Medical encounters among 94,033 race-starters during 16.1 km running event over 3-years in The Netherlands: SAFER XXVI

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Data sharing statement:

No additional data are available

Summary Sentence for Social Media:

Serious medical encounters during the Dam-tot-Damloop 10mile running race are high compared to other road running events – watch out for heat-related illnesses!! @NSewry @wiggersrunning @UPTuks #running

Abstract

Background: There are limited data on the medical encounters (MEs) occurring during mass community-based running events of shorter distances (10–21.1km). To determine the incidence and nature of MEs during the largest mass-participation running event in The Netherlands.

Hypothesis: We hypothesize that the incidence and nature of MEs will be similar to other running events.

Study Design: Descriptive epidemiological study over three years of a 16.1km (10miles) running event.

Level of Evidence: Level 4

Methods: 94033 race starters at the 2017-2019 Dam tot Damloop (16.1km), a point-to-point road race from Amsterdam to Zaandam, The Netherlands. All MEs were recorded by race medical staff on race day each year. MEs were retrospectively coded by severity, organ system, and final specific diagnosis (2019 consensus statement definition on mass community-based events). Incidence (I) per 1000 starters (95%CI) were calculated for all MEs and serious/life-threatening MEs.

Results: The overall incidence (per 1000 starters) of all MEs was 2.75 (95%CI: 2.44-3.11), the overall incidence of serious/life-threatening MEs was 1.20 (95%CI: 1.00-1.45) (44% of MEs). Heat illnesses accounted for most MEs: hypothermia I=0.54 (95%CI: 0.41-0.71), and hyperthermia I=0.46 (95%CI: 0.34-0.62). Central nervous system MEs were also common (dizziness/nausea I=0.79; 95%CI: 0.63-0.99), followed by the cardiovascular system MEs (exercise associated postural hypotension I=0.36; 95%CI: 0.26-0.51).

Conclusion: The overall incidence of MEs was low compared to races of longer distance (21.1–90km), but the incidence and relative frequency of serious/life-threatening MEs (44% of all MEs) was much higher. Heat illness (hypothermia and exertional heat stroke) accounted for most serious/life-threatening MEs.

Clinical Relevance: There is a need to implement prevention strategies and interventions by specialised medical practitioners in this and similar events.

Key Words: SAFER, distance running, medical encounters, mass participation, hyperthermia

Introduction

Physical exercise has extensive health benefits, and is a major lifestyle factor in the prevention of non-communicable diseases.[10,13] Running is an inexpensive and popular way of physical exercise,[13] and this has led to an increase in popularity of mass community-based participation road running events in the last decade.[16] However, vigorous exercise is also associated with an increase incidence of medical encounters (MEs), and specifically serious/life-threatening encounters such as acute myocardial infarction and exertional heat stroke.[5,12,23] It is therefore necessary that ME data at mass community-based participation running events be documented to assist with future prevention programs and to plan that appropriate medical care facilities are available on race day.

ME data have been explored for events of marathon distances,[15,17,24] but ME data for shorter distance events such as 10km and 16.1km (10mile) events are not as well known. In an recent meta-analysis, the incidence of life-threatening MEs in running events from 21.1km to 42.2km distances, ranged from 3.2 – 3.7 per 100 000 starters.[6] However, using more recent consensus definitions, the incidence of serious/life-threatening MEs in a previous 21.1km and a 56km were much higher (51 and 65 per 100 000 starters respectively), illustrating a possible underreporting in earlier studies.[18] Although there is much literature published on MEs in these events, very few studies document all MEs of a "moderate severity",[21] and often only serious/life-threatening, cardiac arrests or deaths are reported. The most common MEs during road running races are of "moderate severity" and include exercise-associated collapse, musculoskeletal injuries, dehydration, and gastro-intestinal complaints.[15,18-20] "Minor" MEs such as dermatological encounters (blisters) and medication requests are also frequently reported.

An important consideration is that factors on race day could influence the ME incidence rate and should therefore also be documented. Environmental conditions are considered a major factor in the incidence of "moderate severity" or "serious life-threatening" MEs during running events. A commonly used measure of environmental exposure is the wet-bulb globe temperature (WBGT).[4,7,14] The WBGT is a calculated measure of air temperature, humidity, wind speed and solar radiation.

World Athletics and the International Institute for Race Medicine Web[11] provides guidelines based on WBGT and classifies the environmental conditions as low, moderate, high or very high risk for heat-related illnesses along with recommended physical activity modifications. Exploring the ME data, along with environmental data, could assist medical directors and race organisers to foresee what the most commonly occurring MEs will be on race day and so be better prepared for the event.

The Dam tot Damloop is the largest mass community-based participation event in The Netherlands (approximately 33 000 participants annually). It is a point-to-point road-running run over 10miles (16.1km) from the capital Amsterdam to the city of Zaandam. This race takes place annually over the third weekend of September and ME data for this race are not known. The aim of this observational study is to document the incidence of all MEs (at least of moderate severity), as well as the serious/life-threatening MEs, from the Dam tot Damloop.

Materials and Methods

Type of study

This is a prospective observational study in a 3-year cohort (2017–2019) of runners participating in the Dam tot Damloop 16.1km event.

Data collection

This study forms part of a series of studies known as the SAFER IMAP (**S**trategies to reduce **A**dverse medical events **F**or the **E**xercise**R** **I**nternational **M**illion+ **A**thlete **P**roject) studies. Ethical approval was granted by the University of Pretoria (South Africa) (574/2017). Collection of medical encounter (ME) data was performed by the responsible medical services. These were professionals and volunteers from the Rode Kruis (Red Cross) and Ambulance Amsterdam. There is collaboration with the hospital closest to the finish line (Zaans Medisch Centrum, Zaandam, The Netherlands). Aid stations of the Rode Kruis were placed at the start, at the finish of the race and another 13 stations along the course (approximately at 2km, 4km, 5km, 6km, 7.5km, 9km, 11km, 13km, 14km, just before 15km and 3 between 15km and the finish line). Hydration stations were placed at the start, at the finish

and another 4 stations along the course (approximately at 5km, 9km, 11km and 14km). In 2019, cold water immersion (CWI) was introduced (cooling tubs filled with water and ice cubes reaching a water temperature between 10-15˚C). The CWI facilities were placed at 2 locations: at 15.5km (2 cooling tubs) and at the finish line (2 cooling tubes). At each cooling tub, the medical responsibility and supervision was assigned to an emergency medicine specialist. Every runner who required treatment from these medical facilities was registered.

Data of the environmental conditions (temperature, humidity, rainfall, windspeed, wet-bulb globe temperature [WBGT]) were obtained from the Royal Dutch Meteorological Institute. Based on the WBGT index the risk level of hyperthermia was determined: WBGT of <18°C = low risk, 18 – 23° C = moderate risk, 23 – 28° C = high risk and ≥ 28° C = very high risk.[11]

Incidence of medical encounters (MEs)

MEs were classified using the international consensus on mass community-based endurance sporting events.[21] Only MEs of at least a moderate severity are reported. A ME of moderate severity was defined as "*a medical encounter that is significant (severe) enough to result in withdrawal of the athlete from the event following assessment by the medical staff, or is non-life threatening but requires medical assessment and admission to the event medical facilities with supervised medical care, or is non-life threatening but requires referral or transfer to a hospital*".[21] A serious life-threatening ME was defined as *"a medical encounter that requires immediate emergency medical treatment with either admission to a high-care (intensive care and observation) medical area at the event, or transport (with or without admission) to a hospital. A medical complication that could result in death unless urgently diagnosed and treated"*.[21]

MEs were retrospectively coded into main organ system (and specific diagnosis) as follows: multiple organ, cardiovascular, respiratory, central nervous system, rheumatological, gastrointestinal, genitourinary/renal, endocrine/metabolic, dermatological, psychological/psychiatric, drug use/overdose, musculoskeletal and medical illness (other or undiagnosed). Serious/life-threatening

MEs and event-related deaths were also recorded per organ system and specific diagnosis. The diagnoses of medical encounters were made by experienced physicians, using clinical criteria.

Statistical analysis of data

All the data from the starter / finisher database and medical encounters database were entered into an Excel spreadsheet (Microsoft 2010) and then analysed using the SPSS statistical software (version 25). The incidence (I) of all MEs (moderate and serious life-threatening) were calculated as runners with MEs per 1000 race starters with 95% Confidence Intervals (95%CIs). The incidence rates are presented per 1000 starters as per the international consensus statement on mass community sports events.[21] Crude IRs are reported for all MEs and by severity (moderate and severe life-threatening), organ system (for illness-related encounters) and for specific diagnosis.

Results

Participants

The profile of the starters and finishers for the three years of the Dam tot Damloop, with a total of 94 033 race-starters are presented in Table 1.

There was a predominance of male runners (62.9%). Male runners were mostly in the 31-40 years age-category and female runners in the ≤ 30 years age-category. The number of non-finishers each year were: 3254 in 2017, 2995 in 2018 and 3209 in 2019, with an overall did-not-finish rate of 10.1%.

***Table 1**: Participant characteristics by sex and age group per year (n; %).*

		2017 n (%)	2018 n (%)	2019 n (%)	Total n (%)
Total Entrants		37580 (100)	37256 (100)	38513 (100)	113349 (100)
Total race starters	**All**	33243 (100)	31440 (100)	29350 (100)	94033 (100)
Males	All	23579 (62.7)	23576 (63.3)	24150 (62.7)	71305 (62.9)
	≤ 30 yrs	5640 (15.0)	5294 (14.2)	5716 (14.8)	16650 (14.7)
	31-40 yrs	6572 (17.5)	6651 (17.9)	6850 (17.8)	20073 (17.7)
	41-50 yrs	6156 (16.4)	6177 (16.6)	5920 (15.4)	18253 (16.1)
	>50 yrs	4379 (11.7)	4687 (12.6)	4883 (12.7)	13949 (12.3)
	Missing	832 (2.2)	767 (2.1)	781 (2.0)	2380 (2.1)
Females	All	14001 (37.3)	13680 (36.7)	14363 (37.3)	42044 (37.1)
	≤ 30 yrs	5079 (13.5)	4735 (12.7)	4987 (12.9)	14801 (13.1)
	31-40 yrs	4026 (10.7)	3772 (10.1)	3888 (10.1)	11686 (10.3)
	41-50 yrs	3170 (8.4)	3265 (8.8)	3411 (8.9)	9846 (8.7)
	>50 yrs	1349 (3.6)	1512 (4.1)	1656 (4.3)	4517 (4.0)
	Missing	377 (1.0)	396 (1.0)	421 (1.1)	1194 (1.1)
Total Finishers	**All**	29989 (100)	28445 (100)	26141 (100)	84575 (100)
Males	All	19272 (64.3)	18494 (65.0)	17378 (66.5)	55144 (65.2)
	≤ 30 yrs	4513 (15.0)	4085 (14.4)	4064 (15.5)	12662 (15.0)
	31-40 yrs	5263 (17.5)	5133 (18.0)	4820 (18.4)	15216 (18.0)
	41-50 yrs	5082 (16.9)	4852 (17.1)	4266 (16.3)	14200 (16.8)
	>50 yrs	3668 (12.2)	3734 (13.1)	3486 (13.3)	10888 (12.9)
	Missing	746 (2.5)	690 (2.4)	742 (2.8)	2178 (2.6)
Females	All	10717 (35.7)	9951 (35.0)	8763 (33.5)	29431 (34.8)
	≤ 30 yrs	3776 (12.6)	3396 (11.9)	2958 (11.3)	10130 (12.0)
	31-40 yrs	3030 (10.1)	2622 (9.2)	2270 (8.7)	7922 (9.4)
	41-50 yrs	2480 (8.3)	2449 (8.6)	2058 (7.9)	6987 (8.3)
	>50 yrs	1104 (3.7)	1143 (4.0)	1075 (4.1)	3322 (3.9)
	Missing	327 (1.1)	341 (1.2)	402 (1.5)	1070 (1.3)

Environmental conditions

The environmental conditions are presented in Table 2.

During 2019 the WBGT index was the highest of the three years, and the only year with a moderate heat stress risk, whilst in 2018 the WBGT index was close to the hypothermia risk category (<10°C).[9,11]

Table 2: *The environmental conditions over the three years*

Year	Temperature (C)	Humidity (%)	Rainfall (mm)	Wind speed (m/s)	WBGT index	Risk level of Hyperthermia*
2017	14.0	76.3	0.0	1.2	13.9	Low Risk
2018	10.7	91.3	1.1	1.2	10.9	Low Risk
2019	21.6	54.4	0.0	1.7	18.7	Moderate Risk

WBGT index: Wet-bulb globe temperature
**IIRM risk level*[11]

Medical Encounters (MEs)

The incidence for all MEs and serious/life-threatening MEs for each year are presented in Table 3.

Table 3: *The number (n) and incidence (I, per 1000 starters: 95%CI) of all medical encounters and serious/life-threatening medical encounters in the 3-year study period*

	2017 (n=33243)		2018 (n=31440)		2019 (n=29350)		All years (n=94033)	
Medical Encounters	**N**	**I (95%CI)**	**N**	**I (95%CI)**	**N**	**I (95%CI)**	**N**	**I (95%CI)**
All MEs	78	2.35 (1.88-2.93)	73	2.32 (1.85-2.92)	108	2.80 (2.32-3.39)	259	2.75 (2.44-3.11)
Serious/life-threatening MEs	26	0.78 (0.53-1.15)	51	1.62 (1.23-2.13)	36	1.23 (0.88-1.70)	113	1.20 (1.00-1.45)

The overall incidence of all MEs was 2.75 (95% CI: 2.44-3.11) per 1000 runners, and the overall incidence of serious/life-threatening MEs was 1.20 (95% CI: 1.00-1.45) per 1000 runners. Serious/life-threatening MEs made up 44% of all MEs. The highest incidence of all MEs was in 2019, with the highest incidence of serious/life-threatening MEs in 2018. There were no deaths during the three years and there was one sudden cardiac arrest.

The MEs by main organ system affected and specific diagnoses illnesses are presented in Table 4.

Table 4: *The number (n) and incidence (I, per 1000 starters: 95%CI) of illness-related medical encounters by main organ system and by final diagnosis in all runners for the 3-year period.*

Main organ system and final diagnosis	**All Starters (n=94033)**		
	n	**I**	**95%CI**
Multiple Organs			
Allergic Reaction	1 *	0.01	-
Heat Illness			
Hypothermia	51	0.54	0.41-0.71
Hyperthermia / exertional heat stroke	43	0.46	0.34-0.62
Cardiovascular System			
Syncope	2 *	0.02	-
Exercise associated postural hypotension (EAPH)	34	0.36	0.26-0.51
Chest pain (non-specific)	1 *	0.01	-
Cardiac arrest (successfully resuscitated)	1 *	0.01	-
Respiratory/ENT System	7	0.07	0.04-0.16
Central Nervous System			
Dizziness/nausea (non-specific)	74	0.79	0.63-0.99
Epilepsy	1 *	0.01	-
Endocrine/Metabolic System			
Diabetes Mellitus	3 *	0.03	-
Dermatological	4 *	0.04	-
Psychological/Psychiatric			
Anxiety/ panic disorder, including hyperventilation	8	0.09	0.04-0.17
Other psychological/ psychiatric disorder not otherwise specified	4 *	0.04	-
Musculoskeletal	19	0.20	0.13-0.32
Medical Illness (Other or undiagnosed)	6	0.06	0.03-0.14

ENT = ear, nose, throat
*: numbers too small to calculate 95% CIs accurately

The largest contributor to all MEs were heat illnesses (hypothermia and hyperthermia). The incidence of hypothermia was 0.54 (95% CI: 0.41-0.71) per 1000 starters, and hyperthermia was 0.46 (95% CI: 0.34-0.62) per 1000 starters. Other common organ system affected were: 1) the central nervous system where dizziness/nausea was most common specific diagnosis (I= 0.79; 95% CI: 0.63-0.99), and 2) the cardiovascular system where exercise associated postural hypotension was the most common specific diagnosis (I=0.36; 95% CI: 0.26-0.51). The year with the highest incidence of serious/life-threatening MEs was 2018 where 48 runners presented with hypothermia.

The serious/life-threatening MEs by main organ system affected are presented in Table 5.

***Table 5**: The number (n) of serious/life-threatening medical encounters by main organ system in all runners for the 3-year period.*

Main organ system and final diagnosis	**All Starters (n=94033)**
	n
Multiple Organs	94
Cardiovascular System	4
Respiratory/ENT System	-
Central Nervous System	1
Endocrine/Metabolic System	3
Dermatological	-
Psychological/Psychiatric	10
Musculoskeletal	1
Medical Illness (Other or undiagnosed)	-

The "organ system" with the most serious/life-threatening MEs was the "multiple organs" and consisted of hypo- and hyperthermia MEs. The second most affected organ system was "psychological", which were mostly hyperventilation MEs.

Discussion

This is the first study to document the medical encounters (MEs) during a 10-mile (16.1km) mass community-based running event in The Netherlands. The main findings were that the overall incidence MEs was 2.8 per 1000 starters (1 in 357) and the incidence of serious/life-threatening MEs was 1.2 per 1000 starters (1 in 833). Importantly, serious/life-threatening MEs made up 44% of all MEs. The most common specific diagnoses were non-specific dizziness/nausea, followed by hypothermia and hyperthermia.

The overall incidence of MEs presented in this study was much lower compared to other previously documented events but differences in race distances and methodological issues (e.g. definition of MEs) make comparisons less valid. For example, the incidence of MEs at 10km races was 6 per 1000 finishers,[2] which is much higher than that recorded in the Dam tot Damloop, however the 10km races

did not use the consensus definitions when documenting and reporting the MEs.[21] Comparing to Two Oceans 21.1km and 56km incidence of MEs, again the Dam tot Damloop had a lower incidence (Dam tot Damloop=2.8, vs 21.1km=5.1, 56km=13 per 1000 starters), which is expected as it is a shorter distance race than the Two Oceans races.[18] Compared to marathons, this study again had a lower incidence compared to the Boston Marathon (42km) where the incidence was 18.9 per 1000 entrants,[15] however the distance is 2.6 times further, and the definitions of MEs were not aligned.

Whilst the incidence of all MEs was much lower compared to other events (even shorter races), the most important finding of this study is that incidence of serious/life-threatening MEs did not follow this pattern. The overall incidence of serious/life-threatening MEs in the Dam tot Damloop was 1.2 per 1000 starters (44% of all MEs) and this was higher than the incidence of serious/life-threatening MEs documented in the Two Oceans 21.1km (0.51; 10% of all MEs) and the 56km (0.65; 5% of all MEs) races.[18] In a recent study on the Comrades Marathon, a 90km road race in South Africa, the overall incidence MEs was 19.1 per 1000 starters, and the incidence of serious/life-threatening MEs was reported at 1.8 per 1000 starters (9% of all MEs).[22] Whilst in the Dam tot Damloop, the overall incidence of MEs was lower (2.8 per 1000 starters), the proportion of serious/life-threatening MEs in the Dam tot Damloop was higher (44% of all MEs). This illustrates how high a proportion of MEs are serious/life-threatening MEs in the Dam tot Damloop compared to other races. The Dam tot Damloop had at least 4 X the relative risk of serious/life-threatening MEs (compared to all MEs) when compared to other events, regardless of distance.

The reasons for the high incidence of incidence of serious/life-threatening MEs, relative to other races, is not clear, and this study was not specifically designed to answer that question. However, we can speculate that the high incidence of serious/life-threatening MEs in the shorter race distance may be due to a higher “risk profile” of participants, lack of experience/training of the participants and environmental conditions that participants are not acclimatised to. The Dam tot Damloop is famous for their big “business run” entries, and the distance of 10miles is thought to be manageable for most. “Business run” entries/starters could potentially represent a higher risk group with a higher prevalence

of risk factors for cardiovascular disease and other chronic disease. They may also represent a group of less regular runners that are undertrained, and not acclimatised to environmental conditions.

In this race, environmental conditions on race day appear to be specifically important. The main organ system affected was "multiple organs" with heat illnesses accounting for most MEs. In 2017 and 2019 hyperthermia was the prominent heat illness, however in 2018 there were 48 hypothermic MEs. World Athletics and other organisations use guidelines based on WBGT index in advising sporting organizations, athletes and trainers when extra precautionary measures should to be taken and when cancelation of competitions is advisable. Based on environmental conditions, medical services of mass participation running events can prepare for specific heat-related problems, such as exertional heat stroke (EHS) and exercise-associated hyponatremia (EAH) at high WBGT index,[3,4,8] and hypothermia at low WBGT index. The findings from our study support this. In 2018, there were 48 hypothermic MEs when the WBGT index was close to the hypothermic cut-off. On the other hand, in 2019, when the WBGT index was in the upper moderate range, there were 29 EHS. EHS is also strongly related to physical exertion at a higher intensity shorter duration (45-90 min) exercise due to the higher rate of metabolic heat production.[4] Therefore, EHS can be more prominent during road running races of shorter duration such as 10–21.1km.

In our study, the serious/life-threatening ME incidence is high largely due to the two heat related illnesses (EHS and hypothermia). Although speculative, the high incidence of hypothermia and EHS could be due to the lack of acclimatization,[1] inexperience of runners, and the rapidly changing weather patterns in the region. These results do highlight that serious heat related illness MEs can occur even in relative moderate conditions. Therefore, we recommend that medical facilities at these races, such as CWI, are mandatory in mass-participation running events of shorter durations even if environmental conditions are at a moderate risk (WBGT index $\geq$18). Race organisers should take rapidly changing environmental conditions into account when planning races and runner education, particularly for relatively inexperienced runners should form part of a preventative strategy to reduce the risk of heat

illness. Further investigation into the cut-offs for WBGT index and the implications thereof should be performed to determine the "true risk" for recreational events in climates such as The Netherlands.

In our study, there was one sudden cardiac arrest (SCA) (incidence of 1 per 100 000 starters), which was successfully resuscitated. This incidence of SCA is lower than that reported in marathons (2 per 100 000 starters),[23] but similar to the estimated incidence of SCA reported for various races in a recent meta-analysis (0.82 per 100 000).[6] There were also no deaths, illustrating that the race had a lower incidence of cardiovascular MEs and, more importantly serious cardiovascular MEs.

Limitations and Strengths

The limitations with these data are that the ME data were anonymized, and therefore could not be traced back to individual runner race day database data. Therefore, individual risk factor analyses (e.g. age, sex, race experience, fitness level, medical history, medication use) could not be performed on the data. Future data collection will look to include the matching of medical encounter to individual runner race day data to allow for these analyses. There were many strengths in this study. This study included a large sample size of three years of data, with 94033 race starters. In the three years, there was a large variation in WBGT index, and this allowed us to observe the role of environmental conditions on ME rates at mass community-based running events. All ME data were documented by medically trained staff, and retrospectively coded using the consensus statement,[21] allowing for comparisons with previously published data, and future comparisons.

Conclusion

The overall incidence of medical encounters was 2.8 per 1000 starters, with an incidence of 1.2 per 1000 starters for serious/life-threatening medical encounters. The most common "organ system" affected was related to heat-related illnesses (hypothermia and hyperthermia) resulting in a high percentage of serious/life-threatening MEs (44% of all MEs). These MEs occurred at the lower and upper limits of "safe" WBGT index ranges, and therefore further investigation into the cut-offs for WBGT index should be performed to determine the "true risk" for recreational events in climates such

as The Netherlands. This makes it a unique race when compared to other longer distance events. The main take home message is that serious/life-threatening medical encounters accounted for a large % of all MEs emphasising the need for interventions/prevention strategies, by specialised medical practitioners, to be implemented in this event.

Acknowledgements

The authors acknowledge all the medical staff for their service to the athletes participating in the Dam tot Damloop over the years and all the athletes for their participation in the races.

Funding

IOC Research Center (South Africa) (partial funding)

Conflicts of Interest

None

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