

# European Heart Journal

## Sports cardiology in Europe from the ancient Greek-Roman era to the present

--Manuscript Draft--

<b>Manuscript Number:</b>	
<b>Article Type:</b>	CardioPulse
<b>Section/Category:</b>	Epidemiology and Prevention
<b>Keywords:</b>	sports cardiology; exercise; athlete heart; history; sudden cardiac death
<b>Corresponding Author:</b>	Michael Papadakis, MBBS, MD St George's, University of London London, UNITED KINGDOM
<b>First Author:</b>	Silvia Castelletti
<b>Order of Authors:</b>	Silvia Castelletti Flavio D'Ascenzi Michael Papadakis, MBBS, MD
<b>Abstract:</b>	Not applicable.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

# *Sports cardiology in Europe*

## *from the ancient Greek-Roman era to the present*

Silvia Castelletti<sup>1</sup>, Flavio D'Ascenzi<sup>2</sup>, Michael Papadakis<sup>3</sup>

1. Cardiomyopathy Unit and Department of Cardiovascular, Neural and Metabolic Sciences, IRCCS Istituto Auxologico Italiano, Milan, Italy.
2. Department of Medical Biotechnologies, Division of Cardiology, University of Siena, Siena, Italy.
3. Cardiovascular Clinical Academic Group, Institute of Molecular and Clinical Sciences, St George's, University of London and St George's University Hospitals NHS Foundation Trust, London, United Kingdom.

*Word count:* 1393 (limit 1400)

*Disclosures:* Authors have no disclosures

*Keywords:* sports cardiology, exercise, athlete heart, history, sudden cardiac death

*Corresponding author:* Michael Papadakis, Cardiovascular Clinical Academic Group, Institute of Molecular and Clinical Sciences, St George's, University of London and St George's University Hospitals NHS Foundation Trust, London, United Kingdom. E-mail: mipapada@sgul.ac.uk

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

*If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health.*

### *Hippocrates*

Imagine walking 40 kilometres crossing fields and villages along the sea. Imagine this to be your doctor's prescription. Impossible? Not in the 5<sup>th</sup> century B.C., when Herodicus recommended his patients walking from Athens to Megara. Herodicus, the "father" of sports medicine, was a wrestling and boxing instructor and a physician who combined his medical and sports expertise to develop a new medicine for body health; strict diet and regular exercise. He promoted exercise as therapy and dedicated a chapter to athletic training in his book "Regimens in Health". It is alleged that Herodicus was one of Hippocrates teachers, who in turn, influenced the Roman physician Galen, who wrote on the importance of training. Galen's work influenced the Renaissance period and the studies of the body of Leonardo Da Vinci, Michael Severtus, Realdus Columbus, Andreas Vesalius, Santorio Santorio and William Harvey, who explored the pulmonary and cardiac circulation, and of the Italian Hieronymus Mercurialis whose book on the "Art of Gymnastics Among the Ancients" influenced perceptions on exercise and health in Europe and America. The teachings of Herodicus, Hippocrates and Galen formed the basis of medical school curriculums through the late 1700s. In 1794 John Pugh wrote on the benefits of exercise. In the late 1800s the first accounts on the potential harmful effects of exercise on the heart were reported, first as the "soldier's heart syndrome" and then as the "athlete's heart syndrome". This opened the door to a debate which has continued through the centuries<sup>1</sup>.

In the current era, systematic research has proven that routine exercise prevents cardiovascular and non-cardiovascular diseases. On the other hand, it has also been accepted that exercise can trigger life-threatening events in individuals with cardiovascular diseases, which are often silent. Therefore, preventive strategies, which promote safe participation to exercise, have become essential, laying the foundations of sports cardiology.

### **Sports cardiology as a distinct entity**

In 1950, Italy established the medical evaluation prior to sports participation in athletes by law. Concerns relating to the number of athlete deaths led to a session dedicated to "death in sport" during the 18th World Congress in Sports Medicine in Oxford in 1970. In April 1978, "sports cardiology" appeared as a distinct entity from sports medicine, when cardiologists and sports physicians gathered in Rome for the Sports Cardiology International Congress. However, only on

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

March 13<sup>th</sup> 1981 the first sports cardiology society was born. It was founded in Rome by a group of eminent cardiologists including Antonio Venerando, Francesco Furlanello, Antonio Pelliccia, Paolo Zeppilli. In its constitution, they wrote “The Italian Society of Sports Cardiology aims to advance the knowledge on the effects of physical activity and sport on the cardiovascular system through facilitating research, congresses, and courses... it aims to provide the guidance for participation in exercise and sport, including elite, recreational and rehabilitation exercise”. In 1983, the first congress of the Italian Society of Sports Cardiology was held in Rome<sup>2</sup>. In 1989 the first recommendations for sports eligibility and disqualification were published by the Italian Society of Sports Cardiology and the Italian Federation of Sports Medicine.

In 1982, the Italian government introduced by law a nationwide sports pre-participation cardiac screening program. The screening was based on personal and family history, physical examination, resting electrocardiogram and an abbreviated exercise stress test. This approach was criticized as it was not based on evidence but reflected the will of the Italian society to protect its athletes. The systematic screening allowed the collection of large volumes of data which in turn helped us define the incidence and causes of SCD in athletes, the impact of cardiac screening, the training-induced electrocardiographic and echocardiographic changes in athletes and how to differentiate physiological adaptations from phenotypes of heart disease. On the other side of the Atlantic, in 1985, the results of the 16<sup>th</sup> Bethesda Conference were published, which were the first American recommendations for eligibility for competition in athletes with cardiovascular disease. Since the original Bethesda conference, the American Heart Association and subsequently the American College of Cardiology have recommended pre-participation screening of young athletes using a 14-point questionnaire and physical examination, alone.

In 2001 Alessandro Biffi organized the first European Society of Cardiology (ESC) course on Sports Cardiology at the Heart House in Nice, which led to the creation of the ESC Sports Cardiology Group by Hans Halvor Bjørnstad, Domenico Corrado, Antonio Pelliccia and others. The group was officially recognized in 2002 and was incorporated in the Working Group of Cardiac Rehabilitation and Exercise Physiology<sup>2</sup>. The working group developed to the European Association of Preventive Cardiology (EAPC), counting almost 5000 members, with Sports Cardiology and Exercise being one of its core sections. In 2005 the ESC sports cardiology group published its first consensus document on the role of pre-participation cardiac screening in reducing the burden of sudden cardiac death (SCD) in competitive athletes. In the same year, the group

1 published the first European recommendations for competitive sports participation in athletes with  
2 cardiovascular disorders.  
3  
4

5 In 2003, Domenico Corrado, demonstrated that sports, *per se*, is not a cause of increased mortality  
6 among athletes, but it may trigger arrhythmias in those affected by a cardiovascular condition<sup>3</sup>. The  
7 study, investigated the cause of SCD in 300 adolescents and young athletes and reported an  
8 increased risk of SCD associated with sports activity compared to non-athletes in those who had an  
9 underlying cardiac disorder<sup>3</sup>.  
10  
11  
12  
13  
14  
15

16 Acceptance of the Italian screening program started to increase in 2006, after the publication by  
17 Domenico Corrado that the implementation of the screening program in Italy had resulted to an  
18 89% reduction in SCD of athletes over a 25-year period<sup>4</sup>. In 2009 the International Olympic  
19 Committee (IOC) and the Fédération Internationale de Football Association (FIFA) recommended  
20 ECG screening prior to sports participation in all athletes. This has led to the inclusion of the ECG  
21 screening in many countries and advanced knowledge of the athlete's heart.  
22  
23  
24  
25  
26  
27

28 In 2008 Antonio Pelliccia showed how electrocardiographic abnormalities might precede  
29 morphological evidence of underlying cardiomyopathies, such as hypertrophic cardiomyopathy.  
30 However, the Italian groups' data on the athletic heart were all on Caucasian athletes. Sanjay  
31 Sharma first showed ethnic differences in the left ventricular remodelling in highly-trained athletes  
32 in 2008<sup>5</sup> and a few years later, along with Michael Papadakis, published the first extensive study on  
33 the electrocardiographic characteristics of the Afro-Caribbean athletes<sup>6</sup>.  
34  
35  
36  
37  
38  
39  
40  
41

42 In 2005 the first recommendations for interpreting the electrocardiogram in athletes were published  
43 by the European group. As more evidence emerged, these recommendations were refined in 2010,  
44 offering for the first time a clear distinction between physiological and potentially pathological  
45 ECG phenotypes. In 2011, the American College of Cardiology created the Sports Cardiology and  
46 Exercise Section of the ACC, founded by ten American sports experts including Aaron L. Baggish.  
47 Jonathan A. Drezner in 2013 led an effort which produced an international consensus on the  
48 interpretation of the athlete's ECG, referred as the "Seattle criteria". In 2017, the same international  
49 collaboration produced a comprehensive evaluation of the athlete's ECG, referred as the  
50 "International ECG criteria", which today forms the gold standard for the interpretation of the  
51 athlete's ECG<sup>7</sup>.  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1 The interest in Sports Cardiology has grown exponentially over the past two decades, as has the  
2 output of innovative research from centres throughout Europe and the world. The Herodicus,  
3 Hippocrates and Galen's teachings have withstood time, through all the debates and scepticism, and  
4 reappeared in a different guise. In the current era, sports cardiology spearheads the promotion of  
5 safe participation to exercise as an antidote to the growing epidemic of sedentarism, obesity and  
6 cardiovascular disease. The growing population of amateur athletes competing at mass events and  
7 the expansion of cardiac pre-participation screening programs have provided unparalleled  
8 momentum and are no longer confined to the elite athletes. Sports Cardiology forms one of the key  
9 pillars of Preventive Cardiology. In 2013, the European Sports Cardiology group led by Hein  
10 Heibuchel, published a proposal for a core curriculum for a European Sports Cardiology  
11 qualification.<sup>8</sup> The aim was to facilitate uniform training and guideline implementation throughout  
12 Europe, and safeguard that evaluation and guidance of athletes or individuals who wish to engage in  
13 leisure-time sports activities is performed by physicians with expertise in the field. Elements of  
14 Sports Cardiology were subsequently included in the ESC curriculum for the general cardiologist  
15 and the preventive cardiology curriculum of the EAPC<sup>9</sup>. Finally, in 2020, the ESC released the first  
16 Guidelines on Sports Cardiology and Exercise in patients with cardiovascular disease. These  
17 guidelines underlie the therapeutic role of exercise in preserving the health of the body<sup>10</sup>, and set a  
18 number of key research priorities for the future.  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35

## 36 **ACKNOWLEDGEMENT**

37 This article does not offer a comprehensive list of all the sports physicians and cardiologists who  
38 have contributed to the field of sports cardiology. We apologize we could not acknowledge every  
39 individual in our article.  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

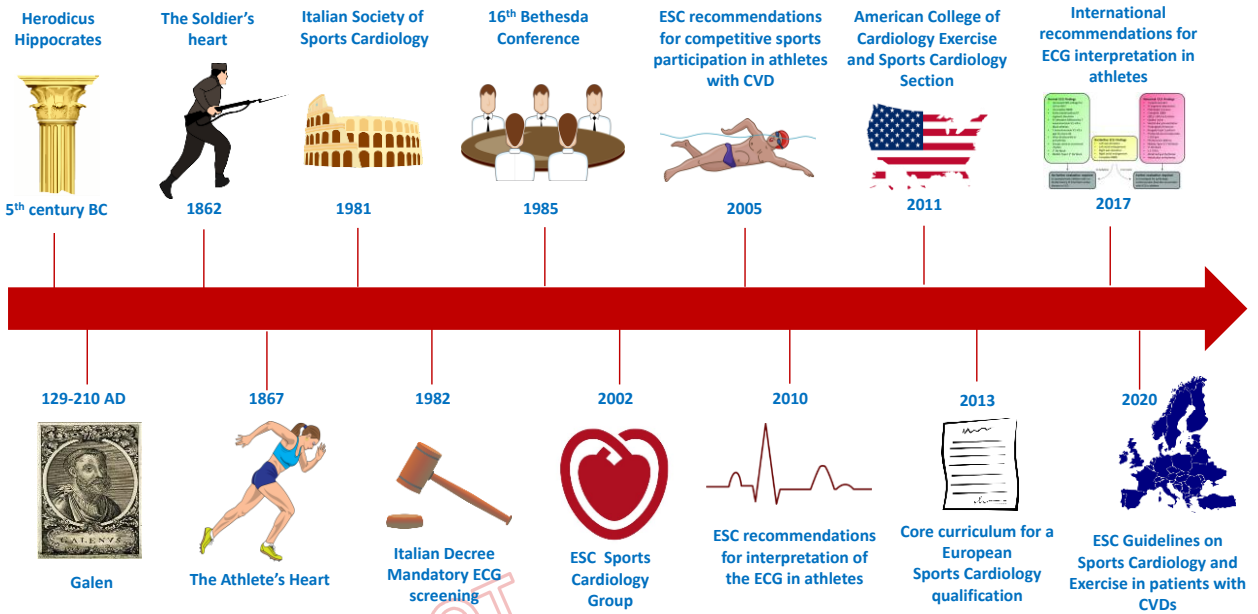
1  
2 **REFERENCES**  
3

- 4 1. Castelletti, S. & Pieleas, G. The Athlete's Heart from Philpippides to the modern marathon  
5 runners. On publication (2022).  
6  
7  
8  
9 2. De Backer, G. *et al.* A short history of the European Association of Preventive Cardiology  
10 (EAPC). *Eur. J. Prev. Cardiol.* zwac027 (2022) doi:10.1093/eurjpc/zwac027.  
11  
12 3. Corrado, D., Basso, C., Rizzoli, G., Schiavon, M. & Thiene, G. Does sports activity enhance the  
13 risk of sudden death in adolescents and young adults? *J. Am. Coll. Cardiol.* **42**, 1959–1963  
14 (2003).  
15  
16 4. Corrado, D. *et al.* Trends in sudden cardiovascular death in young competitive athletes after  
17 implementation of a preparticipation screening program. *JAMA* **296**, 1593–1601 (2006).  
18  
19 5. Basavarajaiah, S. *et al.* Ethnic Differences in Left Ventricular Remodeling in Highly-Trained  
20 Athletes. *J. Am. Coll. Cardiol.* **51**, 2256–2262 (2008).  
21  
22 6. Papadakis, M. *et al.* The prevalence, distribution, and clinical outcomes of electrocardiographic  
23 repolarization patterns in male athletes of African/Afro-Caribbean origin. *Eur. Heart J.* **32**,  
24 2304–2313 (2011).  
25  
26 7. Sharma, S. *et al.* International recommendations for electrocardiographic interpretation in  
27 athletes. *Eur. Heart J.* **39**, 1466–1480 (2018).  
28  
29 8. Heidbuchel, H. *et al.* Position paper: proposal for a core curriculum for a European Sports  
30 Cardiology qualification. *Eur. J. Prev. Cardiol.* **20**, 889–903 (2013).  
31  
32 9. Wilhelm, M. *et al.* EAPC Core Curriculum for Preventive Cardiology. *Eur. J. Prev. Cardiol.*  
33 zwab017 (2021) doi:10.1093/eurjpc/zwab017.  
34  
35 10. Pelliccia, A. *et al.* 2020 ESC Guidelines on sports cardiology and exercise in patients with  
36 cardiovascular disease. *Eur. Heart J.* (2020) doi:10.1093/eurheartj/ehaa605.  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

# FIGURES

Figure: Graphical abstract of the history of sports Cardiology with key milestones



DO NOT  
DISTRIBUTE



## Disclosures

Dr Castelletti is a nucleus member of the Italian Society of Sports Cardiology. She has received consulting fees from Educazione Nutrizionale Grana Padano.

Dr Flavio D'Ascenzi has nothing to declare.

Dr Michael Papadakis has received research grants from the charitable organisation Cardiac Risk in the Young and consulting fees from Bristol Myers Squibb.

DO NOT  
DISTRIBUTE



Click here to access/download

**ICMJE Conflicts of Interest form (1 for each author listed)**

**coi\_disclosure\_SC.docx**



DO NOT  
DISTRIBUTE



Click here to access/download

**ICMJE Conflicts of Interest form (1 for each author listed)**

COI\_disclosure\_FDA.pdf



DO NOT  
DISTRIBUTE



Click here to access/download

**ICMJE Conflicts of Interest form (1 for each author listed)**

coi\_disclosure\_MP.docx



DO NOT  
DISTRIBUTE