

Leisure athletes at risk of medical complications: outcomes of pre-participation screening among 15778 endurance runners - SAFER VII

Karen Schwabe¹, Martin Schwellnus^{2,3,4}, Sonja Swanevelder⁵, Esme Jordaan,^{5,6}
Wayne Derman^{3,7}, Andrew Bosch¹

¹ *Division of Exercise Science & Sports Medicine, Department of Human Biology, Faculty of Health Sciences, University of Cape Town, South Africa*

² *Sport, Exercise Medicine and Lifestyle Institute (SEMLI) and Section Sports Medicine, Faculty of Health Sciences, University of Pretoria, South Africa*

³ *International Olympic Committee (IOC) Research Centre, South Africa*

⁴ *Emeritus Professor, Faculty of Health Sciences, University of Cape Town, South Africa*

⁵ *Biostatistics Unit, South African Medical Research Council*

⁶ *Statistics and Population Studies Department, University of the Western Cape*

⁷ *Institute for Sport and Exercise Medicine, Faculty of Medicine & Health Sciences, University of Stellenbosch*

Address for correspondence:

Martin P. Schwellnus, Director: Sport, Exercise Medicine and Lifestyle Institute (SEMLI) and Section Sports Medicine, Faculty of Health Sciences, University of Pretoria, South Africa, Sports Campus, Burnett Street, Hatfield, Pretoria 0020, South Africa

Telephone: -27-12-420 6057 Fax number: -27-12-362 3369

Email: mschwell@iafrica.com

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Author responsibility information:

Karen Schwabe (KS): study planning, data collection, data interpretation, manuscript editing

Martin Schwellnus (MS): principle investigator, responsible for the overall content as guarantor, study concept, study planning, data collection, data interpretation, manuscript (first draft), manuscript editing, facilitating funding

Wayne Derman (WD): study concept, study planning, data collection, data interpretation, manuscript editing

Sonja Swanevelder (SS): study planning, data analysis including statistical analysis, data interpretation, manuscript editing

Esme Jordaan (EJ): study planning, data analysis including statistical analysis, data interpretation, manuscript editing

Andrew Bosch (AB): data interpretation, manuscript editing

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Abstract

Objective: International guidelines for pre-participation screening of masters/leisure athletes to identify those that require medical assessment exist, but have not been implemented in mass-community based sports events. We determined the prevalence of runners who, according to these guidelines, would require a medical assessment before participating in a distance running event.

Methods: Participants of the 2012 Two Oceans races (21.1 and 56km) in South Africa (n=15778) completed an online pre-race medical screening questionnaire using European pre-participation screening guidelines. We determined the prevalence of runners that would require a pre-race medical assessment, based on risk factors, symptoms and disease.

Results: The pre-participation “self assessment of risk” screening identified 4941 runners (31.3%; 95% CI 30.6-32.0) that would need to undergo a full pre-participation medical assessment prior to running, if the current pre-participation screening guidelines are applied. Although musculoskeletal complaints and prescription medication use were the main triggers for a medical assessment, 16.8 % (n=2657) runners should undergo medical evaluation for suspected cardiac disease based on the questionnaire results: 3.4% (n=538) reporting existing CVD (very high risk) and 13.4% (n=2119) reporting multiple CVD risk factors (high risk). Other possible risk factors were reported as follows: history of chronic diseases (respiratory = 13.1%, gastro-intestinal = 4.3%, nervous system = 3.8%, metabolic/endocrine = 3.5%, allergies = 13.9%); chronic prescription medication = 14.8%, used medication before or during races = 15.6%; past history of collapse during a race = 1.4%.

Conclusions: Current guidelines identified that >30% runners would require a full medical assessment before race participation - mainly linked to runners reporting musculoskeletal conditions. We suggest a revision of guidelines and propose that pre-race screening should be considered to identify runners with a “very high”, “high” and “intermediate risk” for medical complications during exercise. Pre-race screening and educational intervention could be implemented to reduce medical complications during exercise.

Key words:

Running, pre-participation medical screening, cardiovascular disease, chronic disease, risk factors

Introduction

Regular participation in physical activity (> 150min per week at moderate- to high-intensity) has numerous health benefits, including the prevention and management of chronic non-communicable disease [1, 2]. Recreational running has become an increasingly popular form of regular physical activity and participation in community based recreational distance running events such as the 21.1km (half-marathon), marathon (42.2km), and ultra-marathon races has concomitantly increased [3]. Annual reports from Running USA (<http://www.runningusa.org/annual-reports> - accessed on 1 March 2017) show an increase of >12 fold in overall participation in marathon runners since 1976, specifically increases in participation in the older age groups (> 40 years).

Whilst the health benefits of exercise are numerous, medical complications during moderate- to high-intensity vigorous physical activity, such as distance running, in a variety of organ systems have been described [4, 5, 6] Acute cardiac events, including myocardial infarction and sudden death, are described in both younger and older runners [7, 8, 9, 10]. Determining the risk of sudden death during exercise, in particular during distance running events such as the half-marathon (21.1km) and marathon (42.2km) [11, 12] using pre-screening tests and detailed diagnostics (ECG) has been proposed [5, 6, 7, 8, 13, 14, 15, 16].

Pre-participation screening for CVD is routinely recommended and performed for younger competitive elite athletes across the world [17, 18, 19] [18, 20, 21, 22] but not in leisure athletes older than 35 years, despite an exponentially higher risk of acute cardiac episodes in these older athletes due to increased incidences of atherosclerotic coronary artery disease [23]. Pre-participation screening guidelines for masters (≥ 50

years) and leisure athletes have been proposed by the American Heart Association (AHA) [24], American College of Sports Medicine (ACSM) [25], Canadian Physical Activity Readiness Questionnaire (PAR-Q+) and the Physical Activity Readiness Medical Examination (ePARMed-X+) [26], and the European Society of Cardiology (ESC) together with the European Association of Cardiovascular Prevention and Rehabilitation (EACPR) [27] [28].

These guidelines “provide a pragmatic and practical approach to identifying higher-risk individuals to minimize the risk of sudden cardiac death (SCD)” [28]. The screening process begins with a “self-assessment of risk” which is followed up by medical intervention for identified high-risk athletes. The “self-assessment of risk”, recommended by the ESC and EACPR, can be conducted by the individual athlete or by non-physician health professionals [28] and is based on the recommended AHA/American College of Sports Medicine (ACSM) pre-participation screening questionnaire for individuals at Health/Fitness facilities [29]. The initial “self-assessment of risk”. In section 1, health information related to known cardiovascular disease, cardiovascular symptoms, medication use, and other health issues is collected and in section 2, known risk factors for cardiovascular disease are identified. If the respondents provide one positive response to any question related to section 1 (health information), or if 2 or more risk factors are identified in section 2, they are advised to undergo a thorough medical assessment by a qualified physician before participating in moderate- to high-intensity exercise, such as distance running [28]. More recently, a task force from the ACSM published revised screening guidelines, and in these new guidelines, risk factors for CVD (section 2) were omitted [25].

We are only aware of one study where the ESC/EACPR screening guidelines were

applied to adult participants > 40 years of age [30]. In this study, based on “self assessment of risk”, approximately 95% of women and 93.5% of men were advised to consult a physician before embarking on exercise [30]. We are not aware of any studies describing the outcome of the ESC/EACPR screening guidelines when applied to participants in mass community based endurance events. `

In the first of our **SAFER** (**S**trategies to reduce **A**dverse medical events **F**or the **E**xercise**R**) studies [5, 31, 32, 33] we report a high risk of serious of cardiac and non-cardiac medical complications at endurance events [5].

In this study, as part of the ongoing SAFER initiative, we wanted to determine the prevalence of runners who, according to the current European guidelines for “risk self assessment”, would be at higher risk of acute cardiac medical complications and be required to undergo a medical assessment before participating in the Two Oceans 21.1km or 56km races. Furthermore, we wanted to determine the factors in the current guidelines that trigger this recommendation. As a secondary aim, we also explore the prevalence of other potential “risk factors” associated with serious non-cardiac medical complications such as other chronic systemic diseases, use of medication and previous collapse during exercise [6] that are not currently routinely included in international pre-exercise screening guidelines.

Methods

Setting

The Old Mutual Two Oceans Marathon races are mass community-based running events that take place annually during late summer in Cape Town, South Africa. Approximately 25 000 runners are attracted to the two main events, the 21.1km (half-marathon) and the 56km (ultra-marathon) races every year. Males and females of all ages older than 16 years can enter, and entries to the 21.1km race are open to novice runners and require no qualifying time. Entries for the 56km race requires completion of any one of the following qualifying times: a standard 42.2km marathon in < 5 hours, 50km in < 6 ½ hours, 56km in < 7 hours, 90km in < 12 hours, or a 100km race in < 13 ½ hours. A high rate of acute medical complications, including sudden death, in the runners competing in the Old Mutual Two Oceans Marathon races [5, 32] precipitated the design and implementation of an online pre-race medical screening program for all race entrants in 2012.

Participants

In 2012, all race entrants (n=25455) completed a pre-race medical screening questionnaire as part of the online registration process. Of these, 15778 (62.0% of all race entrants) gave informed consent that their personalized medical data could be used for research purposes and these runners were designated as participants in this study. The study participants were representative (for gender, age and race type) of all race entrants (Table 1).

Table 1. The profile by race type, sex, and age groups of all race entrants and runners who participated in this study.

		All race entrants (n = 25 455)		Runners participating in this study (n = 15 778)	
		N	%	N	%
Race type	21.1 km	16,284	64.0	10,786	68.4
	56 km	9,171	36.0	4,992	31.6
Gender	Males	14,775	58.0	8,916	56.5
	Females	10,680	42.0	6,862	43.5
Age groups	≤ 30 years	7,471	29.4	4,951	31.4*
	31–39 years	8,074	31.7	4,499	28.5
	≥ 40 years	9,910	38.9	6,328	40.1*
Males x Age	Males < 45 years	21,150	83.1	13,304	84.3
	Males > 45 years	4,305	16.9	2,474	15.7*
Females x Age	Females < 55 years	25,013	98.3	15,509	98.3
	Females > 55 years	442	1.7	269	1.7

*: Significantly different from all race entrants ($p < 0.05$)

The 15778 study participants consisted of 8916 (56.5%) male and 6862 (43.5%) female entrants. In the study group, compared to all entrants, there were equal proportions of athletes in the 21.1km and 56km races and in males vs. females. In the age categories there were equal proportions of runners in the age group 31 to 39 years old (All=31.7%, Study group=28.5%), but there was a large proportion of runners in the younger (<30 years) (All=29.4%, Study group=31.4%) and older (>40 years) (All=38.9%, Study group=40.1%) age groups (Table 1).

For purposes of conducting research on this population, permission to investigate the prevalence of risk factors for cardiovascular disease, existing medical diseases, allergies, medication use and injury history during endurance running in the Two Oceans races was obtained from the Research Ethics Committee of the University of Cape Town (REC 009/2011) (REC 030/2013) and the Research Ethics Committee of the University of Pretoria (REC 433/2015).

Online pre-race medical screening questionnaire

An online pre-race medical screening questionnaire (OPRMSQ) or “self-assessment of risk” was developed to identify runners that are at possible increased risk of acute medical complications during moderate-to high intensity exercise such as a distance running race [6]. The questions were based on the ESC and the EACPR guidelines for pre-exercise screening [28] with additional questions on general prescription medication use, including medication use during racing and a past history of collapse during racing.

The main elements of the questionnaire (Table 2) consisted of 2 injury related questions (muscle cramping and running injuries) and 13 questions that included the following categories of medical history: cardiovascular disease (CVD), symptoms of CVD, risk factors for CVD, other chronic disease (respiratory disease, metabolic or hormonal disease, gastrointestinal disease, nervous system disease, renal or bladder disease, haematological or immune system disease, cancer, allergies), With the exception of a question regarding pregnancy, the OPRMSQ included all the questions in the AHA/ACSM pre-participation screening questionnaire for individuals at Health/Fitness facilities [29], as recommended by the ESC and the EACPR for the pre-participation screening of leisure athletes engaging in moderate- to high-intensity exercise [27].

Table 2. Summary: Main elements of the medical screening questionnaire.

Medical screening questionnaire – self-assessment of risk *

1. Have you ever suffered from any heart or blood vessel conditions including heart attack, undiagnosed chest pain, coronary artery bypass operation, angioplasty (balloon), heart failure, heart transplant, cardiac arrhythmia (abnormal heart beat), rheumatic fever, heart murmur, cardiomyopathy, myocarditis, use of a pacemaker, or inherited heart defect?
2. Do you currently suffer from any symptoms of heart or blood vessel disease, including any of the following: shortness of breath when sitting or lying down, shortness of breath with mild exercise, waking up with shortness of breath at night, palpitations that make you dizzy, chest pain when sitting or performing exercise or when you are emotionally stressed, pain (or discomfort) in the neck jaw arms at rest or during exercise, dizziness during exercise or fainting spells)?
3. Are you aware or have you ever been diagnosed with any risk factors for heart or blood vessel disease including high blood cholesterol, a family member with heart disease, cigarette smoking, lack of physical activity, high blood pressure, being overweight, or having diabetes mellitus (sugar sickness)?
4. Do you currently suffer from any metabolic or hormonal disease including diabetes mellitus thyroid gland disorders hypoglycemia (low blood sugar) hyperglycemia (high blood sugar), or heat intolerance?
5. Do you suffer from any respiratory (lung) disease including asthma, emphysema (COPD), wheezing, cough, postnasal drip, hay fever, or repeated flu like illness?
6. Do you suffer from any gastrointestinal disease including heartburn, nausea, vomiting, abdominal pain, weight loss or gain (> 5kg), a change in bowel habits, chronic diarrhea, blood in the stools, or past history of liver or gallbladder disease?
7. Do you suffer from any diseases of the nervous system including past history of stroke or transient ischemic attack (TIA), frequent headaches, epilepsy, depression, anxiety attacks, muscle weakness, nerve tingling, loss of sensation, or chronic fatigue?
8. Do you suffer from any disease of the kidney or bladder including past history of kidney or bladder disease, blood in the urine, loin pain, kidney stones, frequent urination, or burning during urination?
9. Do you suffer from any disease of the blood or immune system including anemia, recurrent infections, HIV/AIDS, leukemia, or are you using any immunosuppressive medication?
10. Do you suffer from any growths or cancer, including a past history of cancer?
11. Do you suffer from any allergies including a past history of allergies, to medication, plant material, or animal material?
12. At the moment do you use any prescribed medication on a daily weekly or monthly basis to treat chronic (long-term) medical conditions or injuries?
13. Have you ever collapsed (fell down not because of an accident needing medical attention) during at the finish or after a race or training session?
14. Do you, or did you suffer from any symptoms of a running injury (muscles tendons bones ligaments or joints) in the last 12 months?
15. Have you ever in your running career suffered from muscle cramping (painful spontaneous sustained spasm of a muscle) during or immediately (within 6 h) after running (in training or competition)?

*: Once a participant answered “yes” to any of the main screening questions, further details were obtained using “dropdown” boxes with additional questions

Statistical analysis

All data from the runner and medical questionnaire database were analysed using the SAS Enterprise Guide (V6.1) statistical package (SAS Institute Inc., Cary, North

Carolina, USA). Crude numbers, prevalence and 95% confidence intervals are reported throughout.

Results

Prevalence of risk factors for cardiovascular disease (CVD), symptoms of CVD, and existing CVD in runners

The prevalence of existing CVD, symptoms of CVD, and risk factors for cardiovascular disease (CVD) in runners is depicted in Table 3. In this group of distance runners (n=15778), 360 (2.3%; 95% CI 2.1-2.5) reported suffering from existing CVD. The most common reported cardiovascular condition in runners with existing CVD (n=360) was a heart murmur (0.6%; 95% CI 0.5-0.7), followed by known coronary artery disease (0.5%; 95% CI 0.4-0.6), and arrhythmia (0.4%; 95% CI 0.3-0.6) (Table 2). Other reported specific CVD's were a history of rheumatic fever (0.2%; 95% CI 0.1-0.3), and myocardial infarction (0.2%; 95% CI 0.1-0.3). In this category of “other”, less than 0.4% of runners reported existing CVD.

Table 3. The prevalence of existing cardiovascular disease (CVD), history of any symptoms of CVD, or any risk factor for CVD in all runners (n = 15 778) (% runners; 95% CI).

	All runners (n = 15 778)			
	n	%	95% CI	
Any existing CVD	360	2.3	2.1	2.5
Myocardial infarction (MI)	31	0.2	0.1	0.3
Angina	22	0.1	0.1	0.2
Coronary artery bypass graft (CABG)	19	0.1	0.1	0.2
Angioplasty – no stent	10	0.1	0.0	0.1
Angioplasty – with stent	31	0.2	0.1	0.3
Coronary artery disease (CAD)	80	0.5	0.4	0.6
Heart failure	1	0.01	0.0	0.0
Heart transplant	0	0.0	-	-
Angioplasty with/without stent	40	0.3	0.2	0.3
Heart failure/transplant	1	0.01	0.0	0.0
Arrhythmia	70	0.4	0.3	0.6
Rheumatic fever	33	0.2	0.1	0.3

Table 3. The prevalence of existing cardiovascular disease (CVD), history of any symptoms of CVD, or any risk factor for CVD in all runners (n = 15 778) (% runners; 95% CI).

	All runners (n = 15 778)			
	n	%	95% CI	
Heart murmur	98	0.6	0.5	0.7
Pacemaker	6	0.04	0.0	0.1
Inherited cardiac condition	11	0.1	0.0	0.1
Other	64	0.4	0.3	0.5
Any history of symptoms of CVD	284	1.8	1.6	2.0
Swollen ankles	40	0.3	0.2	0.3
Water retention	25	0.2	0.1	0.2
Shortness of breath sit/lying	8	0.1	0.0	0.1
Short breath mild exercise	39	0.3	0.2	0.3
Waking up short breath	4	0.03	0.0	0.1
Palpitations/no dizziness	22	0.1	0.1	0.2
Palpitations/dizziness	4	0.03	0.0	0.1
Chest pain sitting	4	0.03	0.0	0.1
Chest pain/exercise	8	0.1	0.0	0.1
Chest pain normal	20	0.1	0.1	0.2
Pain in the neck, jaw or arms at rest	52	0.3	0.2	0.4
Chest pain	32	0.2	0.1	0.3
Dizziness during exercise	46	0.3	0.2	0.4
Fainting	23	0.2	0.1	0.2
Dizziness/fainting	61	0.4	0.3	0.5
Chronic cough	21	0.1	0.1	0.2
Painful calves during walking	72	0.5	0.4	0.6
Any risk factors for CVD	2544	16.1	15.5	16.7
High blood pressure	696	4.4	4.1	4.7
High Blood cholesterol concentration	921	5.8	5.5	6.2
Cigarette smoking	335	2.1	1.9	2.4
Overweight	186	1.2	1.0	1.4
Diabetes mellitus	150	1.0	0.8	1.1
Family history of heart disease	688	4.4	4.0	4.7
Males > 45 years	2474	15.7	15.1	16.3
Females > 55 years	269	1.7	1.5	1.9

*: Prevalence (%) in all runners

Of the runners surveyed, 284 (1.8%; 95% CI 1.6-2.0) reported at least one symptom of CVD. The more common specific symptoms of CVD in runners were painful calves

during walking (0.5%; 95% CI 0.4-0.6), a history of dizziness or fainting during exercise (0.4 %; 95% CI 0.3-0.5), pain in the neck, jaw or arms (0.3%; 95% CI 0.2-0.4), swollen ankles (0.3%; 95% CI 0.2-0.3), shortness of breath with mild exercise (0.3%; 95% CI 0.2-0.3), and chest pain (0.20%; 95% CI 0.1-0.2) (Table 2). Other possible symptoms of CVD (water retention, palpitations, chronic cough) were reported by \leq 0.2% of runners. The total number of runners who reported either known CVD or symptoms suggestive of CVD was 538, which is 3.4% of all the runners.

In this group of runners, 2544 (16.1%; 95% CI 15.5-16.7) reported at least one risk factor for CVD. The most common risk factor for CVD in runners was a combination of male and age > 45 years (15.7%; 95% CI 15.1-16.3). Other common specific risk factors for CVD included high blood cholesterol concentration (5.8%; 95% CI 5.5-6.2), high blood pressure (4.4%; 95% CI 4.1-4.7), and a family history of heart disease (4.4%; 95% CI 4.0-4.7). Less than 4% of runners reporting other CVD risk factors such as smoking, being overweight or suffering from diabetes mellitus (Table 2). The total number of runners who reported more than one risk factor for CVD was 2119, which is 13.4% of all the runners.

Prevalence of chronic diseases in other organ systems in runners

In this study, 2061 runners (13.1%; 95% CI 12.5-13.6) reported a history of respiratory disease. The more common specific respiratory diseases were reported as follows: allergies/hay fever (8.6%; 95% CI 8.2-9.1) and asthma (5.9%; 95% CI 5.5-6.3) (Table 4). Runners also reported a history of other chronic disease, including GIT disease (4.3%; 95% CI 4.0-4.7, n=683), metabolic and endocrine disease (3.5%; 95% CI 3.2-3.8, n=552), and kidney or bladder disease (2.3%; 95% CI 2.0-2.5, n=358).

Furthermore, 13.9% (95% CI 13.3-14.4, n=2189) runners reported a history of any allergy, while 14.8% (95% CI 14.2-15.3, n=2333) runners reported the use of chronic prescription medication.

Table 4. The prevalence of runners (% runners; 95% CI) with disease in other organ systems, medication use, and history of collapse (n = 15 778).

Chronic disease/medication use	All runners (n = 15 778)			
	n	% *	95% CI	
History of respiratory disease	2,061	13.1	12.5	13.6
Asthma	928	5.9	5.5	6.3
Allergies/hay fever	1,359	8.6	8.2	9.1
Recurrent respiratory tract infections	76	0.5	0.4	0.6
Previous lung complaints	31	0.2	0.1	0.3
COPD	3	-	-	-
Interstitial lung disease	1	-	-	-
Cystic fibrosis	2	-	-	-
Other respiratory complaints	20	-	-	-
History of metabolic or endocrine disease	552	3.5	3.2	3.8
History of gastrointestinal (GIT) disease	683	4.3	4.0	4.7
History of nervous system disease	593	3.8	3.5	4.1
History of kidney or bladder disease	358	2.3	2.0	2.5
History of blood or immune system disease	138	0.9	0.7	1.0
History of growths/cancers	298	1.9	1.7	2.1
History of any allergy	2,189	13.9	13.3	14.4
History of chronic prescription medication use	2,333	14.8	14.2	15.3

*: Prevalence (%) in runners

Prevalence of medication use by runners one week before, or during racing

In this group of runners, 2459 runners (15.6%; 95% CI 15.0-16.2) reported using medication to treat injuries either before or during races. In the week before a race, runners commonly used anti-inflammatory medication (12.8%; 95% CI 12.3-13.3), specifically non-steroidal anti-inflammatory medications (NSAIDs) (9.1%; 95% CI 8.7-9.6), while 3.9% (95% CI 3.6-4.2) of runners reported using paracetamol, and 1.6% (95% CI 1.4-1.8) used cortisone in the week prior to a race (Table 5).

Table 5. The prevalence of more specific medication use during a race in all the runners (% runners; 95% CI) (n = 15 778).

Medication group	Specific medication	All runners (n = 15 778)		
		n	% of all runners	95% CI
One week before a race				
Analgesics	Paracetamol	621	3,9	3.6 4.2
	Codeine	67	0,4	0.3 0.5
	Other analgesics	212	1,3	1.2 1.5
Anti -inflammatory medication		2,022	12,8	12.3 13.3
	NSAIDs	1,442	9,1	8.7 9.6
	Cortisone (any)	255	1,6	1.4 1.8
	Cortisone pills	43	0,3	0.2 0.4
	Cortisone injection	228	1,5	1.3 1.6
During a race				
Analgesics	Paracetamol	484	3,1	2.8 3.3
	Codeine	46	0,3	0.2 0.4
	Other pain killers	278	1.8	1.6 2.0
Any anti- inflammatory medication		1,227	7,8	7.4 8.2
	NSAIDs	776	4,9	4.6 5.3
	Cortisone (any)	41	0,3	0.2 0.3
	Cortisone pills	14	0,1	0.0 0.1
	Cortisone injection	29	0,2	0.1 0.3

NSAIDs: Non-steroidal anti-inflammatory drugs

During the race, the most common reported specific medication used was also anti-inflammatory medication (7.8%, 95% CI 7.4-8.2), more specifically, the NSAIDs (4.9%; 95% CI 4.6-5.3). In addition, 3.1% (95% CI 2.8-3.3) of the runners used paracetamol during a race, followed by the use of other analgesics (1.8%; 95% CI 1.6-2.0) (Table 5).

Prevalence of past history of collapse during training or racing in runners

In this group of runners, 196 (89.1%, 95% CI: 84.9 – 93.2) reported a history of collapse either during training or during a race.

The total number of runners who reported any known underlying chronic diseases, and/or medication use, and/or a past history of collapse was 7738, which is 49.1% of all runners.

In how many runners did the pre-participation “self assessment of risk” medical screening (using the ESC/EACPR guidelines) identify the need to undergo a full pre-participation medical assessment prior to running?

The pre-participation “self assessment of risk” screening identified 4941 runners (31.3%; 95% CI 30.6-32.0) that would need to undergo a full pre-participation medical assessment prior to running, if the current ESC/EACPR pre-participation screening guidelines are applied [27, 28]. Of these runners, 16.8 % (n=2657) runners should undergo medical evaluation for suspected cardiac disease based on the questionnaire results: 3.4% (n=538) reporting existing CVD (very high risk) and 13.4% (n=2119) reporting multiple CVD risk factors (high risk). The specific criteria (by Section 1 and 2 of the AHA/ACSM screening recommendations in the ESC/EACPR guidelines), that were responsible for the recommendation to undergo a full medical assessment (expressed as a % of the 4941 runners that were identified), are depicted in Table 6.

Table 6. Runners with specific criteria, expressed as a % (95% CI) of all runners (n = 4941) that were identified by the current ESC/EACPR guidelines (Sections 1 and 2) to undergo a pre-exercise medical assessment.

Sections/main categories per section	Specific criteria	All identified runners (n = 4,941)			
		N	%	95% CI	
Section 1 – Medical conditions					
History	Heart attack	50	1.0	0.7	1.3
	Heart surgery	19	0.4	0.2	0.6
	Coronary angioplasty	40	0.8	0.6	1.1
	Heart rhythm disturbance ^a	74	1.5	1.2	1.8
	Heart valve disease	64	1.3	1.0	1.6
	Heart failure	1	0.0	0.0	0.1
	Cardiac transplantation	-	-	-	-
	Congenital heart disease	11	0.2	0.1	0.4
Symptoms/medication use	Chest pain with exertion	31	0.6	0.4	0.9
	Unreasonable breathlessness	48	1.0	0.7	1.3
	Dizziness or fainting	61	1.2	0.9	1.5
	Heart medication ²	-	-	-	-
Other health issues	Musculoskeletal conditions	2,710	54.9	53.5	56.2
	Concerns about exercise	-	-	-	-
	Prescription medications	2,333	47.2	45.8	48.6
	Pregnant ³	-	-	-	-
Section 2 – Risk factors					
CVD Risk factors	Male > 45 years (n = 1152)	1,152	23.3	22.1	24.5
	Female > 55 years ⁴ (n = 142)	142	2.9	2.4	3.3
	Smoking	218	4.4	3.8	5.0

Table 6. Runners with specific criteria, expressed as a % (95% CI) of all runners (n = 4941) that were identified by the current ESC/EACPR guidelines (Sections 1 and 2) to undergo a pre-exercise medical assessment.

Sections/main categories per section	Specific criteria	All identified runners (n = 4,941)		
		N	%	95% CI
	High blood pressure ⁵	641	13.0	12.0 13.9
	High cholesterol ⁶	760	15.4	14.4 16.4
	Diabetic/medication for diabetes	140	2.8	2.4 3.3
	Family history of CVD	514	10.4	9.6 11.3
	Physical inactivity ⁷	-	-	- -
	Overweight ⁸	156	3.2	2.7 3.6

^{a1}: Includes pacemaker/implantable defibrillator/rhythm disturbance; ²: No specific question on heart medication; ³: No question on pregnancy; ⁴: No specific question about hysterectomy or being post-menopausal; ⁵: No specific question on unknown blood pressure and blood pressure medication; ⁶: No specific question about unknown cholesterol; ⁷: No question on physical inactivity – all participants entered a distance running event; ⁸: Question was on ‘obesity’ and not specific to > 20 pounds overweight

*: Significantly different between 56 km and 21.1 km runners

The main criteria that would lead to the recommendation for referral to undergo a full medical assessment before competing was a self reported musculoskeletal condition (54.9% of the runners that were identified). The use of prescription medication and the gender/age criterion (male gender: over 45 years) followed as criteria for referral. Risk factors associated with CVD, including a high serum cholesterol concentration, high blood pressure and diabetes mellitus were also common criteria for referral.

Of the 4941 runners that were identified through the screening process, 22% were identified because of CVD risk factors, 23% were identified because of other medical conditions plus one other risk factor for CVD, and another 55% were identified because

of other medical conditions, with no CVD risk factors. Almost half of the athletes with any one CVD risk factor were not identified for screening (1996/4244).

We also noted that 2% more 56km runners (n=1630, 32.7%) were identified to undergo screening by the guidelines, compared to 21km runners (n=3311, 30.7%), and 1.4% more male runners (n=2847, 31.9%) were identified compared to female runners (n=2094, 30.5%).

Discussion

The main finding of this study was that an online pre-participation “self-assessment of risk”, as currently recommended by European guidelines could be implemented successfully during pre-race registration in a community-based mass sports participation (distance running) event. In >15 000 recreational distance runners, the pre-race screening tool identified that over 30% of entrants for this event would, according to current European guidelines, require referral for a full medical assessment prior to participation in the distance races (moderate-to-high intensity exercise). Additional findings of this study were as follows: a) 2.3% runners reported suffering from existing CVD, 1.8% reported current symptoms suggestive of existing CVD, and 16.1% reported at least one risk factor for CVD, b) the prevalence of other existing chronic diseases, by organ systems was as follows: respiratory (13.1%), gastro-intestinal (4.3%), nervous system (3.8%), metabolic or endocrine system (3.5%), c) 13.9% runners reported suffering from allergic disease, d) 14.8% runners reported using chronic medication, e) 15.6% of runners reported using medication to treat injuries 7 days before or during races, and f) 1.4% of all runners reported a past history of collapse during a race.

International pre-exercise screening recommendations in leisure athletes [27, 28] [25] are currently not applied at community-based mass participation events and there are few data that these guidelines are indeed appropriate for pre-event medical screening of leisure athletes. To our knowledge, this is the first study to report pre-participation screening data to determine the risk profile of participants in such a community-based mass participation distance running event and we cannot compare our main finding to any other similar population of recreational athletes. We do note that distance running events (21.1km and ultra-marathon), such as the ones described in our study, are hosted all over the world, are becoming increasingly popular, and that participation in these events is encouraged as part of promoting a healthy active lifestyle. As far as we are aware, in most cases, these events are also open-entry and attract runners from all age groups. This can result in an increased proportion of runners that require no pre-entry qualifying times and enter races where there are no pre-event medical screening criteria.

Data reported on medical complications of participants during such events are largely limited to retrospective analysis of the incidence of sudden cardiac arrest and death. However, cardiac arrest and sudden death only represent the most severe medical complications during such events. There are few published data regarding other medical complications that do not necessarily lead to cardiac arrest, but are still regarded as potentially serious and even life-threatening medical complications medical complications and all medical complications during these events [5, 34].

We show that the presence of musculoskeletal complaints (54.9% of runners) was the main criteria identified by the current European guidelines [27, 28], for recommending consulting a physician before exercise, and that 32.34% of the runners that would be

referred for a medical assessment, reported musculoskeletal complaints as their only criteria for referral. Distance running is associated with a high prevalence of musculoskeletal complaints; therefore, we question the value of including the history of a musculoskeletal problem as part of a screening tool for this population as this would require referral of a large number of runners for pre-participation medical examinations.

The use of prescription medication (47.2% of runners) was the next most common criteria identified by the current European guidelines [27, 28], for recommending consulting a physician before exercise. The potential risk of a medical complication during exercise, as a result of prescription medication, can vary greatly and is related to the underlying medical condition for which the medication is prescribed, and the side effect profile of the medication. Some pharmacological agents may be associated with an increased risk of developing cardiac arrhythmias [35, 36, 37, 38], renal complications including acute renal failure [39], rhabdomyolysis [40, 41], gastrointestinal bleeding [42, 43, 44], and risk of tendon injuries including acute tendon rupture [45, 46]. We recommend that a screening tool could be modified to include more specific information about classes of medication that may be associated with increased risk of medical complications during exercise.

In our study, we did explore the prevalence of underlying chronic medical conditions in this population of runners. We identified that 2.3% of all runners reported known existing cardiovascular disease (CVD) and the most common CVD's were coronary artery disease (0.5%), and arrhythmia (0.4%). A history of a heart murmur was reported by 0.6% runners, but this may not necessarily indicate CVD. Furthermore, 1.8% runners reported symptoms that may be suggestive of CVD, but we acknowledge that some of

the symptoms, such as painful calves when walking and chronic cough, are not specific and may not indicate underlying CVD. As is recommended by international guidelines [28][25], we would strongly recommend that runners with existing CVD and those with symptoms suggestive of CVD undergo a full medical assessment before participating in moderate- to high-intensity exercise such as distance running events, because they represent a “very high risk” group for developing potentially serious acute cardiovascular complications during a distance-running event.

Our data showed that 16.1% of runners reported at least risk factor for CVD, with 13.4% reporting more than one risk factor. The most common specific risk factors for CVD were high blood cholesterol concentration (5.8%), high blood pressure (4.4%) and a family history of heart disease (4.4%). In addition, over 15% of the runners were males > 45 years. According to the European guidelines [27, 28], older runners (males \geq 45 years; females \geq 55 years) with one or more risk factors for CVD, and runners of younger age with two or more risk factors for CVD require medical assessment before engaging in moderate- to high-intensity exercise such as distance running. The recently revised recommendations by the ACSM excluded risk factors for CVD as criteria for a pre-exercise medical assessment [25]. However, in our experience at the Two Oceans races, runners who died or suffered from serious life threatening medical complications were mostly in this “high risk” group. Therefore, we would recommend that runners with \geq 1 risk factor for CVD undergo a full medical assessment before participating in these moderate- to high-intensity exercise events, until there is stronger evidence that the risk of an acute medical complication in runners falling into this category is not increased.

In our population of runners, the prevalence of existing disease in other organ systems varied between 1.9% (cancer) to 13.1% (respiratory disease). We recognise that there is a variable risk of a medical complication in this group of runners and the risk is likely based on many factors such as: a) the stage of the disease including the presence or absence of multi-organ complications of a disease, b) the level of control of the disease, c) side effects of any treatment (e.g. medication, radiation therapy, previous surgery), and d) the effect of significant environmental conditions or physiological stress such as moderate-to-high intensity exercise in “unmasking” disease exacerbation or any of the above (a to c). We recognise the complexity and individual variability of determining the specific risk of a medical complication during exercise in the presence of an underlying chronic disease. We suggest that underlying chronic disease constitutes at least an “intermediate risk” for medical complications during exercise and should be included in any pre-race screening program for leisure athletes, and that these runners undergo a full medical assessment before participating in these events.

The finding that 15.6% of runners reported ingestion of pharmacological agents, mainly anti-inflammatory medication (7.8%) and more specifically NSAIDs (4.9%), in the 7 days before or during races is of concern. The association between NSAID use and medical complications is known, specifically the risk of acute renal [39] and gastrointestinal complications [42, 43, 44]. We therefore suggest that the use of these medications during racing also constitutes an “intermediate risk” for medical complications during exercise and should be included in any pre-race screening program for recreational athletes.

Finally, in our study, 1.4% runners reported a past history of collapse during exercise. It is well-established that a history of collapse during exercise can be indicative of a more serious medical complication [47, 48, 49], therefore we suggest that this constitutes an “intermediate risk” and this information should be included in any pre-race screening program for recreational athletes.

The main strengths of this study are that it is, as far as we are aware, the first study to report on the feasibility and outcomes of an online pre-race medical screening tool for a large population of recreational runners participating in a mass community based distance running event. Furthermore, we report the data on a large sample size that is a representative sample (age, gender and race type) of race entrants with a response rate of 62.8%.

Limitations of this study are firstly that we note that older males were under-represented in the consent sample and this is a limitation since the proportion of athletes identified for screening could then be under-reported in this study. A further limitation is that data are self-reported and that not all runners may have fully understood the questions asked or may have under-appreciated the importance of the request for accuracy in the answers. Therefore, again the data presented in this paper may indeed be under-reported. If this is in fact the case, the risk profile of runners in this the sample may under-represent the actual risk profile. Finally, although runners in the higher risk categories (existing CVD and those with risk factors for CVD) were advised (by email communication) to undergo medical evaluation, we do not report data on how many actually took up this advice and how many developed any medical complications. In future studies, we will address this limitation.

Opinion and recommendations

We describe the development and implementation of a relatively low-cost pre-race screening tool to determine the “self-assessment of risk” of a medical complication during exercise in a community-based mass participation distance running event. We show that by using current screening guidelines, > 30% of all runners entering for these events would require a full medical assessment, where a history of a musculoskeletal complaint and the use of prescription medication were the main criteria in the existing guidelines that triggered a referral to undergo a full medical assessment. We suggest a revision of the screening guidelines triggering a full medical assessment and propose risk stratification and educational intervention (Table 7) as follows: 1) excluding the question on musculoskeletal complaints from triggering a full medical assessment, 2) including a question on prescription medication but refining it for specific classes of drugs that could potentially increase the risk of medical complications during exercise, and 3) including questions on other chronic diseases with organ system and disease specific recommendations on full medical assessment. Finally, future studies, should determine the feasibility and implementation of such a screening and educational intervention program on reducing medical complications during these events. This pre-race screening program is on-going and has already been implemented in other large endurance events. In future, we will continue to report on the relationship of the risk profile of endurance athletes (“very high risk”, “high risk” and “intermediate risk” groups) and the actual risk of medical complications during endurance events. These data will assist in decision-making regarding pre-participation screening guidelines for these leisure distance-running athletes.

Table 7. Recommendations: Risk categories, criteria and recommendations for medical assessment and educational intervention.

Risk category	Criteria	Recommendation	Prevalence (in this study)
Very high	<ul style="list-style-type: none"> Existing CVD * Symptoms suggestive of existing CVD 	<ul style="list-style-type: none"> Targeted educational intervention for existing CVD Information about the risk of a medical complication during exercise (CVD) Recommendation for a full medical assessment before participation in an endurance event 	3.4%
High	<ul style="list-style-type: none"> Risk factors for CVD (≥ 2 risk factors) 	<ul style="list-style-type: none"> Targeted educational intervention for risk factors of CVD Information about the risk of a medical complication during exercise (CVD) Recommendation for a full medical assessment before participation in an endurance event 	13.4%
Intermediate	<ul style="list-style-type: none"> Existing chronic disease in other organ systems Use of prescription medication Use of anti-inflammatory drugs immediately before and/or during a race History of collapse during exercise 	<ul style="list-style-type: none"> Targeted educational intervention (organ system/disease specific) Information about the risk of a medical complication during exercise (organ system/disease specific) May require a full medical assessment before participation in an endurance running event (organ system/disease specific) 	49.1%
Low	<ul style="list-style-type: none"> None of the criteria in the very high, high and intermediate risk categories 	<ul style="list-style-type: none"> General educational material to all race participants (e.g. anticipated environmental conditions, fluid and hydration guidelines, access to medical stations during the race) 	34.1%

*: CVD – Cardiovascular Disease

Declaration of Helsinki: Permission to analyse the medical histories of the study subjects was obtained from the Research Ethics Committee of the University of Cape Town (REC 009/2011) (REC 030/2013) and the Research Ethics Committee of the University of Pretoria (REC 433/2015). This study complied with the Declaration of

Helsinki's ethical principles for conducting medical research involving human participants.

Conflict of Interest and Source of Funding:

None of the authors report any conflict of interest pertaining to this manuscript.

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