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# Managing Load to Optimize Well-Being and Recovery During Short-Term Match Congestion in Elite Basketball

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In elite basketball, players are exposed to intensified competition periods when participating in both national and international competitions. How coaches manage training between matches and in reference to match scheduling for a full season is not yet known. ***Purpose:*** First, to compare load during short-term match congestion (ie, ≥2-match weeks) with regular competition (ie, 1-match weeks) in elite male professional basketball players. Second, to determine changes in well-being, recovery, neuromuscular performance, and injuries and illnesses between short-term match congestion and regular competition. ***Methods:*** Sixteen basketball players (age 24.8 [2.0] y, height 195.8 [7.5] cm, weight 94.8 [14.0] kg, body fat 11.9% [5.0%], $VO_2$max 51.9 [5.3] $mL \cdot kg^{-1} \cdot min^{-1}$) were monitored during a full season. Session rating of perceived exertion (s-RPE) was obtained, and load was calculated (s-RPE × duration) for each training session or match. Perceived well-being (fatigue, sleep quality, general muscle soreness, stress levels, and mood) and total quality of recovery were assessed each training day. Countermovement jump height was measured, and a list of injuries and illnesses was collected weekly using the adapted Oslo Sports Trauma Research Center Questionnaire on Health Problems. ***Results:*** Total load (training sessions and matches; $P < .001$) and training load ($P < .001$) were significantly lower for ≥2-match weeks. Significantly higher well-being ($P = .01$) and less fatigue ($P = .001$) were found during ≥2-match weeks compared with 1-match weeks. ***Conclusion:*** Total load and training load were lower during short-term match congestion compared with regular competition. Furthermore, better well-being and less fatigue were demonstrated within short-term match congestion. This might indicate that coaches tend to overcompensate training load in intensified competition.

***Keywords:*** RPE, regeneration, wellness, performance, overuse

In elite basketball, players are subject to the delicate balance between load and recovery during in-season intensified competition periods, participating in both national and international competitions. This leads to a high match frequency and subsequently to a high physical and psychosocial load.[1,2]

Density in match schedules is often referred to as fixture congestion and may influence performance.[1,3–5] It is known that playing 2 competitive matches per week impairs players' capacity to sprint, jump, and perform repeated intensive activities compared with 1 match per week.[2]

Apart from the physical consequences in reference to dense match schedules, it may also lead to psychosocial stress, given the consequences of, for example, the team dynamics, pressure of spectators, and coach–athlete relationship. Results of previous studies have shown deteriorations in psychological state after competitive matches.[6,7] This might negatively influence subsequent performance along injury occurrence.[8]

Training and coaching staff may anticipate short-term match congestion by squad rotation management.[9] Furthermore, training sessions in between can be adjusted in load by decreasing frequency, intensity, or duration. When planning subsequent training sessions, coaches ideally take the individual ability to recover into account and determine personalized training regimes.[10,11]

Sufficient recovery time between successive matches is assumed key in fixture congestion. To understand possible performance decrements, it is crucial to have clear insight into players' recovery during short-term match congestion (ie, ≥2-match weeks) compared with regular competition (ie, 1-match weeks).[12] Furthermore, it is imperative for training and coaching staff to manage players' fatigue by monitoring it to avoid maladaptive responses throughout the competitive season.[13]

To understand the complex mechanisms of recovery kinetics in elite basketball, especially during match congestion, multidimensional monitoring of players' recovery is recommended.[10,14] It is previously demonstrated that self-reported well-being and recovery are sensitive to an acute increase in load and are impaired during periods of intensified competition.[15,16] Next to that, neuromuscular recovery as a complementary objective measure is used.[16] If there is inadequate recovery while the load remains high, it is assumed that injury occurrence increases.[16] Moreover, rapid increases of load are likely to increase the risk for injuries and illnesses.[17,18]

In summary, considering the potentially negative consequences of multiple matches per week, it is important to gain more insight in training load periodization. How coaches are dealing with this matter is unclear. Moreover, its consequences on the recovery kinetics over an entire season in elite basketball remain to be determined to maintain performance and prevent injuries and illnesses. Therefore, the aim of this study is to compare load during short-term match congestion (ie, ≥2-match weeks) with regular competition (ie, 1-match weeks) over a full season in elite male professional basketball players. Subsequently, to gain more insight in recovery kinetics, differences in well-being (ie, fatigue, sleep quality, general muscle soreness, stress levels and mood), total quality of recovery (TQR), neuromuscular performance (NMP), and injuries and illnesses will be compared between the 2 conditions.

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# Methods

## Subjects

Sixteen elite basketball players playing at the highest level of the Dutch Basketball Association of 2 professional basketball teams participated in this study. Characteristics of the players were as follows: age 24.8 (2.0) y, height 195.8 (7.5) cm, weight 94.8 (14.0) kg, body fat 11.9% (5.0%), and $VO_2$max 51.9 (5.3) $mL \cdot kg^{-1} \cdot min^{-1}$ (mean [SD]).

All training sessions and matches were executed as prescribed by the head coaches, assistant coaches, and strength and conditioning staff without any interference or manipulation. Training sessions consisted of strength training, technical training, tactical training, shooting practice, drills, intermittent exercise sessions, and recovery training. Measurements were organized in a way that minimized impact on the normal preparation and structure of training sessions and matches. During preseason, players were familiarized with the experimental protocol, procedures, and measurements. The ethical committee of the Center for Human Movement Sciences of the University of Groningen approved the study protocol, and written informed consent was obtained from the subjects.

## Experimental Protocol and Procedures

During this prospective observational study, players were monitored during a full season. Figure 1 presents an overview of measurements during an intensified competition week (ie, ≥2-match week) within the study. Next to daily training and match load, well-being, TQR, NMP, and injuries and illnesses were measured.

Session rating of perceived exertion (s-RPE) was obtained individually 30 min after each training session or match. Intensity was rated on a 6 (no exertion) to 20 (extreme exertion) scale. Training and match load were calculated by multiplying s-RPE with training or match duration (excluding warming-up, interruptions, time-outs, time between quarters, match stops, and injury time) and expressed in arbitrary units.[19] The s-RPE is a valid method to monitor exercise intensity, including disruptions and substitutions, in professional elite-standard basketball players.[20]

Well-being and TQR were assessed individually 30 min before the first training session on training days between 8.00 and 10.00 AM. The "Well-Being Questionnaire"[21] consists of 5 items (fatigue, sleep quality, general muscle soreness, stress levels, and mood) and was rated on a scale from 1 (most negative) to 5 (most positive) with 0.5 intervals. The overall well-being was calculated by summarizing the scores on the 5 items. The "Well-Being Questionnaire" was based on previous recommendations[22] and showed sensitivity for changes of preceding load.[21] TQR was rated on a 6 (no recovery) to 20 (maximal recovery) scale. The TQR scale was designed to monitor individual characteristics of player recovery.[23]

The NMP was assessed by performing countermovement jumps (CMJ) between 8.00 and 10.00 AM of that day. CMJ is a reliable and valid indicator of NMP in team sports.[24] CMJ height was measured using a portable contact platform (ProJump; Lode BV, Groningen, The Netherlands). Players were instructed and demonstrated to perform 5 maximal vertical jumps with ~3 s of rest between each jump.[25] The jump began with the player standing in an upright position, followed by bending the knees to a self-selected depth, before jumping with maximal vertical height. Hands were placed on the hips during the whole procedure to exclude arm swing influence on CMJ performance. The mean CMJ height of 5 jumps was calculated and used for analysis, as it provided the most reliable performance measure for repeated CMJs (coefficient of variation is 1.9% in elite athletes).[24]

Acute and overuse injuries and illnesses were collected weekly using the adapted Oslo Sports Trauma Research Center Questionnaire on Health Problems.[26] The questionnaire contains 4 key questions on the consequences of health problems on sports participation, training volume, and sports performance, as well as the degree to which athletes have experienced symptoms. Each of these questions has 4 possible answers, in which answering the minimum score on all of them finishes the questionnaire. However, if athletes reported anything other than the minimum value for any question, subsequent questions followed. The remaining questions provided additional information about the problem. Most importantly, they specified whether the problem was an injury or illness and included the number of days of time loss caused by it. The Oslo Sports Trauma Research Center Questionnaire on Health Problems, based on the Oslo Sports Trauma Research Center Overuse Injury Questionnaire, which is validated in elite team sports, enables reliable registration of all type of problems, including illness, acute injury, and overuse injury.[26]

## Statistical Analysis

Individual player data were analyzed per week. Mean (SD) was calculated for total load (training sessions and matches), duration, and s-RPE and training load, and training duration and training s-RPE for ≥2-match weeks and 1-match weeks. Subsequently, well-being, fatigue, sleep quality, general muscle soreness, stress levels, mood, TQR, CMJ, prevalence of injuries and illnesses, severity scores, and time loss were calculated for ≥2-match weeks and 1-match weeks over the season. Matchless weeks were excluded from the analysis, and players had to have ≥10 min of playing time in 90% of all matches to be included in the analysis. To investigate changes for well-being, fatigue, sleep quality, general muscle soreness, stress

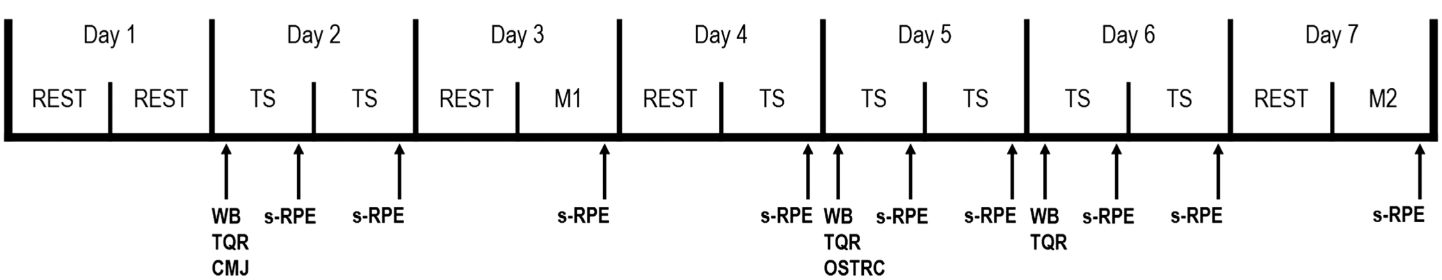


**Figure 1** — Overview and time points of measurements during ≥2-match weeks in the study. CMJ indicates countermovement jump; M1, match 1; M2, match 2; OSTRC, Oslo Sports Trauma Research Center Questionnaire on Health Problems; s-RPE, session rating of perceived exertion; TS, training session; TQR, total quality of recovery; WB, well-being.

levels, mood, TQR, CMJ, prevalence of injuries and illnesses, severity scores, and time loss, the data were analyzed using multilevel modeling with MLwiN (version 2.35 for Windows; Centre for Multilevel Modelling, University of Bristol, United Kingdom).[27] Multilevel analysis is able to include dependent data and can handle a varying number of measurements between players, which is inevitable in a repeated-measures design. The actual data do have missing values. Multilevel analysis can make use of all available data in the prediction of model parameters due to its flexible treatment of the time predictor. Missing values in the data set were at random.

Separate multilevel models were created for the following outcome measures: well-being, fatigue, sleep quality, general muscle soreness, stress levels, mood, TQR, CMJ, and injuries and illnesses. The multilevel model was created with repeated measures within players (level 1), differences between players (level 2), and differences between teams (level 3). The first step was to create an empty model predicting the averages of the players on the outcome measures. The second step was to create a 2-level model indicating possible differences between measurements; therefore, time points were added to the intercept model. Finally, a 3-level model was created to indicate possible differences between teams. The model fit was evaluated by comparing the −2 log likelihood of the empty model with the final model. Furthermore, differences between ≥2-match weeks and 1-match weeks were evaluated by comparing the mean of the coefficient and its SE (coefficient/SE >1.96 = significant). The possible differences were calculated for well-being, fatigue, sleep quality, general muscle soreness, stress levels, mood, TQR, CMJ, and injuries and illnesses. Effect sizes were calculated by $f^2$.[28] Guidelines for interpretation of $f^2$ indicate that 0.02 is a small effect, 0.15 is a medium effect, and 0.35 is a large effect.[29] *P* values lower than .05 were considered as statistically significant.

## Results

Table 1 presents total load (training sessions and matches) and training load, which displays duration, s-RPE and training duration, and training s-RPE, respectively, for ≥2-match weeks compared with 1-match weeks. Furthermore, perceived well-being, fatigue, sleep quality, general muscle soreness, stress levels, mood, TQR and CMJ height, outcome measures for injuries and illnesses, severity scores, and time loss are presented. The prevalence of injuries and illnesses is 17.2% and 3.3% for ≥2-match weeks and 18.1% and 4.6% for 1-match weeks, respectively.

To indicate load distribution over the season for ≥2-match weeks and 1-match weeks for 1 team (N = 9), total load (training sessions and matches) and training load are presented (Figure 2). Note that matchless weeks 12, 13 (winter break), and 20 were excluded in the analysis and, therefore, not presented.

Table 2 presents predicted total well-being and fatigue. Adding level 2 (measurements between players) to the empty model significantly increased the model fit. No increased model fit was found for differences between teams (level 3). Therefore, a 2-level model is used. Well-being ($f^2 = 0.0001$; confidence interval, 17.72–18.78) and fatigue ($f^2 = 0.04$; confidence interval, 3.16–3.52) are significantly improved in ≥2-match weeks compared with 1-match weeks. Sleep quality, general muscle soreness, stress levels, mood, TQR, CMJ height (individual coefficient of variation is 1.1%–5.9%), severity score, and time loss are not significantly different for ≥2-match weeks compared with 1-match weeks.

## Discussion

The aim of this study was to compare load during short-term match congestion (ie, ≥2-match weeks) with regular competition (ie, 1-match weeks) in elite male professional basketball players over a full season. The second aim was to investigate differences in well-being (ie, fatigue, sleep quality, general muscle soreness, stress levels and mood), TQR, NMP, and injuries and illnesses for both conditions.

The first main finding was that total load (training sessions and matches) and training load were significantly lower during short-term match congestion compared with regular competition. Although this is the first study that captured a full season in basketball, this has been reported previously.[30] More specifically, players reported significantly lower total s-RPE and training s-RPE

**Table 1 Total Load (Training Sessions and Matches) and Training Load Display Duration and s-RPE for ≥2-Match Weeks and 1-Match Weeks, as Well as Perceived Well-Being, TQR and CMJ Height, Severity Score and Time Loss for ≥2-Match Weeks and 1-Match Weeks**

| | ≥2-match weeks | 1-match weeks | *P* |
|---|---|---|---|
| Total load (s-RPE × duration), AU | 7730.5 ± 2499.27 | 9307.8 ± 3028.63 | <.001 |
| s-RPE | 13.1 ± 1.84 | 13.7 ± 1.59 | <.001 |
| Duration, min | 592.1 ± 171.93 | 671.7 ± 201.00 | .001 |
| Training load (s-RPE × duration), AU | 5651.8 ± 2259.72 | 8155.11 ± 2870.41 | <.001 |
| Training s-RPE | 12.2 ± 2.24 | 13.3 ± 1.70 | <.001 |
| Training duration, min | 446.2 ± 159.49 | 596.8 ± 194.04 | <.001 |
| Well-being | 18.5 ± 1.36 | 18.2 ± 1.60 | .01 |
| Fatigue | 3.5 ± 0.44 | 3.4 ± 0.51 | .001 |
| Sleep quality | 3.8 ± 0.30 | 3.8 ± 0.35 | .18 |
| General muscle soreness | 3.4 ± 0.50 | 3.3 ± 0.56 | .08 |
| Stress levels | 3.9 ± 0.33 | 3.8 ± 0.38 | .27 |
| Mood | 4.0 ± 0.30 | 4.0 ± 0.35 | .12 |
| TQR | 14.0 ± 1.03 | 13.9 ± 1.06 | .16 |
| CMJ height, cm | 36.5 ± 1.35 | 36.4 ± 1.39 | .91 |
| Severity score (0–100) | 13.5 ± 29.11 | 16.4 ± 30.46 | .34 |
| Time loss (number of days) | 2.5 ± 2.70 | 2.5 ± 2.93 | .53 |

Abbreviations: AU, arbitrary units; CMJ, countermovement jump; s-RPE, session rating of perceived exertion; TQR, total quality of recovery. Note: All data are displayed as mean ± SE.

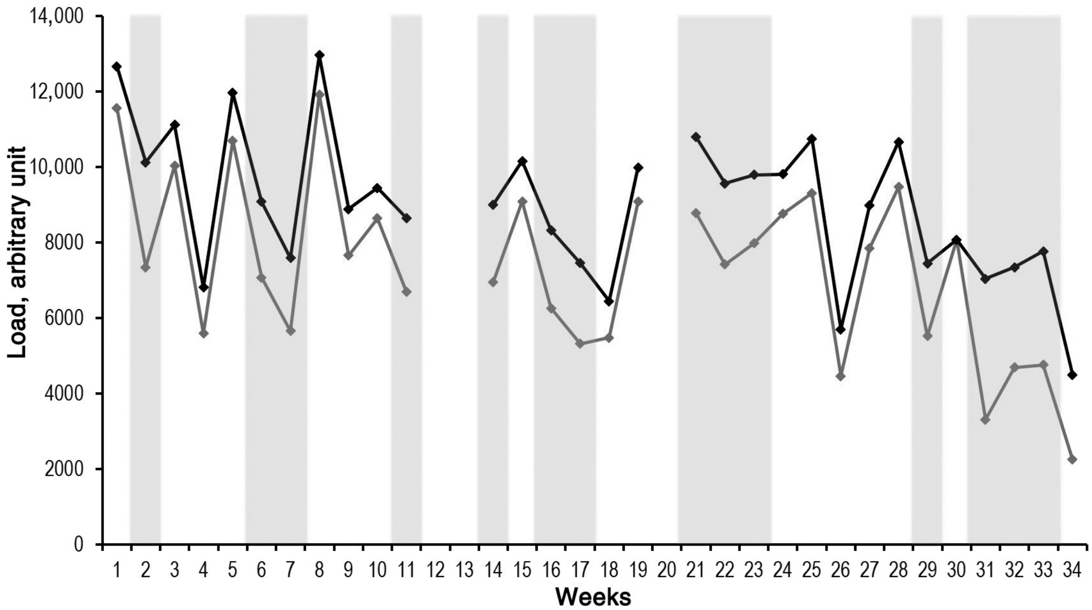


**Figure 2** — Total load (training sessions and matches; black line) and training load (gray line) for 1 team (N = 9) per week over the season. Gray vertical blocks indicate ≥2-match weeks.

**Table 2 Multilevel Models for Predicted Well-Being and Fatigue and the Difference Between 1-Match Weeks and ≥2-Match Weeks**

| N = 427 | Model | Intercept (constant) | Estimate (SE) | Level 2 between players | Level 1 within players | Log likelihood ($\chi^2$) |
|---|---|---|---|---|---|---|
| Well-being | Empty model | 18.37 (0.26) | — | 1.05 (0.39) | 1.26 (0.09) | 1361.68 |
| | | 18.25 (0.27) | 0.28 (0.11) | 1.05 (0.39) | 1.24 (0.09) | 1355.20* |
| Fatigue | Empty model | 3.41 (0.09) | — | 0.18 (0.04) | 0.12 (0.01) | 353.31 |
| | | 3.34 (0.09) | 0.11 (0.03) | 0.12 (0.04) | 0.12 (0.01) | 342.75** |

*$P$ = .01. **$P$ = .001.

during short-term match congestion compared with regular competition. Their s-RPE corresponded with *fairly light* for short-term match congestion and *somewhat hard* for regular competition. Next to a lower s-RPE, total and training duration were significantly lower during short-term match congestion. Interestingly, a large SD was seen in duration of training, which suggests that programs were tailored to the needs of the individual player.

A lower training load during short-term congestion indicates that coaches focused on maintenance of fitness and prevention of overload.[30] Fairly light perceived exertion and relatively short training duration are likely a result of a carefully managed training program, including effective recovery strategies.[23] Although this might be interpreted as beneficial, it could also result in underload and suboptimal performance. Our results suggest that the training and coaching staff considered the number of matches being played per week when planning training,[20] but that they tended to overcompensate. One explanation for this is that coaches may overestimate exertion of players during matches[1] and more carefully planned prematch and postmatch training sessions. This not only affects training adaptations in the short term, but it could also have consequences in the long term, leading to suboptimal performance.[31]

Our second finding was higher well-being and less fatigue reported by players during short-term match congestion compared with regular weeks. Well-being and fatigue scores during regular competition were 18.2 (1.60) and 3.4 (0.51), respectively, which is relatively high compared with other research.[30,32] Fatigue corresponded with *normal* and *fresh* and can thus be considered as ready to perform. The fact that players' well-being was higher (18.5 [1.36]) and that they reported less fatigue (3.5 [0.44]) during congested weeks may indicate that players could train harder. In our study, we captured a full competitive season that included irregular weeks of short-term match congestion. Certain phases of the season consisted of more dense weeks compared with others. Although our analysis did not discriminate between these phases, it is important to realize that within-season variation may exist. Indeed, Conte et al[30] showed lower well-being during short-term match congestion during the initial 10 wk of the season. This could also be caused by relatively poor fitness after the summer break. Although the present study also shows high variability in load during the initial phase of the season, periods of unloading (matchless weeks or winter break) within a full season were also included. It is clearly recognized that this has beneficial consequences for psychological and physical recovery.[33]

Next to well-being and fatigue, no changes in sleep quality, general muscle soreness, stress levels, mood, and TQR were found between short-term match congestion and regular competition. These findings are partly in line with previous research that found no changes in sleep quality, stress levels, and mood after increased load.[32] Associations between changes in training load and general muscle soreness[34] and TQR[35] are previously demonstrated, though they depend on weekly training load exposure. For the current study, lack of association is likely explained by the relatively low total load and training load.[35]

Our third finding was that NMP did not significantly change between short-term match congestion and regular competition. This means that the players maintained jump performance. As players reported less fatigue during congested weeks, one could expect that players would jump even higher. However, ~48 h of recovery prior to CMJ testing may have washed out this influence.

Finally, the prevalence of injuries and illnesses was 17.2% and 3.3% for short-term match congestion and 18.1% and 4.6% for regular weeks, respectively. The prevalence and days of time loss in our study are in line with previous research of other team sports at a professional level.[26] It is known that the risk for injuries and illnesses is higher with increases in load.[36] However, no significant differences for severity scores and time loss were observed between short-term match congestion and regular competition. This is likely because of reduced training load to compensate for multiple matches during the congested schedule.

To our knowledge, this is the first study that demonstrated that coaches intend to manage load in reference to match scheduling in elite male professional basketball for an entire season. Moreover, multilevel modeling was used for data analysis to assess associations at an individual level. Finally, next to insight in total load (training sessions and matches) and training load, the study provides outcomes for well-being, recovery, NMP, and injuries and illnesses.

## Limitations and Future Research

A limitation of the study is that with 2 participating teams, only 2 coaches were involved. This is a well-known issue for studies in team sports.[1] Furthermore, no insight was gained into recovery activities outside the field or regarding other stressors in life (eg, life events, family situation, daily hassles). This may provide additional insight on well-being and recovery state.

Future research should aim at finding the optimal balance between load and recovery for the competitions involved within team sports, including recovery activities and other stressors. Next to training guidelines (eg, intensity, duration), type of training should be examined in quasi-experimental designs. For example, intensity, duration, and type of training can be adjusted intermediate via feedback loops in 1 team, but not for the other. Thereafter, results could be integrated into the macroperiodization schedule of the season. Consequently, training potential for the individual player is used utmost while well-being and recovery are maintained.

## Conclusion

The results of this study demonstrated that total load (training sessions and matches) and training load were lower during short-term match congestion compared with regular competition in elite basketball players. Furthermore, better well-being and less fatigue were seen within short-term match congestion. This may indicate unused training potential to improve performance during short-term match congestion.

## Practical Applications

For short-term match congestion (ie, ≥2-match weeks) and regular competition (ie, 1-match weeks), total load (training sessions and matches) and training load were presented. Results suggest that the coaches overcompensate training load during congested weeks. An explanation for this is that coaches often apply tapering off toward prematch[20] and tend to overestimate match intensity.[1] The latter could result in lower intensity during postmatch training sessions. If more matches are played within a week, this overcompensation effect is expected to become larger. Therefore, training and coaching staff are advised to closely monitor training load and perceived fatigue of players. This may help them to guide the training process and increase training load when possible. Absence of evidence was found for the use of the other well-being items, with TQR and NMP.

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