Application of Pre-Participation Cardiovascular Screening Guidelines to Novice Older Runners and Endurance Athletes.

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Application of pre-participation cardiovascular screening guidelines to novice older runners and endurance athletes

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Abstract

Objectives: Despite robust growth in participation in marathons and endurance sports among older individuals, guidance regarding pre-participation cardiovascular evaluation of these athletes is lacking. The objective of this study was to assess the utility of currently available pre-participation cardiovascular evaluation guidelines as applied to a cohort of older novice endurance athletes.

Methods: We applied data from 1457 novice runners and endurance athletes aged 35 years and older to two pre-participation screening tools, the American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire and the 2001 Working Group recommendations for pre-participation screening of masters athletes (2001 Masters).

Results: Application of the American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire identified 42.1% for which pre-participation cardiovascular evaluation was indicated. Of those who met criteria, 51.5% reported completion of a healthcare evaluation. Application of the 2001 Masters guidelines identified 75.2% who qualified for pre-participation electrocardiogram and 34.0% for pre-participation stress testing. Of those who met 2001 Masters criteria for pre-participation testing, 43.7% and 24.6% underwent recommended electrocardiogram and stress testing, respectively. While there was modest concordance with recommendations for pre-participation evaluations based on both American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire and 2001 Masters, only athlete age was independently associated with completion of a pre-participation healthcare evaluation and only athlete age and athlete's participation in marathons were independently associated with pre-participation stress testing.

Conclusion: Among older novice endurance athletes, application of the American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire and 2001 Masters guidelines identifies a significant percentage of athletes for whom pre-participation evaluation and testing are recommended. Concordance with these guidelines was modest and providers were primarily influenced by athlete age and competitive goals when planning pre-participation testing. Given the rarity of cardiovascular events among older participants in endurance events, the cost-effectiveness of the American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire and 2001 Masters guidelines may be unacceptable for general use.

Keywords

Cardiovascular, sports medicine, pre-participation evaluation, stress testing, marathon

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Introduction

A growing body of evidence supports the health benefits of regular exercise in the aging population.[1–4] As a result, there is a universal acceptance of the concept that the overall benefits of exercise outweigh the risks of participation.[5–8] However, the occasional media reports of runners dying suddenly while competing in endurance events bring to the forefront the question of how to screen individuals for risk of complications related to participation.[9]

In 2012, a record 850 marathons were held in the United States alone, compared to approximately 300 such events in 2000.[10] The growth of participation in endurance events is likely due in large part to the numerous health benefits exercise has been shown to offer.[8,11–15] Not surprisingly, the growth in participation in marathons and endurance sports has resulted in parallel increases in the number of older athletes competing in these events.[15–18] The population of athletes aged 35 years and older, so-called "masters-age" athletes, represents a challenge for healthcare providers who are asked to make decisions regarding assessments of cardiovascular risk associated with participation in such physically demanding events.[8,19–22]

There are currently no validated tools to help physicians assess participation risk in masters athletes because most tools are geared toward screening younger participants.[23–27] In contrast to younger elite athletes, aging athletes are at particular risk of exercise-induced cardiovascular events related to undiagnosed coronary artery disease (CAD).[5,9] To help fill this void, the American Heart Association (AHA) and the American College of Sports Medicine (ACSM) developed the American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire (AAPQ) to screen for cardiovascular risk among sedentary individuals who desire to initiate a fitness program.[25] In addition, the 2001 Masters Athletics Working Group has previously developed a set of pre-participation guidelines aimed at higher-level masters athletes who desire to participate in more competitive sporting events (2001 Masters).[28] The latter were the recommendations of a working group with representation from the World Heart Federation, the International Federation of Sports Medicine, and the AHA. The goal of both the 2001 Masters and the AAPQ guidelines is to enable cost-effective screening of novice athletes for high-risk characteristics that warrant further cardiovascular evaluation.[28]

Little is known about these screening tools' effectiveness in identifying athletes who will ultimately suffer sport-related cardiovascular events. In addition, there is little evidence as to whether these tools are being used by healthcare providers for guidance in pre-participation evaluation of older individuals who plan to begin training for endurance events. In this study, we applied the AAPQ and 2001 Masters pre-participation screening tools to self-reported health risk and assessment data from a population of novice masters runners and triathletes. Our goal was to determine whether the use of these tools in a population of older novice runners would "screen-in" a reasonable percentage of these athletes to be referred for further pre-participation cardiovascular assessment. In addition, we assessed whether pre-participation testing was indeed being applied to individuals who "screen-in" for further workup based on these tools. Finally, we assessed the factors that were independently related to the performance of pre-participation evaluations in our population of older runners.

Methods

We designed the Masters Athletic Study of Training and mEdical characteristics of older RunnerS (MASTERS) Study as an ongoing longitudinal, Internet-based survey of training and health aspects of runners aged 35 years and older. The survey consists of 50 questions concerning health issues, training duration and intensity, and perceptions regarding health benefits and risks of endurance sports. The study was launched from a secure, Health Insurance Portability and Accountability Act (HIPAA)-compliant website (Survey Monkey, Palo Alto, CA) in July 2013. Respondents were recruited from eligible runners who responded to an advertisement in a national running publication (*Running Times* Magazine, Rodale Press, Emmaus, PA) and on multiple running-related Internet message boards. For this study, we included respondents who met criteria as "novice" runners: those who reported that they began a recreational or competitive running career within the past 5 years. These novice runners were asked about specific aspects of their health histories, medicine usage, and training characteristics and were also queried about medical evaluations within the past 5 years, a time period that coincided with their reported running careers.

The AAPQ was designed to identify individuals embarking on a fitness program who are of high enough risk to warrant an evaluation by a healthcare provider prior to participation.[25] The AAPQ is a one-page self-assessment tool with questions covering three areas: cardiovascular history, symptoms, and cardiovascular risk factors (see Appendix 1). If a subject responds positively to any of the statements regarding cardiac history or symptoms, or to two or more of the statements regarding risk factors, a recommendation is made for a pre-participation evaluation (PPE). For this study, questions applied to the AAPQ were based on the relationship of the survey question to the AAPQ questionnaire topic. All but 6 of the 30 questions could be answered using survey questions; those that could not be applied included five questions in section 1: three related to symptoms of chest pain, breathlessness, or syncope; one question regarding current pregnancy; and one question regarding current musculoskeletal problems. In addition, one question in section 2 related to obesity could not be answered from the survey responses.

The 2001 Masters pre-participation guidelines were designed to assess competitive sports participants at the masters level and, as a result, the recommendations regarding specific pre-participation testing are more aggressive than the AAPQ. The 2001 Masters makes three specific recommendations: (1) pre-participation stress test for men aged

>40 years and women aged >50 years who also have one of the following conditions: hypercholesterolemia, systemic hypertension, current or recent cigarette smoking, diabetes mellitus, or history of myocardial infarction or sudden cardiac death in a first-degree relative aged <60 years; and (2) pre-participation stress testing for all athletes aged ⩾65 years; and (3) pre-participation electrocardiogram (ECG) for all athletes male and female aged >40 years. All criteria required to determine the need for pre-participation assessment per the 2001 Masters guidelines could be applied to our questionnaire using specific survey responses. For assessment of independent predictors of PPE, in addition to information applied to AAPQ and AHA Masters, we also utilized questions regarding whether or not respondents participated in marathon distance races or longer, and the respondents' perceived risk of dying in a running race (from 1:1000 to 1:10,000,000).

Categorical data were evaluated using chi-square analysis. Independent variables of the performance of pre-participation evaluation were identified using multivariable logistic regression analysis. For all assessments, a p value of <0.05 was considered significant.

This study, including a waiver of informed consent, was approved by the Institutional Review Board of Lehigh Valley Health Network, Allentown, PA.

Results

Of the 5850 survey respondents, a total of 1457 were defined as "novice" runners and are included in the analysis. Demographic and health details of the cohort are summarized in Table 1. Of note, 485 (33%) respondents reported they had previously run in a marathon or ultra-distance event, while 230 (15.8%) had participated in a triathlon.

Results of the application of the AAPQ pre-participation guidelines are summarized in Table 2. After applying AAPQ criteria, we identified 614/1457 (42.1%) for whom PPE was indicated. Of those who met the criteria for PPE, slightly more than half reported a physician visit within the past 5 years. A significantly greater percentage of athletes who met AAPQ criteria reported a physician visit, ECG, stress test, and performance of coronary calcium scoring or carotid ultrasonography within the past 5 years compared to those athletes who did not meet AAPQ criteria for PPE.

The application of the 2001 Masters PPE guidelines to the survey population is summarized in Table 3. Of the 1457 novice runners, 1096 (75.2%) of respondents met criteria for the performance of pre-participation ECG and 495 (34.0%) of respondents met criteria for pre-participation stress testing. Of those athletes who met criteria for pre-participation ECG and stress testing by the 2001 Masters guidelines, 458 (43.7%) and 122 (24.6%) reported having undergone these tests past 5 years, respectively. In comparison, 105 (29.8%) and 111 (11.5%) of athletes who did not meet the criteria had undergone ECG and stress testing, respectively.

Table 1. Participant demographics.

Characteristics (n = 1457)	N	%
Age		
Mean, years (range)	44.5 (35–86)	
Gender		
Male	940	64.5
Female	517	35.5
Risk factors		
Hypertension	167	11.5
Hypercholesterolemia	333	22.9
Diabetes mellitus	27	1.9
History MI	6	0.4
History of cardiovascular disease	34	2.3
Family history of CVD	577	39.6
Ever smoked	578	39.7
Running habits		
Have run marathon/ ultra-marathon	485	33.3
Participate in triathlons	230	15.8

MI: myocardial infection; CVD: cardiovascular disease.

Table 2. Results of application of AAPQ pre-participation guidelines.

Variable	AAPQ screen-in[a] (n = 614)	AAPQ screen-out[a] (n = 843)	p value
Pre-participation doctor visit	316 (51.5)	335 (36.4)	<0.001
ECG	299 (48.7)	277 (30.1)	<0.001
Stress test	136 (22.1)	97 (10.5)	<0.001
CAC/CIMT	62 (10.1)	27 (3.2)	<0.001

[a]Values listed as n (%).
AAPQ: American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire; CAC: coronary artery calcium; CIMT: carotid intima media thickness; ECG: electrocardiogram.

Table 3. Performance of ECG and stress testing, stratified by AHA 2001 Masters guidelines.

	Screen-in	Screen-out	p value
ECG	458/1048 (43.7)	105/352 (29.8)	<0.001
Stress test	122/495 (24.6)	111/962 (11.5)	<0.001

ECG: electrocardiogram; AHA: American Heart Association.

It is unlikely that the majority of decisions by novice runners and their physicians regarding PPE were made using screening tools such as AAPQ or the 2001 Masters guidelines as references. The factors considered in decisions regarding the need for PPE in our population are unclear. Therefore, we assessed the independent drivers of the use of pre-participation medical evaluation and stress testing using multivariable logistic regression analysis of selected components of AAPQ/2001 Masters recommendations. The only independent driver of the

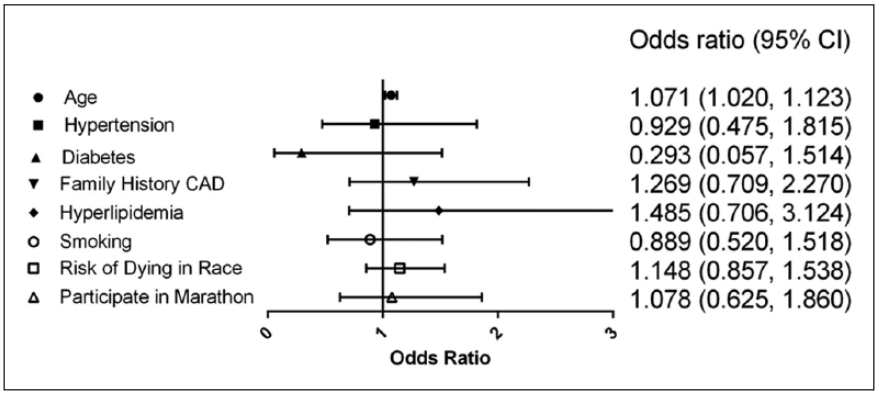

Figure 1. Forest plot representation of independent predictors of pre-participation healthcare provider evaluation based on AAPQ simulation. CAD: coronary artery disease; "risk of Dying in Race": respondents' numerical perception of the risk of death in running races.

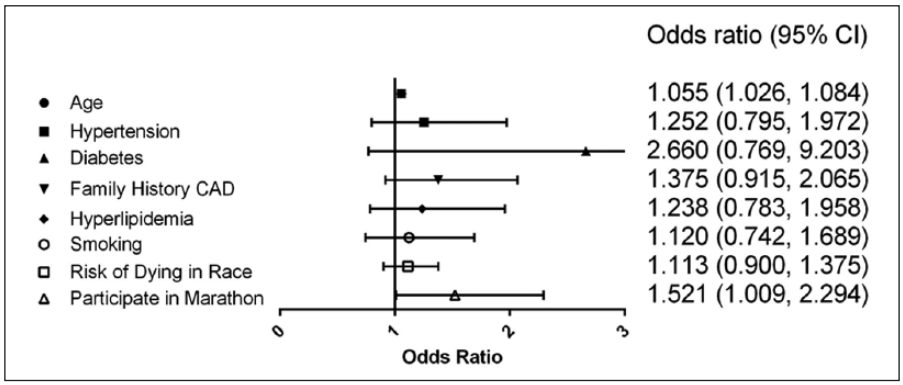

Figure 2. Forest plot representation of independent predictors of pre-participation stress testing based on 2001 Masters simulation. CAD: coronary artery disease; "risk of Dying in Race": respondents' numerical perception of the risk of death in running races.

performance of pre-participation medical evaluation was increasing age (odds ratio (OR), 1.071; 95% CI (95% confidence interval), 1.020–1.123; Figure 1). The independent drivers of the performance of pre-participation stress testing were athlete age (OR, 1.055; 95% CI, 1.026–1.084) and athlete's report of participation in races of marathon length or greater (OR, 1.521; 95% CI, 1.009–2.294; Figure 2). Traditional risk factors such as hypertension, diabetes, and hypercholesterolemia did not appear to influence these pre-participation screening decisions.

Discussion

The growing popularity of endurance sports is exemplified in the explosion of the number of marathons conducted in the United States.[10,15,29] Since 2001, US marathon participants have nearly doubled from 295,000 to 425,000.[30] The increase in endurance sport participation over the past decade has been paralleled by escalating participation by older competitors, including older novice participants.[15–18,25] These athletes are at increased risk of exercise-related cardiovascular events, specifically acute coronary ischemia related to underlying CAD.[11,13,19,31] The majority of national and international pre-participation evaluation guidelines have focused on screening younger (aged <35 years), elite competitive athletes, primarily for congenital cardiovascular abnormalities that predispose them to sudden cardiac death.[20,23,24,26,27] In contrast, the older competitive athlete has distinctly different concerns than younger competitors and requires a different diagnostic approach, focusing on risk related to subclinical CAD.[23–27,32]

The need for effective and usable tools for pre-participation screening of novice recreational and non-elite athletes led to the development of the AAPQ and 2001 Masters pre-participation guidelines. The AAPQ was originally designed to aid non-medical personnel in identifying persons at risk of cardiovascular complications resulting from the initiation of an exercise program.[25] The 2001 Masters pre-participation guidelines were designed to identify risk in older athletes who wish to participate in high-level competitive athletics.[28] A recent study applied the AAPQ to participants of the National Health and Nutritional Examination Survey (NHANES) to determine the rate of referral for pre-participation medical evaluation in this population.[33] Interestingly, application of AAPQ would have resulted in a physician referral rate of greater than 90% of NHANES participants, making it an ineffective screening tool

for this population. Importantly, the NHANES population represents a relatively sedentary, non-physically fit population, including less than 40% of respondents reporting being even minimally physically active.[33] Thus, the NHANES population appears to be distinctly different from our population of novice marathoners and endurance athletes, all of whom had recently embarked on a high-level endurance exercise regimen. Little data are available regarding the typical risk factor profile of older marathoners and endurance athletes or the performance of currently available screening tools applied to this population. Not surprisingly, AAPQ applied to our population performed comparatively better, as it identified a much more reasonable percentage of individuals for pre-participation medical evaluation versus that of its application to NHANES (40% versus >90%). When the 2001 Masters pre-participation guidelines were applied to our population, they likewise performed reasonably well, with just over one-third of athletes identified as needing pre-participation stress testing. Taken together, the application of current guidelines for pre-participation evaluation to a cohort of novice endurance athletes yields a significant but reasonable percentage of athletes identified as being of high enough risk for exercise-associated cardiovascular events to warrant pre-participation evaluation and testing. These data in no way validate AAPQ or 2001 Masters as effective screening tools for the pre-participation assessment of older endurance athletes; at present, we cannot evaluate the sensitivity and specificity of these tools for identifying athletes at risk for exercise-related events.

We did not assess whether surveyed athletes or their healthcare providers utilized available screening tools to make decisions regarding PPE. When we examined concordance with guidelines, we did find that significantly more athletes who met either AAPQ or 2001 Masters criteria for evaluation and testing underwent these indicated procedures compared to those who did not meet the criteria. However, two interesting findings should be noted: first, the percentage of those individuals undergoing appropriate evaluation and testing was modest, with just over half of those "screening in" by AAPQ criteria undergoing pre-participation medical evaluation and less than one-quarter of those "screening in" by 2001 Masters criteria undergoing pre-participation stress testing. Second, a significant percentage of athletes identified by AAPQ and 2001 Masters as not needing PPE nonetheless underwent pre-participation evaluation regardless. Regardless, assuming AAPQ and/or 2001 Masters accurately identify individuals for which PPE is appropriate, our data suggest that stringent use of these guidelines would lead to the identification and pre-participation evaluation of a substantial number of athletes in order to successfully identify those athletes who are truly at risk of endurance sport-related cardiac events. Assuming the rate of endurance sport-related sudden cardiac death in older athletes is 1:50,000[34,35] and PPE accurately identifies individual at risk of exercise-related cardiovascular events, application of AAPQ and 2001 Masters would result in the identification of 15,000–20,000 athletes who would require screening in order to identify one individual who ultimately would suffer sudden cardiac arrest during an endurance event. The economic impact of a screening program with these requirements makes it an unattractive option for PPE of older endurance athletes.

Other than available guidelines for PPE, little is known about the specific variables that determine both decisions by older athletes to seek a pre-participation medical consult and decisions by athletes and their providers to perform pre-participation diagnostic testing. Using multivariable logistic regression analysis, we found that the only independent driver of the need for PPE by a healthcare provider was increasing age. In contrast, independent drivers of pre-participation stress testing included both increasing age and participation in marathon or ultra-marathon distance events. That increasing age is identified as a risk factor for cardiovascular complications of endurance sports and, hence, drives PPE and testing is not surprising.[29,36,37] The reason that marathon participation also led to more frequent use of stress testing is less obvious—it is possible that both athletes' and healthcare providers' perceptions of the extreme physical nature, and resultant cardiovascular risk, of these events led to more testing. Conspicuously absent as independent drivers for testing were hypertension, diabetes, hypercholesterolemia, smoking history, and family history of CAD. A reasonable interpretation of this finding is that older athletes and their care providers are basing decisions regarding pre-participation CAD screening more on the perceived risks of the training or of the endurance events themselves, rather than on the risk factor profile of the participant.

While the rates of "screening in" by both AAPQ and the 2001 Masters guidelines are promising candidate screening tools for the identification of high-risk older endurance athletes requiring PPE; further study is required both to validate the accuracy of these tools for identifying at-risk athletes and to demonstrate that cardiovascular complications of endurance sport participation can be prevented in a cost-effective manner using the results of these assessments. While sudden deaths occurring among participants of endurance events such as marathons and triathlons receive significant media attention and draw attention to the safety of participation in these events, cardiovascular complications of endurance sports remain rare occurrences.[5] Thus, it is critical that a thorough cost assessment of the application of pre-participation screening tools to older athletes is a focus of future studies in this area.

There are several limitations to our study. Perhaps most important, this was a survey completed by runners drawing on recall of the past 5 years. Thus, we made the assumption that the survey respondents were accurate in their recall of the timing of both the start of their endurance sport careers and their medical evaluations and testing. Without comprehensive information regarding the timing of medical evaluations

with regard to completion of endurance events, we cannot be sure that, although both occurred within the past 5 years, the relationship of the evaluations to initiation of training or racing was proximate and valid. Optimally, an assessment of runners with less than 1 year of experience or those anticipating initiation of a training program may have yielded more accurate and robust results, but such an assessment was not possible with our current survey population. Additionally, our survey questions did not conform to the complete AAPQ; specifically, we had no data regarding symptoms in our respondents. We made the assumption that, because our respondents were embarking on an endurance sport career (including a significant percentage of participants in marathons and triathlons), any presence of symptoms would have prompted a medical evaluation long before the initiation of this career. Admittedly, omitting these questions may have resulted in an under-estimate of the percentage of respondents who would be referred for PPE on the basis of AAPQ; however, we believe the overall magnitude of this under-estimate is likely to be small. In addition, because this was an online survey, it may be pooling a specific subset of the endurance athletes and thus not reflect the risk profile or pre-participation workup of the general novice endurance athlete population. The large number of respondents helps manage, but does not completely mitigate, this possibility.

Conclusion

Applying AAPQ and the 2001 Masters Athlete pre-participation guidelines to a large sample of novice runners and endurance athletes yields a substantial percentage of athletes that are recommended for pre-participation provider evaluation and/or testing. A modest percentage of novice athletes meeting guideline criteria for PPE actually underwent guideline-recommended evaluations, and athlete age and competitive plans seemed to be the major drivers for PPE. Application of currently available guidelines for pre-participation screening of older endurance athletes will require further refinement before they can be considered standard of care for the evaluation of novice older athletes for cardiovascular risk of endurance sports.

Declaration of Conflicting Interests

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Appendix 1

American Heart Association/American College of Sports Medicine Pre-Participation Questionnaire

Table 4. AHA/ACSM Health/Fitness Facility Pre-Participation Screening Questionnaire.

Assess your health needs by marking all *true* statements.	
History You have had: a heart attack heart surgery cardiac catheterization coronary angioplasty (PTCA) pacemaker/implantable cardiac defibrillator/rhythm disturbance heart valve disease heart failure heart transplantation congenital heart disease	If you marked any of the statements in this section, consult your healthcare provider before engaging in exercise. You may need to use a facility with a medically qualified staff
Symptoms You experience chest discomfort with exertion You experience unreasonable breathlessness You experience dizziness, fainting, blackouts You take heart medications	Other health issues You have musculoskeletal problems You have concerns about the safety of exercise You take prescription medications You are pregnant
Cardiovascular risk factors You are a man older than 45 years You are a woman older than 55 years or you have had a hysterectomy or you are postmenopausal You smoke Your blood pressure is >140/90 You don't know your blood pressure You take blood pressure medication Your blood cholesterol level is >240 mg/dL You don't know your cholesterol level You have a close blood relative who had a heart attack before the age of 55 years (father or brother) or age 65 years (mother or sister) You are diabetic or take medicine to control your blood sugar You are physically inactive (i.e. you get <30 min of physical activity on at least 3 days per week) You are >20 pounds overweight	If you marked two or more of the statements in this section, consult your healthcare provider before engaging in exercise. You might benefit using a facility with a professionally qualified exercise staff to guide your exercise program
None of the above is true.	You should be able to exercise safely without consulting your healthcare provider in almost any facility that meets your exercise program needs

Source: Balady et al.[25] (with permission).
AHA/ACSM: American Heart Association/American College of Sports Medicine; PTCA: percutaneous transluminal coronary angioplasty.