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Seven years follow-up of early repolarisation patterns in French elite special forces

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Abstract

Background: The early repolarization pattern (ERP) may be a marker of increased risk for sudden cardiac death (SCD). Influence of ethnicity on the ERP has not been extensively studied. The aim of this study was to evaluate the epidemiology of ERP in a male multiethnic population.

Methods: ECG analysis was performed among consecutive recruits from the French Foreign Legion. ERP was characterized by a J-point elevation ≥ 0.1 mV in two continuous inferior-lateral leads, and high amplitude early repolarization (HAER—potentially malignant pattern) by an elevation ≥ 0.2 mV. Ethnic affiliation and level of physical activity were recorded.

Results: A total of 2508 healthy men (24 ± 5 years old) from 105 different native countries were divided into three ethnic groups: 1689 Whites, 388 Afro-Caribbean, and 431 Asians. ERP was found in 489 recruits (19%), 14% in Whites, 33% in Afro-Caribbeans, and 27% in Asians without any difference according to age and physical activity. Sub-Saharan Africans or Caribbeans had the highest rate of ERP (30%), and Hispanics the lowest (8%). People from occidental countries, Middle East, Central Asia or India had a rate of 12%–18%, East and South-Asia 20%–25%. Madagascar was an exception with only 16% of ERP. HAER (2.9%) was more frequent among Asian recruits. After 5 ± 2 years of follow up, one SCD occurred in the ERP group ($p = 0.042$).

Conclusion: This study reports a large multiethnic analysis of ERP. HAER was more frequent in recruits from East and South-East Asia where sudden unexplained nocturnal death syndrome is endemic.

KEYWORDS

clinical electrophysiology, early repolarization, epidemiology/clinical trials, sudden cardiac death

1 | INTRODUCTION

Early repolarization (ER) is a common ECG pattern, which is found in approximately 5% of the population (Antzelevitch et al., 2017). ER pattern (ERP) is electrocardiographically defined by either a sharp well-defined positive end QRS notch (J wave) or slur on the downslope of a prominent R wave with and without ST-segment elevation

(Antzelevitch et al., 2017; Haissaguerre et al., 2008; Tikkanen et al., 2011). ERP diagnosis is also based on an elevated J-point/ST segment of at least 1 mm in ≥ 2 contiguous ECG leads excluding leads V1–V3 and QRS duration < 120 ms (Antzelevitch et al., 2017; Tikkanen et al., 2011). In the late 2000s, the inferolateral ER has been linked with an increased risk of idiopathic ventricular fibrillation (VF) and sudden cardiac death (Antzelevitch et al., 2017; Haissaguerre et al., 2008;

Tikkanen et al., 2011). Quantifying the risk of arrhythmic event and sudden death in case of asymptomatic ER is still challenging. The majority of individuals with ERP are at no or minimal risk for arrhythmic events. Many factors like age, sex gender, intense athletic activity, or ethnicity are known to influence cardiac repolarization. The influence of ethnicity on the ERP has not been extensively studied.

The aim of this prospective study is to describe the ERP according to ethnicity in a population of young males recruited by the French Foreign Legion. A follow up of these recruits was performed.

2 | METHODS

2.1 | Study population

From September 2009 to November 2012, we led a prospective 12-lead ECG analysis among recruits of the French Foreign Legion. All soldiers were healthy and physically active men, aged 18–41 years old, and coming from all over the world.

2.2 | ECG analysis

All the ECGs were performed on the day of their enrollment. ECG records were reviewed by two independent cardiologists. To minimize errors in the evaluation process, we assessed 200 ECGs for interobserver and intraobserver variations (kappa value 0.70 and 0.90 respectively). ERP was defined as an elevation of the QRS–ST junction (J point) in at least two adjacent leads with QRS duration <120 ms. The amplitude of J-point elevation had to be at least 1 mm (0.1 mV) above the baseline level, either as QRS slurring (a smooth transition from the QRS segment to the ST segment) or notching (a positive J deflection inscribed on the S wave) in the inferior leads (II, III, and avF), lateral leads (I, avL, and V4–V6), or both. Early repolarization without clear end QRS notch or slur was defined as “undetermined ERP”. We defined low-amplitude ER (LAER) as at least a 0.1–0.2 mV J-point elevation, and high-amplitude ER (HAER) as a J-point elevation of more than 0.2 mV with horizontal/downsloping ST segment. HAER seems to be a high-risk ER feature as described before (Antzelevitch et al., 2017). Subjects without ERP were noted NERP (No ERP).

2.3 | Data collection

We collected the following data: ethnical affiliation (Whites, Afro-Caribbean, and Asians), detailed geographical origin (native country), and level of physical activity (hours of activity per week). Due to ethical considerations, ethnical affiliation was self-determined. Electrocardiographic variables were measured with the use of automated software and were verified manually. The QTc interval was calculated after correction for heart rate according to Bazett's formula. High amplification signal-averaged electrocardiograms were considered to indicate the presence of late ventricular potentials when two of the following measurements were recorded: QRS duration of more than 120 ms, a root mean square of terminal QRS of <25 mV and a low-amplitude signal lasting more than 40 ms.

2.4 | Follow-up

All the recruits were seen routinely at least every 12 months according to the French Forces medical recommendations. The registry of death certificates in the French Foreign Legion was reviewed in May 2017 and sudden cardiac arrests were collected.

2.5 | Statistical analysis

Stata software version 11 (StataCorp LLC, USA) was used for statistical analysis. Continuous variables were reported as means $\pm$ SD or medians (with 25th and 75th percentiles), when appropriate. Comparisons between the ERP/NERP groups and LAER/HAER groups were performed with Student's *t* test for continuous variables. Categorical variables were compared with Fisher's exact test. Sudden cardiac death in the two groups (ERP group and NERP group) was compared using the log-rank test. All tests were two-tailed, and a *p* value of <0.05 was considered to indicate statistical significance.

3 | RESULTS

We enrolled 2,508 healthy consecutive men from 105 different native countries who were divided into three self-reported ethnic groups: 1,689 Whites, 388 Afro-Caribbean, and 431 Asians (Table 1). The mean age of the population was 24 ± 5 years. There was no difference concerning the age neither the level of physical activity between these ethnic groups.

3.1 | Characteristics of early repolarization

Early repolarization pattern was observed in 489 subjects (19% of the population), 14% in Whites, 33% in Afro-Caribbeans, and 27% in Asians. Nearly half of the ERP (49%) was found in inferior leads and 17% was found in both inferior and lateral leads. Notched QRS was the main morphology (56%), followed by the slurred ERP (26%), and the undetermined ERP (18%).

Subjects with ERP had a lower heart rate than the NERP group (69 vs 72 bpm, *p* = 0.001), with increased PR interval, QRS complex and corrected QT interval durations, and Sokolow–Lyon index (Table 1). The presence of ventricular late potentials was significantly more frequent in ERP patients than in NERP patients without significant difference between HAER and LAER patients.

Early repolarization with a J-point elevation of more than 0.2 mV (HAER) was found in 2.9% of the population: 1.7% in Whites, 3.8% in Afro-Caribbeans, and 8.5% in Asians. Subjects with HAER had a significantly lower heart rate and a greater Sokolow–Lyon index than LAER subjects, but there was no difference in the length of the PR, QRS, and QTc intervals. When associated with notched QRS and infero-lateral repolarization, HAER was only found in 27 men (1.1%).

TABLE 1 Characteristics of the study population and ECG patterns in 2,508 French Foreign Legion recruits

	NERP (n = 2018)	ERP			NERP vs. ERP	LAER vs. HAER
		All ERP (n = 489)	LAER (n = 416–16.6%)	HAER (n = 73–2.4%)		
Age, year	24 ± 5	23 ± 6	26 ± 6	25 ± 6	p = 0.58	p = 0.37
Ethnic group						
White N (%)	1,444 (72%)	244 (50%)	213 (51%)	30 (41%)	—	p = 0.16
Afro-Caribbean N (%)	260 (13%)	128 (26%)	113 (27%)	15 (20%)	—	p = 0.37
Asian N (%)	314 (16%)	117 (24%)	90 (22%)	27 (37%)	—	p = 0.004
Physical activity—hours per week	5.4 ± 3	5.5 ± 3	5.5 ± 3	5.6 ± 3	p = 0.32	p = 0.58
Cardiac Frequency (bpm)	72 ± 13	69 ± 12	70 ± 11	65 ± 11	p = 0.001	p = 0.001
PR interval (ms)	149 ± 24	153 ± 25	152 ± 21	157 ± 24	p = 0.02	p = 0.08
QRS interval (ms)	84 ± 16	87 ± 13	87 ± 13	89 ± 15	p = 0.001	p = 0.13
QTc Interval (ms)	384 ± 27	393 ± 26	394 ± 26	391 ± 27	p = 0.001	p = 0.51
Sokolow–Lyon (mV) ^a	29 ± 6	33 ± 5	33 ± 5	34 ± 4	p = 0.001	p = 0.02
ER localization						
Inferior, N (%)	—	251 (51%)	221 (53%)	36 (49%)	—	p = 0.057
Lateral, N (%)	—	154 (32%)	143 (34%)	10 (14%)	—	p = 0.001
Infero-Lateral, N (%)	—	84 (17%)	52 (13%)	27 (37%)	—	p = 0.001
ER morphology						
Notch N (%)	—	273 (56%)	228 (55%)	45 (61%)	—	p = 0.27
Slur N (%)	—	129 (26%)	108 (26%)	21 (29%)	—	p = 0.6
Borderline N (%)	—	87 (18%)	80 (19%)	7 (10%)	—	p = 0.04
Presence of late ventricular potentials, no./total N (%) ^a	3/70 (4%)	21/70 (30%)	22/59 (37%)	2/11 (18%)	p = 0.03	0.5

Notes. ERP, early repolarization pattern; HAER, high-amplitude early repolarization (J-point elevation >0.2 mV); LAER, low-amplitude early repolarization (0.1 mV < J-point elevation ≤0.2 mV); NERP, no early repolarization pattern.

^aSokolow–Lyon index (mV): S in V1 or V2 + R in V5 or V6 (whichever is larger).

Bold values indicate statistically significance (p < 0.05).

3.2 | Geographical distribution of ER

The analysis of the geographic distribution of ERP identified distinct groups of populations. Subjects coming from Sub-Saharan Africa or from the Caribbean had the highest rate of ERP (30%). Hispanics had the lowest rate (8%). People from occidental countries, Middle East, Central Asia or India had an intermediary rate of ERP (12%–18%). ERP was frequent in subjects from East and South Asia (20%–25%). Considering ERP rate in Africa and Asia, Madagascar was an exception with only 16% of ERP (Figure 1).

3.3 | Follow up

After a mean follow up of 5 ± 2 years, one sudden cardiac death was reported. Survival analysis revealed a slight difference for increased risk of sudden cardiac death in the ERP group (p = 0.042). A soldier originating from the Vanuatu Islands without any cardiovascular risk factor or family history of sudden death died suddenly at the

4th km of the “Camarón day” 13-km running race (every year, the French Foreign Legion commemorates the anniversary of the Battle of Camarón) 6 years after the inclusion. Initially, a shockable rhythm was detected and two shocks were delivered by the automated external defibrillator. His ECG at the inclusion demonstrated a lateral ERP with a J-point notched elevation >0.2 mV without any other typical high-risk pattern (Figure 2). His family refused an autopsy.

4 | DISCUSSION

4.1 | Early repolarization epidemiology

Early repolarization is a common ECG pattern, observed in 19% of our study population. The rate of ERP greatly varies from a study to another. Subsequent large population studies reported the prevalence of ERP to be between 6% and 13% (Antzelevitch et al., 2017; Haissaguerre et al., 2008; Tikkanen et al., 2011). It is well known that ERP is strongly influenced by the male sex gender, physical training

	Total population (<i>n</i> = 2508)	Early repolarization (ER) (<i>n</i> = 489)	LAER (<i>n</i> = 416)	HAER (<i>n</i> = 73)
Europe				
<i>Western and Central Europe - N (%)</i>	775	93 (12%)	84 (10,8%)	9 (1,2%)
<i>Eastern Europe - N (%)</i>	262	35 (13,4%)	31 (11,8%)	4 (1,5%)
Asia				
<i>Middle East - N (%)</i>	36	6 (16,7%)	5 (13,9%)	1 (2,8%)
<i>Central Asia - N (%)</i>	55	12 (21,8%)	10 (18,2%)	2 (3,6%)
<i>Southern Asia - N (%)</i>	144	40 (27,8%)	34 (23,6%)	6 (4,2%)
<i>Eastern Asia - N (%)</i>	200	49 (24,5%)	35 (17,5%)	14 (7%)
<i>Southeastern Asia - N (%)</i>	31	16 (51,6%)	12 (38,7%)	4 (12,9%)
<i>Pacific - N (%)</i>	20	6 (30%)	5 (25%)	1 (5%)
Americas				
<i>North America - N (%)</i>	225	41 (18,2%)	34 (15,1%)	7 (3,1%)
<i>The Caribbean - N (%)</i>	35	11 (31,4%)	11 (31,4%)	0 (0%)
<i>Central and South America - N (%)</i>	181	15 (8,3%)	13 (7,2%)	2 (1,1%)
Africa				
<i>Northern Africa - N (%)</i>	173	46 (26,6%)	39 (22,5%)	7 (4%)
<i>Sub-Saharan and Central Africa - N (%)</i>	256	100 (39%)	87 (33,9 %)	14 (5,4 %)
<i>Southern Africa - N (%)</i>	18	1 (5,6%)	0 (0%)	1 (5,6%)
Oceania				
<i>Madagascar - N (%)</i>	115	18 (15,7%)	17 (14,8%)	1 (0,9%)

FIGURE 1 Geographical distribution of the early repolarization pattern. LAER, low-amplitude early repolarization ($0.1 \text{ mV} < \text{J-point elevation} \leq 0.2 \text{ mV}$); HAER, high-amplitude early repolarization ($\text{J-point elevation} > 0.2 \text{ mV}$). Western and Central Europe: Germany, Albania, France, Belgium, Croatia, Denmark, Spain, Finland, Greece, Hungary, Eire, Italy, Kosovo, Macedonia, Montenegro, Norway, Poland, Romania. Eastern Europe: Belarus, Bulgaria, Estonia, Latvia, Lithuania, Georgia, Moldova, Russia, Ukraine. Middle East: Azerbaijan, Israel, Iran, Lebanon, Cyprus, Turkey. Central Asia: Afghanistan, Kyrgyzstan, Uzbekistan, Turkmenistan, Tajikistan. Southern Asia: Bangladesh, India, Nepal, Pakistan, Sri Lanka. Eastern Asia: China, South Korea, Japan, Mongolia. Southeastern Asia: Cambodia, Laos, Thailand, Malaysia, Vietnam. North America: USA, Canada, Mexico. Central and South America: Argentina, Brazil, Colombia, Equator, Honduras, Paraguay, Peru, Suriname, Uruguay, Venezuela. The Caribbean: Haiti, Dominican Republic. Northern Africa: Algeria, Egypt, Libya, Morocco, Mauritania, Tunisia. Sub Saharan and Central Africa: Angola, Benin, Burundi, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Congo, Democratic Republic of Congo, Ivory Coast, Djibouti, Ethiopia, Gabon, Gambia, Ghana, Equi Guinea, Guinea Bissau, Kenya, Mali, Niger, Nigeria, Uganda, Rwanda. Southern Africa: South Africa, Mozambique, Namibia. Pacific: Australia, New Zealand, Vanuatu. Madagascar

FIGURE 2 ECG of a 32-year-old recruit who died suddenly during de “Camarón day” 13-km running race. Lateral early repolarization pattern (ERP) was based on the following criteria: end-QRS notch on the downslope of a prominent R-wave, with a J-point elevation $> 0.2 \text{ mV}$ in two continuous leads (V4 and V5) and QRS duration was 84 ms ($< 120 \text{ ms}$). QTc was 388 ms

and decreases with aging (Klatsky, Oehm, Cooper, Udaltsova, & Armstrong, 2003; Smetana, Batchvarov, Hnatkova, Camm, & Malik, 2002). The studied population was a male, young and physically trained population; the high prevalence of ER was therefore expected. Afro-Caribbeans presented the highest rate of ERP, followed by Asians, while Whites had the lowest one. These observations are consistent with published data (Table 2) in the recent literature (Haruta et al., 2011; Klatsky et al., 2003; Kui et al., 2008; Noseworthy et al., 2011; Serra-Grima et al., 2015; Sinner et al., 2010; Sun et al., 2017; Uberoi et al., 2011).

Early repolarization pattern is also considered as a witness of physical training in athletes. Though rather well trained (on average

5.4 hr/week), the reported study population consisted in young military recruits who did not have a high athletic level at the time of the study. We did not observe difference in sport practice neither between ERP and NERP subjects, nor between LAER and HAER subjects.

Early repolarization pattern subjects had a lower heart rate and longer PR, QRS, and QTc intervals, which underlines the existence of a greater vagal tone than in NERP subjects as previously described (Bianco & Zeppilli, 2009; Wilhelm et al., 2010). A relatively high incidence of ventricular late potentials on signal-averaged ECG has been reported in ER syndrome patients (Abe et al., 2010). As expected, the presence of late potentials was significantly more frequent in

TABLE 2 Characteristics of studies including population based cohorts or athletes cohorts

Study	Population	Early repolarization	Main results
Tikkanen et al. (2009)	10,864 individuals—Finnish population 52.4% male (44 ± 8.5 years) Follow-up 30 ± 11 years	J point ≥0.1 mV: 630 (5.8%–70% male) -Inferior: 384 (59.5%) -Lateral: 262 (40.5%) [Both: 16 (2.5%)] J point >0.2 mV -Inferior: 36 (0.3%) -Lateral: 31 (0.3%)	ERP in inferior leads was associated with increased risk of death from cardiac causes ERP with J point >0.2 mV had markedly increased risk of death from cardiac causes
Sinner et al. (2010)	6,213 individuals (German population) 48.9% male (52 years) Follow-up 18.9 years	J point ≥0.1 mV: 812 (13.1%–96% male) -Inferior: 58.3% -Anterolateral: 33.9% [Both: 7.8%]	ERP was associated with a two- to fourfold increased risk of cardiac mortality in individuals between 35 and 54 years. An inferior localization of ERP was associated with a particularly increased risk
Uberoi et al. (2011)	29,281 individuals (13% Black, 6% Hispanic, 81% White or other) 87% male (55 ± 14 years) follow-up 7.6 ± 3.8 years	J point ≥0.1 mV: 664 (2.3%–96% male) -Inferior: 28% -Lateral: 72% [Both: 43 (6.5%)]	No significant association between any components of ERP and cardiac mortality Patients with lateral ERP were younger, had a lower heart rate and a higher prevalence of black race
Haruta et al. (2011)	5,976 individuals (Japanese—Nagasaki -population-based study over a study period of 46.5 years) 43.7% male	J point ≥0.1 mV: 1,429 (23.9%), 57% male. -Inferior: 30% -Lateral: 40% -Both: 30%	ERP was associated with an elevated risk of unexpected death and a decreased risk of cardiac and all-cause death
Sun et al. (2017)	11,956 individuals (Chinese rural population)	J point ≥0.1 mV: 1.3% (men 2.6%— women 0.2%, $p < 0.001$). -Inferior: 15.3% -Lateral: 73% -Both: 11.7%	ERP prevalence was low in this population
Noseworthy et al. (2011)	879 Collegiate athletes (20 sports)— Caucasian 84.3%, Black 10.5%, Asian 4.1%, Latino 0.7% 64% male 18 ± 0.8 years, training volume 6.7 ± 3.8 hr/week Follow-up 21 ± 13 months	J point ≥0.1 mV: 221 (25.1%–96% male) -Inferior: 2.5% -Lateral: 21.3% -Both: 1.3%	No death or unexplained syncope ERP athletes were more likely to be male, black, taller with lower heart rate and higher training volume
Serra-Grima et al. (2015)	299 white elite athletes, 66% men (20 ± 6.4 years)	J point ≥0.1 mV: 94 (31.4%) -Inferior: 6.4% -Lateral: 57.4% -Both: 37.2%	After a long follow-up period (24 years), no difference in outcome of sudden cardiac death was seen
Present study	2,508 men (French Foreign Legion- trained military recruits) 24 ± 5 years 489 Showed ERP (19%)—training volume 5.5 ± 3 hr/week. 1,689 Whites (14% with ERP), 388 Afro-Caribbeans (33% with ERP) and 431 Asians (27% with ERP) Follow-up 5 ± 2 years	J point ≥0.1 mV: 416 (16.6%) -Inferior: 53% -Lateral: 34% -Both: 13% J point >0.2 mV: 73 (2.4%) -Inferior 49% -Lateral 14% -Both: 37%	J point>0.2 mV was more frequent in Asian recruits. When associated with notched QRS complex and localized in inferior and lateral territories, ERP with J point >0.2 mV was rare (1%) One sudden death occurred in ERP group

Notes. ERP, early repolarization pattern.

ERP required a J-point elevation ≥0.1 mV in ≥2 adjacent leads with either slurring or notching morphology.

ERP patients than in NERP patients in the present study. Late potentials are thought to represent areas of delayed ventricular conduction. Clinical and prognostic significance of such finding is not known (Abe et al., 2010).

4.2 | High amplitude early repolarization and the risk of sudden death

Early repolarization is known to be a potential cause of sudden death, especially when located in the inferior or lateral ECG leads (Haissaguerre et al., 2008). It is not currently possible to distinguish

malignant from benign ER. Recent studies have tried to isolate criteria which could be associated with a higher risk of malignant arrhythmia (Antzelevitch & Yan, 2011; Antzelevitch, Yan, & Viskin, 2011). Those criteria consist in a notched QRS complex, a both inferior and lateral localization of ER, and a J-point elevation of more than 0.2 mV (also called HAER in our study) (Haissaguerre et al., 2009). HAER remained a relatively rare ECG feature, found in 2.9% of this study population and 1.1% when the three above-mentioned criteria were associated.

It is even more interesting to note that HAER was primarily found in the Asian group, with 8.5% prevalence (Table 1). These ethnical

origins are not trivial. Thus, the sudden unexpected nocturnal death syndrome (SUNDS) is an endemic cause of sudden death in Asia (Goh, Chao, & Chew, 1990). For the last two decades, the SUNDS was attributed to the Brugada syndrome. Recent studies raised the hypothesis that the SUNDS, the Brugada Syndrome, and the ER syndrome were different manifestations of a common nosological entity, called “J waves syndromes” (Antzelevitch & Yan, 2010). These observations argue that finding a notched and widespread HAER may not be as innocent as thought before.

4.3 | The Malagasy exception

Because of their isolation from mainland, it is discussed that island populations present less genetic variations than other populations (Frankham, 1997). Considering ERP rate observed among recruits from Africa (30%) and Asia (25%), Madagascar was an exception with only 16% of ERP (Table 2; Figure 1). The understanding of the peopling of Madagascar remains incomplete, but recent researches in archeology and genetics confirm that the Malagasy were originally and overwhelmingly Austronesian, native to the Indonesian archipelago (Burney et al., 2004; Hurles, Sykes, Jobling, & Forster, 2005). These crossbreeding of African and Asian populations may partially explain this lower rate of ERP.

4.4 | Cardiac event

During the follow-up, one sudden cardiac death was reported in a recruit originating from the Pacific area. For many reasons, the association between ERP and sudden cardiac death is questionable in this case. ECG analysis showed a notched lateral ERP with ascending ST segment. The distribution of J-point elevation has been proposed to influence risk of VF in ER syndrome. Multiple clinical studies have demonstrated that J-point abnormalities in the lateral ECG leads are associated with the lowest risk of VF whilst J-point abnormalities in the inferior leads and global J-point abnormalities are associated with progressively increasing risk of VF (Antzelevitch et al., 2011). A horizontal or downsloping morphology of the ST segment has been reported to be a marker of increased arrhythmic risk in cohorts of patients with the ER pattern (Antzelevitch et al., 2017; Haissaguerre et al., 2008; Tikkanen et al., 2011). Such was not the case here. Other significant risk factors were absent: QTc was not >400 ms, T/R ratio was not <0.25 in V5, and J-wave duration was not >60 ms (Cristoforetti et al., 2016; Roten et al., 2016). The association of ER with arrhythmic risk is typically at rest or during sleep, and not during physical activity (Obeyesekere et al., 2013). For all these reasons, the slight difference for sudden cardiac death between ERP and NERP subjects should be interpreted cautiously.

4.5 | Study limitations

This study was designed to appreciate the influence of ethnicity in a physically trained population. Soldiers of the French Foreign Legion

being all male, the choice of this population imposed a recruitment bias and the results cannot be applied to female. However, even if sex-stratified analysis has revealed an association of ER with cardiac mortality in males, 28% of the ER related idiopathic VF were female in the study reported by Haissaguerre et al. (2008) and Sinner et al. (2010). ERP and NERP patients had a similar level of physical activity but it may still be a confounding factor.

To avoid information bias, we did not collect information about family history of sudden cardiac death: as soldiers were in a probationary period of incorporation, they were susceptible to hide some medical information likely to compromise their commitment.

To our knowledge, this is one of the largest studies ever conducted about ethnicity and ERP in young athletes, but it is not possible to summarize the genetic diversity of human populations to a few hundred men.

5 | CONCLUSION

By providing information about the ethnical distribution of the ERP, this study confirmed that ERP is a common ECG finding. A J-point elevation of more than 0.2 mV (also called High Amplitude Early Repolarization—HAER—in our study) remains a relatively rare ECG feature (2.9%) but is more frequent in Asian recruits. This stresses the intriguing association of this suspicious HAER among subjects coming from East and South-East Asia, which is a notorious region because of its high exposure to the sudden unexplained nocturnal death syndrome. The only case of sudden cardiac death was originating from the Asian Pacific area in our study. HAER associated with a notched QRS and a double localization in the inferior and lateral territories which are three criteria of highest risk of malignant ventricular arrhythmias is found in only 1%. Prolonged follow-up and special attention may be required in such cases.

CONFLICT OF INTEREST

The authors report no relationships that could be construed as a conflict of interest.

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