Louis, J, Dinu, D, Leguy, E, Jacquet, M, Slawinski, J and Tiollier, E

Effect of dehydration on performance and technique of three-point shooting in Elite Basketball.

Article title: Effect of dehydration on performance and technique of three-point shooting in Elite Basketball

Submission type: Letter to Editor

Authors: Julien Louis[1]*, Daniel Dinu[2], Elsa Leguy[3], Marine Jacquet[3], Jean Slawinski[4], Eve Tiollier[2]

Affiliations:

[1*] Liverpool John Moores University, Research Institute for Sport and Exercise Sciences, Liverpool, United Kingdom. J.B.Louis@ljmu.ac.uk; [2] French National Institute of Sport, Expertise and Performance. Sport, Expertise and Performance Lab, EA7370, Paris; [3] ESO Paris, Superior School of Osteopathy, Paris; [4] Université de Paris 10, UFR STAPS, Centre de recherche sur le sport et le mouvement (EA 2931), Nanterre, France.

***Corresponding Author:** Dr Julien Louis, Liverpool John Moores University Research Institute for Sport and Exercise Sciences**,** L3 3AF, Liverpool, UK**,** J.B.Louis@ljmu.ac.uk
+44 (0)151 904 6285, **ORCID ref:** orcid.org/0000-0002-9109-0958

Introduction

Basketball play is classically accompanied with a significant loss of body water with a potential negative impact on both physical and cognitive performance [1]. Very few studies have examined the impact of dehydration on biomechanical adjustments required to score in basketball, though joints angles, the position of the centre of mass and ball release parameters (i.e. height, release speed and angle) are among the best predictive factors of success in basketball shooting [2]. Dehydration might alter the biomechanical requirements of successful shots and especially three-point shots (3PS) which generate 16% of points scored during a match. However, only 35% of 3PS are successful in game. Within this framework we analysed the effects of a controlled dehydration protocol on the success and technique of 3PS in elite basketball players. Changes in shooting technique were analysed through changes in body kinematics (i.e. 3D angles of the ankle, knee, hip, shoulder, elbow and wrist, and the height of the centre of mass) and ball release parameters (i.e. height, velocity and angle of the ball at release) of 3PS in a dynamic playing condition.

Materials and Methods

Nine male basketball players (age: 16.2 ± 0.7 years; height: 1.97 ± 0.07 m; body mass: 87.7 ± 8 kg) all affiliated to the U18 squad of the basketball academy of the National team, volunteered to participate in this study. Each participant completed two basketball trials scheduled at least one week apart, in a random order, either euhydrated (EUH) or dehydrated (DEH, -2% of body mass). EUH and DEH were obtained following 60 min of light exercise (cycling at 90 ± 10W) in an environmental chamber set at 39°C with different hydration guidelines. After 10 min of rest and equipment with nanotechnology inertial measurement units (Xsens Technologies BV, Enschede, The Netherlands), participants undertook a basketball protocol consisting of a habitual warm-up followed by a series of 3PS in dynamic condition during which each participant was instructed to perform the maximum possible number of 3PS in 1 min.

The maximal and minimal positions of the centre of mass (CoM) were identified in order to calculate its vertical displacement. Then, ankle, knee, hip, shoulder, elbow and wrist angles for abduction/adduction, internal/external and flexion/extension angles of the joints on the side of the shooter were computed between the time when the CoM was at its lowest position (CoMmin), at toe-off time (Toe-off) and the time when the ball was released (CoMmax) (figure 1). Ball release parameters (speed, angle and height at ball release) were also estimated. Kinematic analysis was performed with the software provided by MVN Biomech and a customized MatLab™ software was used to calculate the elbow, trunk, knee, and ankle joint angles. The success rate at 3PS and rate of perceived exertion were also recorded during the protocol.

Paired t-tests were used to compare the variables of interest between conditions (EUH vs DEH). Effect sizes were also calculated using Cohen's d values, with values ≤ 0.2, 0.5, 0.8, and > 0.8 considered as trivial, small, medium and large effects, respectively. A P-value of 0.05 was considered to indicate significance.

Results

The success rate tended to decrease (*P*=0.16, *d*=0.65) for 7 players out of 9 following the dehydration protocol, from 51.2 ± 12.2% to 41.3 ± 18.3% in EUH and DEH conditions, respectively (figure 2). The number of throws per minute was not different (*P*=0.78, *d*=0.14) between DEH (10.7 ± 0.9) and EUH (10.8 ± 0.7) conditions, respectively. The rate of perceived exertion (RPE) at the end of the basketball protocol was significantly greater (*P*=0.003, *d*=1.50) in DEH condition (13.0 ± 2.5) compared to EUH condition (9.1 ± 2.6). At toe-off time, the knee angle was significantly increased (*P*=0.02, *d*=0.23) when dehydrated (DEH: 174.3 ± 5.5°) compared to euhydrated (EUH: 173.1±5.2°). The hip angle between CoMmax and CoMmin was also significantly lowered (*P*=0.01, *d*=0.60) in DEH condition (38.7 ± 12.0°) compared to EUH condition (45.1 ± 8.5°, figure 3). The position of CoM was not altered by dehydration at three key moments of 3PS. Only the speed of ball release tended to be increased (*P*=0.05, *d*=0.53) in DEH condition (7.82 ± 0.12m.s^{-1}) compared to EUH condition (7.76 ± 0.13m.s^{-1}).

Discussion and conclusion

The main results indicate a slight but non-significant decrease of performance in 3PS with a 2% dehydration status, accompanied with minor changes of body kinematics and ball release variables. These results suggest that the body kinematics engaged to perform a 3PS are robust enough in elite basketball players to maintain their ability to score despite a 2% dehydration. Similarly, several studies have reported a greater consistency of kinematic patterns of free throw shooters who had more playing experience compared to less trained players [3]. More recently, Verhoeven et al. [4] recently showed that among 25 college basketball players repeating 50 3PS, the poor shooters presented the largest CoM trajectory variations between shots compared to the best shooters. Another possible hypothesis to explain the absence of any alteration of the shooting technique is that our players were probably used to mild dehydration (~1-2% body mass loss) due to a combination of warm playing environments and chronic hypohydration [5]. In addition, the speed of ball release tended to be greater when dehydrated. Although, it is well accepted that a high ball release allows a lower movement velocity and release angle leading to a better accuracy [2], recent findings suggest that ball release parameters would not necessarily rely on specific patterns automated through practice. On contrary, ball release parameters would rather be highly variable and adaptable to the position of the body segments at shooting time [4]. According to these data, variance in ball release parameters might reflect a positive biomechanical adaptation in response to postural variance (i.e. knee and hip joint angles in the present study) to maintain the 3PS success rate.

In conclusion, the present data suggest that a 2% dehydration represents a tolerable level of dehydration to maintain performance and technique of 3PS in elite basketball players.

References

1. Baker LB, Dougherty KA, Chow M, Kenney WL. Progressive dehydration causes a progressive decline in basketball skill performance. Med Sci Sports Exerc. 2007 Jul;39(7):1114-23. PubMed PMID: 17596779. Epub 2007/06/29. eng.
2. Hamilton GR, Reinschmidt C. Optimal trajectory for the basketball free throw. J Sports Sci. 1997 Oct;15(5):491-504. PubMed PMID: 9386207. Epub 1998/01/10. eng.
3. Button C, MacLeod M, Sanders R, Coleman S. Examining movement variability in the basketball free-throw action at different skill levels. Res Q Exerc Sport. 2003 Sep;74(3):257-69. PubMed PMID: 14510290. Epub 2003/09/27. eng.
4. Verhoeven FM, Newell KM. Coordination and control of posture and ball release in basketball free-throw shooting. Hum Mov Sci. 2016 Oct;49:216-24. PubMed PMID: 27442763. Epub 2016/07/22. eng.

5. Osterberg KL, Horswill CA, Sperber T, Tedeschi F, Murray R. Fluid balance, hydration status, and sweat electrolyte concentrations in NBA basketball players during pre-season practice. Med Sci Sports Exerc. 2004;36((suppl)):S180.

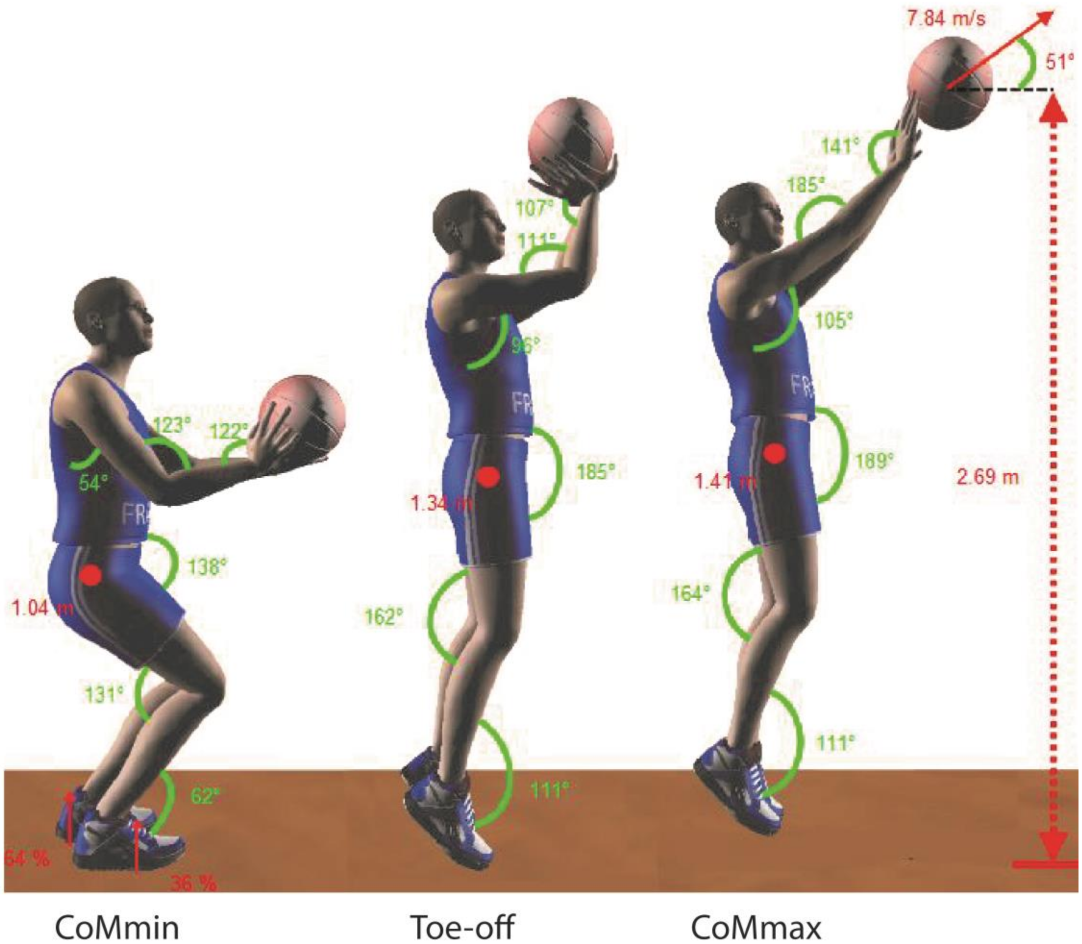

Figure 1: Joint angle orientations (**green lines**) for flexion/extension of all body joints and the position of the centre of mass (**red dot**) at the key time points of the 3PS.

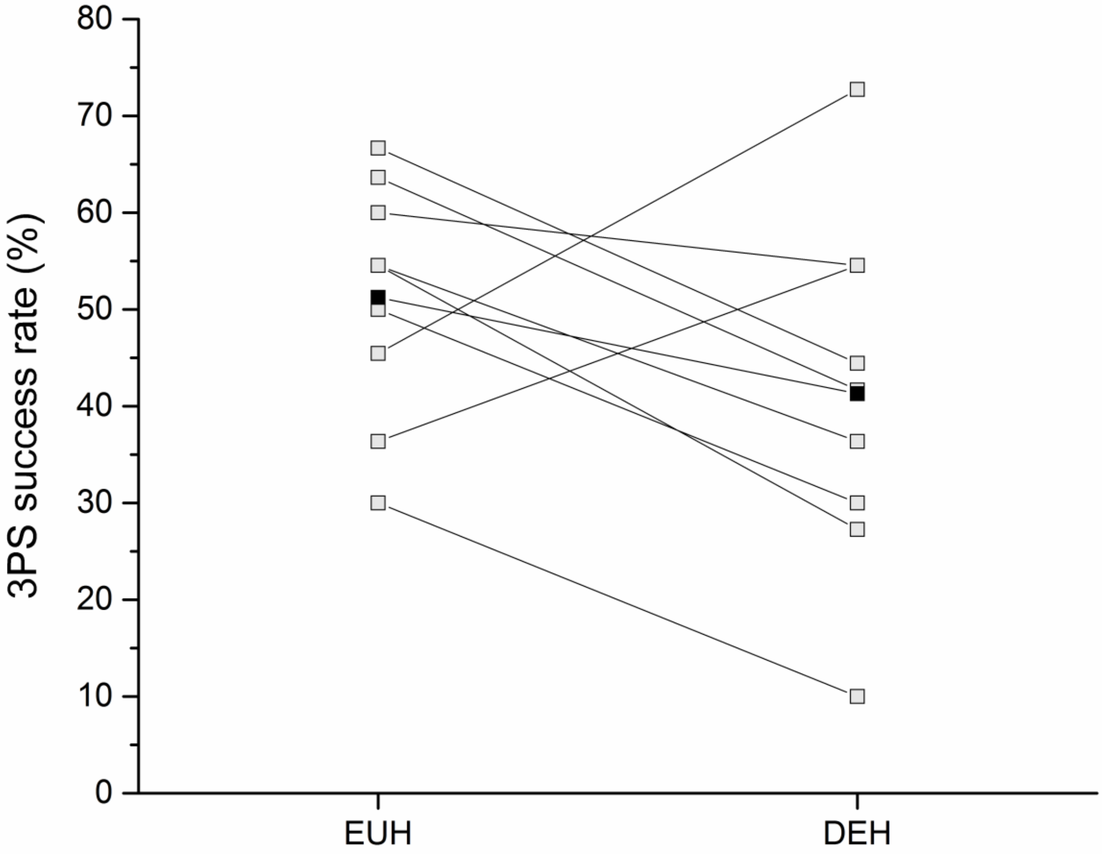

Figure 2: Mean (**black dots**) and individual (**white dots**) 3PS success rate in the EUH and DEH conditions.

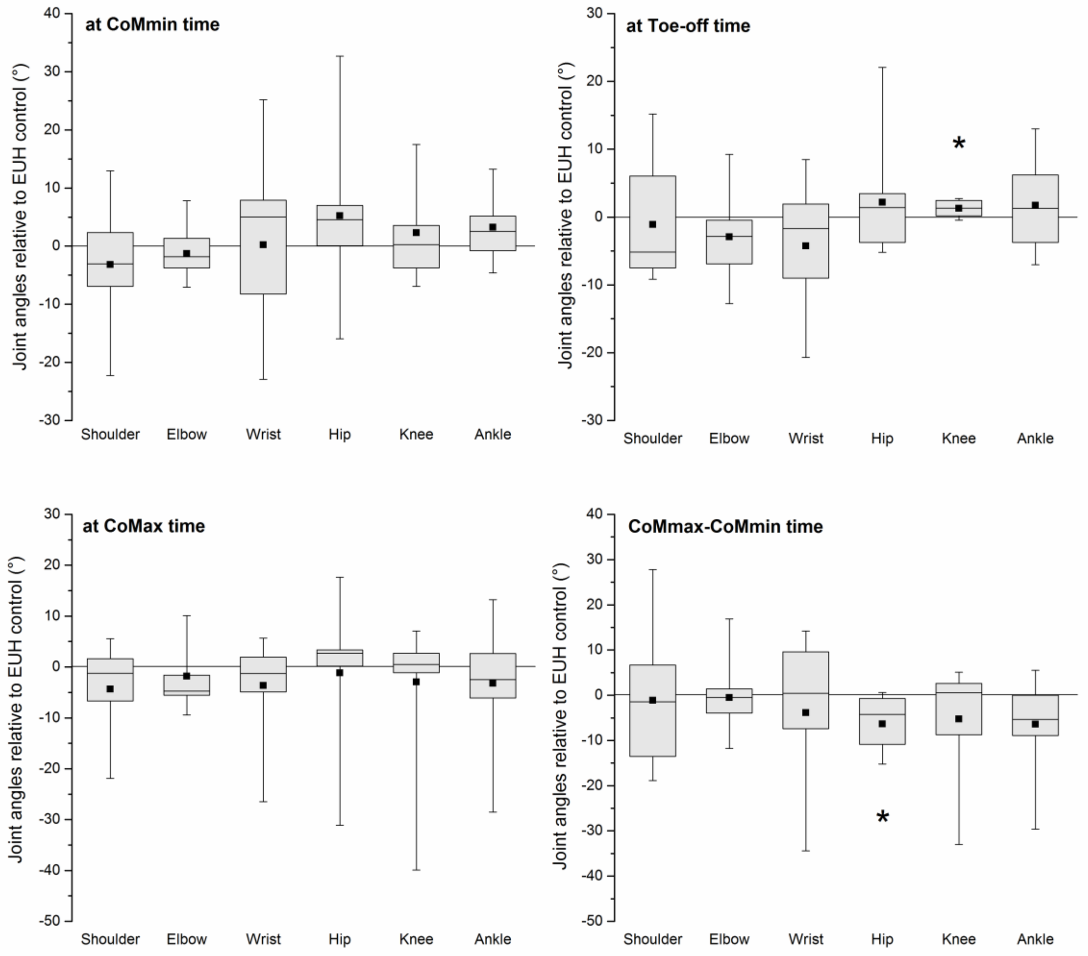

Figure 3: Box plots of joint angles changes at key time points of 3PS in DEH relative to EUH condition. The black square near the centre of each box represents the mean difference from EUH for each time point. * denotes a significant difference between EUH and DEH ($p < 0.05$).