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Electrocardiographic diversity in football players: how distinct ethnic patterns shape athletes' hearts

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Ethnic admixture reshapes the athlete's ECG, demanding precision beyond one-size-fits-all criteria.

Filipe Ferrari and Ricardo Stein

In this exclusive interview, we speak with Filipe Ferrari (F.F.) and Ricardo Stein (R.S.), two of Brazil's leading researchers in sports cardiology and authors of four landmark studies examining electrocardiographic (ECG) patterns in Brazilian soccer players[1–4] (*Figure 1*). Their work sheds light on the complex interplay between ethnicity, athletic training, and cardiovascular screening. With data collected over two decades from more than 6000 athletes, their research provides critical insights that challenge established norms and contribute to evolving international guidelines.

➢ *You've now published a series of studies across four major journals,[1–4] examining over 6000 Brazilian footballers' ECGs. What inspired you to take on such a large, long-term investigation?*

F.F. and R.S.: We started this research due to the clear lack of ECG data on Brazilian athletes, especially Mixed-race players who are underrepresented in current athlete ECG guidelines.[5] To address this, we partnered with football clubs across the country to build a robust and diverse dataset. In addition to ECGs, we collected imaging data to enhance interpretation and understanding structural correlates. Over time, this comprehensive database allowed us to conduct multiple analyses, resulting in several publications that help refine ECG interpretation in Brazil and contribute valuable insights to the global sports cardiology community.

➢ *In one of the papers,[1] you show that 97% of ECGs were normal, even in this ethnically diverse, highly trained population. Did this low prevalence of abnormalities surprise you? And how do you think these challenges or reinforces current preparticipation screening practices?*

F.F. and R.S.: The low prevalence of abnormal ECGs (3%) was not entirely surprising, as we had initially estimated around 5%. Most players were young (aged 15 to 25), and in one of our studies,[4] we found that abnormalities tend to become more common with age, especially between 26 and 35 years, which helps explain our overall results.

Compared to an African cohort of male soccer players (23%),[6] our lower rate may be partially attributed to Brazil's high genetic admixture, which tends to dilute distinct ECG patterns seen in more homogeneous populations.

These findings support the effectiveness of current international ECG interpretation criteria,[5] which, when applied correctly, reduce false positives and still identify athletes at risk—even in diverse populations.

➢ *Your work consistently shows that Black athletes have more training-related ECG changes, but the 'African/Afro-Caribbean' pattern is much rarer in Brazilian players than in African or European cohorts. Do you think this is mostly genetic (due to Brazil's high admixture), environmental, or something else entirely?*

F.F. and R.S.: Yes, we believe genetics play a key role, particularly Brazil's extensive ethnic admixture, which contributes to greater diversity and a lower prevalence of the typical 'African/Afro-Caribbean' ECG pattern.[3]

It's also important to note that the category of 'Black athletes' in Brazil is heterogeneous. Individuals identifying as Black or Mixed-race often have diverse ancestral backgrounds, which likely influences the expression of training-related ECG changes compared to more genetically homogeneous African or Afro-Caribbean populations.

➢ *In another publication,[2] you meticulously classified early repolarization into seven distinct morphologies. Was there one pattern that clinicians should pay closer attention to, especially in athletes of mixed or black ethnicity?*

F.F. and R.S.: In our sample of 6353 players, early repolarization (ER) was common (40%), especially among Black (48%) and Mixed-race (41%) athletes. The classic J-wave with ascending ST-segment—typically benign and training-related—was the most frequent morphology.

Patterns considered higher risk in the general population, such as horizontal ST-segment or inferolateral J-waves morphologies, were rare. During a mean 4-year follow-up, no sudden cardiac deaths occurred. These results suggest that ER, especially in athletes, is likely a benign finding when interpreted in the appropriate clinical context.

➢ *You've emphasized the underrepresentation of mixed-race athletes in current ECG interpretation guideline.[5] Based on your data, what are the key*

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Figure 1 Images of the interviewed authors. Left: Filipe Ferrari. Right: Ricardo Stein.

differences between mixed-race and other groups—and what practical changes would you like to see in future recommendations?

F.F. and R.S.: Mixed-race athletes remain underrepresented in current ECG guidelines,[5] despite comprising a large proportion of the Brazilian football population. In our study, their ECG findings were generally intermediate between those of White and Black athletes, including in early repolarization prevalence, PR interval duration, and voltage criteria for left ventricular hypertrophy. The 'African/Afro-Caribbean' ECG pattern was rare in this group and, when present, was not associated with structural abnormalities on echocardiography. These findings highlight the need for ECG interpretation criteria to better reflect admixed populations, particularly in countries with high genetic diversity.

➢ *Your current research focuses on male athletes. Given the growing participation of women in professional sports, what are your thoughts on extending this ECG research to female athletes—and what differences would you anticipate?*

F.F. and R.S.: Our current publications are limited to male athletes, but we are now collecting ECG data from over 1200 female footballers across Brazil. This is an important step, given the growth of women's sports and the known sex-related differences in ECG interpretation.

We anticipate findings such as higher rates of T-wave inversion in leads V1-V3 and lower prevalence of early repolarization and left ventricular hypertrophy compared to male athletes. Expanding this research will help develop sex-specific criteria and improve screening accuracy for female athletes in Brazil and beyond.

➢ *Let's imagine you're talking to a team physician about to screen a squad of young athletes. Based on all your research, what's one thing they should stop worrying about, and one thing they shouldn't overlook?*

F.F. and R.S.: One thing a team physician should stop worrying about is early repolarization patterns. These are frequent in Brazilian athletes and have not been associated with sudden cardiac death in our sample or in other athletic populations. Overinterpreting early repolarization can lead to unnecessary testing.

However, inferolateral T-wave inversion should never be overlooked, even when the echocardiogram appears normal. This pattern may indicate underlying cardiac pathology, and in such cases, cardiac magnetic resonance imaging is essential for a more accurate evaluation.[4]

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Data availability

There are no new data associated with this article.

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