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SYMPTOMS AND ELECTROCARDIOGRAPHIC EVALUATION IN YOUTH: A PERSPECTIVE BASED ON GENDER

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Symptoms and electrocardiographic evaluation in youth: a perspective based on gender

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Summary

Abbreviations

BBB: Bundle Branch Block

ECG: Electrocardiogram

HR: Heart Rate

LVH: Left Ventricular Hypertrophy

SCD-SOS: Sudden Cardiac Death – Screening Of Risk Factors

TLOC: Transient Loss Of Consciousness

Abstract

Background: Gender differences between male and female hearts have been known for many years. For the past years, researchers and clinicians have been focusing their attention on gender differences in illness. We know that some cardiac symptoms are more prevalent in women and electrocardiographic differences have also been demonstrated. The purpose of this study was to find the gender differences in symptoms and electrocardiographic features in a group of college students.

Methods: We selected 241 random participants from the *Sudden Cardiac Death – Screening Of Risk Factors* (SCD-SOS) project, aged from 18 to 34 years. All participants filled out a questionnaire evaluating physical activity, major cardiac symptoms, known heart disease and family history of sudden death and were submitted to a 12-lead electrocardiogram (ECG).

Results: 56,4% of our population were women and 39,4% practiced regular physical activity, with men being more physically active ($p \leq 0,0005$). Syncope was reported by 30,7% of participants, palpitations by 27,4% and chest pain by 21,6%. All symptoms were more frequent in women, but no statistical significance was observed. Men reported more visits to a cardiologist ($p \leq 0,0001$). Women had faster resting heart rates ($p \leq 0,05$), shorter PQ intervals ($p \leq 0,01$), narrower QRS complexes ($p \leq 0,0001$) and longer QTc intervals ($p \leq 0,0005$). Although not statistically significant, bundle branch block and early repolarization patterns were more frequent in males, while ST abnormalities were more frequent in females. Electrocardiographic criteria for Left Ventricular Hypertrophy (LVH) were considerably more prevalent in our male population ($p \leq 0,0005$).

Conclusions: Our data were in agreement with what was already published in literature, except for LVH being more prevalent in males. These differences in cardiac

electrophysiology explain gender-related prevalence of certain cardiac conditions and the increased risk for drug-related Torsades de Pointes in women. We hope this study may contribute to a better understanding of these issues and their relation with disease.

Key-words

Symptoms, ECG, youth, gender

Resumo

Introdução: Diferenças entre os corações masculinos e femininos são conhecidas há muito tempo mas, nos últimos anos, os clínicos e investigadores têm procurado perceber o impacto dessas diferenças na doença. Sabe-se que alguns sintomas do foro cardiológico são mais prevalentes em mulheres e algumas diferenças eletrocardiográficas foram já documentadas. O objetivo deste estudo foi estudar as diferenças, entre géneros, no que diz respeito aos sintomas e características eletrocardiográficas num grupo de estudantes universitários.

Métodos: Selecionámos aleatoriamente um grupo de 241 participantes no projeto *Sudden Cardiac Death – Screening Of Risk Factors (SCD-SOS)*, com idades compreendidas entre os 18 e os 34 anos. Todos os participantes preencheram um questionário onde se avaliava a atividade física, sintomas cardíacos major, doença cardíaca conhecida e história familiar de morte súbita e realizaram um eletrocardiograma de 12 derivações.

Resultados: 56,4% da nossa população eram mulheres e 39,4% praticavam atividade física regulamente, sendo que o género masculino afirmou ser mais fisicamente ativo ($p \leq 0,0005$). 30,7% dos participantes relataram episódios de síncope, 27,4% referiram palpitações e 21,6% referiram dor torácica. Todos os sintomas foram mais frequentes no género feminino, embora sem significado estatístico. Os homens referiram mais vezes ter recorrido a consultas de cardiologia ($p \leq 0,0001$). As mulheres apresentaram frequências cardíacas em repouso mais elevadas ($p \leq 0,05$), intervalos PQ mais curtos ($p \leq 0,01$), complexos QRS mais estreitos ($p \leq 0,0001$) e intervalos QTc mais longos ($p \leq 0,0005$). Os padrões de bloqueio de ramo e repolarização precoce foram mais frequentes no género masculino e as anomalias do segmento ST foram mais frequentes no género feminino, embora sem significado estatístico.

Os critérios eletrocardiográficos para hipertrofia ventricular esquerda foram mais prevalentes no género masculino ($p \leq 0,0005$).

Conclusões: Os nossos resultados estão de acordo com o que já havia sido publicado na literatura, excetuando a maior prevalência de hipertrofia ventricular esquerda no género masculino. Estas diferenças na eletrofisiologia cardíaca explicam as disparidades encontradas na prevalência de certas condições cardíacas entre géneros, bem como o aumento do risco de Torsades de Pointes induzido por fármacos verificado no género feminino. Esperamos que este estudo possa contribuir para uma melhor compreensão destas questões, bem como a sua relação com as doenças.

Palavras-chave

Sintomas, ECG, jovem, género

Background

Women (XX) and men (XY) differ in their genetic composition by a single chromosome out of the 46 that define human species. This difference affects their social and behavioural characteristics as well as the expression of disease. For decades, researchers and clinicians have been focusing their attention on gender differences in illness. In what concerns the heart, the differences between male and female exist and are clinically relevant.[1] These can be manifested either by different incidences of cardiac diseases, different clinical expressions of the same illness (different signs and symptoms), different diagnostic accuracy of tests, namely, the electrocardiogram or by different responses to therapy.

Although the literature is full of clinical and laboratory trials carried out in males, there is a growing number of studies that specifically addresses gender differences and nowadays we know that some diseases have different incidence and prognosis concerning gender. Estrogens have been pointed out as the great responsible for these different outcomes. But nothing is so simple.[1]

Regarding symptoms, syncope is a common problem in the general population and has a first peak around 15 years followed by a sharp increase after 70 years. In all age groups, syncope affects women more frequently than men and the majority of cases are vasovagal (reflex syncope), followed by cardiac causes, which become more common with advancing age. Some authors attributed the gender difference to lower cardiac filling in women.[2] Palpitations are a very common complaint in young patients and the majority of these are explained by ventricular premature beats or innocent supraventricular tachycardia. These usually become more frequent with age, especially if a structural heart disease is present.[3]

Chest pain is a frequent complaint in women. Typical, atypical or non-anginal chest pain in women is not always related with epicardial coronary disease.[4]

Concerning electrocardiographic differences, it has been well demonstrated that women have faster resting heart rates,[5–10] slightly shorter P-waves and PQ intervals,[8,10] shorter QRS duration[9,10] and lower QRS voltage,[9,10] longer QT and QTc intervals[5–12] and more variable ST-segments.[9] The gender differences in heart rate become apparent during childhood and persist throughout life and can be explained by intrinsic differences in the sinus node[5,8] as well as by a non-intrinsic mechanism related to gender hormones.[8] P-wave variances may suggest possible differences in atrial electrophysiology in men and women.[8] PQ interval differences might be due to disparities in the function of the atrioventricular node and conducting system.[8] A possible explanation for the differences in QRS duration and voltage has yet to be found.[10] QT and QTc intervals differences are absent in new-borns and children, become apparent during puberty and disappear after the age of fifty.[5,6,12] Gender hormone levels may explain these differences[5–7] as it is believed that progesterone and especially endogenous testosterone shorten the action potential and estrogens antagonize this effect.[8,11] However, the precise mechanism is not known.[5] Finally, the greater variation of the ST-segment in women also remains significant throughout adulthood and adds difficulty to accurately diagnosing subtle ischemic-related ECG changes.[9]

The purpose of this study was to find the gender differences in symptoms and ECG features in a group of college students.

Materials and Methods

This study was part of the SCD-SOS[13,14] project, which included about 15000 participants, the majority of which were college students, from Coimbra, aged between 18 and 34 years. All participants enrolled voluntarily after signing the informed consent (**attachment 1**) and were screened for cardiac diseases likely to cause sudden cardiac death. This screening consisted of an electronic questionnaire (**attachment 2**) and a 12-lead ECG. This protocol was accepted by the National Commission for Data Protection and by the Ethics Committee of Coimbra Hospital and University Centre. The anonymity of participants was guaranteed.

From this population, we randomly selected 241 participants to integrate our study.

A) SCS-SOS questionnaire

The SCD-SOS questionnaire v2.0 in digital form was filled out on a laptop computer and consisted of several multiple choice questions, with blank spaces for further description of symptoms and other relevant information. Participants were briefly asked about physical activity, previous syncope, diagnosis of epilepsy, palpitations, chest pain, medication, known heart disease, cardiology consultation and family history of sudden death before the age of 50.

The Cardiopulmonary technicians had had formation on the questionnaire and were able to clarify any questions regarding the interpretation of the questionnaire.

B) ECG

A 12-lead ECG was performed using a digital portable electrocardiograph (Mortara Eli 10) with a duration of 15 seconds, paper speed of 25 mm/s and amplification of 0.1 mV/mm. Parameters studied were: heart rate, PQ interval, QRS complex duration and QT and QTc intervals. Other important patterns considered were: bundle branch block, sinus arrhythmia, left ventricular hypertrophy, ST abnormalities, axis deviation, signs of early repolarization and ventricular or supraventricular extrasystoles.

C) Definitions

For the purpose of this study, we considered physical activity as any physical exercise practiced regularly, with or without participation in official sports competition.

Syncope was considered any transient loss of consciousness (TLOC). Palpitations were defined as sensations of irregular heart action ever felt by the participants. Chest pain was any pain with precordial localization. Cardiac disease referred to any cardiac condition known by the subject.

Normal ECG definitions[4,15–17] are presented in **Table 1**. All intervals were automatically measured by the electrocardiograph.

D) Statistical analysis

Quantitative variables were represented by mean ± standard deviation and unpaired Student's T-test was used to compare them. Categorical variables were compared by Chi square test with Fisher's exact test and were represented by proportion in the total.

The statistic program used was STATVIEW, version 5.0, SAS Institute.

Table 1 – Normal ECG definitions

Parameter	Description	Normal range
Heart Rate (HR)		60-100 bpm
PQ interval	Measured from the onset of the P wave to the end of the Q wave, in all leads	120-200 ms
QRS complex duration	Measured from the onset of the Q wave to the end of the T wave, in widest lead	≤100 ms
QT interval	Measured from the beginning of the QRS complex to the end of the T wave	
QTc interval	QT interval corrected for heart rate with Bazett's formula	350-450 ms
Complete Bundle Branch Block (BBB)	Intraventricular conduction disturbance with widening of QRS complex duration	≥120 ms
Incomplete BBB		100 – 120 ms
Sinus arrhythmia	Mild acceleration and slowing of the heart rate with breathing	Variation of P-P interval >120 ms, according to the phases of the respiratory cycle, with a constant PQ interval
LVH		Sokolow-Lyon criteria: SV1+RV5 or V6 > 35 mm
ST abnormalities	ST depression with T-wave inversion	
Normal axis	Mean orientation of the QRS vector with reference to the six frontal plane leads	-30º to +100º
- Left axis deviation		More negative than -30º
- Right axis deviation		More positive than +100º
Early repolarization pattern		ST segment elevation ≥0,5 mm in two consecutive leads and J wave or terminal slurring of R wave
Ventricular extrasystoles	Premature beats with origin above the atrioventricular node (supraventricular) and below (ventricular)	

Results

Our population of 241 young individuals had a mean age of 25,8 ± 6,3 years. There were 105 male participants and 136 female young adults (**Fig. 1**). When asked, 95 individuals (39,4%) admitted to practice regular physical activity.

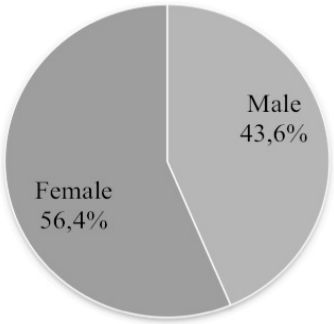

Figure 1 – Gender distribution

Data collected from questionnaires and ECG is summarized in **Tables 2-4**. Syncope was the most commonly reported symptom, followed by palpitations and chest pain. One individual did not answer neither if he had ever been diagnosed with a cardiac disease nor if he had been to a cardiologist and only 225 of the participants answered the question about having a relative that died unexpectedly before the age of 50 (**Table 2**).

Table 2 – Data collected from questionnaires

	Overall	Yes	No
Syncope	241	30,7% (74)	69,3% (167)
Palpitations	241	27,4% (66)	72,6% (175)
Chest pain	241	21,6% (52)	78,4% (189)
Cardiac Disease	240	5,8% (14)	94,2% (226)
Cardiology Consultation	240	31,7% (76)	68,3 (164)
Sudden Death in a <50 years family member	225	8,0% (18)	92,0% (207)

Mean with standard deviation of the quantitative ECG parameters studied are presented on **Table 3**. Most common ECG patterns were sinus arrhythmia (21,6%), early repolarization (8,7%) and LVH (8,3%). Among the 241 cases studied there was only one case of complete right BBB, which is why this case, as well as both supraventricular and ventricular extrasystoles and right and left axis deviation were not compared between genders (**Table 4)**.

Table 3 – Quantitative ECG parameters

	Mean ± 1 sd
Heart Rate	69,6 ± 11,8 bpm
PQ interval	148,3 ± 21,3 ms
QRS complex	94,8 ± 11,7 ms
QT interval	377,7 ± 28,2 ms
QTc interval	394,7 ± 18,3 ms

sd: standard deviation

Table 4 – ECG patterns

	Overall	Yes	No
Complete right BBB	241	0,4% (1)	99,6% (240)
Incomplete BBB	241	6,2% (15)	93,8% (226)
Sinus arrhythmia	241	21,6% (52)	78,4% (189)
LVH	241	8,3% (20)	91,7% (221)
ST Abnormalities	241	6,2% (15)	93,8% (226)
Left Axis Deviation	241	1,2% (3)	98,8 (238)
Right Axis Deviation	241	4,1% (10)	95,9% (231)
Early Repolarization	241	8,7% (21)	91,3% (220)
Supraventricular extrasystoles	241	0,4% (1)	99,6% (240)
Ventricular extrasystoles	241	0% (0)	100% (241)

Comparing genders, we found that male participants (mean age of 27,1 ± 6,3 years) were significantly older than female ones (mean age of 24,8±6,2 years) ($p \leq 0,01$). Data from questionnaires and ECG were compared between genders and our findings are presented in **Tables 5-7.**

There was a statistical significant relationship between gender and physical activity, with male participants being more physically active ($p \leq 0,0005$). Furthermore, almost half of the male population referred having gone to a cardiologist, contrasting with 20% of female individuals ($p \leq 0,0001$). In terms of symptoms, the differences found were not statistically significant although all the complaints were more frequent in females (**Table 5**).

Table 5 – Data collected from questionnaires, according to gender

	Overall	Male (n=105)	Female (n=136)	p
Physical Activity	95	52,4% (55)	29,4% (40)	≤ 0,0005
Syncope	74	24,8% (26)	35,3% (48)	ns (0,09)
Palpitations	66	21,9% (23)	31,6% (43)	ns
Chest Pain	52	18,1% (19)	24,2% (33)	ns
Cardiac Disease	14	4,8% (5)	6,7% (9)	ns
Cardiology Consultation	76	47,1% (49)	19,9% (27)	≤ 0,0001
Sudden Death in a <50 years family member	18	6,3% (6)	9,2% (12)	ns

Considering ECG quantitative parameters, we found that female population had faster resting heart rates (p≤0,05), shorter PQ intervals (p≤0,01), narrower QRS complexes (p≤0,0001) and longer QTc intervals (p≤0,0005) (**Table 6**).

Table 6 – Quantitative ECG parameters, according to gender

	Mean ± 1 sd		p
	Male	Female	
Heart Rate	67,9 ± 11,0 bpm	70,9 ± 12,3 bpm	≤ 0,05
PQ interval	152,5 ± 20,3 ms	145,0 ± 21,5 ms	≤ 0,01
QRS complex	100,3 ± 10,7 ms	90,5 ± 10,6 ms	≤ 0,0001
QT interval	376,8 ± 28,2 ms	378,4 ± 28,3 ms	ns
QTc interval	391,0 ± 18,3 ms	397,6 ± 17,8 ms	≤ 0,005

sd: standard deviation

When studying ECG patterns we found that LVH was much more prevalent in male participants (p≤0,0005). We did not find any other gender-prevailing abnormalities that were statistically significant (**Table 7**).

Table 7 – ECG patterns, according to gender

	Overall	Male (n=105)	Female (n=136)	p
Incomplete BBB	15	6,7% (7)	5,9% (8)	ns
Sinus arrhythmia	52	21,2% (22)	22,1% (30)	ns
LVH	20	15,2% (16)	2,9% (4)	≤ 0,0005
ST abnormalities	15	5,7% (6)	6,6% (9)	ns
Early Repolarization	21	12,4% (13)	5,9% (8)	ns

Discussion and Conclusions

Population: Although all participants were submitted to an ECG, not all of them answered the complete questionnaire. The least answered question was regarding sudden death of a relative under 50 years, with only 225 answers obtained, which could be explained by a lack of knowledge or interest regarding events in the family.

Physical activity: Almost 40% of our population admitted to being engaged in some kind of regular physical activity. There was a significant gender difference in this matter, as 52,4% of male participants claimed to be physically active contrasting with only 29,4% of females. This male prevalence was not surprising as it has been noted before that men are frequently more active than women.[18–21]

Syncope: At least one syncopal episode was referred by 30,7% of our population. Although syncope is a common problem, its true incidence is difficult to estimate due to variation of definition, differences in population prevalence and under reporting in general population.[2] However, incidence in our study seemed coincident with a Portuguese survey which reported a prevalence of TLOC in young adults of 29,7%.[22]

Syncopal episodes are known to be more frequent in the female population.[2,22,23] Although, in this study, this difference was not statistically significant (p=0,09), a larger sample would probably find a relation between women and syncope. This gender difference was thought to be due to differences in cardiac pressures, namely a lower cardiac filling in women when compared to men.[2]

Syncope is frequently associated with a benign prognosis, since the majority of triggers involves stress or conditions that affect orthostatic blood pressure regulation and therefore

syncope is most likely to be reflex.[2,22] However, when associated with certain clinical profiles, namely history of sudden death of a relative under 50 years, during physical exercise, due to fright or loud noise and sudden syncope with no apparent reason,[22] it may herald serious cardiac diseases that might need cardiologic assessment and investigation.

Palpitations: About 27% of our population referred palpitations. Although not statistically significant, these were more prevalent in the female population. Palpitations are a very common complaint in general population but its incidence in either normal or abnormal hearts is not well documented.[3] Palpitations can be benign, such as those caused by anxiety, emotions or exercise[24] or caused by pathological conditions, such as cardiac arrhythmias (sinus tachycardia, atrial fibrillation, premature ventricular beats or ventricular tachycardia), non-arrhythmic cardiac problems (mitral valve prolapse, pericarditis and congestive heart failure) or non-cardiac problems (hyperthyroidism, vasovagal syncope, hypoglycemia or stimulant drugs).[3,25] Most frequent cardiac causes of palpitations in young adults are premature ventricular beats or innocent supraventricular tachycardia.

Although the causes of palpitations are typically benign, it is important to distinguish those from cardiac causes, given the potential risk of sudden death or injury. Patients with sudden onset of palpitations associated with syncope, pre-syncope or family history of sudden cardiac death,[13] abnormal cardiac examination, abnormal ECG or non-sinus tachycardia[26] should be referred to a cardiologist.

Chest Pain: In our population, chest pain complaints were mentioned in 21,6% of questionnaires. As expected they were more frequent in women, although not in a statistically significant proportion.

Chest pain is mostly benign in this age group, the majority being related to the musculoskeletal system. However, there are more serious heart problems that may require a extensive evaluation, such as supraventricular tachycardia, atrial septal defect, mitral valve prolapse, myocardial infarction or myocarditis.[4]

Cardiology consultation: Almost 32% of our population admitted having seen a cardiologist at least once. Surprisingly, almost 50% of our male individuals went to a cardiology consult, contrasting with only 20% of female population. We attributed this disparity to the gender difference found in physical activity, as men, being more frequently physically active, would pay more visits to the cardiologist for routine exams. Also, many might have had an ECG that was reported by a cardiologist and this was interpreted as a cardiology consultation.

Heart Rate: Similarly to what was already known,[5–10] we found that female individuals had higher resting heart rates than males. The difference between the mean of male and female heart rates was 3 beats per minute, which corresponded to the 3 to 5 beats per minute described in literature.[5,6,10] It is also known that women are more prone to sinus tachycardia, and that sinus bradycardia is more frequent in men.[27]

The cause of these disparities in heart rate between genders is unclear. Initially, it was thought to be due to autonomic modulation[5] but these differences remain after double autonomic blockade by administration of ß-blockers and atropine, which suggests a possible intrinsic gender-related difference in the sinus node function[8,10,27] as well as a non-intrinsic mechanism related to gender hormones and a different exercise capacity.[5,8,10,27]

PQ interval: In this study, similar to what had been previously reported,[8,10,27] PQ interval was slightly but significantly longer in men than in women, with a mean difference of 7,5 ms.

As PQ interval is strongly influenced by the delay in conduction at the atrioventricular node it provides evidence for gender differences in the function of the atrioventricular node and conducting system.[8] These differences between gender tend to attenuate with age.[27]

QRS complex: In our study we found that women have a significantly shorter QRS complex duration comparing to men (9,8 ms shorter), which was in agreement with findings of several studies,[9,10] reporting a difference of about 10 ms.[9] Moreover, it is also known that QRS voltage is lower in women.[9,10]

These differences in duration and voltage of QRS complex between gender were thought to be due to differences of cardiac mass as result of male hormones[9] and body weight, but they persisted after correction for cardiac mass and body weight and in disease states such as ventricular hypertrophy.[10] A lack of awareness for these gender differences when interpreting ECG can negatively affect the validity of diagnosis made, particularly in cases of ischemic cardiomyopathy, in which women have less intraventricular conduction disturbance.[9] Also it can make the electrocardiographic criteria for LVH more specific but less sensitive in women.[10]

QT and QTc intervals: As expected,[5–12] we found that QT and QTc intervals were longer in female participants. The mean difference was 1,6 ms for QT interval (p=n.s) and 6,6 ms for QTc interval ($p \leq 0{,}005$). Although QTc mean difference between gender was statistically significant, it was still below the expected 10 to 20 ms (about 2-6%).[6,8,10,11]

As QT interval represents the duration of activation and recovery of ventricular myocardium it should shorten as heart rate increases.[11] This might explain why QT interval difference in women was not significant and QT corrected for heart rate accentuated that difference.

It is believed that disparities in QT and QTc interval between genders are mediated by the effect of sex steroid hormones[5,7,9] on Ca^{2+} and K^{+} channel function.[8,10] Specifically, it is believed that endogenous testosterone and progesterone are likely to suppress $I_{Ca,L}$ and enhance I_K channel currents, shortening the QT interval, while estrogen supresses I_k channel currents and has the opposite effect.[6,11] The establishment of the presence of cytoplasmatic and nuclear sex steroid receptors in cardiac myocytes supported this idea[5,6,9] and the possible involvement of I_{Na}, cannot yet be excluded.[9] It has also been proven that exogenous gender hormones modify the QT interval.[9,11]

Incomplete Bundle Branch Block: About 6% of our population had an incomplete BBB on ECG. It is difficult to estimate its true incidence given its great variance among different studies.[27,28] Incomplete BBB is known to be more frequent in young males than females,[27] which was also observed in our study. One possible explanation for this finding might be the increased cardiac muscle mass in male gender and resultant conduction delay.[29] Additionally, the higher prevalence of physically active males compared to females could explain the differences found, as incomplete BBB is a frequent finding in athletes.[29]

Sinus arrhythmia: This feature was present in 21,6% of our population with no inter-gender difference. Sinus arrhythmia is a common physiologic finding in healthy young adults[4,15] and the changes in ECG are due to cardiac vagal tone modulation with breathing.[4]

Left Ventricular Hypertrophy: In our population, 8,3% met the Sokolow-Lyon criteria for LVH, which was much higher than the 1,2% prevalence found in a similar study.[27] This disparity could be explained by lack of specificity of voltage criteria in individuals aged under 40, as they often have high amplitude QRS complexes in the absence of disease.[30,31]

Although there is no evidence of gender preponderance,[27] we found a statistically significant higher prevalence in male population. This gender difference in our study could be explained by the higher prevalence of physically active male participants, as LVH is one of the commonest ECG changes in athletes ECG.[32]

ST abnormalities: About 6% of our population presented ST segment abnormalities, differing from the 3,1% found in a similar study.[27] Previous studies reported ST segment abnormalities to be twice as frequent in women.[9,27] Our findings, however, did not support this evidence, which could be explained by our sample size. The mechanisms that lead to this gender disparity are yet to be discovered, but has been suggested that it might be due to hyperventilation in women, abnormalities of left ventricular wall motion related to mitral valve prolapse and altered myocardial sensitivity to circulating catecholamines.[27]

Physicians need to be aware of these singularities in female ST-segment, in order to accurately diagnosing subtle ischemic-related ECG changes, that might be further dissimulated in these ST differences.[9]

Early repolarization: This is a common finding in ECG. In fact the 8,7% prevalence we found in our study was consistent with 1-13% incidence reported in literature.[33] Early repolarization pattern is described as being more frequent in males.[33] Although not statistically significant, we did verify a male preponderance of this pattern.

In young and healthy individuals, particularly in males, blacks and athletes, this pattern has commonly been considered to represent an innocent finding.[34] However, the presence of this pattern, specially in inferior and lateral leads, might be associated with an elevated risk of unexpected death due to ventricular fibrillation.[33,34]

Conclusions: Our data were in agreement with what was already published in literature. We found that women mentioned episodes of syncope, palpitations and chest pain more frequently than man. Also, women had higher resting heart rates, shorter PQ intervals, shorter QRS complexes and longer QT and QTc intervals. Electrocardiographic patterns of incomplete bundle branch block and early repolarization were more prevalent in men, while ST abnormalities were more frequent in women. Surprisingly, more men admitted to having gone to a cardiologist and electrocardiographic left ventricular hypertrophy pattern was more prevalent in our male population.

Utility of study and future Differences between male and female cardiac electrophysiology exist and are clinically relevant. Several heart diseases and arrhythmias have gender-related prevalence. Women have higher risk of inappropriate sinus tachycardia, atrioventricular nodal re-entry tachycardia, congenital or acquired Long QT syndrome, while conditions such as Wolff-Parkinson-White syndrome, atrial and ventricular fibrillation, Brugada syndrome and sudden cardiac death have higher prevalence in men.[5–8,10,11] Although the mechanisms by which differences in electrophysiology translate into arrhythmia behaviour are not well understood, it is important for health care providers to be aware of these differences in order to provide optimal care for their patients.[5,10] These gender differences also affect the response to therapy as well as prognosis. In fact, the female gender is an independent risk factor for developing drug-related Torsades de Pointes which is related to longer QT intervals observed in women.[9,11] This fact must be taken into account when prescribing antiarrhythmic drugs such as type IA and III and other QT prolonging drugs.[5,6,8]

We find this study useful because the young population is not frequently studied and we believe that some markers of underdiagnosed cardiac disease, specifically abnormal symptoms, ECG abnormalities or both may be present since birth. Further research is needed,

but we hope that this study may contribute to a better understanding of these issues and their relation with disease.

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Attachments

Attachment 1 – Informed consent*

It is now known that heart diseases are among the leading causes of death in young people. We hereby request your assistance in a screening for heart disease in order to identify potential risk situations. This screening aims to detect cardiovascular disorders in young people, which may put them in a risk group, requiring monitoring by a cardiologist. We ask you to answer a short questionnaire of 7 questions (held in computerized form on a laptop that will be available to you) and an electrocardiogram. We ask you to give a contact number and the number of your Citizen Card if you want to be informed in case of risk. Therefore, this does not present any risks and the tests are quick and painless.

The answer to this questionnaire could provide important health gains of the participants, since in the light of current knowledge, about 1 in every 333 young people have heart disease risk, potentially treatable and that will be detected this way. This is an opportunity for a cardiac evaluation that is completely free and totally voluntary.

You may, at any time, declare your intention to leave the study. The data provided will be under the tutelage of researchers, will remain completely confidential and will be used only for study purposes, in view of the health of the participants.

I declare that I agree to participate in the SCD-SOS study and I was given me the opportunity to clarify all my doubts concerning this subject:

Name: _____

Date: _____

No. of Identity:: _____

Telephone No.: _____

I wish to be informed in case of alterations in the examinations	
Yes	No

**This informed consent was reviewed and modified according to suggestions made by the Ethics Committee of Coimbra Hospital and University Centre.*

Attachment 2 – SCD-SOS questionnaire

Identification:

Gender: □Female □Male Age: _____

First and Last Name:_____

No. of Identity:_____ Telephone No. :_____

Occupation: _____ If student, indicate the area:_____

Do you practice any sports/physical activity regularly? □Yes □No

Which one(s)? _____ How many hours per week?_____

Have you ever practiced competition sports/pre-competition/federated?_____

How long have you stopped?_____

1) Have you ever fainted/lost consciousness?

□No □Yes (if not, go strait to question 2)

For how long did you lose consciousness? (Choose the best option)

□Did not lose consciousness

□Less than 30 seconds

□Between 30 seconds and 5 minutes

□Between 15 and 30 minutes

□More than an hour

How old were you when you first fainted?_____

How many times have you fainted in the last 5 years?

□None □Once □2 to 5 times □Monthly □Weekly

In what context? (choose one or more as necessary)

□During physical exertion □After physical exertion

□Fright/Loud noise □Stress □Pain □Hunger □Drugs

□Heat □Prolonged standing □Sight of blood/injection

□Alcohol □Other – specify _____

Prior to fainting, do you usually experience one or more of the following?

□Racing heart □Nausea/feeling unwell □Pallor □Sweating

□Sensation of intense malaise □Change in vision □Disturbed hearing

□None. The fainting occurred without any warning.

□Other – specify_____

Did you fall down?

□No □Yes – If yes, were you injured?

□No □Yes – specify_____

If you didn't fall down, explain why:_____

Have your fainting episodes been witnessed by others?

□No □Yes – If yes, did you have a seizure?

□No □Yes

2) Do you have epilepsy or have you ever taken medication for epilepsy?

□No □Yes

3) Do you ever feel your heart racing or have tachyarrhythmic episodes?

□No □Yes – If yes, how long does it last?

□Seconds □Up to 5 minutes □Up to 15 minutes □More than 1 hour non-stop

When this happens, have you ever measured your pulse/heart rate?

□No □Yes – Indicate the measurement_____

During these episodes, have you ever felt any of the following? Select the appropriate(s)

□Feeling unwell □Dizziness □ Feeling faint □ Trouble breathing

During these episodes, have you ever had to:

□Stop everything you were doing □Seek medical help?

4) Do you ever experience chest pain?

□No □Yes

If yes, in what context does the pain occur?

□Physical exertion □Stress/emotion □At rest □Other – specify_____

If yes, how would you describe the pain?

□Stabbing □Tightness □Crushing □Burning

Is it accompanied by any of the following symptoms? Select the appropriate(s)

□Feeling unwell □Dizziness □Trouble breathing □Nausea □Sweating

What effect does the pain have on your activity? Select the appropriate

□You have to stop what you were doing □You carry on

How long does the pain last?

□Less than 10 seconds □1 minute □Up to 5 minutes □15 minutes □1 hour

5) Do you take any medication?

□No □Yes – which one(s)? _____

6) Have you ever been diagnosed with heart disease? (Among others, pay attention to the list below*)

□No □Yes – which?_____

7) Have you ever been seen by a cardiologist?

□No □Yes – In what context? _____

8) Do you have any relatives who:

– Died suddenly before the age of 50? □No □Yes

Indicate the cause: _____ □Don't know □Not known

Relationship_____ Age_____

– Died in a car accident before the age of 50? □No □Yes

– Type of accident: □Collision whit other vehicle □Crashed alone □Other

Relationship_____ Age_____

– Died of drowning before the age of 50? □No □Yes

Relationship_____ Age_____

– Has a pacemaker? □No □Yes

Relationship_____ Age fitted with device_____

– Has an implantable cardioverter-defibrillator (ICD)? □No □Yes

Relationship_____ Age fitted with device_____

Has a known heart disease (see list below*)

□No □Yes – which disease? _____

Relationship_____ Age_____

** List of diseases for question 8: hypertrophic cardiomyopathy, Marfan syndrome, arrhythmogenic right ventricular dysplasia, dilated cardiomyopathy, left ventricular non-compaction, aortic aneurysm, Wolff-Parkinson-White syndrome, anomalous origin of coronary arteries, Brugada syndrome, long QT syndrome, catecholaminergic ventricular tachycardia.*