REVIEW

DOI: 10.4274/ijca.2025.97269
Int J Cardiovasc Acad 2025;11(3):86-96

Pre-participation Cardiovascular Evaluation for the Arbaeen Walking Ceremony, A Practical Guidance

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Abstract

As an important mass gathering event, the Arbaeen walking ceremony has a high risk of cardiovascular events. Walkers with backpacks walk many kilometers in hot and air-polluted weather. Many of them have sedentary lifestyles and lack cardiovascular adaptation to this type of physical activity. They can be susceptible to acute cardiac events such as sudden cardiac death and myocardial infarction during their walking route. Authors of this study, who are experienced in this field, aimed to introduce practical pre-participation cardiovascular guidance based on expert opinions, sports medicine textbooks, and other related high-quality findings from the literature that would be applicable to the Arbaeen walking ceremony. An appropriate cardiovascular pre-participation evaluation can help to find those people with a high risk of cardiovascular impairments to maximize safe participation on the field in the Arbaeen walking ceremony. The last physical activity readiness questionnaire for everyone and electronic physical activity readiness medical examination and American College of Sports Medicine pre-participation screening algorithm for the general public can be used for pre-participation cardiovascular assessment for this march. For proper cardiovascular adaptation and training of high-risk pilgrims, this assessment must be done annually, 2 months at least before the walking ceremonies.

Keywords: Pre-participation evaluation, prevention, cardiovascular risk factor, cardiovascular disease

INTRODUCTION

There has been a significant increase in the number of pilgrims coming to Iraq for Arbaeen ceremonies held on the 40th day after Imam Hossein's martyrdom at Karbala since the last decade. In yearly Arbaeen ceremonies, millions of travelers of various ages go on foot from Iraq and adjoining countries to Karbala, a city 100 km southwest of Baghdad. The capital of Iraq.

They may walk hundreds of kilometers in a few days, with backpacks, alongside pilgrims who travel by vehicle on the same route.[1] As an important mass gathering event, the Arbaeen walking ceremony has a high risk of infectious and non-infectious diseases.[2,3] On the other hand, the climate in Karbala is characterized as desert and has extremely high temperatures and low rainfall. The summer temperatures are extremely high and can reach over 50 degrees Celsius.[4] Pilgrims walking to Karbala are therefore susceptible to cardiovascular strain due to environmental hazards such as heat exposure and air pollution.[5,6] For example, heart rate (HR), an important physiologic indicator of cardiovascular stress, increases with heat exposure. It has been shown that for an increase of one degree Celsius in core body temperature, HR increases by approximately 33 beats per minute.[7,8] On the other hand, the metabolic demand of walking with a backpack is considerably higher than walking without a backpack. Level walking on a firm surface with a usual speed of 2.5 mph has

To cite this article: Hajian M, Mohaghegh S. Pre-participation cardiovascular evaluation for the Arbaeen walking ceremony, a practical guidance. Int J Cardiovasc Acad. 2025;11(3):86-96

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Received: 24.03.2025
Accepted: 11.07.2025
Publication Date: 15.09.2025

an energy consumption of 3 metabolic equivalents (MET). While under the same conditions, a moderate pack load has a metabolic cost of 7 MET, and the MET value increases as the pack weight, speed of walking, and uphill gradient increase. For example, walking with a speed of 5 mph (twice the usual speed of 2.5 mph) has an energy cost of 8 MET.[9] Classically, intensity of physical activity can be categorized based on its energy expenditure levels. These categories are sedentary (‹1.6 MET), light (1.6‹3 MET), moderate (3‹6 MET), vigorous (6‹9 MET), and high (≥9 MET). 1 MET equals resting energy expenditure or 3.5 mL O2 consumption/kg/min. When a physical activity intensity is rated as 2 METs, it requires twice the O2 and energy consumption as at rest.[10]

The main walking pathway of pilgrims in the Arbaeen ceremony is the 76-kilometer road between the cities of Najaf and Karbala, which takes about three days on foot. It is asphalted and level.[11] The main influential factors that can overstress their cardiovascular system are backpack weight, the pace of walking, and environmental conditions such as heat exposure. Cardiovascular emergencies were the major finding in some studies focusing on Arbaeen ceremonies. These include ischemic heart diseases, hypertension, and myocardial infarction.[4] Cardiovascular diseases (43.5%) were the primary cause of death in the 2014 Arbaeen ceremony in the Hantoosh et al.[12] report which include 54 deaths from total 124 ones 12 and were the main cause of death (90% of cases) in total 177 Iranian patients hospitalized in Iraqi hospitals in the 2012 Arbaeen event in Sadeghi et al.[13] study. A total of 84 (47%) patients were female. Mean age of cardiovascular patients was 63.29±16.87 years.[13] Also in Lami et al.[14] study in the 2014 Arbaeen ceremony in 4425 non-communicable diseases emergencies including 54.31% male and 45.69% female patients, percentage of severe hypertension as an emergency complaint was higher (29.04%) than other non-communicable disease emergencies including asthma (19.23%), ischemic heart diseases (21.1%), diabetes (16.43%), cerebrovascular accident (2.45%) and pulmonary edema (3.86%) emergencies. The age groups of patients were as follows: <20 years (5.11%), 20-39 years (18.46%), 40-49 years (39.55%) and >60 years (36.88%).[14]

The main aim of pre-participation cardiovascular evaluation before physical activities such as the Arbaeen walking ceremony is to find those people with a high risk of cardiovascular impairments. According to the American College of Cardiology (ACC), the American Heart Association (AHA), and the American College of Sports Medicine (ACSM), as the risk of sudden cardiac death (SCD) and acute coronary syndrome in susceptible persons regardless of their age increases during vigorous physical activities, screening to detect such high-risk individuals is both justified and beneficial.[15-17] Such medical screening could include a history and physical examination and if necessary exercise stress testing, or more extensive diagnostic testing. So, the authors of this article aimed to define a cardiovascular pre-participation evaluation (PPE) and related management and prevention strategies which can be done by trained primary health providers for Arbaeen walking ceremony. Nevertheless, it should be emphasized that even a comprehensive cardiac screening program will not identify all high-risk persons for SCD, and adequate preparation for cardiac emergencies is always necessary.[18,19]

METHODS

The authors who are experienced in this field relied heavily on sports medicine textbooks (Brukner Clinical Sports Medicine, ACSM guidelines for exercise testing and prescription) and expert opinions from professional societies including AHA, ACC, Canadian cardiovascular society, European Resuscitation Council, Heart Rhythm Society, Asia Pacific Heart Rhythm Society, European Association of Preventive Cardiology, American Medical Society for Sports Medicine, Society for Cardiovascular Pathology, Canadian Medical Association, physical activity readiness questionnaire for everyone (PAR-Q+) electronic physical activity readiness medical examination (ePARmed-X+) resources and ACSM and their related journals. Also a literature review using Google Scholar, PubMed, up-to-date, and Cochrane databases was performed to identify relevant systematic reviews / meta-analysis and randomized clinical trial studies (as high quality studies) from beginning until time of study (March 2025) for review. The used key words were Iraq, Arbaeen, cardiovascular disease, myocardial infarction, ischemic heart disease, SCD, heatstroke, walking, preparticipation evaluation, acute coronary syndrome, hypertrophic cardiomyopathy (HCM), screening and prevention. The findings were summarized and appropriate information was given based on mentioned references.

RESULTS

The database search revealed only 2 systematic review / meta-analysis studies and no randomized clinical studies (Figure 1). Two systematic reviews (and / or meta-analysis) have been done by authors[4] and Harmon et al.[20]

Cardiovascular Events

A review of the literature shows that sudden cardiac arrest (SCA) or death during exercise is not a rare occurrence even in young athletes. A thorough review of 28 studies about the incidence of SCD in exercisers showed that this can vary from 1:3,000 to 1:917,000. However, studies with better methodological quality reported a higher incidence, ranging from 1:40,000 to 1:80,000.[21,22] Increasing age, and male sex are risk factors for SCD. The ratios of male to female in SCD range from 5:1 to 9:1. A 5-year prospective study, in the French general population aged 10-70 years, reported that 94% of SCD during exercise occurred in

recreational athletes, usually in the fifth decade. Also, cardiac death is not specific to competitive athletes. Based on data from the center for disease control, cardiovascular disease was the second cause of death (after malignancy), in individuals younger than 24 years old in the USA. So PPE can be recommended for both athletic and non-athletic populations[18,23] such as pilgrims participating in the Arbaeen march.

The cause and mechanism of SCD are important. Primary ventricular tachyarrhythmia (in hereditary and congenital conditions), myocardial ischemia and infarction (in master athletes), and aortic rupture or dissection (in Marfan syndrome) are 3 primary mechanisms of SCD during exercise.[24] In those over the age of 50 years, coronary artery disease (CAD) is the main cause of SCD during physical activity (more than 80% of cases), while SCD in younger athletes (<35 years old) is primarily due to hereditary or congenital structural and electrical cardiac or vascular problems[25,26] which include myocardial diseases (HCM, arrhythmogenic ventricular cardiomyopathy, and dilated cardiomyopathy), CAD / anomalies (congenital coronary artery anomalies and premature atheromatous CAD), cardiac conduction tissue abnormalities (Wolff-Parkinson-White syndrome and right ventricular outflow tachycardia), valvular heart diseases (mitral valve prolapse and congenital aortic stenosis), disorders of the aorta (Marfan syndrome), and ion channelopathies (congenital long QT syndrome, Brugada syndrome, congenital accessory electrical pathways, and catecholaminergic polymorphic ventricular tachycardia). A variety of acquired conditions are also reported in this group (younger athletes) such as infections (myocarditis), drugs (cocaine, amphetamine), electrolyte disturbances (hypokalaemia or hyperkalemia), hypothermia, hyperthermia and trauma (commotio cordis).[18] A meta-analysis of 34 studies that examined post-mortem findings of 4,605 young individuals (under the age of 35 years) who succumbed to SCD, showed that structurally normal hearts were more common than HCM both in athletic (26.7% versus 10.3% of cases) and non-athletic (30.7% versus 7.8% of cases) groups.[27] These findings have led to the

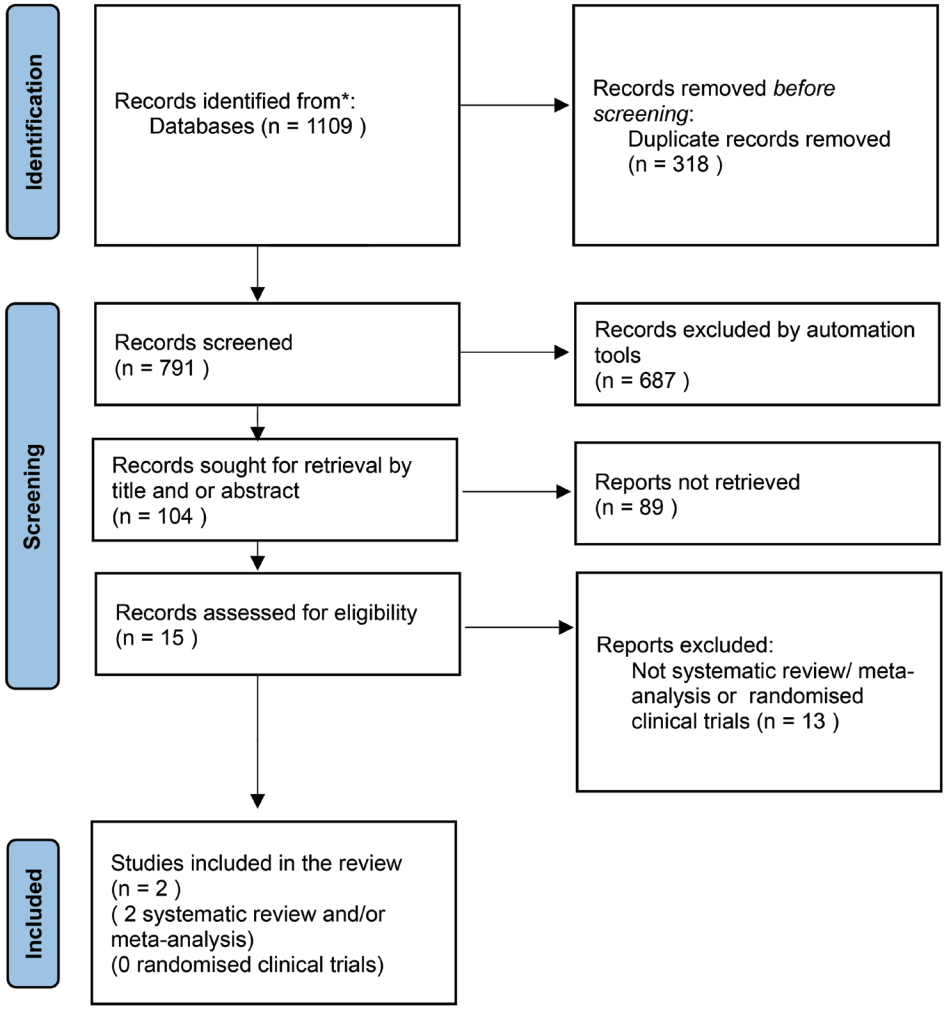

Figure 1. Flow chart of the review of databases.

use of the term sudden arrhythmic death syndrome when there is a postmortem structurally normal heart, and negative toxicology profile.[28,29] HCM, a primary myocardial pathology has a prevalence of 0.2% in the general population. This is an autosomal dominant disorder with varying clinical and morphologic characteristics. SCD can be the first manifestation in an individual. Death usually occurs in males during or immediately after exercise.[30,31]

Medical History

Although up to 80% of athletes with SCD had reported no history of cardiovascular symptoms,[32] medical history is an important component of cardiovascular PPE and can be a clue of underlying serious silent cardiac disease. In addition to sex and age, the race of pilgrims can be important factors in determining health outcomes. SCD has occurred more in black / African-American athletes than their white counterparts (3.2 times greater risk).[18,33] A sedentary lifestyle can be a major risk factor for cardiovascular events during vigorous physical activity. According to ACSM, persons with history of performing regular, organized physical activity of at least moderate intensity (target HR of 40 to 60% of HR reserve or 3‹6 MET) for minimum 30 min on 3 or more days per week during the previous 3 months are categorized as current exercisers).[34] This classification is the basis of the last ACSM pre-participation screening algorithm for the general public (Figures 2 and 3).

History of heart attack or surgery, cardiac catheterization, coronary angioplasty (percutaneous transluminal coronary angioplasty), pacemaker/implantable cardioverter defibrillator usage, ablation procedures for dysrhythmias, heart valve disease, murmur or other abnormal heart sounds, peripheral vascular disease, pulmonary disease, cerebrovascular disease (for example transient ischemic attacks and stroke), blood dyscrasias and anemia (such as systemic lupus erythematosus); deep vein thrombosis / emboli, phlebitis; pregnancy; cancer; emotional / mood diseases (depression is a cardiovascular risk factor),[35] heart failure or transplantation and congenital heart diseases must be questioned. Also, medication history (including dietary/nutritional supplements) and use of caffeine, tobacco, or recreational (illicit) drug use must be asked.[18,34]

Family history is very important as many etiological conditions of SCD are hereditary. A history of premature cardiac disease or death or a known hereditary disease, such as Brugada syndrome or cardiomyopathy, in a first-degree relative necessitates referral for a more precise cardiac examination.[36] Ventricular arrhythmias as a common pathologic mechanism in these hereditary conditions may present as syncope, epilepsy, or unexplained drowning, and so, asking about these symptoms and signs in close family members may reveal genetically transmitted cardiac diseases. Seeking post-mortem reports on first-degree relatives who suffered premature SCD is important as this can differentiate a hereditary disorder (such as HCM) from a congenital disorder such as congenital coronary artery anomalies.[18,37]

History of SCA, syncope (loss of consciousness) especially during physical activity, palpitations (an annoying perception of the heart contractions), dizziness of unknown cause, chest pain (especially with exercise, exertion, stress, cold weather and after meal), intermittent claudication (the pain, often described as a cramp in the lower extremities that is brought on by walking especially when walking uphill and disappears within 1-2 min after stopping walking, reproducible from day to day and does not occur with standing or sitting), unusual exertional dyspnea / fatigue and orthopnea or paroxysmal nocturnal dyspnea (dyspnea with onset usually 2-5 h after the sleep which may be disappeared by sitting or walking out) should also be assessed by more diagnostic workup.[18,20,34] Chest pain characteristics favoring cardiac origin include sensation of heaviness, burning, squeezing or constricting feeling, with a location in mid thorax, the substernal area, interscapular region, in arms (one or both), neck, shoulders, forearms, cheeks, teeth and fingers. Vague aches, sharp, “knifelike”, stabbing pains, respiration induced pains, pains of the left hemithorax or submammary areas, and pains after end of exercise or induced by a particular body movement are features that indicate against the ischemic origin of chest pain.[34,38]

Although in the last ACSM pre-participation screening algorithm of the general public, cardiovascular disease risk factors are not mentioned, knowledge of these risks, is necessary for a more precise assessment of the cardiovascular health of the pilgrims and, if necessary, referral for medical clearance and decisions about exercise testing and prescription. These include age (men ≥45 yrs.; women ≥55 yrs.); a family history (myocardial infarction, coronary revascularization, or sudden death before 55 yrs. in father or other male first-degree relative or before 65 yrs. in mother or other female first-degree relative); a blood glucose (fasting plasma glucose ≥100 mg/dL; or 2 h plasma glucose values in oral glucose tolerance test ≥140 mg/dL; or HbA1C ≥5.7%); blood pressure (systolic blood pressure ≥130 mmHg and/or diastolic ≥80 mmHg, based on an average of ≥2 readings obtained on ≥2 occasions, or on antihypertensive medication); and body mass index (BMI) / waist circumference (BMI ≥30 kg/ m-2 or waist girth).

>102 cm for men and >88 cm for women), cigarette smoking (current cigarette smokers or those who quit within the previous 6 months o or exposure to environmental tobacco smoke), Chronic obstructive pulmonary disease, lipids (total serum cholesterol ≥200 mg/dL, low-density lipoprotein cholesterol ≥130 mg/dL or high-density lipoprotein cholesterol <40 mg/dL in men and <50 mg/dL in women or on lipid-lowering

medication) and sedentary lifestyle (not meeting the minimum threshold of 75-150 min/week of moderate-to-vigorous intensity physical activity). High-density lipoprotein cholesterol ≥60 mg/dL is considered a negative risk factor which means can eliminate one positive risk factor from the sum of positive risk factors.[34,39]

Physical Examination

The main components of preparticipation cardiac physical examination include measurement of body weight / height, BMI, waist circumference, pulse rate and rhythm, resting blood pressure in seated, supine, and standing states, palpation of the cardiac apical impulse and point of maximal impulse, cardiac and pulmonary auscultation, inspection and palpation of lower extremity for arterial pulses, edema, and cutaneous signs of hypercholesterolemia (tendon xanthoma and skin xanthelasma). Bilateral lower extremity edema, which is most evident at night, is a characteristic sign of heart failure or bilateral chronic venous insufficiency.[34,40] HCM and aortic stenosis the two most common causes of physical activity-

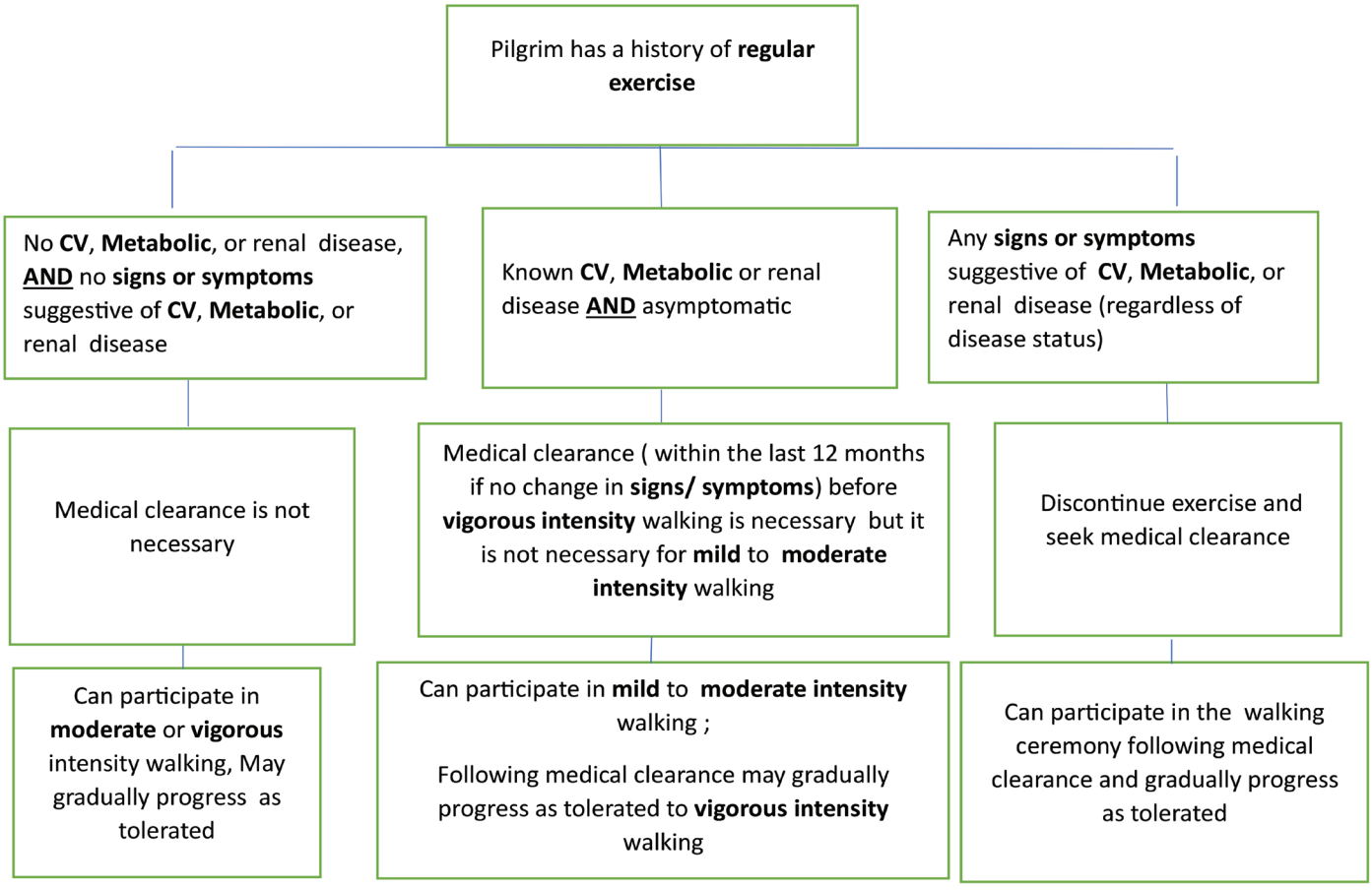

Figure 2. Pre-participation cardiovascular screening algorithm for the general public based on the American college of sports medicine (ACSM) guidelines for current exerciser pilgrims[34]

MET: Metabolic equivalent

Regular exercise is the history of participation in regular exercise of at least moderate intensity for at least 30 minutes on 3 or more days per week during the past 3 months. **Mild-intensity** walking (1.6-2.9 MET) is an intensity that causes a slight increase in heart rate and breathing (30%-39% heart rate reserve or rate of perceived exertion 9-11). **Moderate-intensity** walking and backpacking (3-5.9 MET), is an intensity that causes a considerable increase in heart rate and breathing (40%-59% heart rate reserve or rate of perceived exertion 12-13). **Vigorous intensity** walking and backpacking (6<=MET) is an intensity that causes a high increase in heart rate and breathing (60% or more heart rate reserve or rate of perceived exertion 14 or more). **Cardiovascular (CV)** disease is a cardiac, cerebrovascular, or peripheral vascular disease (hypertension is considered a CV risk factor and not a disease). **Metabolic disease** is type 1 or 2 diabetes mellitus. **CV** signs and symptoms are the following at rest or during activity: chest pain or other areas with potential ischemic origin such as neck, jaw, and arms; dyspnea; dizziness or syncope; orthopnea or paroxysmal nocturnal dyspnea; ankle edema; palpitation or tachycardia; intermittent claudication; known heart murmur; unusual fatigue with usual activities.

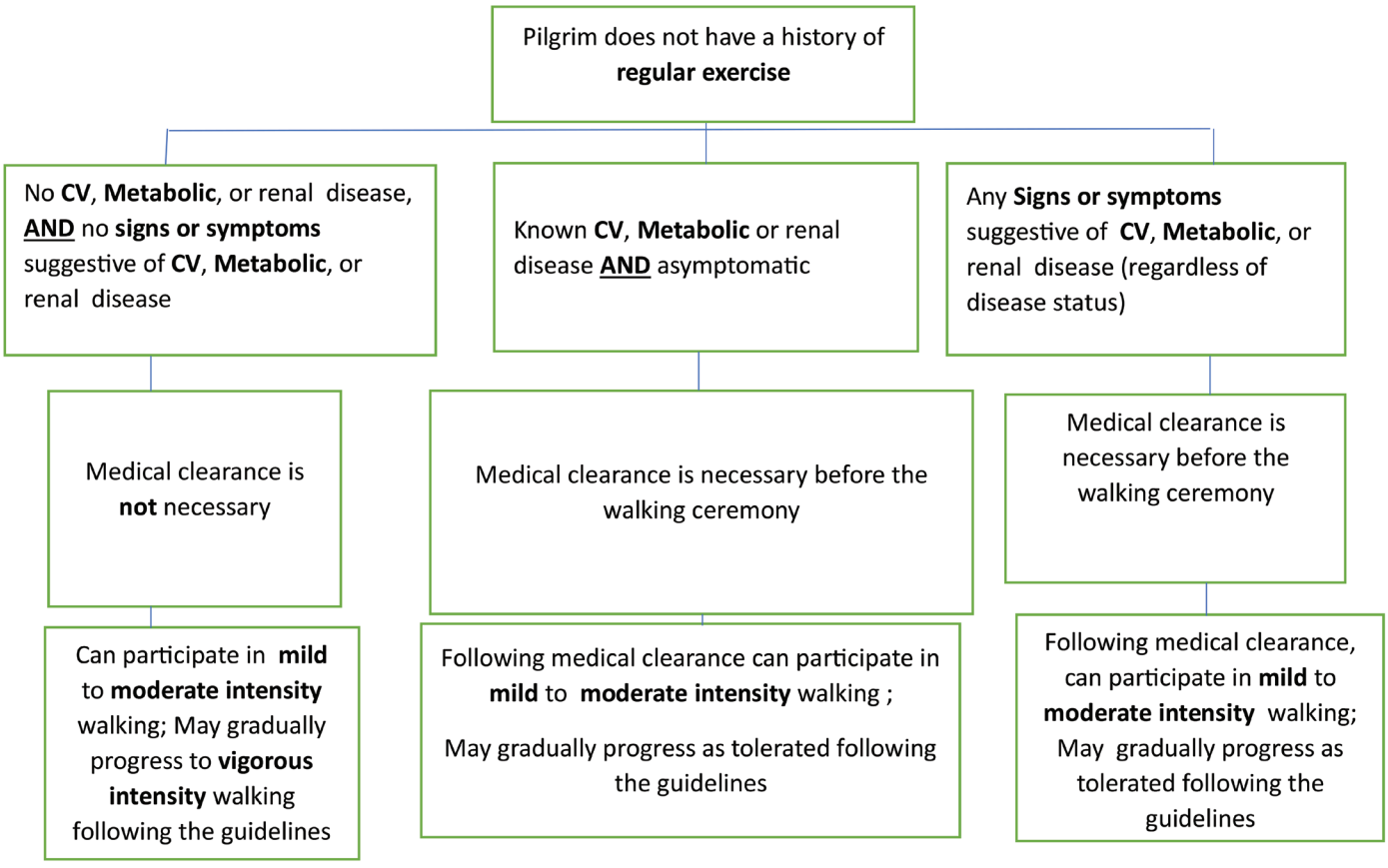

Figure 3. Pre-participation cardiovascular screening algorithm for the general public based on the American college of sports medicine (ACSM) guidelines for non-current exerciser pilgrims[34]

MET: Metabolic equivalent

Regular exercise is the history of participation in regular exercise of at least moderate intensity for at least 30 minutes on 3 or more days per week during the past 3 months. **Mild-intensity** walking (1.6-2.9 MET), is an intensity that causes a slight increase in heart rate and breathing (30%-39% heart rate reserve or rate of perceived exertion 9-11).

Moderate-intensity walking and backpacking (3-5.9 MET), is an intensity that causes a considerable increase in heart rate and breathing (40%-59% heart rate reserve or rate of perceived exertion 12-13). **Vigorous intensity** walking and backpacking (6<=MET) is an intensity that causes a high increase in heart rate and breathing (60% or more heart rate reserve or rate of perceived exertion 14 or more). **Cardiovascular (CV)** disease is a cardiac, cerebrovascular, or peripheral vascular disease (hypertension is considered a CV risk factor and not a disease). **Metabolic disease** is type 1 or 2 diabetes mellitus. **CV signs and symptoms** are the following at rest or during activity: chest pain or other areas with potential ischemic origin such as neck, jaw, and arms; dyspnea; dizziness or syncope; orthopnea or paroxysmal nocturnal dyspnea; ankle edema; palpitation or tachycardia; intermittent claudication; known heart murmur; unusual fatigue with usual activities.

related SCD, can manifest themselves as systolic ejection heart murmurs.[41] HCM patients can have resting left ventricular outflow obstruction in 25% of cases but this can rise to 50% during exertion.[18,42] Murmurs of dynamic left ventricular outflow tract obstruction become louder when the venous return is decreased, so it is recommended to examine the patient in both the supine and standing positions (and with Valsalva maneuver), specifically to identify the diagnostic murmur of HCM (if present). Such murmurs are typically early systolic, are harsh, and are heard best at the right upper sternal border.[43] On the other hand, murmurs of aortic stenosis typically attenuate when the venous return is decreased and increase with maneuvers that increase venous return (i.e., squatting).[44] In general, harsh systolic murmurs and any diastolic murmur should be considered pathologic.[18]

Other than HCM, some important causes of SCD such as arrhythmogenic ventricular cardiomyopathy, dilated cardiomyopathy, long QT syndrome, catecholaminergic polymorphic ventricular tachycardia, ventricular preexcitation,

and Brugada syndrome generally have normal physical examinations; so these cannot be excluded by physical examination findings alone.[18,45] Screening for hypertension and coarctation of the aorta is also an important aspect of the cardiovascular physical examination. Right and left arm blood pressure measurements and femoral artery palpation must be done.[18,34]

Marfan syndrome, an autosomal dominant collagen disorder (with 25% of cases from de novo mutations), with a prevalence of 1 in 5,000 to 10,000, with no gender predilection, and variable gene expression, can result in aortic dilatation, rupture/dissection, and valvular dysfunction. Despite medical improvements, aortic dissection still occurs in about one-tenth of the patients and the disorder has been responsible for approximately 3% of all exercise-related SCDs in young people. Heart failure can also occur due to aortic valve insufficiency.[18] More than half of the dissections have occurred in patients undiagnosed with this syndrome, therefore early diagnosis is important and can be lifesaving.[46] The physical stigmata of Marfan syndrome are a high-arched palate, arachnodactyly (long, slender fingers), hyperlaxity, tall height, lens dislocation (ectopia lentis), and a long arm / wing span. Cardiovascular (especially aortic root aneurysm) and ocular manifestations are primary clinical features in making an unambiguous diagnosis of suspected cases in the absence of any family history.[18,47]

DISCUSSION

Screening and Referring the Pilgrims

As mentioned before, according to the ACSM pre-participation screening algorithm for the general public (Figures 2 and 3), the current physical activity level of pilgrims is the basis of their pre-participation cardiovascular assessment. Accordingly, the pilgrims can be divided into 2 categories: those who have a history of participation in regular physical activity moderate intensity for at least 30 minutes on 3 or more days per week during the past 3 months and those who do not have such a history.[34]

Identifying individuals with known CV, metabolic, or renal diseases or those with signs or symptoms suggestive of cardiac, peripheral vascular, renal, or cerebrovascular diseases,

Types 1 and 2 diabetes mellitus are the next level of screening. In this algorithm, hypertension is considered a CV risk factor and not a disease. Finally, the desired walking intensity is an important factor in this algorithm.[34] Electrocardiographic records and other sophisticated diagnostic methods, such as echocardiography, are not included in this Algorithm, and trained health care providers can obtain necessary information based on appropriate history taking, laboratory data, and concise physical examination. This can be advantageous for the screening of a large number of pilgrims, such as those participating in the Arbaeen walking ceremony.

This algorithm is based on the direct relationship between the relative risk of SCD and acute myocardial events during vigorous-to-near maximal intensity physical activity and the presence of CVD and / or exertional symptoms,[17] and an inverse relationship with the current physical activity level of individuals.[48,49] Also, there is insufficient evidence to indicate that the presence of CVD risk factors without underlying disease poses a substantial risk of adverse exercise-related CV events. This is especially true among otherwise healthy adults. Note that this algorithm is not a substitute for appropriate cardiovascular pre-participation assessment, and decisions about a referral to a qualified specialist for medical clearance, should be made individually based on sound clinical judgment regarding all previously mentioned risk factors of cardiovascular diseases and the desired physical activity intensity of pilgrims during walking.[34] The 2021 PAR-Q+ and ePARmed-X+ 50 can be a useful adjunct for this algorithm. The tools developed have no age limits, allow for self-management, and include a three-step risk assessment process. In step one, clients answer seven general health questions using the PAR-Q+. The questions are not specific to cardiovascular problems and point to reveal heart, circulatory, balance, chronic medical, and joint problems that could make exercise difficult, or even dangerous for clients (Table 1). If all responses are “no”, they are permitted to engage in unrestricted activities following general exercise guidelines. A “yes” on any question prompts further follow-up. In step two, those who responded “yes” on the previous stage must answer additional follow-up questions related to chronic conditions (Table 2); if they respond with all “no”, they can self-clear and receive customized exercise advice, while any “yes” leads them to the ePARmed-X+. It consists of a series of medical condition specific questions designed electronically and must be completed in tandem. It has been translated into several languages and is available publicly. After finishing the ePARmed-X+, a client could be given one of three suggestions. Low risk means the client is approved for unrestricted participation in physical activities. Intermediate risk indicates that the client is authorized for low to moderate intensity exercise, but the client needs to consult or be supervised by a qualified exercise professional. High risk indicates that the client should engage in low-intensity physical activity until a physician or healthcare professional provides clearance. It is advised that they exercise under the direct supervision of a qualified exercise professional.[50,51] These tools are self-screening and can be beneficial for pre-participation screening of a large number of pilgrims. Indeed, they lower the referral rate of pilgrims. Pilgrims can be advised to follow the instructions of these tools and consult their trained primary

Table 1. The 2021 physical activity readiness questionnaire for everyone plus (PAR-Q+) general health questions[50]		
General health questions		
Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**YES**	**NO**
1) Has your doctor ever said that you have a heart condition or high blood pressure?	o	o
2) Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?	o	o
3) Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise).	o	o
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? Please list condition(s) here:	o	o
5) Are you currently taking prescribed medications for a chronic medical condition? Please list condition(s) and medications here:	o	o
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer NO if you had a problem in the past, but it does not limit your current ability to be physically active. Please list condition(s) here:	o	o
7) Has your doctor ever said that you should only do medically supervised physical activity?	o	o

Table 2. The 2021 physical activity readiness questionnaire for everyone plus (PAR-Q+) follow- up main questions[50]
1-Do you have arthritis, osteoporosis, or back problems?
2-Do you currently have cancer of any kind?
3-Do you have a heart or cardiovascular condition? This includes coronary artery disease, heart failure, diagnosed abnormality of heart rhythm.
4-Do you currently have high blood pressure (resting blood pressure with or without medication equals or greater than 160/90 mmHg).
5-Do you have any metabolic conditions? This includes type 1 diabetes, type 2 diabetes, pre-diabetes.
6- Do you have any mental health problems or learning difficulties? This includes Alzheimer's, dementia, depression, anxiety disorder, eating disorder, psychotic disorder, intellectual disability, down syndrome.
7- Do you have any respiratory disease? This includes chronic obstructive pulmonary disease, asthma, pulmonary high blood pressure.
8- Do you have a spinal cord injury? This includes tetraplegia and paraplegia.
9- Have you had a stroke? This includes transient ischemic attack or cerebrovascular event
10-Do you have any other medical condition not listed above or do you have two or more medial conditions?

health providers accordingly when it is necessary to refer to a qualified exercise or healthcare professional. Trained primary health care providers as community health workers or who work in mobile health units can then use the ACSM algorithm in the case of pilgrims' references.

Another important consideration in using this algorithm is monitoring and training pilgrims for changes that may alter their categorization and subsequent health recommendations. For example, the development of new signs or symptoms after beginning walking can change their categorization and make it necessary to adopt new health recommendations accordingly.

Medical clearance in this algorithm is an approval from a health care professional (for example sports medicine specialist or cardiologist) to engage in exercise (walking and backpacking). The type of medical evaluations and procedures necessary for the cardiovascular clearance can vary widely, as there is not a single recommended screening test and the health care professional can choose them based on their discretion and clinical judgment. This may include more detailed taking of medical history and physical examination, resting or stress electrocardiogram / echocardiogram, computer tomography angiography (for the assessment of coronary artery calcium), or even nuclear medicine imaging studies, or coronary angiography. Accordingly, the health care professional can recommend instructions and restrictions (e.g., exercise duration and intensity) to the pilgrim in question, and continued communication between health care professionals and primary care providers is strongly recommended.[34] Also medical clearance for other non-cardiovascular problems based on PARQ+ and ePARMed-X+ can be obtained by referring the pilgrims to related health care professionals.

Management and Prevention Strategies

Effective management and prevention of acute cardiovascular events during Arbaeen walking ceremonies focus on several key strategies. These include:

1- Implementation of simplified screening and management algorithms for those with or at risk of cardiovascular disease.[52]

2- Adequate preparation for cardiac emergencies in the mobile health units. Creating efficient resuscitation protocols and enhancing the accessibility of automated external defibrillators in public spaces are the most effective methods for lowering the occurrence of SCD.[53]

3- As there is a low risk of cardiovascular events associated with participation in light-to-moderate intensity physical activity, much of the risk of these events during vigorous physical activity can be reduced by following a "progressive transitional phase" for 2-3 months before ceremony during which the duration and intensity of exercise are gradually increased (if the individual remains asymptomatic).[34] This is especially important for previously sedentary and high-risk pilgrims who want to participate in the Arbaeen walking ceremony.

4- In warm conditions, like Arbaeen walking ceremonies, it is essential to regulate core temperature while walking. Elements that impede this regulation, including lack of hydration, unsuitable clothing, and inadequate salt, and electrolyte consumption, will raise the risk of heat-related illnesses and increase cardiovascular strain. In warm conditions, pre-cooling methods are essential for postponing the rise of dangerous body temperatures, thus safeguarding walking performance and avoiding heat-related cardiovascular stress. Successful pre-cooling methods encompass ice packs, the wearing of ice vests, remaining in air-conditioned spaces, taking cold baths, and drinking chilled water. Additionally, maintaining good physical fitness greatly decreases the risk of heat-related problems.[54] Drinking and eating regularly, wearing lightweight and loose clothing, using diluted fruit juice or sports drink for walking more than 1 hour, providing 12.5 mg potassium, 45 mg sodium, and 6-8 grams of carbohydrate per 100 cc water are recommended.[55] Limiting walking during peak temperatures and instead walking at night if possible, offer other options that can help pilgrims avoid heatstroke.[4]

5- Exercise heat acclimatization causes physiological adaptations including improved fluid balance, sweating and thermoregulation, lowered body temperatures, reduced physiological and cardiovascular strains, improved skin blood flow, altered metabolism, enhanced cellular protection and a reduced risk of serious heat illness. As heat acclimatization is specific to the climatic heat conditions and physical exercise intensities, it is recommended that low-risk pilgrims be exposed gradually to climatic temperatures and walking intensities similar to those in Arbaeen walking ceremonies for about 7-10 consecutive days before the real march. Optimal heat acclimatization requires a minimum daily heat exposure of about 90-120 min (can be broken into two 45-minute / 1-hour exposures) combined with walking with equal intensities during a real march. Pilgrims should gradually increase each day of heat exposure and/ or the walking duration and intensity as tolerated.[56]

CONCLUSION

For pre-participation cardiovascular assessment of the Arbaeen march, PAR-Q+, ePARmed-X+, and the ACSM pre-participation screening algorithm for the general public can be useful tools. Adequate preparation for cardiac emergencies in the field, regulating core body temperature during walking, exercise heat acclimatization before the real march, and following a "progressive transitional phase" for 2-3 months before the ceremony especially for high-risk pilgrims are other important considerations for Arbaeen walking pilgrims. This provides enough time for both cardiovascular adaptation and the monitoring of these pilgrims.

Footnotes

Authorship Contributions

Concept: M.H., S.M., Design: M.H., S.M., Data Collection or Processing: M.H., S.M., Analysis or Interpretation: M.H., S.M., Literature Search: M.H., S.M., Writing: M.H., S.M.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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