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DELLA FEDERAZIONE MEDICO SPORTIVA ITALIANA

GUARDIAMO AL FUTURO:
L’ATLETA AL CENTRO.
LA TUTELA DELLA SALUTE È IL NOSTRO TRAGUARDO

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SPORTS PHYSICALS AND FOCUSED ECHOCARDIOGRAM

SUMMARY

BACKGROUND: The sports physical is the only means of implementing a strategy for the prevention of sudden cardiac death; however, on an international level, there are still differing opinions as to how this can be achieved. In this context there are essentially two schools of thought: the European, which is in favor of introducing the ECG as part of the sports physical, and the American view, which does not consider this test indispensable because it is not yet sufficiently specific. At the same time, the growing use of echocardiography and our growing understanding of the athlete’s heart have led a number of authors to imagine its possible use in the context of pre-competition screening. The purpose of this study was to assess the improvement in effectiveness that could be obtained by including a “focused” echocardiogram as part of pre-competition screening in Italy.

METHODS: The study was based on a sample of 920 athletes (75.80% male; 24.20% female; average age 28.39), who were tested in order to renew their competitive and non-competitive certificates. The study analyzed the incremental effectiveness of three different pre-participation screening strategies. Strategy 1: physical examination and family and personal medical history; strategy 2: physical examination, family/personal medical history and 12-lead ECG; strategy 3: physical examination, family/personal medical history, 12-lead ECG and Focused ECHO. In all three options a standard echocardiogram was performed to calculate the sensitivity and specificity of the tests. For each option, we also calculated the direct and indirect costs of each screening method right up to the final diagnosis. The cost of the pre-participation screening examination was estimated to be: €20 for the first option, €45 for the second option and €80 for the third option.

RESULTS: The introduction of the ECG has significantly increased the sensitivity of the diagnostic test, enabling us to identify two conditions that are potential causes of sudden death; however, it also identified a false positive rate of 7.3%, corresponding to a specificity of 87.17%. On the other hand, the introduction of the focused echocardiogram resulted in a considerable increase in both specificity and sensitivity (specificity of 96.57%, sensitivity of 80.50%).

The total cost of each individual option (considering the total cost of the screening, the cost of any second and third level tests, any daily income lost due to supplementary testing) increases over all to: €34,752.70 for the first strategy; €68,761.55 for the second strategy; €90,297.89 for the third strategy.

CONCLUSIONS: Based on these results we can state that a focused echocardiogram can be included as part of a screening physical at a reasonable cost and could, in our opinion, be a strategy to improve the specificity of the screening in particular.


KEY WORDS: Echocardiography - Cost-benefit analysis - Death, sudden, cardiac.

RIASSUNTO

OBIETTIVO: La visita medico-sportiva rappresenta l’unico mezzo attraverso cui attuare una strategia di prevenzione contro la morte cardiaca improvvisa; tuttavia esistono ancora delle divergenze a livello internazionale circa le modalità di esecuzione della stessa. In questo contesto esistono essenzialmente due scuole di pensiero: quella europea, a favore dell’introduzione dell’ECG all’interno della visita medico-sportiva, e quella americana, che non considera tale esame indispensabile, in quanto non ancora sufficientemente specifico. D’altra parte la sempre maggiore diffusione dell’ecocardiografia e la nostra più approfondita conoscenza del cuore di atleta, ha portato alcuni autori a ipotizzarne un possibile ruolo nell’ambito dello screening preagonistico. L’obiettivo di questo studio è quello di valutare l’efficacia incrementale dell’introduzione di un esame ecocardiografico “focused” o “mirato” all’interno dello screening pre-agonistico italiano.
Today sports medicine is the only means of implementing a strategy for the prevention of sudden cardiac death, because it makes it possible to identify athletes with asymptomatic heart conditions and to program appropriate treatment. Over the years there has been a great deal of debate about how sports physicals should be performed. In this context there are essentially two schools of thought: the European, which is in favor of introducing the ECG as part of the sports physical, and the American view, which does not consider this test indispensable because it is not yet sufficiently specific. In fact, whereas on one hand an ECG significantly increases the sensitivity and negative predictive value of the screening, on the other it produces a high false positive rate which restricts its introduction as part of a screening program. Starting from this assumption, over the years numerous attempts have been made to improve the specificity of the ECG and therefore to optimize its cost-benefit ratio. This is borne out by the fact that since the 1990s the criteria for the interpretation of an athlete’s ECG have been updated several times; in particular, in 2010 the “Sport Cardiology” section of the “European Association of Cardiovascular Prevention and Rehabilitation” produced its first supporting document, which was implemented in 2011 by the so-called “Stanford” criteria and later, in 2013, by the “Seattle criteria”; this led to a considerable decrease in the percentage of false positives given by ECGs (it was reduced from about 40% with the first criteria to about 6% with the Seattle criteria).1-5 If we were to

La medicina dello sport rappresenta, a oggi, l’unico mezzo attraverso cui attuare una strategia di prevenzione contro la morte cardiaca improvvisa, in quanto strumento in grado di identificare gli atleti con una cardiopatia asintomatica e progettarne un percorso terapeutico adeguato. Negli anni si è molto dibattuto sulle modalità di esecuzione della visita medico-sportiva, in questo contesto esistono due scuole di pensiero: quella europea, che non considera tale esame indispensabile, in quanto non ancora sufficientemente specifico. Infatti, se da una parte l’ECG aumenta in maniera considerevole la sensibilità e il valore predittivo negativo dello screening, dall’altra produce un notevole numero di falsi positivi che ne limitano la sua introduzione all’interno di un programma di screening. Partendo da questo presupposto, negli anni sono stati fatti diversi tentativi di migliorare la specificità dell’ECG e quindi ottimizzarne il rapporto costo-beneficio. A dimostrazione di ciò dalla fine degli anni ’90 a oggi, sono stati aggiornati più volte i criteri per l’interpretazione dell’ECG dell’atleta; in particolare, nel 2010 la sezione “Sport Cardiology” della “European Association of Cardiovascular Prevention and Rehabilitation” ha prodotto un primo documento di consenso, implementato, prima, nel 2011 dai cosiddetti criteri di “Stanford” e poi, nel 2013 dai “Seattle criteria”, che ha portato ad una considerevole diminuzione della percentuale dei falsi positivi del ECG (si è ridotta da circa il 40% dei primi criteri fino a circa il 6% dei Seattle criteria).1-5 Ora, se provassimo a trasportare questo numero su una popolazione di 10 milioni di atleti (dati...
Materials and methods

The study was conducted on a sample of 920 consecutive athletes, who attended the “Il Quadrifoglio” Sports medicine clinic in 2014, a First Level center recognized by FMSI (the Italian Federation of Sports Medicine) and approved by the University of L’Aquila. Each athlete gave his informed consent before the physical examination was performed according to the protocol of this study. The sample of 920 athletes was 75.80% male and 24.20% female; the average age of the sample was 28.3 years ±15.582; their BMI average was 22.76 kg/m² ±3.55; the sports practised and analysed are listed in Figure 1, with the respective percentages. The study was

transpose this number on to a population of 10 million athletes (American data), it would mean that we would need to perform a second level test on about 500,000 athletes, in order to exclude asymptomatic heart disease, which would demand a considerable outlay of energy and money by the health system. We are therefore faced with a difficult problem because we need to combine two types of problem: an ethical problem, related to the proven sensitivity of an ECG, and an economic problem that arises out of the fact that it is not yet sufficiently specific. This issue is particularly relevant because the “State System” is called upon, today more than ever before, to tackle the problem of the allocation of scarce resources, but without overlooking the social repercussions of this decision. From our perspective one possible solution could be to introduce a focused echocardiogram as part of a sports physical, a solution that has already been contemplated by a number of authors; this would enable us not only to reduce the false positive rate but also to diagnose conditions that cannot be detected by a physical examination or even by careful analysis of an ECG, such as anomalies of the coronary arteries. The purpose of this study is therefore to assess the incremental effectiveness of three different pre-participation screening strategies. Strategy 1: physical examination, family and personal medical history (American screening model); strategy 2: physical examination, family/personal medical history and 12-lead ECG (Italian and European screening model); strategy 3: physical examination, family/personal medical history, 12-lead ECG and Focused ECHO (screening model proposed by our study).

光电心向量图

![ECG Image](image1)

**Materials and methods**

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![ECG Image](image2)

**Materials and methods**

The study was conducted on a sample of 920 consecutive athletes, who attended the "Il Quadrifoglio" Sports medicine clinic in 2014, a First Level center recognized by FMSI (the Italian Federation of Sports Medicine) and approved by the University of L’Aquila. Each athlete gave his informed consent before the physical examination was performed according to the protocol of this study. The sample of 920 athletes was 75.80% male and 24.20% female; the average age of the sample was 28.3 years ±15.582; their BMI average was 22.76 kg/m² ±3.55; the sports practised and analysed are listed in Figure 1, with the respective percentages. The study was
Ogni partecipante allo studio è stato sottoposto a una visita comprendente:
— anamnesi personale e familiare;
— esame obiettivo con rilevazione della pressione arteriosa;
— esame spirometrico;
— esame delle urine;
— elettrocardiogramma a riposo;
— elettrocardiogramma durante e dopo step test;
— test ergometrico massimale (per gli atleti di età maggiore di 35 anni);
— esame ecocardiografico focalizzato secondo il protocollo definito nello studio;
— esame ecocardiografico standard per il calcolo della specificità e sensibilità del test di screening.

I risultati di ogni esame sono stati valutati separatamente da due medici sportivi esperti nell’esecuzione e nell’interpretazione degli esami previsti dal protocollo.

Personal and family medical history and physical examination

All participants underwent a scrupulous physical examination and provided a detailed record of their family and personal medical history, based on the 12-point protocol drawn up by the American Heart Association.8

Anamnesi personale e familiare ed esame obiettivo

Tutti i partecipanti sono stati sottoposti a un accurato esame obiettivo ed ad una puntuale raccolta dell’anamnesi familiare e personale, sulla base del protocollo a 12 punti elaborato dalla Società Americana di Cardiologia 8.
**ECG at rest and during a Step Test**

Immediately after the physical examination the athletes were given a standard 12-lead electrocardiogram (MAC, GE Healthcare, Milwaukee, WI, USA); this was interpreted according to the Seattle criteria (2013). After a standard ECG, an ECG was recorded during a step test. This examination is based on an initial resting electrocardiogram lasting one minute, after which the patient is invited to climb up and down a step, of variable height, 30 times a minute for 3 minutes, and the recording was continued to the fifth minute of recovery, after the effort.

**Focused echocardiogram**

All 920 athletes were given what is known as a “focused” echocardiogram (Alpinion Medical Systems – E-Cube 7 Seoul, Korea). This test was based on a protocol that envisages recording 8 images for a maximum length of 12 minutes (Table I). And finally, each athlete was given a complete echocardiogram, interpreted according to the guidelines of SIEC (Società Italiana di Ecocardiografia). If any anomalies were detected during one of the three steps of the screening protocol described above, the athlete was invited to take additional second and third level tests, in line with national and international guidelines (COCIS 2009, 36th Bethesda Conference 2005).

**Calculation of costs**

The cost of the three types of screening were estimated, calculating the direct costs and indirect costs for each option. In particular, the cost of the pre-participation screening examination

<table>
<thead>
<tr>
<th>Projection</th>
<th>To be evaluated</th>
<th>Number of images obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasternal long axis</td>
<td>Rating M-mode, size of the left ventricle, Measuring aorta diameters (annulus, Valsalva sinuses, sino-tubular junction-thoracic aorta).</td>
<td>2 (aorta and left ventricle size)</td>
</tr>
<tr>
<td>Parasternal short axis</td>
<td>Rating aortic valve morphology, CW Doppler pulmonary valve, coronary anomalies evaluation, evaluation of left ventricular at papillary muscle level. Evaluation of the kinesis of the left ventricle</td>
<td>2 (aortic valve morphology, pulmonary valve CW)</td>
</tr>
<tr>
<td>4 apical rooms</td>
<td>Diastolic filling evaluation, estimated pulmonary systolic pressure, TAPSE</td>
<td>2 (diastolic pattern, pulmonary systolic pressure)</td>
</tr>
<tr>
<td>5 apical rooms</td>
<td>CW Doppler of aortic valve</td>
<td>1 (CW aortic valve)</td>
</tr>
<tr>
<td>Subcostal</td>
<td>Rating interatrium septum VCI</td>
<td>1 (Imagine 2d of the projection)</td>
</tr>
</tbody>
</table>
was estimated to be €20 for the first option; €45 for the second option; €80 for the third option. The cost of the examination considered both the direct (cost of the doctor, the assistant, the machinery, electricity, the necessary instruments, etc.) and the indirect costs (administration costs, maintenance costs, etc.) for the screening. In particular, the indirect costs included the cost of training the sports medicine specialist to perform a focused echocardiogram, calculated as approximately €5.21 per patient for a population of 920 athletes. To calculate the total cost of the screening, the daily income lost as a result of any supplementary tests was also estimated. This income was estimated to be €56.65, as per the ISTAT Report for 2013. The costs for each examination referred to average values calculated on the basis of the refunds guaranteed by insurance companies and by DRG.

**Statistical analysis**

The study analyzed the sensitivity, specificity and positive and negative predictive value of the three pre-participation screening options, using the 2x2 contingency table and considering the confidence interval to the 95%. The statistical program used for this purpose was SPSS Statistics, version 18.0 (SPSS, Chicago, IL, USA).

Athletes erroneously considered “unwell” on the basis of alterations detected during the tests proposed as part of the various screening strategies are defined below as false positives; on the other hand, athletes considered “healthy” but suffering from occult heart disease, which is not compatible with the practice of competitive sport, or deserving a more detailed follow-up heart examination, are considered as false negatives.

**Results**

If we consider the first screening option, the anomalies detected most frequently were that of a diastolic or systolic murmur, >2/6 in 10 athletes, a blood pressure reading of >140/90 in 10 athletes and evidence of a family history of cardiovascular disease or sudden death for 7 athletes. These results and subsequent diagnostic analysis, led to the identification of: 1 patent foramen ovale, 1 mitral insufficiency mitigated by the rupture of the tendinous chords and 1 moderate aortic insufficiency. The alterations detected most frequently by an ECG were a left
axis deviation (2%), right axis deviation (0.9%), left atrial enlargement (0.9%) and T wave inversion (1.6%). The electrocardiogram allowed us to diagnose 2 conditions that could potentially be the cause of sudden cardiac death: 1 WPW Pattern and 1 left branch blockage, evidence of dilated cardiomyopathy, confirmed by an MRI scan. And finally, the introduction of the focused echocardiogram made it possible to identify 3 cases of a bicuspid aortic valve with light valve insufficiency, 2 significant dilations of the ascending aorta (≥40 mm), 2 typical prolapses of the mitral valve with limited valve insufficiency, 1 ventricular septal defect and 1 dilation of the coronary septum, leading to a significant increase in the specificity and sensitivity of the screening (specificity of 96.57%; sensitivity of 80.50%).

The overall cost for each option (Table II), taking into consideration the total cost of the screening, the cost of any second and third level tests and lost annual income, amounts to:
- €34,752.70 (€11,584.23/atleta “malato”) for the first option;
- €68,761.55 (€13,752.31/atleta “malato”) for the second option;
- €90,297.89 (€6,449.85/atleta “malato”) for the third option.

Table III lists the anomalies identified by the screening with the related supplementary tests performed to make a conclusive diagnosis.

**Discussion**

The inclusion of an ECG as part of the sports physical is a topic that has been debated extensively in recent years in sports medicine circles. The schools of thought break down into those favourable to its introduction, like the Italian school, which was the first to introduce this test, ficienza aortica moderata. Le alterazioni più frequentemente rilevate all’esame ECG-grafico sono state nel 2% dei casi la deviazione assiale sinistra, nello 0.9% la deviazione assiale destra, nello 0.9% l’ingrandimento atriale sinistro e nell’1.6% l’inversione dell’onda T. L’elettrocardiogramma ci ha consentito di diagnosticare 2 patologie potenzialmente causa di morte cardiaca improvvisa quali: 1 Pattern WPW e 1 blocco di branca sinistra, espressione di una cardiomiopatia dilatativa confermata dalla risonanza magnetica. Infine, l’introduzione dell’ecocardiogramma focused ha permesso di individuare 3 casi di aorta bicuspide con insufficienza lieve, 2 dilatazioni significative dell’aorta ascendente (≥40mm), 2 prolassi valvolari mitralici tipici con lieve insufficienza valvolare, 1 difetto interventricolare perimembranoso e 1 dilatazione del seno coronarico, portando ad un notevole aumento sia della specificità che della sensibilità dello screening (specificità pari a 96.57%; sensibilità pari a 80.50%).

I costi complessivi per ogni singola opzione (Tabella II), considerando: il costo totale dello screening, il costo degli eventuali esami di secondo e terzo livello, il mancato guadagno annuale; ammontano complessivamente a euro:
- €34,752.70 (€11,584.23/atleta “malato”) per la prima strategia;
- €68,761.55 (€13,752.31/atleta “malato”) per la seconda strategia;
- €90,297.89 (€6,449.85/atleta “malato”) per la terza strategia.

Nella Tabella III vengono riportate le anomalie individuate allo screening con i relativi esami supplementari effettuati per giungere ad una diagnosi conclusiva.

**Discussion**

L’introduzione dell’ECG all’interno della visita medico sportiva costituisce uno degli argomenti
in 1982, and those opposed to it, like the U.S. school. If fact, if on one hand an ECG significantly increases the sensitivity of the physical, on the other hand it causes the number of athletes erroneously considered ill (false positives) to rise, with a simultaneous increase in costs due to the need to perform supplementary second and third level tests. In an attempt to reduce the percentage of false positives, over the years several criteria for the interpretation of an athlete’s ECG have been developed, and there has been a significant reduction in the number of false positives since the adoption of the Seattle criteria in 2013. At the same time, growing recourse to the echocardiogram, and our improved knowledge of the athlete’s heart, has led a number of authors to propose the possible use of the latter as a screening test. However, considering that the cost of a complete echocardiogram amounts on average to $350 in the USA and to €80 in Europe, it is easy to see that its introduction has been opposed. On the other hand, some pathological conditions may not come to light even in a detailed physical examination or scrupulous reading of an ECG. The results of our study have once again highlighted the fact that a sports physical based only on medical history and a physical examination are not an efficient screening strategy for the prevention of sudden cardiac arrest. The following table shows some examples of conditions that were only identified through the use of echocardiography.

Table III.—Athletes deserving follow-up.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Age</th>
<th>Sex</th>
<th>Symptoms</th>
<th>Abnormalities at screening</th>
<th>Additional exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>WPW</td>
<td>12</td>
<td>F</td>
<td>None</td>
<td>ECG</td>
<td>TTE, Holter, Physical examination</td>
</tr>
<tr>
<td>Aortic dilatation</td>
<td>32</td>
<td>F</td>
<td>None</td>
<td>Focused Eco</td>
<td>MRI</td>
</tr>
<tr>
<td>Aortic dilatation</td>
<td>45</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>MRI</td>
</tr>
<tr>
<td>Bicuspid aortic valve + light valve insufficiency</td>
<td>14</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>None</td>
</tr>
<tr>
<td>Bicuspid aortic valve + light valve insufficiency</td>
<td>11</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>None</td>
</tr>
<tr>
<td>Prolapse of the mitral valve + light valve insufficiency</td>
<td>14</td>
<td>F</td>
<td>None</td>
<td>Focused Eco</td>
<td>None</td>
</tr>
<tr>
<td>Ventricular septal defect</td>
<td>48</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>TTE</td>
</tr>
<tr>
<td>Dilation of the coronary septum</td>
<td>7</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>MRI</td>
</tr>
<tr>
<td>Aortic insufficiency</td>
<td>72</td>
<td>M</td>
<td>None</td>
<td>Physical examination</td>
<td>MRI</td>
</tr>
<tr>
<td>Dilated cardiomyopathy</td>
<td>51</td>
<td>M</td>
<td>None</td>
<td>ECG</td>
<td>MRI</td>
</tr>
<tr>
<td>Prolapse of the mitral valve + moderate aortic insufficiency</td>
<td>29</td>
<td>M</td>
<td>None</td>
<td>Physical examination</td>
<td>TEE</td>
</tr>
<tr>
<td>Patent foramen ovale</td>
<td>17</td>
<td>F</td>
<td>None</td>
<td>Anamnesi</td>
<td>None</td>
</tr>
<tr>
<td>Bicuspid aortic + stenosis</td>
<td>45</td>
<td>M</td>
<td>None</td>
<td>Focused Eco</td>
<td>None</td>
</tr>
<tr>
<td>Prolapse of the mitral valve + light valve insufficiency</td>
<td>21</td>
<td>F</td>
<td>None</td>
<td>Focused Eco</td>
<td>None</td>
</tr>
</tbody>
</table>

MRI: magnetic resonance imaging; TTE: transthoracic echocardiogram; TEE: transesophageal echocardiogram.
death, thus confirming the extreme importance of an ECG. What is more, it has demonstrated that the specificity of the screening can be considerably improved by a focused echocardiogram. The latter has enabled us not only to exclude from the practice of sports two athletes with significant dilations of the ascending aorta and to program frequent follow-ups for six athletes, but has also significantly reduced the number of false positives and therefore of second level tests. Along similar lines, a Spanish study conducted with 2688 athletes has shown that the inclusion of an echocardiogram in the sports physical resulted in the exclusion from sports activities of 4 athletes, in specific treatment for 3 and an annual follow-up for 152 athletes. These results have been confirmed by Steinberger et al., who, out of a population of 357 British adolescents, revealed that after an echocardiogram, 13 patients, who were deemed to be after a physical examination, in fact required a cardiology follow-up. For these reasons, in recent years work has begun to develop echocardiographic protocols that focus on the analysis of the athlete, with the goal of limiting the economic expenditure while maintaining a good diagnostic capability. The first to understand these peculiar elements was Weidenbener who, more than ten years ago, demonstrated that the introduction of a limited echocardiogram, made up of a single projection on a long axis, could increase the sensitivity of sports screening, at a reasonable cost. In the years that followed, first Wyman, with a 5 minute protocol for a sample of 357 athletes, and then Anderson, revealed the utility of including a limited echocardiogram as part of a sports medicine physical. In spite of this Anderson concluded that this screening option was not sustainable because it was too expensive for the U.S. health system; this contrasted with the results of our study which demonstrates not sustainable because it was too expensive ad un esame eco-cardiografico focused. Quest’ultimo ci ha consentito non solo di escludere dall’attività sportiva due atleti con dilatazione significativa dell’orta ascendente e di programmare un follow-up più frequente per sei atleti ma ha ridotto anche significativamente il numero dei falsi positivi e quindi degli esami di secondo livello. Sulla stessa linea uno studio spagnolo, condotto su 2688 atleti, ha mostrato come l’aggiunta dell’esame ecocardiografico alla visita porti all’esclusione dall’attività sportiva 4 atleti, ad un trattamento specifico 3 ed ad un follow-up annuale 152 atleti. Questi risultati sono stati confermati da Steinberger et al che, su una popolazione di 357 adolescenti inglesi, ha evidenziato come con l’esame eco-cardiografico 13 pazienti, apparentemente sani all’esame obiettivo, erano in realtà meritevoli di un follow-up cardiologico. Per queste ragioni, negli ultimi anni, si sono cominciati a sviluppare dei protocolli ecocardiografici focalizzati allo studio dell’atleta, con l’obiettivo di limitare il dispiego di risorse economiche mantenendo un buon potere diagnostico. Il primo ad intuire tali peculiarità fu Weidenbener che per primo, più di dieci anni fa, dimostrò come l’aggiunta di un ecocardiogramma limited, costituito dalla sola proiezione in asse lungo, potesse aumentare la sensibilità dello screening medico sportivo ad un costo ragionevole. Negli anni successivi prima Wyman, con un protocollo di 5 minuti su un campione di 357 atleti, e poi Anderson hanno dimostrato l’utilità di un eco-limited all’interno della visita medico sportiva. Tuttavia Anderson concludeva la non sostenibilità di questa strategia di screening in quanto troppo costosa per il sistema sanitario americano; ciò è in contrasto con i risultati del nostro studio dove si dimostra come l’introduzione dell’ecocardiogramma focused nella visita pre-agonistica sia, al contrario, una strategia da potersi attuare ad un costo ragionevole. Questa differenza nei risultati è, a nostro parere, da attribuirsi: in parte, ad una più scrupolosa analisi dei costi connessi alle diverse strategie di screening, ma soprattutto all’individuazione di un protocollo ecocardiografico di durata ottimale che ci ha permesso di identificare 9 atleti malati in più rispetto al solo impiego dell’ECG e, soprattutto, ha ridotto al 3,37% la percentuale dei falsi positivi.
Limitations of the study

The limitations of the study lie above all in the fact that it does not produce comparative effectiveness outcomes, which would have enabled us to establish more definitely which of the three screening options is the most cost effective.

Conclusions

Based on the results set out above, we can state that a focused-echocardiogram could be included in pre-competition screening at a reasonable cost; in spite of the fact that it does not impact in the short term on the prevention of sudden death, it does allow us to improve the specificity of the screening and above all to identify conditions (such as a bicuspid aortic valve or a prolapse of the mitral valve) whose natural development in the athlete still needs to be clarified, thus making them worthy of a detailed cardiology follow-up.19

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