental set-up for pilot testing, we found that CMJ height had a coefficient of variation in our laboratory of 1.5%. An average of the 5 jumps was calculated for analysis.

Wellness Questionnaires

To evaluate perceptual items of player wellness throughout the study period, customized psychometric questionnaires were completed privately before the athletes took part in any training or exercise. They submitted their responses via Google Drive using their personal devices. The questionnaire was designed to be short and specific and was based on previous literature.[11,18] The questionnaire consisted of 4 items (ie, perceived soreness, energy, general stress, and sleep), with an additional question relating to any other factors that the player felt was appropriate to share with the medical team. Each item was scored on a scale of 1 to 10 arbitrary units, with 1 representing the *most negative* and 10 representing the *most positive* score. A total wellness score was also calculated by summing the scores from each item. Each player was provided with specific instructions and education on how to complete the questionnaires and familiarized with their use during the preseason period.

Statistical Analysis

We calculated z-scores for all match output variables and fatigue indicators for each player by using the following formula: (individual player's score − individual player's average)/individual player's SD. Descriptive data are presented as mean ± SD unless otherwise indicated. Simple univariate linear regression analysis, using z-scores of seasonal data for each player to account for individual variations in both dependent and independent variables, was conducted to determine whether, firstly, physical match outputs (ie, TD, HSR, VHSR, and AD) were associated with fatigue status (ie, CMJ and wellness) on MD+2 (prospective analysis) and, secondly, whether fatigue status was associated with subsequent physical match output on MD–5 (retrospective analysis). The coefficient of determination (R^2) was computed to determine the variance in the dependent variable(s) explainable by the independent variable(s). Assumptions of linearity, normality of residuals, and homoscedasticity were confirmed via graphical inference. Normal distribution was also assessed using the Shapiro-Wilk test. If assumptions of normality were violated, we removed the outliers and the model was repeated. For all tests, results were considered statistically significant when $P < .05$. All statistical analyses were conducted using RStudio (version 4.0.2).

RESULTS

Descriptive statistics for physical match output are displayed in Table 2. The combined population mean and SD for MD+2 indicators of fatigue status are outlined in Table 3.

Prospective Analysis

Significant negative associations were found between MD+2 AD ($\beta = -0.3$, $P = .001$), stress ($\beta = -0.3$, $P < .001$), and total wellness ($\beta = -0.25$, $P = .002$) with subsequent energy. Match AD explained 8%, 9%, and 6% of the variance in MD+2 energy, stress, and total wellness, respectively. All prospective linear regression analyses are shown in Table 4.

Table 3. Seasonal Descriptive Statistics for MD+2 Fatigue Indicators

Fatigue Indicator[a]	No. of Observations	Mean ± SD
Countermovement jump, cm	185	54.2 ± 7.0
Soreness, AU	153	6.9 ± 0.6
Energy, AU	153	7.0 ± 0.5
Stress, AU	153	7.5 ± 0.9
Sleep, AU	153	7.3 ± 0.6
Total wellness, AU	153	28.6 ± 1.7

Abbreviation: AU, arbitrary unit.

[a] Soreness, energy, stress, and sleep were recorded on a scale of 1–10. Total wellness was calculated by summing the scores from each item's score on a given day.

Table 4. Linear Regression Analysis of Physical Match Output and Subsequent Measures of Fatigue (MD+2) (Prospective Analysis)

Fatigue Indicator and Predictor	*F* Statistic	*P* Value[a]	Intercept	B Value	R^2 Value
Countermovement jump					
TD	$F_{1,182} = 1.8$	.177	−0.07	−0.10	0.01
HSR	$F_{1,182} = 0.1$	.822	−0.06	0.02	0.00
VHSR	$F_{1,182} = 0.2$	.636	−0.06	0.04	0.00
AD	$F_{1,182} = 0.1$	.768	−0.06	0.02	0.00
Soreness					
TD	$F_{1,143} = 0.3$	.568	0.00	−0.05	0.00
HSR	$F_{1,143} = 0.2$	.693	0.00	0.03	0.00
VHSR	$F_{1,143} = 0.2$	.646	0.00	0.04	0.00
AD	$F_{1,143} = 1.1$	.298	−0.01	−0.09	0.01
Energy					
TD	$F_{1,119} = 3.6$	.060	0.00	−0.17	0.03
HSR	$F_{1,119} = 0.5$	.464	−0.00	−0.06	0.00
VHSR	$F_{1,119} = 0.3$	.571	−0.00	−0.05	0.00
AD	$F_{1,119} = 11.0$	**.001**	−0.02	−0.30	0.08
Stress					
TD	$F_{1,132} = 1.0$	.328	0.00	−0.09	0.01
HSR	$F_{1,132} = 0.7$	.411	−0.00	−0.07	0.01
VHSR	$F_{1,132} = 0.5$	.466	0.00	0.06	0.00
AD	$F_{1,132} = 13.1$	<**.001**	−0.03	−0.30	0.09
Sleep					
TD	$F_{1,150} = 0.2$	.695	0.00	−0.03	0.00
HSR	$F_{1,150} = 0.2$	.627	−0.00	−0.04	0.00
VHSR	$F_{1,150} = 0.9$	.335	−0.00	−0.08	0.01
AD	$F_{1,150} = 0.0$	.994	0.00	0.00	0.00
Total wellness					
TD	$F_{1,150} = 1.5$	.220	0.00	−0.10	0.01
HSR	$F_{1,150} = 0.5$	.486	−0.00	−0.06	0.00
VHSR	$F_{1,150} = 0.0$	.899	−0.00	−0.01	0.00
AD	$F_{1,150} = 9.6$	**.002**	−0.01	−0.25	0.06

Abbreviations: AD, accelerations and decelerations; HSR, high-speed running; TD, total distance; VHSR, very high-speed running.

[a] Bold values indicate significance at $P < .01$.

Table 5. Linear Regression Analysis of Fatigue Measures (MD–5) and Subsequent Physical Match Output (Retrospective Analysis)

Physical Match Output Variable and Predictor	*F* Statistic	*P* Value[a]	Intercept	B Value	R^2 Value
TD					
CMJ	$F_{1,186} = 3.5$	.064	0.02	0.14	0.02
Soreness	$F_{1,158} = 0.8$	.380	−0.01	0.07	0.00
Energy	$F_{1,143} = 0.5$	.492	−0.03	0.06	0.00
Stress	$F_{1,139} = 3.4$	.068	−0.01	−0.16	0.02
Sleep	$F_{1,150} = 0.2$	.628	−0.01	−0.04	0.00
Total wellness	$F_{1,155} = 0.0$	.843	−0.01	−0.02	0.00
HSR					
CMJ	$F_{1,186} = 1.2$	.267	0.02	0.08	0.01
Soreness	$F_{1,158} = 0.7$	.415	0.00	0.07	0.00
Energy	$F_{1,143} = 0.9$	.346	0.01	0.08	0.01
Stress	$F_{1,139} = 3.0$	.087	−0.00	−0.15	0.02
Sleep	$F_{1,150} = 0.3$	.560	0.01	−0.05	0.00
Total wellness	$F_{1,155} = 0.1$	.776	0.01	−0.02	0.00
VHSR					
CMJ	$F_{1,186} = 1.4$	.240	−0.01	0.09	0.01
Soreness	$F_{1,158} = 0.8$	.366	0.03	0.07	0.01
Energy	$F_{1,143} = 0.7$	.413	0.02	0.07	0.00
Stress	$F_{1,139} = 0.0$	.876	0.03	0.01	0.00
Sleep	$F_{1,150} = 0.0$	.981	0.02	0.00	0.00
Total wellness	$F_{1,155} = 0.5$	.468	0.02	0.06	0.00
AD					
CMJ	$F_{1,186} = 10.1$	**.002**	0.01	0.22	0.05
Soreness	$F_{1,158} = 0.1$	.804	−0.04	−0.02	0.00
Energy	$F_{1,143} = 0.8$	.358	−0.05	−0.08	0.01
Stress	$F_{1,139} = 12.0$	<**.001**	−0.05	−0.28	0.08
Sleep	$F_{1,150} = 4.6$	**.034**	−0.03	−0.17	0.03
Total wellness	$F_{1,155} = 7.8$	**.006**	−0.03	−0.22	0.05

Abbreviations: AD, accelerations and decelerations; CMJ, countermovement jump; HSR, high-speed running; TD, total distance; VHSR, very high-speed running.

[a] Bold values indicate significance.

Retrospective Analysis

A significant positive association was present between MD–5 CMJ ($\beta = 0.22$, $P = .002$) and subsequent AD. Furthermore, significant negative associations were noted between MD–5 stress ($\beta = -0.28$, $P < .001$), sleep ($\beta = -0.17$, $P = .034$), and total wellness ($\beta = -0.22$, $P = .006$) with subsequent AD. The CMJ, stress, sleep, and total wellness explained 5%, 8%, 3%, and 5% of the variance in AD, respectively. All retrospective linear regression analyses are provided in Table 5.

DISCUSSION

The purpose of our study was to investigate associations between physical match output and subsequent CMJ and wellness on MD+2, as well as any associations between CMJ and wellness on MD–5 and subsequent physical match output in under-18 youth soccer players. In agreement with the primary hypotheses, AD was negatively associated with MD+2 energy, stress, and total wellness. Additionally, MD–5 CMJ was positively associated with AD of the subsequent match. However, MD–5 stress, sleep, and total wellness were negatively associated with AD during the subsequent match. These findings suggest that wellness measures are sensitive in detecting postmatch fatigue and that CMJ performance at the start of the microcycle may affect subsequent match output. Interestingly, we did not show any associations between match output and MD+2 CMJ. Yet factors other than match output and fatigue markers explain a large proportion of variance in subsequent fatigue and match output. These results may have important implications for monitoring postmatch fatigue and designing the upcoming microcycle in youth soccer players.

It is well documented[1,8,19] that elevated fatigue is present in cohorts of both amateur and professional male soccer players, as assessed via CMJ and wellness questionnaires, and is evident for up to 72 hours postmatch as a result of soccer match play. Furthermore, the magnitude of external loading, such as distance covered, during a match is related to the magnitude of the decrement in postmatch fatigue status.[1] As such, we reported a relationship between AD and subsequent MD+2 perceived energy, stress, and total wellness. Similarly, Varley et al[20] described a moderately positive relationship ($r = 0.52$) between accelerations performed and wellness responses at 40 hours postmatch in elite male soccer players. Given the large neuromuscular and mechanical demands and resultant decreased force output, structural damage, and soreness associated with AD actions, these findings were expected.[3] It was interesting that no other match outputs were associated with CMJ or wellness; trivial associations have also been observed between HSR and TD and wellness measures in elite soccer players.[21] However, in agreement with previous literature,[22] most of the associations between match output (ie, TD, HSR, and VHSR) and subsequent wellness in our investigation were nonsignificant or of weak magnitude ($R^2 \leq 0.09$) or both. Indeed, earlier authors[11,23] observed the influence of contextual factors such as the match result and location on postmatch wellness responses, which may confound such dose-response relationships. Evidence has also emerged to suggest that the length of time over which load is evaluated influences the relationship between load and wellness.[18] Importantly, recent researchers[24] studying high-performing youth soccer populations demonstrated poor reliability of short, customized subjective wellness questionnaires frequently used in applied practice, such as that we used, in both rested and fatigued states. The use of a more continuous scale (eg, 1 to 10 versus 1 to 5) might have improved the reliability of our participants' wellness responses.[24] Response distortion with subjective measures remains a potential cause of poor reliability,[2] particularly in youth athletes who may be more susceptible to peer-to-peer coercion or recall error.[25]

We noted nonsignificant relationships between match output and MD+2 CMJ height in the present study. This finding agrees with some[20] but not all[26] previous research. It appears that the metrics for jump output, such as height, are less sensitive to fatigue-induced decrements in neuromuscular function than those for jump strategy, such as flight time: contraction time.[19] This is thought to be due to a reorganization of jump strategy to maintain similar jump outputs under fatigued conditions.[19] Furthermore, although jump height is commonly used to assess recovery postmatch, the duration of CMJ jump decrement from baseline varies[27] and may recover within 48 hours. Moreover, among elite youth soccer players, CMJ may not vary postmatch.[28] Other potential explanations for the lack of significant associations between physical match output and MD+2 fatigue markers in our work include the measures of physical output studied. Traditional external-load metrics such as TD, AD, and HSR thresholds do not reflect the energetic cost of changes in velocity or load incurred during physical contests that do not involve displacement.[29] In addition, the internal load, rather than the external load, has been suggested as determining the fatigue response.[30] Finally, although z-scores express match output relative to individual norms, the use of individualized external-load metrics accounts for the influence of physical fitness on the fatigue response, which may have improved dose-response relationships in the current study.[31]

To the best of our knowledge, we are the first researchers to publish an examination of the association between fatigue markers at the start of a microcycle (MD–5) and subsequent match output in elite youth soccer players. Significant associations ($R^2 = 0.03$ to 0.08) were found between MD–5 CMJ, stress, sleep, and total wellness and subsequent match AD. In a previous study[12] of high-performing field hockey players, the investigators demonstrated relationships between wellness and traditional physical match output metrics normalized to time or ratings of perceived exertion. Ihsan et al[11] collected data over a 9-day tournament consisting of 6 matches, in which greater variability (small to large effect-size changes) in wellness and match output was seen. Also, the strength of relationships was greater ($r = -0.87$ to -0.95) when match outputs were normalized to both time and ratings of perceived exertion.[12] These factors may explain the disparity in the magnitude of associations between wellness and match output in our study versus that of Ihsan et al.[11] Earlier authors[15,21] addressed the influence of pretraining wellness on physical training outputs. In contrast and in agreement with our findings, Bellinger et al[12] showed no influence of prematch wellness on accelerometer-derived match output and the way in which it accumulated in elite Australian football players. Indeed, it is possible that players do not self-regulate physical output during match play based on wellness as they do during training due to greater motivation for maximum effort during competition.[11]

We measured fatigue status at the start of the microcycle (MD–5), 2 days after the previous match. As a result, postmatch fatigue may have dissipated due to sufficient time before the subsequent match; thus, it may have had no influence on physical output,[11] which is a potential reason for the negative association between wellness and AD. Furthermore, differences in training load among players may have contributed to different fatigue statuses on match day, thereby confounding retrospective relationships.[10] Players may have self-regulated their training loads based on their pretraining neuromuscular fatigue and perceived wellness[15,16] Additionally, these weak retrospective relationships may reflect successful management (ie, weekly periodization) of players who displayed elevated fatigue at the start of a microcycle. For example, players with lower-than-normal CMJ and wellness may have been prescribed smaller training loads and recovery interventions to mitigate any residual fatigue before the upcoming match, which is the ultimate aim of a weekly periodization model.[7] Match output is also known to be highly variable and influenced by a host of factors such as the athlete's own and the opponent's playing style, team formation, and tactics.[32] Therefore, these factors may account for a large proportion of the remaining unexplained variance that is beyond the scope of our study.

These results should be considered in light of several limitations. For instance, even though we took the previous literature[11,18] into consideration, our wellness questionnaire has not undergone a rigorous process to ensure validity and reliability. Moreover, the relationship between load and wellness may be nonlinear; thus, linear statistical techniques may have a limited capacity to model such relationships.[4,18] Also, our relatively small sample of athletes may have impaired our ability to detect relationships. Moving forward, researchers should consider accounting for additional factors, such as nutrition, other sport involvement, and maturity status, to capture a more holistic insight into player readiness.

PRACTICAL APPLICATIONS

Systematic monitoring of wellness may have practical utility for monitoring postmatch fatigue and informing training for the upcoming microcycle in high-performing youth soccer players, whereas CMJ may be useful only for the latter. For example, based on the dose-response relationships reported between match output and postmatch fatigue we noted, players who perform more AD during match play may be prescribed recovery interventions, an extra rest period, or both after a match. Furthermore, players whose fatigue status is elevated at the start of the microcycle may be prescribed smaller loads or modified training or recovery strategies during the upcoming microcycle to ensure sufficient physical preparation for the subsequent match. Our work also adds to the literature opposed to the use of CMJ height for detecting fatigue; hence, CMJ metrics that describe jump strategy rather than jump output may offer a more appropriate approach. Finally, the relationships we reported were of weak magnitude, highlighting that a large proportion of the variance in postmatch fatigue and match output is accounted for by factors other than match output and fatigue, respectively. Therefore, it is essential that practitioners analyze changes in match output and fatigue status in the context of other factors, such as recent training load, measurement reliability, and team tactics,[18,24,32] and that decisions regarding player management are not based solely on CMJ and wellness scores.

CONCLUSIONS

We demonstrated that, in a cohort of high-performing youth soccer players, match AD predicted MD+2 energy, stress, and total wellness and MD–5 CMJ, stress, sleep, and total wellness predicted AD during the subsequent match. These results may have important implications for monitoring postmatch fatigue and designing the upcoming microcycle among high-performing youth soccer players. However, these associations were weak, and thus, changes in CMJ and wellness should be interpreted in the context of a wider athlete-monitoring system.

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