Do you even exercise, ref? Exploring habits of Spanish basketball referees during practice and matches

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Abstract

Background. Basketball referees are a vital part of the organised competition system, ~~although they remain an "outgroup" in sport~~. While physical development and fitness programming are deemed necessary for basketball officiating excellence, there is a paucity of literature exploring strategies for physical fitness management in this population. Therefore, the purpose of this study….

Methods. This research was a nationwide cross-sectional, self-administered online survey conducted in 2021. A sample of 628 (531 males, 97 females) referees from 18 regional referee organisations in Spain provided information on ~~individual responses to gather information on demographic details, level of participation in refereeing,~~ physical fitness practices, and match-day exercise-based regimens. The data were described using summary statistics, and the associations of the assessed variables were subsequently calculated using contingency tables.

Results. Our findings revealed~~, in order of descending relevance,~~ that a large fraction of the Spanish basketball referees focused ~~population focuses~~ on aerobic (83%) and strength (73.6%)

activities, while less attention is paid to speed (36.9%) and flexibility (23.2%), and agility, coordination, and balance tasks are somewhat overlooked (%). No significant differences were observed among the referee categories regarding weekly training days or session duration, with most training for 15-60 minutes per session. Elite referees were more likely to hire personal trainers and engage in strength and flexibility exercises. Sub-elite referees showed a higher tendency to perform stretching and joint mobility activities post-match, while regional referees did so less frequently. Approximately 30.7% of referees across all competitive levels engaged in re-warm-up (RW-U) activities, with stretching and joint mobility being the most prevalent. (1)

Conclusions. Spanish basketball referees participate in routine physical exercise and fitness practices, irrespective of their competition level. While warm-up activities are prevalent, some sub-elite and regional referees do not consistently perform them, and re-warm-up routines are not extensively embraced.

This study provides an opportunity to critically evaluate and address the basketball referee community's policies and procedures for managing physical fitness and injury prevention. These insights may assist each individual and referee organisation in pre and during match preparation and physical performance level enhancement regimens, creating standards for physical conditioning.

Introduction

Referees play a crucial role inare essential in maintaining the integrity of the sport professional sports' integrity and legitimacy, as they operate in high pressure environments and are expected to make by making unbiased judgments in high-pressure environments (Cunningham, Mergler & Wattie, 2022), (Cunningham, Mergler & Wattie, 2022; Karacam & Adiguzel, 2019)). This task is particularly challenging but for basketball referees, who must make quick and accurate decisions underface high pressure situations where they must make quick decisions (Karacam & Adiguzel, 2019). Changes in basketball rules have led to a more dynamic game, increasing with increased the physical demands (García-Santos et al., 2020), potentially which may resulting i n to heightened physiological leading to greater fatigue, during competition and contributing to hampering hinder low-quality decision-making performance (Nabli et al., 2019). FurthermoreConsequently, physical fitness is essential considered a critical aspect of competence for basketball referees (Anshel, 1995), and poor physical condition has been found to negatively affects impact their decision-making accuracy (Nabli et al., 2016b). In this contextThis highlights, research indicates the need forimportance of effective physical conditioning regimes programs for both elite (Leicht et al., 2020) and sub-elite basketball referees (Leicht et al., 2019). While referees have higher aerobic conditioning (Leicht, 2007; Rupčić et al., 2011; Bonganha et al., 2013), body composition is similar to the general population (Leicht, 2007), and body mass index is above the normal range (Leicht, 2007; Rupčić et al., 2011; Bonganha et al., 2013).

MoreoverNevertheless, scant research exists on how referees train their physical condition, despite existing recommendations in this regard (García-Santos et al., 2020), or what competition

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routines are usually put into practice by them. The only study that described physical fitness practices among basketball referees focused on 78 Brazilians at the regional level. Data were only provided on how many participants performed three types of exercise and hours per week in relation to physical preparation (n = 64; bodybuilding, running, other) and sport (n = 42; basketball, cycling, other) (de Paula, da Cunha & Andreoli, 2021). This lack of data makes it challenging to identify the extent to which basketball referees are concerned about maintaining a good physical condition and whether the strategies used for this purpose vary according to their competitive status. In this context, we hypothesize that referees at the highest competitive level may be the ones who most frequently engage in physical fitness practices and undertake match-day exercise-based regimens.

Therefore, this study aimed to identify physical fitness practices among Spanish basketball referees at elite, sub-elite and regional competitive levels. The secondary objectives were: a) to depict the demographic characteristics and officiating duties of Spanish basketball referees based on competition level, and b) to describe their typical match-day exercise-based regimens depending on their competition level.

Materials & Methods

Design

A cross-sectional study was developed following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al., 2008).

Participants

We recruited 637 male and female basketball referees with experience in different Spanish leagues from 18 regional organizations via professional and personal contacts at the start of the 2021/22 season. The highest competitive level determined three categories: elite referees in the top professional men's basketball league (*Liga Endesa*), sub-elite referees officiating in national non-professional leagues for men and women, and regional referees officiating in a region-wide or lower-level league.

Participants were informed of the study requirements and provided written informed consent according to the Declaration of Helsinki. The study protocol was approved by the University of Vigo Ethics Committee with code 01-1421.

Procedures

All regional referee organizations in Spain received invitations to participate in an online survey during the 2021/22 pre-season clinics, accompanied by a letter of invitation and written guidelines distributed. The credibility of a researcher, who is an active elite internationally

ranked basketball referee, fostered trust among participants. The survey remained open for 11 weeks (26 August to 6 November 2021), with follow-up telephone reminders sent to each organization. Anonymous data was collected ensured participants' privacy.

Questionnaire

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According to previous investigations, it was deemed necessary to create a specific questionnaire to gather valuable data (Blagrove et al., 2020; Murphy, Mason & Goosey-Tolfrey, 2021). Four authors with expertise in basketball research and practice (three doctors and one PhD student in Physical Activity and Sports Sciences) designed an ad hoc questionnaire to collect data on physical fitness practices and match-day exercise-based regimens. The first author initiated the questionnaire development process by determining key areas of the questionnaire. A second author supervised this process. After debating how best to gather information, these two researchers developed an initial questionnaire including 24 items.

Subsequently, two other authors familiar with the needs of licensed referees by the International Basketball Federation (FIBA) reviewed the preliminary questionnaire and suggested shortening it for better readability. The questionnaire was revised accordingly.

Eventually, the fifth author ~~(an active elite internationally ranked basketball referee) was invited~~contributed to ~~provide his opinion on the refined~~refining the questionnaire. ~~Without objection to its design and content, all authors approved this latest~~The final version, unanimously approved, ~~consisting of~~comprised 24 closed and open-ended questions ~~developed through~~in Google Forms. It collected data on demographics, refereeing level, physical fitness practices, and match-day regimens, focusing on a regular pre-pandemic season to minimize confounding factors. The questionnaire began with informed consent and obtained personal and refereeing data, facilitating body mass index estimation using height and weight. It inquired about the specific season, competition types, weekly refereed match frequency, and categories officiated. The main section examined participants' exercise habits, including regular exercise, personal coaching, exercise types, daily duration, and weekly frequency. It also explored activities during basketball competition: warm-up routines, time spent on routines, exercise routines during match breaks, re-warm-up (RW-U) activities, and reasons for performing RW-U or not. Additionally, it investigated participants' stretching and joint mobility exercises. A comments section allowed for further insights, suggestions, or concerns~~It gathered quantitative and qualitative data on demographic details, refereeing level, physical fitness practices, and match-day exercise-based regimens, focusing on a regular season before COVID-19 restrictions. Thus, the confounding influence of seasonal and health-related exercise habit variations was avoided~~.

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~~fifth author's credibility helped establish trust with the participants. The survey was open for 11 weeks (26 August to 6 November 2021), with follow-up telephone reminders to each organization. Data was collected anonymously to ensure privacy.~~

Analyses~~Statistical analysis~~

~~In this study, we utilized a descriptive cross-sectional survey design, which led us to primarily focus on descriptive analysis and data presentation~~~~The present study is a descriptive cross-sectional survey design and, therefore, the analysis and presentation of data is predominantly descriptive~~. ~~All statistical analyses were performed using the SPSS 15.0 (SPSS Inc., Chicago, IL, USA)~~. We calculated summary statistics for dichotomous or categorical variables and presented them as percentages. We also formulated contingency tables to identify systematic associations among the assessed variables. To analyze all variables, we employed the~~Summary statistics were calculated as dichotomous or categorical variables and are presented as percentages. Contingency tables were calculated to detect the systematic associations of the assessed variables. All variables were analyzed using the~~ Chi-Square Test of Independence (χ^2) or Fisher's exact test when the contingency table was 2 x 2, setting the significance level at~~when the contingency table was 2 x 2 (~~$\alpha = 0.05$~~)~~. The degrees of freedom (Df) for Chi-Square Test were calculated using the following formula: Df = (r-1) (c-1) where "r" is the number of rows, and "c" is the number of columns. Adjusted standardized residuals (CR) were applied to isolate the sources of variation among the groups (Haberman, 1973). Cramér's V statistic was used to test the practical significance of these associations (values of 0.1 regarded as a small effect, 0.3 as a moderate effect, and 0.5 as large effects). All statistical analyses were performed using the SPSS 15.0 (SPSS Inc., Chicago, IL, USA)

Open-ended question responses and voluntary comments were carefully transcribed, ~~and~~ with the content specifically addressing motivations for implementing RW-U routines ~~was~~ analyzed ~~for~~ to discern ~~common~~ key themes.

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Results

Out of 637 initial respondents, 628 referees (mean age: 30.0 ± 9.4 years; mean number of seasons serving as a referee: 8.9 ± 7.3; 15.4% female) were included after eliminating 9 respondents with contradictory data. The final sample included 531 males and 97 females, aged 15 to 58 years (mean age 30.0 ± 9.4 years). Table 1 shows their demographic characteristics.

[Table 1 around here]

Female referees were underrepresented (6%-17.2%) across the competitive level categories, precluding gender comparison. Elite referees, who were older and more experienced, officiated almost exclusively in senior competitions (93.8 %, $\chi^2 = 120.945$, Df = 4, CR = 7.4, $p < 0.001$) and none in more than three weekly matches ($\chi^2 = 228.435$, Df = 14, CR = -7.5, $p < 0.001$).

About 60% of sub-elite referees participated only in senior competitions (59.6%, $\chi^2 = 120.945$, Df = 4, CR = 6.4, $p < 0.001$), with 30.3% ($\chi^2 = 228.435$, Df = 14, CR = -7.7, $p < 0.001$) involved in more than three weekly matches. All regional referees officiated in youth categories (25.3%, $\chi^2 = 120.945$, Df = 4, CR = 6.7, $p < 0.001$) and the majority had more than three weekly matches (74.1%, $\chi^2 = 228.435$, Df = 14, CR = 11, $p < 0.001$).

Estimated BMI mean values (23.8-24.2 $kg \cdot m^{-2}$) did not differ significantly across the three categories.

Physical fitness practices

Table 2 presents data on physical fitness practices. Almost all referees reported engaging in regular planned physical activity, with a few exceptions. Elite referees were most likely to hire personal trainers (31.3%, $\chi^2 = 18.560$, Df = 2, CR = 3.3, $p < 0.001$), followed by sub-elite and regional referees (20% and 12%, respectively).

[Table 2 around here]

No significant differences in weekly training days were observed among the referees' categories (almost half of the participants exercised 4-5 days). Most participants trained for ~~45~~15-60 minutes ~~or more~~ per session, regardless of their competitive level. ~~Participants with higher competitive levels had longer training sessions ($\chi^2 = 20.350$, Df = 8, p = 0.009).~~ Aerobic (83%) and muscle strengthening (73.6%) activities were common, whereas speed (36.9%) and flexibility (23.2%) were less frequent. Approximately 26% of the referees incorporated balance, agility, and coordination tasks in their training regimes. Elite referees focused more on strength ($\chi^2 = 9.640$, Df = 2, CR = 2.2, $p < 0.008$) and flexibility ($\chi^2 = 6.680$, Df = 2, CR = 2.5, $p < 0.035$) exercises than other categories.

Table 3 depicts the match-day exercise-based regimens. Warm-up activities were less common in the regional category (26.7%, $\chi^2 = 12.027$, Df = 2, CR = -3.3; p = 0.002); 80.4% of referees reported performing stretching and joint mobility activities prior to matches, while 50.6% did so after match. Such activities were less frequent during the half-time (26.1%) and between halves (2%). Among referees not conducting stretching and joint mobility activities (7%), the cited reasons were lack of need, time, habit, or knowledge. Sub-elite referees were significantly more prone to execute these activities post-match (70.6%, $\chi^2 = 21.120$, Df = 2, CR = 4.6, $p < 0.001$), while regional referees performed them less often (8.4%, $\chi^2 = 6.705$, Df = 2, CR = 2.6, p = 0.035).

[Table 3 around here]

A total of 193 referees (~~pproximately~~ 30.7% of the total sample) ~~referees~~ across all competitive levels engaged in re-warm-up (RW-U) activities, with stretching and joint mobility being the most prevalent activities (86%), followed by jogging and running (34%). Strength (8.8%) and coordination and balance exercises (6.7%) were the least commonly used RW-U strategies (Table 3). The data presented in Figure 1 pertain exclusively to these 193 respondents who engaged in RW-U activities. There were no significant differences in RW-U practices among different referee levels, except for "other" RW-U activities where elite (n = 3), national (n = 0), and regional referees (n = 8) selected this option. ~~(Fig. 1).~~

[Figure 1 around here]

The participants identified "*getting active*", "*concentrating*", and "*avoiding injury*" as the main motives for implementing RW-U routines. Conversely, "*perceived lack of need*", "*time constraints*" and "*prioritizing technical aspects of refereeing*" were cited as barriers to performing RW-U regimes (data ~~not~~ shown in Supplemental file 1).

Discussion

~~Physical development and fitness programming for referees are remain under-researched topics (Cunningham, Mergler & Wattie, 2022), despite beingeven though they are of considerable interest to basketball governing bodies and practitioners~~. The purpose of this study was to…. Results revealed that ~~Our study reveals that~~ Spanish basketball referees across all competitive levels consistently engage in weekly planned physical activity, with warm-up exercises being a common component. However, some sub-elite and regional referees do not include warm-ups in their routines. Moreover, ~~the majority of the surveyed referees,~~ approximately two-thirds of the referee population, do not perform RW-U exercises.

In terms of the time commitment to physical activity, w~~W~~e found that ~~most~~ basketball referees engaged in regularly planned physical activity, spending ~~at least~~more than 1~~4~~5 minutes and up to 60 minutes in more than half of the cases, two to five days per week, irrespective of their competitive level. This figure is noteworthy because prior research suggests difficulties in balancing refereeing duties with exercise and other responsibilities (Anshel, 1995). Similarities exist with conventional training programs for sub-elite Spanish referees, who trained around 75 minutes, three times per week (Bayón et al., 2015); and a survey of 78 Brazilian referees at the regional level, where 82% of respondents undertook 6.3 ± 3.0 weekly hours of physical preparation (de Paula, da Cunha & Andreoli, 2021). Possible explanations for these results beyond referees enjoying the physical nature of their role (Warner, Tingle & Kellett, 2013) include the remarkable physical demands at both the elite and sub-elite levels (Nabli et al., 2016a; Leicht et al., 2020), which necessitate physical fitness training (Plessner & MacMahon, 2013). For instance, elite internationally ranked referees may follow FIBA's conditioning program (FIBA, 2020a), while sub-elite (Bayón et al., 2015) and regional referees (Sobko et al.,

2021) are keen to train to pass physical fitness tests for promotion (Inchauspe et al., 2020; FIBA, 2021).

One unanticipated finding was that despite elite basketball referees exercise for at least 30 minutes twice a week, fewer train ~~for longer durations (> 60 minutes)~~more than 60 minutes, or more frequently (at least six days per week) than those in lower levels. Given the mature age exhibited by elite referees in our sample, as they age, they may prioritize smarter exercise over harder training due to concerns about physical limitations (Tittrington, 2021). Elite referees' training schedules may also be affected by geographical, professional, or officiating constraints (de Paula, da Cunha & Andreoli, 2021). Concurrently, the vast majority of this elite group had up to two official matches weekly, while sub-elite and regional referees officiated more frequently. Considering that referees require a minimum of 10,000 hours of pressurized decision-making experience to reach expertise (Mildenhall, 2014), we can assume that lower-level referees may emphasize match practice to enhance their performance and advance to the highest rank.

A second noteworthy result is that a significant fraction of Spanish basketball referees chose aerobic and strength conditioning over speed and flexibility training. Agility, coordination, and balance tasks are underrepresented in their exercise routines, despite their importance in performance (Inchauspe et al., 2020). Previous studies confirm these findings (Bayón et al., 2015; de Paula, da Cunha & Andreoli, 2021). However, this issue appears to be fading because the FIBA includes agility (i.e. footwork) and balance training (i.e. proprioception abilities) in its digital manuals for internationally ranked referees (FIBA, 2020b). Regarding the predominance of aerobic activities, basketball referees require adequate training to maintain cardiovascular fitness because of moderate cardiovascular load during competitions (Leicht, 2004; Suárez Iglesias et al., 2021) and compromised aerobic performance with age (Nabli et al., 2019). Especially when they reach the peak of their careers (first-time candidates for a FIBA Referee License have to be 35 years of age or younger, with the age limit for the license being around 50-55 years) (FIBA, 2021). Furthermore, our sample typically engaged in strength training and sprints. Previous studies have identified similar training patterns among sub-elite (Bayón et al., 2015) and regional referees (de Paula, da Cunha & Andreoli, 2021).

To the best of our knowledge, t~~T~~his novel study ~~study is unique in it's~~ presented comparative analysis of basketball referees across three competitive levels ~~is unique~~. ~~We~~ Although we found ~~negligible~~ minimal differences in exercise types for physical fitness among the groups~~; however,~~, elite basketball referees ~~prioritized~~ exhibited a higher emphasis on strength and flexibility training ~~over~~ compared to their sub-elite and regional counterparts~~,~~. This observation is likely due to the age-related physical decline~~. H~~, as half of the surveyed elite referees were ~~>~~over 34 years old, and physical performance impairment is expected to become more pronounced from age 30 onwards (Castagna, Abt & D'Ottavio, 2007). ~~Thus~~Consequently, ~~allocating~~ devoting

more training time to strength and flexibility exercises may help prevent injury and improve movement efficiency for these referees (Gregson, Weston & Helsen, 2006).

In addition, elite referees reported hiring personal trainers to a greater extent than sub-elite and regional referees, which seems a good practice since they must adapt to the physical capabilities of higher-level athletes (Plessner & MacMahon, 2013). This professional may help them "stay in shape," given that elite players are typically younger than referees (Tittrington, 2021) and have more muscle mass than sub-elite players (Masanovic, Popovic & Bjelica, 2019). Working with a personal trainer has been shown to lead to greater improvements in fitness (i.e. lean body mass) than self-led training (Storer et al., 2014). The latter also accords with our observations, as elite referees include a greater variety of fitness components in their training regimens than their counterparts do. It is worth noting that elite referees may have higher salaries or allocated budgets for personal training, which could contribute to their increased engagement with personal trainers compared to sub-elite and regional referees.

When examining anthropometric measurements, our findings indicate that the ~~Besides, our sample's~~ mean body mass index values in our sample were lower than those ~~reported~~ documented in ~~previous~~ prior studies. Notably, these earlier studies revealed that ~~of~~ elite male basketball referees ~~who were~~ often displayed ~~above~~ above-normal weight ranges (Rupčić et al., 2011; Bonganha et al., 2013; Suárez Iglesias et al., 2021). The reason for this difference is unclear but could be due to the current trend of body image ideals for men valuing a muscular, low body fat physique (Robinson & Lewis, 2016). Documents from the Spanish Basketball Federation suggest training for hypertrophy to improve court presence (Federación Española de Baloncesto, 2022). It has been argued that standing firm and portraying confidence are key communication behaviors of the skillful referee (Plessner & MacMahon, 2013); therefore, being fit could enhance performance by increasing confidence (Morris & O'Connor, 2017) and court presence (Tittrington, 2021). Nonetheless, the interpretation of these findings remains speculative since the participants estimated their height and weight.

In the current study, many referees performed warm-up activities before a match, and this percentage increased with the level of competition. This underscores the importance of pre-match preparation for optimal performance across competitive levels (Anshel, 1995; de Paula, da Cunha & Andreoli, 2021). Elite referees seem to be more aware of establishing match-day routines, which may be due to the demands of top competition and access to standardized warm-up procedures (Suárez Iglesias et al., 2021). Altogether, developing education programs for sub-elite and regional referees to implement competition routines would benefit referee organizations. Some efforts in this direction are already underway through online media (Hrusa & Hrusova, 2020; de Paula, da Cunha & Andreoli, 2021; Sobko et al., 2021).

Conversely, half of our sample did not perform post-match stretching or joint mobility exercises, highlighting the community's possible lack of knowledge. This situation is consistent with previous research showing that most referees do not consider post-match injury prevention strategies as ideal (de Paula, da Cunha & Andreoli, 2021). In our investigation, the proportion of national referees including these strategies was significantly higher than that of the elite and regional referees. Time constraints or a perceived lack of need may explain this discrepancy. Elite referees may have less time due to post-match conferences with their instructors (Hrusa & Hrusova, 2020); while regional referees, especially those between 16-23 years of age (35% of our sample), may be less familiar (Sobko et al., 2021) or interested in physical readiness (Hrusa & Hrusova, 2020) than other categories of referees.

Despite only a third of respondents adopting RW-U activities, primarily stretching or joint mobility exercises, current literature suggests their importance (Silva et al., 2018). Participants who performed RW-U cited injury prevention as their motivation. Nevertheless, numerous national and regional referees neglected RW-U exercises, ascribing this to time constraints during breaks, allocating the brief intermission (3 minutes for children's games, 7-10 minutes for others) to discussing the match, mental preparation for the second half, reviewing the scoresheet with colleagues, hydrating, consuming food, or engaging in passive rest. Additional reasons included the absence of a protocol, observing their peers' behavior, perceiving reduced physical demands in youth matches, and maintaining the belief that activation is not lost during short intervals. These findings reveal a pervasive deficiency among basketball referees, even though injury prevention exercises are crucial in light of the high prevalence of musculoskeletal and overuse injuries (de Paula, da Cunha & Andreoli, 2021).

Despite the strengths of this study, including a large sample size and a broad spectrum of competitive levels, certain methodological limitations exist. These include using an untested "ad hoc" questionnaire and recall bias introduced by focusing on a pre-COVID-19 regular season. Social desirability response bias could also have affected the results, although pre-defined response options may mitigate this (McEwan et al., 2020). The possibility that participants accounted for refereed matches as part of their regularly planned physical activity may have introduced report bias. Also, self-reported anthropometric measurements may be inaccurate, which limits further analysis. Additionally, the sample was predominantly male; hence, future research is required to establish the generalizability of the findings to both sexes.

Conclusions

Spanish basketball referees engage in regular physical activity and physical fitness practices, regardless of their competitive level. Although warm-up activities are common, they are not consistently performed by some sub-elite and regional referees, and re-warm-up routines are not widely adopted. The insights gained may help individual referees and their organizations optimize pre-match and in-match preparations, as well as enhance physical performance levels.

This could contribute to establishing physical conditioning standards, particularly in light of the limited research on these topics to date. Future studies should explore optimal physical training approaches, the timing of each activity, and the factors influencing individual physical development among referees.

Acknowledgements

We thank all the participants taking the questionnaire and the following regional referee organisations for their involvement: Fed. Española de Baloncesto, Fed. Andaluza Baloncesto, Fed. Aragonesa Baloncesto, Fed. Baloncesto Pdo. Asturias, Fed. de Bàsquet de les Illes Balears, Fed. Canaria de Baloncesto, Fed. Cantabra Baloncesto, Fed. Baloncesto C. La Mancha, Fed. de Baloncesto de Castilla y León, Fed. Catalana de Basquetbol, Fed. Extremeña de Baloncesto, Fed. Gallega Baloncesto, Fed. Baloncesto de Madrid, Fed. Melillense Baloncesto, Fed. Baloncesto Región de Murcia, Fed. Navarra Baloncesto, Fed. Riojana Baloncesto, Fed. Vasca Baloncesto and Fed. Baloncesto Com. Valenciana. Besides, the authors would like to acknowledge the linguistic help provided by Amy Bonner (professional FIBA and WNBA referee).

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