Pre-race self-reported medical conditions and allergies in 133 641 Comrades ultramarathon (90km) runners - SAFER XXIII

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Abstract

Objectives: To determine the prevalence of self-reported pre-race chronic medical conditions and allergies in ultramarathon race entrants and to explore if these are associated with an increased risk of race-day medical encounters (MEs).

Methods: Data from two voluntary open-ended pre-race medical screening questions (Q1 – history of allergies; Q2 - history of chronic medical conditions/prescription medication use) were collected in 133 641 Comrades Marathon race entrants (2014-2019). Race-day ME data collected prospectively over 6 years are reported as incidence (per 1000 starters) and incidence ratios (IR: 95%CI's).

Results: Pre-race medical screening questions identified race entrants with a history of chronic medical conditions and/or prescription medication use (6.9%) and allergies (7.4%). The % entrants with risk factors for cardiovascular disease (CVD) was 30% and being older (>45years) and male (27.5%) were the most frequent CVD risk factors. 0.3% of entrants reported existing CVD. The overall incidence of MEs was 20/1000 race starters. MEs were significantly higher in race entrants reporting a "*yes*" to Q1 (allergies) (IR=1.3; 1.1-1.5)

(p=0.014) or Q2 (chronic medical conditions and/or prescription medication use) (IR=1.3; 1.1-1.5) (p=0.0006).

Conclusions: Voluntary completion of two open-ended questions identified chronic medical conditions and/or prescription medication use in 6.9% and allergies in 7.4% of ultramarathon race entrants. This is lower than that reported for other races that implemented compulsory completion of a more comprehensive pre-screening questionnaire. Despite potential under-reporting, a pre-race self-reported history of chronic medical conditions and allergies was associated with a higher risk of race-day MEs.

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

Introduction

Participation in regular physical activity (>150 minutes per week at moderate to high intensity) is recommended by many international organizations such as the World Health Organization (WHO), Centre for Disease Control and Prevention (CDC) and the European Association of Cardiovascular Prevention and Rehabilitation (EACPR) [1, 2, 3]. Distance running is increasing in popularity all over the world [4] and 35% of all marathon participants in 2019 were older than 45 years old [5]. Older participants are at higher risk for acute medical complications during moderate to intense exercise as per the exercise benefit-risk paradox [6, 7]. Also, previous studies have highlighted the increased risk of medical complications during exercise related to the advancing age of participants [2, 8, 9]. Older age is associated with an increased prevalence of pre-existing chronic medical conditions such as atherosclerosis, hypertension and diabetes that might predispose them to medical complications [8, 10, 11].

Acute serious cardiac events such as myocardial infarction, arrhythmia and sudden cardiac arrest are well described in both younger and older athletes during sports events [12, 13, 14]. Leading organizations recommend various pre-exercise screening regimes to identify those at risk, especially in masters (>50 years) athletes [6, 15, 16] using detailed and comprehensive pre-exercise screening questionnaires, in the form of a "self-assessment of risk". The benefits of these screening questionnaires and subsequent interventions to reduce the risk of adverse events have been studied and advocated [6, 17]. Despite this, most endurance sports events either do not perform pre-race screening or only use a limited voluntary declaration of medical conditions and/or allergies as part of the race entry process.

The annual 90km Comrades Marathon in South Africa is the largest ultramarathon road running event in the country, attracting around 25 000 local and international participants. In the Comrades Marathon, for many years, the medical committee have implemented a limited pre-race medical screening, in the form of two open-ended medical questions, and is voluntarily completed by runners at race entry. The inclusion of a single open-ended medical question at race entry is not an uncommon practice at many mass community-based endurance sports events and this information is mostly used by the medical team on race day. We are not aware of any study where the data derived from these limited medical questions has been explored to provide some information on the prevalence of risk factors for cardiovascular disease, pre-existing medical conditions, allergies and prescription medication among entrants. Race starters who self-reported medical conditions and risk factors may have an increased risk of medical encounters (MEs) during a race.

The aim of this study is to determine the prevalence of race entrants and starters with existing medical conditions, some selected risk factors for cardiovascular disease, allergies, and medication use from data obtained through a limited voluntary pre-race medical screen (two, open-ended, standardized health questions). Additionally, the study aims to determine if

the incidence of medical encounters (MEs) is higher in race starters who reported a history of medical condition/prescription medication use or allergies compared to those who reported no such medical history.

Methods

Study Design

This is an observational study with a cross-sectional component.

Setting

This study forms part of the Strategies to reduce Adverse events For the ExerciseR (SAFER) studies [18]. The annual Comrades Marathon is a mass community-based road-running event held in the Kwa-Zulu Natal province of South Africa. The race covers the 90km distance between the cities of Pietermaritzburg and Durban. The start and finish lines alternate between the two cities each year and are known as either "up" or "down" runs reflecting the change in altitude from sea level in Durban to approximately 650m above sea level in Pietermaritzburg [19]. Race entrants are required to be at least 20 years of age on race day, and there is no upper age limit. All entrants must complete a qualifying run within strict cut-off times [20].

Participants and Data Collection

Data were collected from 133 641 race entrants who completed the race entry form in the 6 years of the study (2014 to 2019). In the study period, the Comrades Marathon medical committee requested race entrants to voluntarily complete a *medical* section on their entry form that included a "*yes"* or "*no"* option in response to two open-ended pre-race medical screening questions: Q1: "*Do you have any allergies?"* and Q2: "*any history of special medical conditions/medication?*". Participants were prompted to voluntarily enter information in a "free-text" box to specify their allergy or special medical

condition/medication. As completion of this section was voluntary, entrants that did not select a "*yes*" or "*no*" option were categorized as a "*no response*".

Race day medical encounter (ME) data were collected prospectively. Every year a standardized paper-based form was used by all attending medical doctors during race day to document all MEs on race day. MEs were defined as *"any interaction between the medical team and a race participant requiring medical assistance or evaluation, taking place from the official start of the event, up to 24 hours after the official cut-off time of the event"* [10]. All MEs presented in this study are of at least "moderate" severity which required at least the withdrawal of the athlete from the race. Full details regarding the ME data collection and the definitions of cardiovascular-related MEs and serious cardiovascular-related MEs have previously been published [21].

For the purposes of conducting research on this population, data from the Comrades Marathon were received with permission from the race and medical directors, and ethical clearance was obtained from the Research Ethics Committee (REC 02/2020) (REC 433/2015).

Coding of Responses to the Open-Ended Questions

Entries to the two open-ended questions were a "*yes*", "*no*" or a "*no response*" and these data were entered into an Excel spreadsheet (Microsoft 2020). Specific data volunteered by entrants in reply to a *"yes"* response to the pre-race medical questions were in a free-text format. These specific data were transferred into a template designed by the primary author (SB) for each disease category. Standardized coding for each illness was created and distributed to all coders prior to commencing and then each analyst coded a subset of the data. The template included all main categories of chronic illness and allergies, as well as specific illnesses and allergies. The task of coding the free-text data was divided between

three analysts, all medical doctors (SB, MJ, JL). Once the coding was completed, a random primary check was performed, consisting of at least 15% of free-text entries per year, by each analyst. A secondary coding check for inconsistencies was also performed by SB and MS of all the data. In total 2 403 of the *"yes"* response entries (24% of *"yes"* responses) were checked. There were 340 *"yes"* response entries with inconsistencies, and the two analysts resolved (SB, MS) these by consensus before data analysis began.

It is important to note that a history of any specific risk factor for CVD or a chronic disease by organ system was not explicitly listed or asked for because the questions were open-ended. Pre-existing injuries were also not specifically asked for and may have not been volunteered due to the phrasing of the "medical conditions" question. However, participants were able to self-report specific chronic diseases by organ system, prescription medication use and any injury as free text, and where this information was reported, these responses were coded. Each entrant's age and sex were taken from the race entry data and were included as a potential risk factor.

Medical Encounter Definitions

All ME definitions used in this study are per the 2019 consensus statement [10]. Unless otherwise indicated, the prevalence of medical conditions or allergies is reported per 1000 entrants, and incidence of MEs is reported per 1000 race starters. The did-not-start (DNS) rate is the percentage (%) of athletes who registered for the event but did not begin the race.

Outcome Measures

The primary outcome measures were: a) the self-reported allergies or history of chronic medical conditions/prescription medication use (from the open-ended screening questions), and b) the specific risk factors for cardiovascular disease (CVD), existing cardiovascular and other chronic disease and medication use (data extracted and coded from the free text section

of the screening questions). The secondary outcome measure was the incidence of race-day MEs, cardiovascular-related MEs and serious cardiovascular-related MEs in race starters reporting any allergies and history of chronic medical conditions/prescription medication use.

Statistical Analysis

ME data capturing was done using REDCap (Research Electronic Data Capture) [22, 23] which is a web-based application designed to support data capture for research studies. Electronic data were exported and transferred to SAS 9.4 for analysis. From 2014 to 2019, the details of runners who entered and started the race were obtained. The did-not-start rate was reported for each year. The demographics of the race entrants and starters were described using numbers and percentages by age group and gender as well as for males > 45 years and females > 55 years.

The breakdown of responses ("*yes*", "*no*" and "*no response*") to the two open-ended pre-race medical screening questions ("allergies" and "history of chronic medical conditions/prescription medication use") for all race entrants and starters were provided. The prevalence (95%CI) of race entrants and starters with existing cardiovascular disease (CVD) or risk factors for CVD, those with a disease in other non-cardiovascular organ systems, allergies and prescription medication use were provided.

A Poisson regression model (unadjusted and adjusted for age group and sex) was used to obtain the overall incidence of MEs and the incidence of MEs in each category of the open-ended pre-race screening question per 1000 race starters. The crude association between all cardiovascular-related MEs, serious cardiovascular-related MEs and the history of chronic medical conditions/prescription medication use (*"yes"* or *"no"*) question was also calculated. During the 6-year period runners could participate in the races more than once, resulting in correlated data. An exchangeable correlation matrix was used to account for the correlated structure of the data.

Results:

Total entrants, starters, and did-not-start (DNS) rate per year

The total number of entrants over the six years from 2014 to 2019 was 133 641, with 103 131 of those starting the race, as shown in Table 1.

Table 1: Total entrants, starters, non-starters and the did-not-start (DNS) rate by year

Year	Entrants	Starters	Non starters	DNS Rate (%)
2014	20 189	14 341	5 848	29.0
2015	22 399	16 579	5 820	26.0
2016	21 566	16 846	4 720	21.9
2017	21 489	17 092	4 397	20.5
2018	23 412	19 106	4 306	18.4
2019	24 586	19 167	5 419	22.0
Total	133 641	103 131	30 510	23.0*

*Average %

The average DNS rate over the six years was 23% and the DNS rate varied from year to year. The highest DNS rates were in 2014 and 2015 and the lowest in 2018 and 2017.

Demographics of race entrants and starters

The total study participants included 133 641 race entrants and 103 131 race starters (77.2% of entrants). The demographics of entrants and starters by individual age groups and sex are depicted in Table 2.

Table 2: The demographics of all race entrants and starters (by sex and age category)

		All race entrants (n=133 641)		All race starters (n=103 131)	
		N	%	N	%
Sex	Males	104 475	78.2	81 580	79.1
	Females	29 166	21.8	21 551	20.9
Age groups	≤ 30 years	12 073	9.0	9 032	8.8
	31–40 years	48 954	36.6	38 521	37.4
	41-50 years	47 663	35.7	37 280	36.1
	>50 years	24 951	18.7	18 298	17.7
Males x Age	Males ≤ 45 years	67 737	64.8	53645	65.8
	Males > 45 years	36 738	35.2	27935	34.2
Females x Age	Females ≤ 55 years	27 583	94.6	20459	94.9
	Females > 55 years	1 583	5.4	1092	5.1

*Percentages reported as a percent of the total of subgroup

The 133 641 race entrants consisted of 104 475 (78.2%) male and 29 166 (21.8%) female entrants. More than 50% of entrants were >40 years old and few entrants were ≤30 years old (9%).

Responses to the two open-ended pre-race medical screening medical questions

The breakdown of responses to the two open-ended pre-race medical screening questions ("allergies" and "history of chronic medical conditions/prescription medication use") for all race entrants and starters are shown in Table 3.

Table 3: Total responses (n; %) of all race entrants (n=133 641) and race starters (n=103 131) to the two open-ended medical questions

	Response	Race Entrants n=133 641 n (%)	Race Starters n=103 131 n (%)
Allergies	Yes	9 868 (7.4)	6992 (6.8)
	No	121 954 (91.3)	94688 (91.8)
	No Response	1 819 (1.4)	1451 (1.4)
Medical Conditions / Medication	Yes	9 160 (6.9)	6458 (6.3)
	No	103 877 (77.7)	81764 (79.3)
	No Response	20 604 (15.4)	14909 (14.4)

A total of 7.4% and 6.9% of race entrants responded "*yes"* to the *allergy* and *history of chronic medical conditions/prescription medication use* questions respectively. The "*no* response" rate for Q1 (allergy) was low (1.4%), compared to Q2 (history of chronic medical conditions/prescription medication use) which had a higher "*no* response" rate (15.4%). These data are similar in race starters compared to entrants, who also responded more frequently to Q1 compared to Q2.

Prevalence of self-reported risk factors for cardiovascular disease (CVD) and existing CVD in race entrants

The prevalence of race entrants and starters with self-reported existing cardiovascular disease (CVD) or risk factors for CVD are depicted in Table 4.

Table 4: The prevalence of self-reported risk factors for CVD and existing cardiovascular disease (CVD) in all race entrants and starters (%; 95% CI)

	All race entrants (133 641)		All race starters (103 131)	
	n	%* (95%CI)	n	%* (95%CI)
Risk factors for CVD	**3217**	**2.4 (2.3-2.5)**	**2275**	**2.2 (2.1-2.3)**
Self-reported				
High blood pressure	2127	1.6 (1.52-1.66)	1491	1.45 (1.37-1.52)
High blood cholesterol	617	0.5 (0.43-0.5)	449	0.44 (0.40-0.48)
Cigarette smoking	4	-	-	-
Diabetes mellitus (Type 1 or 2)	684	0.5 (0.46-0.53)	490	0.47 (0.42-0.53)
Family history of heart disease	1	-	1	-
Any existing CVD	**345**	**0.3 (0.23-0.29)**	**235**	**0.23 (0.20-0.26)**
Coronary artery disease (CAD)	93	0.07 (0.03-0.10)	60	0.06 (0.04-0.07)
Myocardial infarction (MI)	23	0.02 (0.01-0.02)	15	0.01 (0.01-0.02)
Angina	8	0.01 (0-0.01)	4	-
Coronary artery bypass graft (CABG)	28	0.02 (0.01-0.03)	19	0.02 (0.01-0.03)
Angioplasty – no stent	5	-	5	-
Angioplasty – with stent	29	0.02 (0.01-0.03)	17	0.02 (0.01-0.02)
Heart failure	1	-	1	-
Heart transplant	1	-	1	-
Arrhythmia	71	0.05 (0.04-0.07)	42	0.04 (0.03-0.05)
Rheumatic fever	3	-	2	-
Heart murmur	18	0.01 (0.01-0.02)	16	0.02 (0.01-0.02)
Pacemaker	29	0.02 (0.01-0.03)	20	0.02 (0.01-0.03)
Inherited cardiac condition	14	0.01 (0-0.02)	11	0.01 (0.0-0.02)
Other	123	0.09 (0.08-0.11)	87	0.08 (0.07-0.10)

*: Prevalence (%) in all entrants/starters

There were 3217 (2.4%) entrants and 2275 (2.2%) starters who reported one or more risk factors for CVD. Hypertension, diabetes mellitus and high blood cholesterol were reported by 1.6%, 0.5% and 0.5% race entrants respectively. Using entry data rather than responses to the two screening questions (Q1 and Q2), the age/sex risk factor classified more entrants with a CVD risk factor (Table 2: males >45years = 27.5%, females >55 years = 1.2%). A total of 345 (0.26%) race entrants and 235 (0.23%) of starters reported a history of previous or existing CVD with 93 (0.07%) entrants reporting coronary artery disease (CAD), and 71 (0.05%) entrants reporting an arrhythmia. There was no significant difference in the prevalence of existing cardiovascular disease (CVD) or risk factors for CVD between race entrants and race starters.

Table 5: The prevalence of disease in other organ systems and prescription medication use in all race entrants and starters (%; 95% CI)

Chronic disease / Allergies / Medication use	All race entrants (n=133 641)		All race starters (103 131)	
	n	%* (95% CI)	n	% (95% CI)
History of respiratory disease	**3220**	**2.4 (2.33-2.49)**	**2313**	**2.24 (2.15-2.33)**
Asthma	2372	1.8 (1.7-1.85)	1677	1.63 (1.55-1.7)
Exercise Induced Asthma	99	0.1 (0.06-0.09)	68	0.07 (0.05-0.08)
Respiratory allergies e.g. Allergic Rhinitis	794	0.6 (0.55-0.64)	605	0.59 (0.54-0.63)
Cystic Fibrosis	5	-	4	-
Other Respiratory Complaints	38	0.02 (0.01-0.03)	17	0.02 (0.01-0.02)
History of metabolic or endocrine disease	**1157**	**0.9 (0.82-0.92)**	**854**	**0.83 (0.77-0.88)**
Pre-Diabetes/Hyperglycaemia	17	0.01 (0.01-0.02)	15	0.01 (0.01-0.02)
Diabetes mellitus	684	0.5 (0.46-0.53)	490	0.47 (0.42-0.53)
Diabetes Mellitus Type 1	114	0.09 (0.07-0.1)	86	0.08 (0.07-0.10)
Diabetes Mellitus Type 2	570	0.4 (0.39-0.43)	404	0.39 (0.35-0.43)
Hypothyroidism	401	0.3 (0.27-0.33)	307	0.3 (0.26-0.33)
Hyperthyroidism	19	0.01 (0.01-0.02)	13	0.1 (0.01-0.02)
History of gastrointestinal (GIT) disease	**243**	**0.2 (0.16-0.2)**	**170**	**016 (0.14-0.19)**
Heartburn/Gastroesophageal reflux disease	76	0.1 (0.04-0.07)	55	0.05 (0.04-0.07)
Liver/Gallbladder Disease	16	0.01 (0.01-0.02)	12	0.01 (0.01-0.02)
Other GIT Disease	152	0.1 (0.1-0.13)	103	0.1 (0.08-0.12)
History of central nervous system disease	**569**	**0.4 (0.39-0.46)**	**392**	**0.38 (0.34-0.42)**
Epilepsy	249	0.2 (0.16-0.21)	171	0.17 (0.14-0.19)
Migraine	21	0.02 (0.01-0.02)	17	0.02 (0.1-0.02)
Depression	101	0.08 (0.06-0.09)	68	0.07 (0.05-0.08)
Anxiety	35	0.03 (0.02-0.03)	21	0.02 (0.01-0.03)
Other Mental Illnesses	85	0.06 (0.05-0.08)	57	0.06 (0.04-0.07)
History of CVA or TIA**	17	0.01 (0.01-0.02)	8	0.01 (0.0-0.01)
History of kidney or bladder disease	**64**	**0.05 (0.04-0.06)**	**35**	**0.03 (0.02-0.04)**
History of blood or immune system disease* **	**417**	**0.31 (0.28-0.34)**	**323**	**0.31 (0.28-0.35)**
Anaemia	41	0.03 (0.02-0.04)	37	0.04 (0.02-0.05)
Bone marrow cancers	12	0.01 (0-0.01)	9	0.01 (0.0-0.01)
Lymphatic system cancers	4	-	2	-
Diseases of immune suppression	137	0.10 (0.09-0.12)	112	0.11 (0.09-0.13)
Other blood disorders	224	0.17 (0.15-0.19)	165	0.16 (0.14-0.18)
History of solid growths/cancers	**53**	**0.04 (0.03-0.05)**	**31**	**0.03 (0.02-0.04)**
History of chronic prescription medication use	**7230**	**5.5 (5.29-5.53)**	**5151**	**4.99 (4.86-5.13)**

*: Prevalence (%) in all entrants
**: CVA – Cerebrovascular Accident, TIA – Transient Ischaemic Attack
*** Leukaemia/lymphoma/myeloma coded as blood cancers, every other cancer as "cancer" i.e. solid cancers or growths
Sections do not necessarily add up to the total, as some participants might report multiple conditions within a section

Prevalence of self-reported chronic diseases in other organ systems in race entrants

The prevalence of race entrants and starters with a self-reported disease in other non-cardiovascular organ systems, allergies and prescription medication use is shown in Table 5.

Respiratory disease was the most frequent chronic disease reported by race entrants (2.4%) and starters (2.2%), followed by chronic metabolic disease and central nervous system disease. Chronic prescription medication use was reported by 5.5% of race entrants and 5% of starters.

There was no significant difference in the prevalence of other chronic diseases and prescription medication use between race entrants and race starters.

Incidence of medical encounters in starters (unadjusted)

The crude overall incidence of MEs on race day (per 1000 race starters) at the Comrades Marathon was 19.1 (95% CIs 18.3-20.0). The incidence of cardiovascular-related MEs was 1.6 (95% CIs 1.4-1.9), including serious cardiovascular-related MEs of 0.5 (95% CIs 0.4-0.6). The incidence per 1000 race starters of MEs in each category of pre-race question is represented in Figure 1.

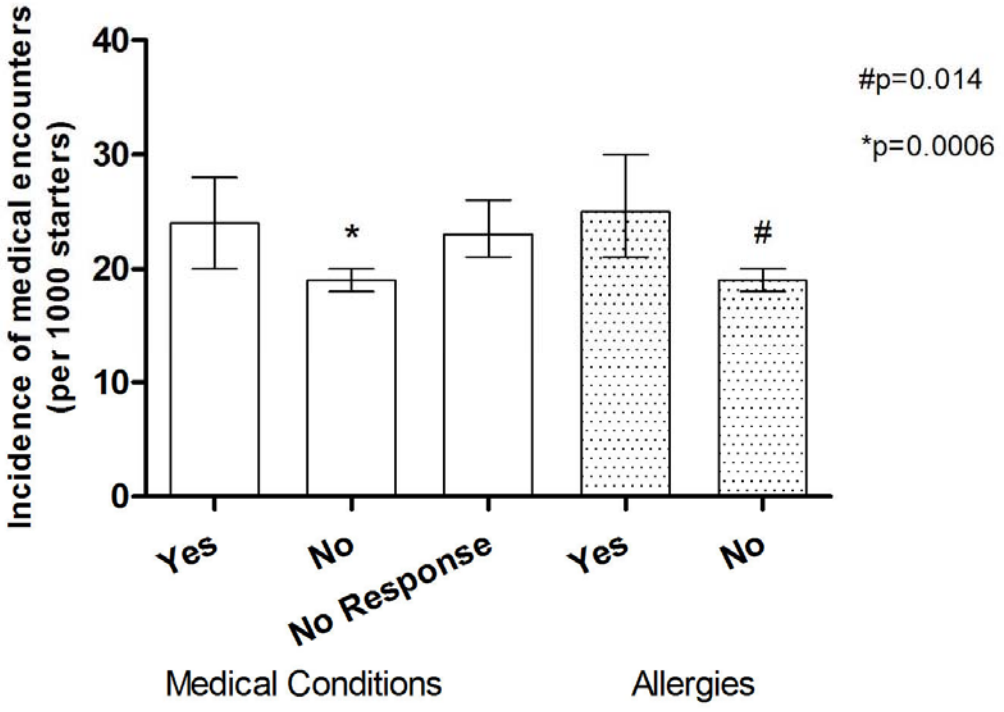

Figure 1: Incidence of medical encounters (per 1000 starters) during the Comrades Marathon in starters who answered and did not answer the two medical questions
*p=0.0006: Medical conditions "*yes*" vs "*no*"
#p=0.014: Allergies "*yes*" vs "*no*"

The incidence ratio (IR) of starters that answered "*yes*" vs. "*no*" to Q1 (allergy question) was 1.3 (1.1-1.5) (p=0.014), and for starters who answered "*yes*" vs. "*no*" to Q2 (the specific medical conditions question was 1.3 (1.1-1.5) (p=0.0006)). After adjusting for age and sex, a "*yes*" response to Q2 (history of chronic medical conditions/prescription medication use) was still significantly associated with a higher risk of MEs on race day (p=0.001). Similarly, a "*yes*" response to Q1 (allergy question) (after adjusting for age and sex) was associated with a higher risk of MEs (p=0.047). The incidence of MEs was similar in race starters with a *"yes"* or a "*no response*" to Q2 (IR: 1.0; 0.8-1.2). The *"no response"* to Q1 was not included in the analysis as it only represented a very small number of responses (1.4%). Furthermore, a *"yes"* answer to Q2 was not associated with a higher incidence of all cardiovascular-related MEs (p=0.2511, or serious cardiovascular-related MEs (p=0.515).

Discussion

This study is the first to describe the prevalence of self-reported medical conditions/medication use and allergies in ultramarathon race entrants using data from a limited pre-race medical screening tool consisting of two open-ended medical questions that race entrants completed voluntarily. Historically, this information has been used to potentially assist the medical team should a runner require emergency medical assistance. We are not aware of any study where this information has been used to identify runners at risk for medical encounters on race day.

The first main finding of this study was that 7.4% and 6.9% of race entrants reported allergies and chronic medical conditions/medication respectively. Using race entrant data, we showed that the most frequent risk factors for CVD were older age/sex, (males >45years = 27.5%, females >55 years = 1.2%). By coding the details voluntarily reported by race

entrants and starters in response to the pre-screening questions, the prevalence of some selected risk factors for CVD were hypertension (1.6% entrants, 1.5% starters), diabetes (0.5% in both), and 0.2-0.3% of runners reported a history of existing CVD. Finally, we showed that there was a significantly higher incidence of any race-day MEs in starters who answered "*yes*" to the allergy question (IR = 1.3; 1.1-1.5: p=0.014), or the chronic medical conditions/medication use question (IR = 1.3; 1.1-1.5: p=0.0006). The incidence of cardiovascular-related MEs and serious cardiovascular-related MEs was not different in starters who answered "*yes*" to either the allergy question or the chronic medical conditions/medication question.

Current international pre-exercise screening guidelines recommend that older individuals (males >45 years and females >55 years) and those that have one or more co-morbidities require medical screening and possible medical assessment before engaging in high-intensity exercise [2]. Older distance runners are at an increased risk of adverse events during races, including sudden cardiac arrest (SCA) or sudden cardiac death (SCD) [2, 16]. In our study we showed that 35.2% of all male race entrants were >45 years old. This is significantly higher than the 15.7% of males >45 years that we reported for another South African endurance running event namely the Two Oceans 21.1km, and 56km [24]. It is however similar to a study of the 109km Cape Town Cycle Tour (CTCT) event where 35% of males were >50years old [25] as well as a report from Running USA in March 2020 where 35% of all entrants were >45 years of age [5]. This subgroup of entrants (males >45years) is at higher risk for CVD, which is a major risk contributor for SCA and SCD during an endurance event [2, 8, 26, 27].

In this study we also report the prevalence of age/sex (from race entrant data) and some selected self-reported CVD risk factors, including hypertension and diabetes (from the Q2 screening question). Overall, 30% of entrants and 29% of starters had one or more risk

factors for CVD (including the age/sex risk factor from entry data), while 0.3% of entrants and 0.2% of starters reported pre-existing serious CVD, including a history of myocardial infarction. In the Two Oceans Marathon study, we showed that 2.3% of entrants reported pre-existing serious CVD, which is about 7X higher than the findings for this study in 90km race entrants [24]. It must be noted, that in the Two Oceans Marathon study a comprehensive and compulsory pre-race medical screening questionnaire (15 questions) was completed by all race entrants [24]. The most likely reason for the large difference in the prevalence of pre-existing CVD between these two studies is under-reporting because the two medical screening questions in the Comrades race entrants were voluntary and open-ended. Specific questions related to all CVD risk factors and multiple chronic conditions were not included in the screening questions. We acknowledge that other factors such as differences in the population at risk could also account for differences in the prevalence of chronic medical conditions between these two populations.

In our study, 5.4% of race entrants and 5% of starters self-reported using prescription medication, and this can be a risk factor for adverse events during an endurance event [28, 29]. Medication has the potential to cause adverse events during exercise such as gastrointestinal complaints [29, 30, 31], musculoskeletal complaints [32, 33, 34], cardiac arrhythmias [35, 36], renal impairment [29, 30] as well as fluid and electrolyte imbalances [30, 37]. The prevalence of medication use in Comrades Marathon race entrants was also significantly less than the 14.8% we reported in the Two Oceans Marathon study [25]. Although we showed that 7.4% of race entrants answered "*yes*" to the pre-screening question on allergies, this is again significantly lower than the prevalence of allergies from our Two Oceans Marathon study data (13.9%) [24]. Again, we postulate that this discrepancy is likely because of under-reporting when using voluntary completion of only two open-ended pre-screening questions.

In this study, the crude (unadjusted) incidence of race-day MEs was 2.0%. The incidence of all MEs, but not cardiovascular-related MEs or serious cardiovascular-related MEs, was significantly higher in race starters who responded "*yes*" to the question on history of chronic medical conditions/medication use or the question on allergies compared to starters who responded "*no*" or had a "*no response*" to the two questions. We note that this finding is significant despite potential under-reporting by race starters of a history of medical conditions/medication use or allergies. Pre-exercise screening is recommended by several international organizations, but it is not routinely implemented, even in higher risk groups such as older males. We have previously shown the value of compulsory pre-race medical screening using a comprehensive set of questions that are based on international guidelines. Screening combined with an educational intervention reduced race-day medical encounters and adverse events [6, 17]. Despite these findings, pre-race medical screening is still not implemented for most distance running events and one possible reason could be the length of a pre-race medical screening tool. The data from this study show that even though this pre-screening tool is limited and potentially associated with under-reporting, those participants at higher risk for race-day MEs were still identified. In a future study, we will compare the two voluntary open-ended pre-screening questions used by race organizers vs. a comprehensive compulsory pre-race screening tool that we developed to identify subgroups of race entrants at risk [24].

The strengths of the current study are (i) that there was a large sample size (133 641 race entrants) and data were collected over 6 years; (ii) this is the first, as far as we are aware, to report the prevalence of a history of self-reported medical conditions and allergies in race entrants of such an ultramarathon and (iii) that there was a high response rate in both entrants and starters (98.6% to the "allergy" question and more than 84% to the "chronic medical condition/medication use" question). The limitations of this study are that these data were

collected from two open-ended questions, and therefore entrants were not asked specific questions regarding diseases, all risk factors for CVD, and medications. We believe that the true prevalence of risk factors in the population might be underreported. Participants are unlikely to know all the potential risk factors for MEs during a race and therefore a more detailed medical screening questionnaire is needed to address this. We note that the "no response" was higher for the medical conditions/medications question than the allergies question. The reasons for this are not clear and our study was not designed to address this. We can speculate that this could be because of a number of reasons including: the medical conditions question was second, there may be a reluctance to report medical conditions for fear of race exclusion, and that it may take longer to enter text and describe a medical condition question than an allergy question. Finally, it must be noted that the specific medical conditions reported in this paper were individually coded by medical doctors. This is labor-intensive, time-consuming and is not feasible for day-to-day practical implementation of open-ended pre-screening questions in the normal functioning of an event. We strongly support the use of electronic data capturing systems with algorithms for detailed, automated pre-race medical screening.

Summary and Conclusions

The 90km Comrades Marathon race is associated with a high risk of serious adverse events in runners [21], particularly in runners with chronic medical conditions. This is the first study to describe the prevalence of self-reported risk factors for CVD and existing chronic disease or allergies in an ultramarathon of this size and distance using a limited pre-race screening tool that race organizers have implemented for several years. We found that about 30% of entrants had one or more risk factors for CVD and 1 in 400 reported established CVD. The risk of a race-day medical encounter during the Comrades Marathon was significantly associated with

a self-reported special medical condition/medication use or a history of allergies. Further research should compare findings of a limited screening tool versus a comprehensive pre-race medical screening questionnaire.

Data sharing statement:

No additional data are available

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