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LETTER TO THE EDITOR

Call for Letters–Viewpoint: Technological Advances in Elite Sport: Should a Line be Drawn?

Footwear technology, running outputs, and technical performance in soccer match-play

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TO THE EDITOR: In response to Viewpoint by Wilkins and Joyner (1) on the potential need of setting limits for the impact of technological advances on performance in elite sports contexts, here we provide a brief critical overview of the evolution of soccer *1*) running/technical performance; *2*) footwear/foot-mounted monitoring systems, and *3*) possible relationship between performance and such technologies in elite soccer match-play and whether there is a need to set limits.

LONGITUDINAL CHANGES IN MATCH PERFORMANCE

Approximately 150,000 players (of both genders) currently compete at a professional level in soccer worldwide, whereas the total number of athletes playing organized football exceeds 40 million. Electronic performance and tracking systems (EPTS) have been often employed—especially at the elite standard—to monitor individual and collective indicators such as running speed and ball-passing networks. Reporting post-match EPTS-derived variables is a common practice, and it reaches many stakeholders and purposes (e.g., helping predict fatigue and training prescription).

The evolution of the soccer game is closely associated with increases in match physical and technical requirements—collected through EPTS—as evidenced by the rise in high-intensity running (2), total amount of occurrences, and effectiveness of ball passing (3). For example, running at high intensities increased 12–15% from the 2014/2015 to the 2018/2019 seasons of the English Premier League even with a roughly 20% increase already observed previously (2006–2013). Similar responses were also observed in women's soccer matches; the amount of sprinting increased by around 20–50% (2015–2019; https://digitalhub.fifa.com/m/4f40a98140d305e2/original/zijqly4oednqa5gffgaz-pdf.pdf). However, most studies examining evolutionary parameters in soccer match-play have predominantly focused on seasons predating the alteration of substitution rules (from 3 to 5 substitutions per match). Individual and contextual factors also influence performance. Moreover, what about the potential effect of updates in tracking systems/software on the time evolution of players' running/technical performance? Considering these factors while analyzing longitudinal changes in soccer performance is advisable.

EVOLUTION OF FOOTWEAR TECHNOLOGY

Substantial increases in running and technical performance across decades have been accompanied by changes in footwear design and, most recently, emergence/approval—by the governing body of association football—of foot-mounted monitoring systems. Indeed, there is evidence that footwear design may affect both running and ball-kicking outputs (e.g., sprinting and accuracy/velocity). To exemplify, the greater the smoothness/uniformity of the upper part of the cleat, the better the kicking accuracy attained while one model with higher traction provided superior kicking velocity. In terms of running aspects, bladed studs/with regular length favored faster sprinting as compared with elliptic/shortened studs (4).

Another aspect that potentially would impact players' future game-play running and notably technical performance refers to the new technological monitoring systems that can be attached to the foot (https://www.nytimes.com/athletic/4881313/2023/09/20/wearable-lower-limb-tracking-system/). This type of technology (i.e., wearable) has been recognized for its potential to provide on-field (bio)feedback. In fact, data collection of kinematics aspects of ball-kicking has been historically linked to intense offline processing of video-based data, and the new wearable solutions can help solve this problem. However, although this EPTS approach is already widespread in elite soccer in various locations,

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particularly in Europe, from our viewpoint, the validity of the commercially available devices is yet to be systematically examined in research, especially concerning ball-kicking measures. From an initial search, only a few studies have been found [e.g., in elite soccer (5)]. It seems that using controlled experimental conditions as opposed to games has often been used in validation experiments, generally also conducted with relatively low sample sizes.

FOOTWEAR TECHNOLOGY AND MATCH PERFORMANCE IN CURRENT ELITE SOCCER: IS THERE A CONNECTION AND NEED TO SETTING LIMITS?

To conclude, it is not uncommon for elite players to wear their individually chosen cleats. This fact can render it challenging to actually measure the association that may exist between footwear and match performance responses. Although certain footwear construction features have been reported as directly related to enhanced performance, it is crucial not to overlook the risk of injury parameters as well. Of note, none of the supporting studies mentioned in the section "EVOLUTION OF FOOTWEAR TECHNOLOGY" were conducted with samples of female players, potentially limiting the generalizability of the current research on this area. Indeed, according to one of the latest reviews available on the subject—to the extent of our knowledge—there is still lacking precise benchmark values for each characteristic of footwear property (4).

With the advent of foot-mounted wearables (and artificial intelligence-assisted markerless motion capture systems), it may become possible to quickly obtain tracking data during official matches—and consequently feedback—on various skill-related performance components. Current rules of the game allow delivering information and data to the technical area during competition in elite soccer. On the contrary, we reinforce that the validation of the newest EPTS technologies should be carefully evaluated and results made publicly available, i.e., strong evidence is required before its implementation in practice. It is yet to be investigated also the impact that such technological advances may have on game running and technical outputs and whether establishing a limit is necessary.

Finally, the present authors do not believe that technology in footwear that prevents injuries or helps monitor the athlete should always face barriers. However, technology that provides a significant advantage to the point of being considered doping will certainly have limits imposed. The issue of "techno-doping" is becoming increasingly relevant in the context of elite sports. Specifically, propulsion technology in footwear may provide a substantial advantage in athletic performance (e.g., jump height, running speed, and energy/movement efficiency). Studies on runners have already demonstrated significant advancements, and it is likely only a matter of time before these technologies reach soccer. For example, running shoes with carbon plates have demonstrated increased runner performance, and a similar application in soccer cleats could substantially impact player performance. Therefore, it is essential to consider if the implementation of limits and regulations for footwear technologies is necessary to preserve fairness and integrity in the sport, based as for example in research with appropriate study design.

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DISCLOSURES

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AUTHOR CONTRIBUTIONS

L.H.P.V., P.R.P.S., and R.A. conceived and designed research; L.H.P.V, P.R.P.S., and R.A. drafted manuscript; L.H.P.V., P.R.P.S., and R.A. edited and revised manuscript; L.H.P.V., P.R.P.S., and R.A. approved final version of manuscript.

REFERENCES

1. **Wilkins BW**, **Joyner MJ.** Technological advances in elite sport: Should a line be drawn? *J Appl Physiol (1985)*. doi:10.1152/japplphysiol.00329.2024.
2. **Allen T**, **Taberner M**, **Zhilkin M**, **Rhodes D.** Running more than before? The evolution of running load demands in the English Premier League. *Int J Sports Sci Coach* 19: 779–787, 2024. doi:10.1177/17479541231164507.
3. **Barnes C**, **Archer DT**, **Hogg B**, **Bush M**, **Bradley PS.** The evolution of physical and technical performance parameters in the English Premier League. *Int J Sports Med* 35: 1095–1100, 2014. doi:10.1055/s-0034-1375695.
4. **Kulessa DJ**, **Gollhofer A**, **Gehring D.** The influence of football shoe characteristics on athletic performance and injury risk – a review. *Footwear Sci* 9: 49–63, 2017. doi:10.1080/19424280.2017.1284273.
5. **Lewis G**, **Towlson C**, **Roversi P**, **Domogalla C**, **Herrington L**, **Barrett S.** Quantifying volume and high-speed technical actions of professional soccer players using foot-mounted inertial measurement units. *PLoS One* 17: e0263518, 2022. doi:10.1371/journal.pone.0263518.