Original research article

International Journal of Sports Science & Coaching

International Journal of Sports Science & Coaching
1–9

DOI: 10.1177/17479541241289078
journals.sagepub.com/home/spo

Sage

Football referees issue more yellow cards following VAR interventions – mental, tactical, and performance considerations

Roy David Samuel[1], Yair Galily[2], Chris Englert[3], and Itay Basevitch[4]

Abstract

VAR (video assistant referee) presents a human-technology interface that was designed to improve referees' ability to make accurate decisions in key match incidents. VAR interventions are pivotal moments in football matches, challenging referees' critical decisions and potentially affecting their perceived ability to manage the game. This study aimed to investigate how referees handle VAR interventions in terms of game management and control. Through statistical analyses, we examined 120 real-match VAR interventions in penalty incidents from the Israeli Premier League, focusing on the number of fouls and yellow cards before and after the VAR interventions. Our findings revealed a significant impact ($d = 0.40$) on yellow cards but not on fouls. Remarkably, referees issued twice the number of yellow cards (normalized per playing minute) following a VAR intervention, irrespective of the time it occurred during the match (i.e., first or second half). These results are discussed within the framework of current research and theories concerning self-control and game management in football refereeing. The increased issuance of yellow cards following VAR interventions suggests that teams may be at a higher risk of receiving disciplinary actions, which can potentially impact their performance and increase the likelihood of losing matches. Consequently, we provide practical recommendations for referee training and match preparation as well as for teams.

Keywords

Decision making, game management, officiating, soccer, technology, video assistant referee

The video assistant referee (VAR) is a technological system that includes a human factor (i.e., the video referee and assistant referee, the operator), a technological factor (the video system, the audio system), a human–technological interface,[1] and a social–ethical factor (e.g., referee team dynamics, perceptions of fairness and justice).[2] Its introduction in 2018, therefore, presented considerable modifications in the way referees train, prepare for, and officiate matches[3,4] and in refereeing psychology.[5] The present study focuses on the influence of a VAR intervention on referees' subsequent decision-making, specifically regarding their application of game management in terms of foul and yellow card decisions.

Research indicates that the inclusion of VAR into football refereeing has influenced the game in terms of referee decision prevalence and accuracy as well as playing time.[6,7] For example, the introduction of VAR into the German Bundesliga and Italian Serie A resulted in more time being added in the first half of games, as well as a reduced number of offside calls, fouls, and yellow cards.[8] In the Chinese Super League, the introduction of VAR resulted in a significant reduction in the number of offsides and fouls, a significant increase in the playing time in the

Reviewer: Robin Schroedter (German Sport University Cologne, Germany)

[1]Baruch Ivcher School of Psychology, Reichman University, Herzliya, Israel
[2]Sammy Ofer School of Communications, Reichman University, Herzliya, Israel
[3]Department of Sports Sciences, Goethe University Frankfurt, Frankfurt am Main, Germany
[4]Health And Kinesiology, Texas A&M University-Kingsville, Kingsville, TX, USA

Corresponding author:
Roy David Samuel, Baruch Ivcher School of Psychology, Reichman University, 8 Ha'universuta St., P.O. Box 167, Herzliya, 4610101, Israel.
Email: roydsamuel@gmail.com

first and second halves and the total playing time, and a slight decrease in the home team advantage.[9] Moreover, a study that examined the match physical demands in the Spanish La Liga found that the players' total distance and relative total distance significantly decreased in seasons with VAR compared to seasons without VAR, while other aspects of the match, such as sprints did not change significantly.[10]

In addition, Errekagorri and colleagues specifically evaluated the influence of VAR interventions on the game in the Spanish La Liga during the 2018–19 season (a total of 375 matches). They found an increase in the number of goals (1.2 vs. 1.5 vs. 1.7) comparing matches with no intervention to matches with single or multiple interventions and a slight decrease in the total distance covered by the players in matches with interventions. Unlike the previous studies that found a general decrease in the average number of foul and yellow card decisions per match as a result of the introduction of the VAR, this study did not find a change in foul decisions in matches with a VAR intervention (13.5 ± 4.0 vs. 13.5 ± 4.0 average fouls per match, for matches without and with one VAR intervention, respectively). The authors concluded that the VAR's intervention during a match only had a marginal effect on team play both on a technical-tactical and physical level.[11]

Indeed, the implementation of VAR has marked a significant milestone in football's history, and it is expected that individuals would need time to fully comprehend and embrace its influence. In recent years our focus has been on fostering understanding and appreciation for technology and its practical applications. Consequently, there has been a notable increase in global awareness regarding the VAR process, leading to greater acceptance among players, coaches, fans, and the media. Nonetheless, we acknowledge that there is room for further enhancements, as continuous improvement remains a priority.

VAR interventions, game management, and self-control

A VAR intervention may occur only in the event of a "clear and obvious error" or "serious missed incident" in relation to (a) goal/no goal, (b) penalty/no penalty, (c) direct red card, or (d) mistaken identity. The on-field referee must always make a decision and is not permitted to give "no decision" and then use the VAR to make the decision. Also, whereas the VAR can only *recommend* initiating a review, only the on-field referee can initiate an on-field review, and in any case, the final decision is always taken by the referee who can either maintain or modify the original on-field decision.[12] Still, it should be noted that in many cases, VAR interventions are initiated concerning match events that are debatable. For example, it was reported that in the first part of the 2022–2023 English Premier League season, the VAR was incorrect in six out of 48 interventions, which reflects an error rate of 12.5%.[13]

Therefore, a VAR intervention is an event that has a high potential of changing the match status in terms of the score or the teams' lineups, and thus it is a moment during the match that can be associated with an increase in players' emotionality (e.g., aggression). Also, a VAR intervention can contest the referee's objective and subjective control over the match when his or her decision is either challenged or ultimately modified.[14,15] Therefore, it is possible that following a VAR intervention, the referee would tend to call out more fouls and/or issue more yellow cards in order to reestablish a sense of control over the match (e.g., reducing the players' aggression). Moreover, the referee might also need to recalibrate the decision-making scale to achieve accuracy in dynamic match conditions.

One of the ways by which referees tend to control the match is through game management.[16,17] Expert referees tend to make decisions that are specifically appropriate for the match, allowing it to flow and intervening only when the consequences of not doing so may adversely affect the game.[18] Within this context, Unkelbach and Memmert attempted to explain why referees tend to issue more yellow cards later in the match compared with the beginning of the match. In two experiments they have shown that the referees used both calibration of the fouls' scale and deliberate game management in their issuance of yellow cards.[17]

Another study added to this line of work by investigating referees' perceptions about their use of decision-making strategies. It revealed that decision-making actions were used strategically to maintain control of the game and to preserve the integrity of the game, through four "pillars" of the game – safety, fairness, accuracy, and entertainment – which varied in importance depending on the state and context of the game.[19] These pillars reflect the game management aspect of refereeing, as the correctness of a decision by itself is not sufficient to be accepted by the teams and fans. So, for example, a yellow card issuance might not only relate to making an "accurate" decision but is also, as a game management technique, related to the referee's aim to avoid other unwanted outcomes in the match.

Recently, two models were suggested in an attempt to account for how referees balance their decisions and the management of the match. The threshold process model for decision-making in sports games considers the importance of context in refereeing (e.g., the score, the time of play) as well as individual differences among referees in rule application (e.g., a "law enforcer" referee vs. a "game manager" referee). If game dynamics require a stricter application of the rules, then the referee is under the threshold of applying game management. However, as soon as a subjective threshold is met, referees apply game management to either let the game flow (e.g., less stoppage

of the match) or if aggression increases – make a call earlier (e.g., using preventive refereeing or an earlier foul call).[16] Next, the decision-flow model consists of three stages: (1) The referee's fast, intuitive decision after a situation, (2) the referee's slow, deliberative evaluation of the decision, and (3) the chosen compensation if, in retrospect, the previous decision is considered an error by the referee. According to this framework, if the referee decides to compensate with consistency, the calibration of the judgment scale must be adjusted, and by doing this, the game manager consciously influences future intuitive decisions.[20]

In addition to the game management approach, we must consider the role of self-control and mental fatigue in referees' decision-making.[21,22] In this context, self-control can be defined as a deliberate attempt to volitionally override dominant response tendencies in order to achieve specific, desirable outcomes.[23] Previous research has reliably shown that exerting control over the self is a rather aversive act that can ultimately lead to increased perceptions of mental fatigue.[24] Mental fatigue is a psychobiological state that is characterized by increased feelings of tiredness, lack of energy, decreased motivation as well as declines in performance.[25] Samuel and colleagues suggested that a VAR intervention might challenge the referee's self-efficacy and self-control, as they are facing a dilemma of whether to change or maintain their original on-field decision.[26] Recently, it has been shown that VAR interventions are associated with higher levels of post-match self-reported mental fatigue and lower self-reported match performance evaluations.[22] Within this context, a recent review article modeled the attention allocation of elite referees under normal and demanding match conditions, using attentional control theory: sport (ACTS) and dual-processing frameworks.[15] A VAR intervention can potentially increase the match demands for referees as well as players, and thus lead to changes in their attention allocation. According to ACTS, referees will shift from top-down, goal-directed, attentional processing, to bottom-up environmental-driven processing following a VAR intervention (e.g., paying more attention to their own arousal levels and to players' dissent), and this can influence their on-field behaviors. ACTS further suggests that inefficient attentional control is sporadic and is most likely to occur at those moments in the match associated with the highest levels of anxiety (e.g., immediately after making a wrong critical decision that is overturned by the VAR).[27] Likewise, players might also shift to bottom-up processing in case they feel threatened by the intervention, which can explain frustration-related responses.

Dual-processing theories would suggest that following a VAR intervention, referees' habitual behaviors (e.g., running, signaling) become less automatic and require more attention capacity (i.e., higher dependency on Type 2 processing).[28] This comes at the expense of attention reserve directed at both gazing behavior and internal processes. The referee may be less efficient in field positioning, gaze behavior to identify match infringements, and communication with the players and the referee team. Also, the referee may become less anticipative of potential match infringements and consequently less accurate in DM. Moreover, less attention is allocated to game-management tasks as the referee is attempting to maintain sufficient attention for the primary DM task. These effects may ultimately result in reduced performance.[29]

Therefore, it is possible that a VAR intervention psychologically influences referees by potentially necessitating them to resume exerting self-control as well as match control through active decision-making, such as calling out more fouls or issuing more yellow cards, which might ultimately lead to higher levels of mental fatigue.[22] It is unclear, though, whether this process is an active attempt to regain a sense of control or rather a passive behavior that reflects a reduced ability to control the impulse to call more fouls and/or issue yellow cards.

As for the match outcome, the issuance of yellow cards may reduce the probability of winning during the course of a match. Fouls can disrupt the flow of the game and disrupt the attacking tactics of the opposing team, potentially benefiting the fouling team in terms of match success. Yet, it is important to note that fouls resulting in yellow cards have a negative impact on match success, which is consistent with previous studies[30] that have shown unsuccessful teams receiving a larger number of yellow cards in prestigious competitions. One possible explanation for this phenomenon is that a yellow card often precedes a red card, which can lead to a more cautious playing style after receiving the yellow card. The accumulation of yellow cards can have a particularly negative effect, especially if a player is sent off toward the end of the match.

Research objectives and hypotheses

To the best of our knowledge, no studies have explored how referees adjust their decision-making behavior in response to a VAR intervention. While previous studies on the introduction of the VAR system reported a general decrease in the average number of foul and yellow card decisions per match, it has also been shown that matches with a VAR intervention were not associated with fewer foul decisions.[11] As foul and yellow card decisions reflect referees' ability to control the match, through the application of game-management strategies, it is important to evaluate the potential effects of a VAR intervention on these decisions. Thus, our aim was to investigate whether referees modify their decision-making following a VAR intervention, specifically focusing on yellow card and foul decisions. We hypothesized that following a VAR intervention, referees would (1) increase the issuance of yellow cards and (2) elevate their frequency of foul decisions.

Methods

Study design

We examined whether VAR interventions in potential penalty incidents were related to changes in the frequency of foul and yellow card decisions (i.e., pre- and post-VAR intervention). We focused on penalty incidents for two main reasons. First, we wished to reduce potential moderating effects related to the inclusion of different types of VAR interventions (e.g., red cards). Secondly, penalty incidents typically reflect "a grey" territory of decision-making where there might be some discrepancy between the interpretations of the VAR and the on-field referee.[14,31] Unlike other potential VAR interventions that are more strongly related to factual information (e.g., offsides), penalties are mostly related to the referee's interpretation of the violation in relation to law criteria. When referees decide on a penalty and are overruled by the VAR, or alternatively when they do not identify or whistle a penalty and are corrected by the VAR, their authority over the players and coaches, their self-efficacy, and their attention might be obscured. Therefore, these incidents might be associated with a need for the referee to resume perceived control as well as control over the match, through foul calling and/or yellow card issuing.

Dataset and analysis

We used the "Refs." platform by SportsMetrix to analyze VAR interventions related to potential penalty incidents that occurred in the Israeli Premier League (Ligat Ha'Al) in the 2019–2020, 2020–2021, and 2021–2022 seasons. Refs is an innovative, video-based, online platform designed especially for (and with) referee organizations for reviewing and guidance. The system allows quick and professional reviews of referees' performances. It includes referee decisions during matches with direct links to the video for quick observation of those decisions. Additional options of creating clips, sharing, and in-house discussions, make it a "complete" system for reviewing as well as an educational tool. The Refs platform reviews the match and tags all main decisions. Thus, it allows the researcher to efficiently review the match, including VAR interventions, and then focus on other selected events, such as foul decisions and card bookings.

We gathered a total of 120 penalty-related incidents during the span of three seasons for our analyses. To ensure data integrity, we excluded interventions that took place within the first 1–2 minutes or the 90th minute of the match, considering them as outliers due to the absence of preceding or subsequent match incidents. Additionally, we removed second interventions within the same match to maintain data independence. Likewise, interventions related to factual information (i.e., in or out of the penalty zone) were excluded. This resulted in 94 VAR interventions in penalty incidents, all with on-field reviews.

To account for the fact that interventions occurred at different playing times during each match, we normalized the number of foul decisions as well as yellow cards per playing minute. So, for example, if there were 10 foul decisions called by the referee in the 30 minutes prior to a VAR intervention, we calculated $10/30 = 0.33$. We examined in each match the actual playing time, removing the time of the VAR intervention itself (i.e., the VAR check and the on-field review) and adding any extra time given. Also, we included only actual decisions called by the referee (i.e., fouls or yellow cards), not events that the referee perhaps needed to call and did not. Thus, our data accurately reflected the match occurrence. To compare the decisions pre- and post-VAR interventions we used paired-sample t-tests and effect size.

Results

The results of the analyses are summarized in Table 1. As shown, on average the referees called 20.85 ($SD = 5.16$) fouls and issued 5.46 ($SD = 2.21$) yellow cards per match. Based on the official data retrieved from the Israel Football Association's website, the average number of yellow cards per the 2019–2020, 2020–2021, and 2021–2022 seasons was 4.7, 4.7, and 5.0, respectively. Thus, descriptively during matches with a VAR intervention, the referees tended to issue an additional yellow card.

Concerning our main objective, on average the referees issued twice the number of yellow cards per playing time following the VAR interventions ($M = 0.08$, $SD = 0.14$) than prior to it ($M = 0.04$, $SD = 0.03$). This difference was statistically significant, $t(93) = -2.91$, $p = .004$, $d = 0.40$. We further examined whether this effect was maintained when analyzing the data separately for VAR interventions occurring in the first or second half of the match. Concerning the data for the VAR interventions occurring in the first half of the match ($n = 53$), a similar effect was

Table 1. Foul and yellow card decisions in total and pre- and post-VAR interventions in penalty incidents over 94 matches.

Decision Type	Range per match	Total per match (*M*, *SD*)	Pre-Intervention*	Post-Intervention*	Diff. (*p*)
Foul	8–36	20.85 (5.16)	0.23 (0.12)	0.20 (0.08)	0.056
Yellow Card	1–11	5.46 (2.21)	0.04 (0.03)	0.08 (0.14)	0.004**

* The number of foul decisions yellow cards were normalized per playing minute.
** $p < .01$.

evident: the referees issued almost twice as many yellow cards following the VAR interventions ($M = 0.063$; $SD = 0.03$) than prior to it ($M = 0.036$; $SD = 0.04$), $t(52) = -3.91$, $p = .001$, $d = 0.79$. Likewise, the data for the VAR interventions occurring in the second half of the match ($n = 41$) indicated that the referees issued more than twice as many yellow cards following the VAR interventions ($M = 0.11$; $SD = 0.20$) than prior to it ($M = 0.05$; $SD = 0.02$), although this effect did not reach statistical significance, $t(40) = -1.99$, $p = .053$, $d = 0.46$. Together with the other significant results, the hypothesis regarding the increase in yellow card issuance following a VAR intervention, can be interpreted as confirmed, as can be seen in Figure 1.

Regarding foul decisions, as shown in Table 1, the data indicated a minor decrease in the average number of fouls per playing time called by referees prior to ($M = 0.23$; $SD = 0.12$) and following ($M = 0.20$; $SD = 0.08$) a VAR intervention. However, this difference did not reach statistical significance, $t(93) = 1.94$, $p = .056$, $d = 0.27$. Consequently, our second hypothesis was not substantiated by the findings.

Discussion

VAR presents a human-technology interface that was designed to improve referees' ability to make accurate decisions in key match incidents.[14] A review of the literature regarding the use of technological officiating aids in various game sports identified seven major issues: the underlying phenomena, usage patterns, accuracy, standard of review, influence on the nature of the game, material as well as immaterial costs, and the amount of authority that is granted to the officiating aid.[32] It could be argued that VAR is a technological aid with important ramifications for all these dimensions. In this study, we focused on how VAR might influence referees' mentality and behavior as manifested in foul and yellow card decisions, thereby tapping into this unique human-technology interface.

The current findings indicate that referees in the Israeli Premier League tended to issue significantly more yellow cards following a VAR intervention (i.e., twice the number per match). Such an effect was not evident in foul decisions. Also, the referees tended to issue more yellow cards during these matches compared with the seasonal average. These findings could be interpreted to support the notion that referees issue more yellow cards to reestablish their control over the match, and their own perceived control following a VAR intervention. As yellow card decisions are within the referee's own judgment, and cannot be challenged by the VAR, these decisions reflect an area of the match by which referees can regain control over the match. Interestingly, the data indicated that referees do not use a similar mechanism via normal foul decisions. Perhaps these types of decisions are more common throughout the match and thus do not necessarily allow the referee to regain a sense of control. In this context, previous studies found a general decrease in foul decisions upon the introduction of VAR.[8,9] However, a study that specifically examined the influence

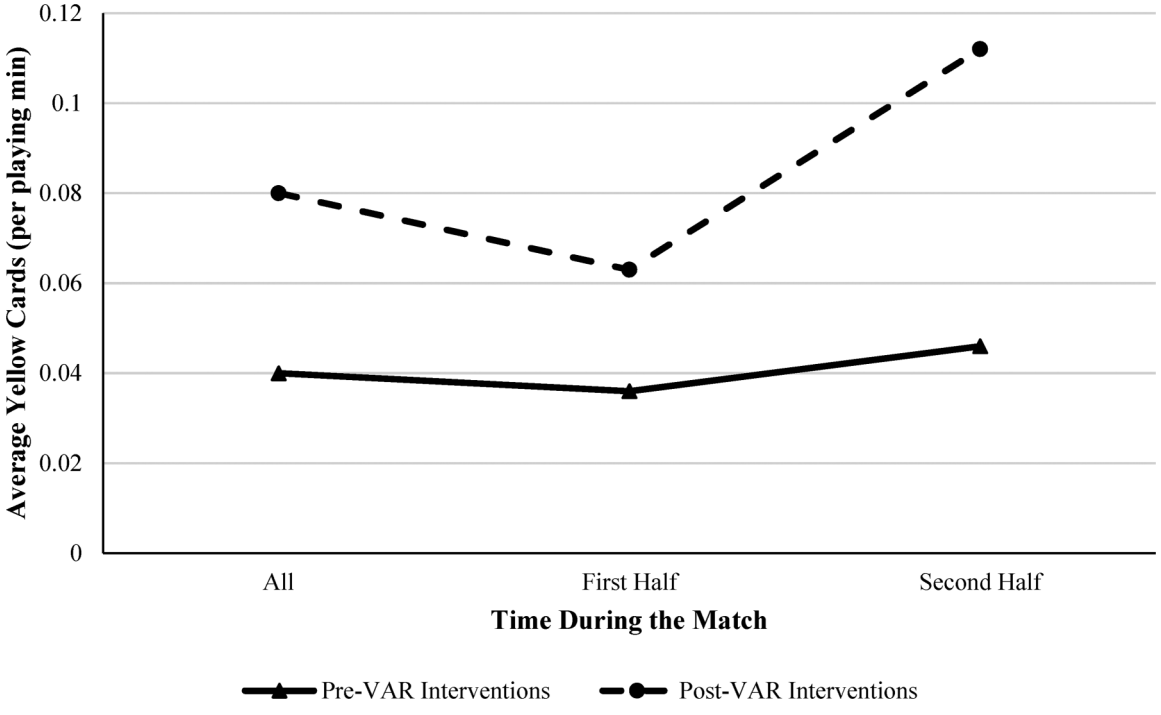

Figure 1. The effect of VAR interventions on average yellow cards (per playing minute).

of VAR interventions on Spanish La Liga matches did not find a significant change in the average number of fouls per match.[11] Therefore, our prediction concerning foul decisions was not supported by the data. It can be concluded that the data from the Spanish La Liga and the Israeli Premier League suggest that a VAR intervention is not associated with increased foul decisions.

Our findings are in line with previous research on game management in football refereeing.[16,17,19] Specifically, Unkelbach and Memmert have shown that yellow card decisions reflect two parallel processes. First, the referees need to calibrate an internal judgment scale that measures whether a foul *actually* falls into the category "yellow card," using a rather automatic process, and depending on rule criteria. Second, the referees are deliberately postponing the issuance of yellow cards early in the match to be able to maintain this option in their arsenal for the more challenging later parts of the match. Their decisions depend on the context of the match, the specifics of the situation, and what is deemed best for an optimal flow of the match.[17] A VAR intervention is an event that can significantly impact the match, and potentially lead to changes in the players' behaviors. According to ACTS, in the moments following a VAR intervention, the players might shift to bottom-up processing potentially leading to frustration-related responses.[15,27] Therefore, upon a VAR intervention, the referees may use both processes suggested by Unkelbach and Memmert. Likewise, Raab and colleagues suggested that referees shift their threshold level between game management and rule application.[16] Upon a VAR intervention, referees might shift to game management and thus issue more yellow cards to resume their control over the players, even at the expense of accuracy.

However, there might be alternative explanations for the study findings. First, we assume that VAR interventions are associated with higher levels of mental fatigue.[22] In such cases, it might become more and more difficult to deliberately inhibit the tendency to issue yellow cards following a VAR intervention. Research on the effects of mental fatigue on the decision-making process supports this assumption, as mentally fatigued individuals' decisions are primarily caused by automatic processes.[33] Within this context, a recent study found that Israeli elite referees' mental fatigue levels increased gradually as the match developed (an effect that was intensified when a VAR intervention occurred).[22] It is, therefore, possible that as the match develops, referees might be more mentally fatigued and thus divert less attention to game management through active communication with the players and proactive behavior.[15] However, since we did not examine these postulations in this study, they are speculative and necessitate further examination through more controlled designs.

Another alternative explanation of the findings is that the match might be heated following a VAR intervention and this is why the referees tend to issue more yellow cards. However, the data concerning fouls did not support this notion, as the referees did not call more fouls following the intervention. An additional alternative explanation for our findings is that referees tend to issue fewer yellow cards at the beginning of the match. Examining six seasons of the German Bundesliga (1836 matches), Memmert and colleagues found that only 606 yellow cards were awarded in the first 1–15 min, whereas for the 16–30, 31–45, 46–60, 61–75, and 75–90 min blocks, 1,175, 1,397, 1,250, 1,453, and 1505 yellow cards were awarded, respectively.[34] Therefore, to establish the effect in the present study, we took two measures. First, we normalized the number of foul and yellow card decisions per playing minute, and we manually considered the real playing times of each match (i.e., including extra time and excluding VAR checking times). Second, we established that this effect occurs in both halves of the match. We believe that by applying these measures, our findings are more robust. Finally, changing game dynamics caused by the VAR intervention outcome (penalty/no penalty) is also a plausible alternative explanation for the increase in yellow card calls. Specifically, the potential impact of these changes in match status on the tactical playing style of a team could result in more open space for the opponent and necessitate a higher number of tactical fouls (thereby increasing the number of yellow card calls). It should be noted, however, that a study conducted in the Spanish La Liga did not find tactical effects of VAR interventions.[11]

Practical recommendations and study limitations

The current findings present some practical implications for referees, referee organizations, and teams. Specifically, referees should be provided with information on the effects of VAR interventions on their decision-making, so they can maintain appropriate game-management strategies.[35] Referees must be aware of the potential influence of a VAR intervention on their tendency to issue more yellow cards and establish additional effective ways to maintain their authority, such as through communication[36] and effective teamwork.[37] Furthermore, training protocols for referees should mimic game situations and conditions (perhaps through the use of virtual reality),[38] including VAR interventions, so that they can prepare and improve their self-control skills (e.g., self-talk) throughout a match, regardless of whether there was a VAR intervention or not.[15,39]

Moreover, teams should be aware of referees' tendency to issue more yellow cards following a VAR intervention and be conscious of their own on-field actions. Yellow cards might be costly for players both monetarily (i.e., fines) and professionally (i.e., being suspended from the current match or from future matches). For example, in the English Premier League teams are fined £25,000 if

they receive six or more yellow cards during a single match. In addition, receiving yellow cards might also influence the match score. A study that examined 1826 matches in the top five European leagues reported that the number of players that have been cautioned with a yellow card had a slight effect on the scoring rate.[30] Specifically, teams with a larger number of booked players have a lower scoring rate when they are winning. Since the first yellow card is a precursor to a second booking, the effect of yellow cards could be indirect.[30] Teams that adapt to the influence of VAR interventions and effectively manage their behavior in response to increased yellow card issuance may gain a competitive advantage. This highlights the importance of player discipline and strategic decision-making in light of VAR interventions. Coaches and teams should analyze the patterns and tendencies of referees in relation to VAR interventions to better understand how these interventions might affect their opponents and devise effective game plans accordingly. Indeed, referees need to be aware of the potential psychological impact of VAR interventions on players and strive to maintain consistency and fairness in their decision-making to ensure a level playing field.

There are several limitations that need to be considered. First, we focused on the Israeli league and not on additional leagues. It is possible that referees in other leagues exhibit different decision-making behaviors following VAR interventions due to professional skills and contextual factors. Second, we did not compare our sample of matches to equivalent matches without VAR interventions to see if referees tend to issue more yellow cards as the match develops. One of the shortcomings of using real match data is the difficulty in having a control group and a comparison to other data. Finally, we did not analyze the types of yellow cards issued in each match to examine for potential trends; for example, if referees tend to issue more game-management-related cards (i.e., for players' dissent) or reckless foul-related cards. In this regard, a more detailed analysis, incorporating additional factors such as the reason for the yellow card, the average deviation between the referees' call and the objectively correct call, or a comparison between games with and without VAR intervention, is needed. These issues, therefore, call for additional research with other populations and a more comprehensive dataset.

Conclusions

Our study represents the first examination of the impact of VAR interventions on football referees' decision-making. The results revealed a significant increase in the number of yellow cards issued by referees following a VAR intervention. Notably, this effect was observed consistently in both halves of the match. Regarding foul decisions, our data suggested a non-significant minor decrease in the average number of foul decisions following VAR interventions. Our findings suggest that referees may have adopted a game management approach by utilizing increased yellow card issuance to regain control of the match. This aligns with existing knowledge on game management in refereeing, as highlighted by previous research.[16,17] Alternatively, we can claim that the referees somewhat experienced a reduced ability to control their tendency to issue yellow cards following a VAR intervention and this would be in line with what we know about mental fatigue processes in sports.[22] As the referees did not call out more fouls following a VAR intervention, it seems that a game management deliberate approach (i.e., they consider the use of yellow cards, and not calling fouls in general, to establish control) is more supported. Still, alternative explanations for this effect must be acknowledged, particularly the potential changes in game dynamics that necessitate issuing more yellow cards.

Furthermore, the study's insights can be useful for teams and coaches in their preparations for high-stakes matches and championships, as they can develop strategies to exploit the potential influence of VAR interventions or mitigate their impact on their team's performance. Overall, the study underscores the significance of VAR interventions in determining the outcome of games and later championships, emphasizing the need for teams, coaches, and referees to adapt and respond effectively to the challenges posed by these interventions to maximize their chances of success.

While the impact of VAR on match dynamics has been observed, further research is necessary to delve into the underlying mechanism and understand why referees tend to issue more yellow cards following a VAR intervention. It is crucial to employ experimental designs that can effectively control for potential factors and establish causal relationships. Such studies would contribute to a deeper understanding of the relationship between VAR interventions and the subsequent increase in yellow cards. Such a deeper understanding will not only enhance our knowledge of the relationship between VAR and yellow card issuance but also inform referee training programs and match preparation strategies to optimize game management and control.

Acknowledgments

The authors would like to thank the Referee Association in the Israel Football Association and SportsMetrix for their support of data collection.

Author's note

Itay Basevitch is currently affiliated with College of Health and Wellness, Barry University, Miami, FL, USA.

Data availability

Due to the nature of the research, due to ethical and commercial restrictions, supporting data is not available.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Roy David Samuel https://orcid.org/0000-0001-9914-3754

References

1. Sánchez Cid M and García-García AL. The interaction between audio and the video assistant referee in football. In: M Armenteros, AJ Benítez and AM Betancor (eds) *The use of video technologies in refereeing football and other sports*. New York, NY: Routledge, 2020, pp.70–85.
2. de Dios Crespo J. The contributions of VARs to fairness in sport. In: M Armenteros, AJ Benítez and AM Betancor (eds) *The use of video technologies in refereeing football and other sports*. New York, NY: Routledge, 2020, pp.23–35.
3. Armenteros M and Webb T. Educating international football referees: the importance of uniformity. In: M Armenteros, AJ Benítez and AM Betancor (eds) *The use of video technologies in refereeing football and other sports*. New York, NY: Routledge, 2020, pp.301–327.
4. Fernández Ruiz M, Betancor MÁ and Armenteros M. Didactic teaching strategies for the VAR: an approach to gamification and 21st-century skills. In: M Armenteros, AJ Benítez and AM Betancor (eds) *The use of video technologies in refereeing football and other sports*. New York, NY: Routledge, 2020, pp.328–338.
5. de la Vega R and Fuentes JP. Psychological response of the referee to the introduction of VAR. In: M Armenteros, AJ Benítez and AM Betancor (eds) *The use of video technologies in refereeing football and other sports*. New York, NY: Routledge, 2020, pp.339–350.
6. Lago-Peñas C, Gómez M and Pollard R. The effect of the Video Assistant Referee on referee's decisions in the Spanish LaLiga. *Int J Sports Sci Coach* 2021; 16: 824–829.
7. Spitz J, Wagemans J, Memmert D, et al. Video assistant referees (VAR): the impact of technology on decision making in association football referees. *J Sports Sci* 2021; 39: 147–153.
8. Lago-Peñas C, Rey E and Kalén A. How does Video Assistant Referee (VAR) modify the game in elite football? *Int J Perform Anal Sport* 2019; 19: 646–653.
9. Han B, Chen Q, Lago-Peñas C, et al. The influence of the video assistant referee on the Chinese Super League. *Int J Sports Sci Coach* 2020; 15: 662–668.
10. Ponce-Bordón JC, Lobo-Triviño D, Rubio-Morales A, et al. The effect of the Video Assistant Referee system implementation on match physical demands in the Spanish LaLiga. *Int J Environ Res Public Health* 2022; 19: 5125.
11. Errekagorri I, Castellano J, Echeazarra I, et al. The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite football. *Int J Per Anal Sport* 2020; 20: 808–817.
12. International Football Association Board [IFAB]. *Video Assistant Referees (VAR) Protocol*; 2022. Available online at: https://www.theifab.com/laws/latest/video-assistant-referee-var-protocol/#procedures.
13. Johnson D. Arsenal's goal at Manchester United among 6 VAR errors in Premier League – sources. *ESPN.com*; 2022, Dec 21. https://www.espn.com/soccer/story/_/id/37634986/arsenal-goal-manchester-united-6-var-errors-premier-league.
14. Samuel RD, Galily Y, Filho E, et al. Implementation of the video assistant referee (VAR) as a career change-event: the Israeli Premier League case study. *Front Psychol* 2020; 11: Article 564855.
15. Samuel RD, Filho E and Galily Y. Attention allocation in elite football refereeing: conceptual, empirical, and applied considerations. *J Cognit Psychol* 2024; 36: 474–492.
16. Raab M, Avugos S, Bar-Eli M, et al. The referee's challenge: a threshold process model for decision making in sport games. *Int Rev Sport Exerc Psychol* 2021; 14: 208–228.
17. Unkelbach C and Memmert D. Game management, context effects, and calibration: the case of yellow cards in football. *J Sport Exerc Psychol* 2008; 30: 95–109.
18. Mascarenhas DRD, Collins D and Mortimer P. The art of reason versus the exactness of science in elite refereeing: comments on Plessner and Betsch (2001). *J Sport Exerc Psychol* 2002; 24: 328–333.
19. Russell S, Renshaw I and Davids K. How interacting constraints shape emergent decision-making of national-level football referees. *Qual Res Sport Exerc Health* 2019; 11: 573–588.
20. Schrödter R, Noël B and Klatt S. Game management by referees to compensate for errors in judgement: a decision flow model. *Int J Sport Exerc Psychol* 2022; 22: 612–631.
21. Samuel RD, Englert C, Zhang Q, et al. Hi ref, are you in control? Self-control, ego-depletion, and performance in football referees. *Psychol Sport Exerc* 2018; 38: 167–175.
22. Samuel RD, Englert C, Basevitch I, et al. The effects of VAR interventions on self-rated mental fatigue and self-rated performance of football referees. *Int J Perform Anal Sport* 2024: 1–18. Advance online publication. https://doi.org/10.1080/24748668.2024.2340195.
23. De Ridder DT, Lensvelt-Mulders G, Finkenauer C, et al. Taking stock of self-control: a meta-analysis of how trait self-control relates to a wide range of behaviors. *Pers Soc Psychol Rev* 2012; 16: 76–99.
24. Boksem MA and Tops M. Mental fatigue: costs and benefits. *Brain Res Rev* 2008; 59: 125–139.
25. Van Cutsem J, Marcora S, De Pauw K, et al. The effects of mental fatigue on physical performance: a systematic review. *Sports Med* 2017; 47: 1569–1588.
26. Samuel RD, Tenenbaum G and Galily Y. An integrated conceptual framework of decision-making in soccer refereeing. *Int J Sport Exercise Psychol* 2021; 19: 738–760.
27. Eysenck MW and Wilson MR. Sporting performance, pressure and cognition: introducing attentional control theory: sport. In: D Groome and M Eysenck (eds) *An introduction to applied cognitive psychology*. New York, NY: Routledge, 2016, pp.330–351. https://doi.org/10.4324/9781315732954.
28. Evans JSBT and Stanovich KE. Theory and meta theory in the study of dual processing: reply to comments. *Perspect Psychol Sci* 2013; 8: 263–271.

29. Englert C. Ego depletion in sports: highlighting the importance of self-control strength for high-level sport performance. *Curr Opin Psychol* 2017; 16: –5.
30. Badiella L, Puig P, Lago-Peñas C, et al. Influence of Red and Yellow cards on team performance in elite soccer. *Ann Oper Res* 2023; 325: 149–165.
31. Johansen BT and Erikstad MK. A preliminary analysis of the importance of distance, angle, and insight when football referees make penalty decisions. *Front Sports Act Living* 2021; 2: Article 595703.
32. Kolbinger O and Lames M. Scientific approaches to technological officiating aids in game sports. *Curr Issues Sport Sci* 2017; 2: 01.
33. Furley P, Bertrams A, Englert C, et al. Ego depletion, attentional control, and decision making in sport. *Psychol Sport Exerc* 2013; 14: 900–904.
34. Memmert D, Unkelbach C, Ertmer J, et al. Gelb oder kein Gelb? Persönliche Verwarnungen im Fußball als Kalibrierungsproblem [Yellow card or no yellow card? Football cautioning as a calibration problem]. *Zeitschrift für Sportpsychologie* 2008; 15: 1–11.
35. Samuel RD. A psychological preparation framework for elite football referees: a practitioner's perspective. *J Sport Psychol Action* 2015; 6: 170–187.
36. Cunningham I, Simmons P and Mascarenhas D. Sport officials' strategies for managing interactions with players: face-work on the front-stage. *Psychol Sport Exerc* 2018; 39: 154–162.
37. Aragão e Pina J, Passos AM, Maynard MT, et al. Self-efficacy, mental models and team adaptation: a first approach on football and futsal refereeing. *Psychol Sport Exerc* 2021; 52: Article 101787.
38. van Biemen T, Müller D and Mann DL. Virtual reality as a representative training environment for football referees. *Hum Mov Sci* 2023; 89: 103091. 1016/j.humov.2023.103091.
39. Kittel A, Cunningham I, Larkin P, et al. Decision making training in sporting officials: past, present and future. *Psychol Sport Exerc* 2021; 56: Article 102003.