

**The injury and illness profile of male and female participants in a 94.7 km cycle race: A cross-sectional study**

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## **Abstract**

*Objective:* To describe the incidence and patterns of injury and illness of male and female participants during a 94.7 km distance cycling event.

*Design:* Descriptive study.

*Setting:* Momentum 94.7 Cycle Challenge 2014.

*Participants:* All 23 055 race starters (males = 17 520, females = 5236, not specified = 299).

*Main Outcome Measures:* The incidence and type of all medical complaints and difference between sexes.

*Results:* Incidence (per 1000 race starters) of all medical complaints was 38.69 (males = 36.52, females = 38.39), adverse medical events 11.88 (males = 10.73, females = 16.42) and serious adverse events 1.3 (males = 0.86, females = 2.67). The incidence of nontraumatic medical complaints was 32.49 (males = 33.39, females = 31.32) and of traumatic injuries was 3.99 (males = 3.14, females = 7.07). Females compared to males had a higher risk of sustaining traumatic injuries ( $P < 0.001$ ), central nervous system, ( $P = 0.0062$ ) and eye complaints ( $P = 0.0107$ ). Most complaints (80.6%) were reported for the musculoskeletal system. Males 10-15 years ( $P = 0.0013$ ) and females 23-39 years ( $P = 0.0336$ ), and older than 50 years ( $P = 0.0002$ ) had a higher than expected risk for traumatic injuries.

*Conclusions:* Medical complaints ratio reported was 1:26 (males = 1:28, females = 1:26) in all starters during the cycling event. Cyclists that did not finish the race (adverse events) were 1:84 (males = 1:93, females = 1:61). Serious adverse events that required hospitalization were 1:769 (males = 1:1163, females = 1:374). The majority of admissions were for traumatic injuries, followed by cardiovascular complaints. Results from this study indicated that a wide spectrum of medical complaints can be expected during such an event with a higher risk for females to sustain traumatic injuries and to encounter central nervous system and eye complaints. Information regarding the pattern and type of medical encounters can prove useful during planning and management of similar future events.

## **Introduction**

Cycling is enjoyed as a recreational activity and a competitive venture. As with most sporting activities, there is an associated risk of injury and illness. Several publications describe the medical coverage at large scale cycling events [1-4], however little is known about the incidence and nature of medical complications of participants during a 1-day endurance cycling event in South Africa.

Medical care of cyclists at these events combines emergency medicine, sports medicine and mass-gathering medical care [1]. There is a wide variety of injuries and illness that can be expected at these races and medical planning for long distance cycling events must provide care across the field ranging from basic treatment for non-acute medical complaints through to advanced life support and stabilisation of critically injured or ill patients [1]. A high incidence of non-traumatic medical complaints seems to be the norm during cycling events, while serious traumatic injuries appear to be less common [1-4]. Most deaths in cycling are due to head injuries [2]. Fortunately helmet use decreases this number [2]. Protecting cyclists from road traffic is also an important factor for fewer traumatic injuries [2]. Two studies on injury surveillance at cycling events reported that being female may be an injury risk factor. One study done in New York reported that females suffered from a higher incidence of traumatic injuries including head injuries, lacerations and abrasion. Another study done in Iowa completed over a 4 year period reported that females tend to have a higher rate of serious traumatic injuries that needed transport to a hospital [2,3]. However, injury reports vary extensively among studies due to differences in race duration, race distance and off-road components during these events. [5].

South Africa hosts two of the world's largest timed 1-day endurance cycling events - the Cape Town Cycle Tour and the Momentum 94.7 Cycle Challenge. This study investigated the medical encounters during the 2014 Momentum 94.7 Cycle Challenge, the second largest 1-day cycling race in South Africa. A medical support plan during these events is based on anticipation of need. Thus, the information gathered in this study may facilitate the planning and management of similar future events. The aim of this study was to describe patterns and incidence of injury and illness in male and female amateur and professional cyclists participating in an organised recreational cycling event.

## **Methods**

The protocol for this study was approved by the Ethical Committee of the Faculty of Health Sciences, University of Pretoria.

The Momentum 94.7 Cycle Challenge is an annual 94.7 kilometre (km) road race that takes place in Johannesburg, South Africa. The race is open to all amateur and professional cyclists. There is no specific compulsory pre-medical screening required and cyclists do not have to qualify to participate. Helmets are mandatory. Participants younger than 12 years need a letter of consent from a parent or guardian to participate.

The road race is a fast circular route through the city of Johannesburg and surrounding areas. There are full road closures and almost 40% of the race is on a 2-3 lane freeway where pelotons are able to spread out more easily. The race has a total elevation gain of 1 503m and a maximum elevation of 1 794m. The race took place on 16 November 2014 - it was a sunny day with a minimum temperature of 14 degrees Celsius and a maximum of 28 degrees Celsius. There was a wind speed of 18km/h predicted and a gust wind of 44km/h.

Medical assistance was provided on the day by Netcare 911 EMS. This included a team of doctors, nurses, physiotherapist and paramedics. During the race, a cyclist could request medical assistance at any of the eight fixed medical stations along the route or at the medical tent at the finish line. The medical points (MP) were stationed at 9.5km, 21.2km, 37km, 50km, 63km, 71.5km, 78km and 87.5km. Mobile teams were stationed on route and patrolled areas along the route. They were in radio contact with marshals and first aid stations to be called out if medical assistance was needed. Emergency medical personnel could either

transport cyclists with injuries or other medical problems to the end medical tent or nearest appropriate hospital depending on the severity of the medical complaint.

Every request for medical assistance was recorded by Netcare 911 EMS personnel. Data captured included the cyclist's race number, age, start time, type of injury or other medical complaint, where on route the complaint was reported and what treatment was provided. At completion of the race all the patient report forms were collected and data were compiled with all the details of the medical complaints. The authors had access to this information in order to investigate and analyse the sex and age difference in medical complaints, the type of medical complaints encountered, the amount of hospital admissions on the day and where on the route the medical complaints were reported.

Non-cyclists requesting medical assistance were not included in the analysis. Medical complaints were defined as any cyclists that reported an injury, illness or other medical problem sustained during the race. Adverse events were defined as cyclists that received medical attention and did not finish the race and serious adverse events defined as cyclists requiring hospital admission. The complaints were divided into two main categories being traumatic injuries, due to direct trauma from falls and collisions, and non-traumatic medical complaints. The anatomical system involved and complaint lodged were differentiated and are illustrated in Table 1.

**Table 1 Medical complaints according to anatomical systems**

<b>Non-traumatic</b>	
<b>System</b>	<b>Complaint</b>
<b>CVS</b>	Chest pain, arrhythmia, palpitations
<b>CNS</b>	Dizziness, headaches
<b>Dermatological</b>	Sunburn
<b>Endocrine</b>	Low blood sugar in a person with diabetes
<b>ENT</b>	Pain, foreign body
<b>Eyes</b>	Pain, foreign body
<b>GIT</b>	Abdominal pain, nausea, vomiting, dehydration
<b>Respiratory</b>	Shortness of breath, asthma
<b>Musculoskeletal</b>	Muscle cramps, muscle pains
<b>General</b>	Request to screen vital signs
<b>Traumatic</b>	
<b>System</b>	<b>Complaint</b>
<b>Musculoskeletal</b>	Abrasion, fractures, dislocation
<b>Head</b>	Facial fractures, lacerations, concussion

CVS: Cardiovascular

CNS: Central nervous system

ENT: Ear nose and throat

GIT: Gastrointestinal

### **Statistical analysis**

The data set was summarised in frequency tables, cross-tabulations and graphs. Chi-square ( $\chi^2$ ) tests were used to assess associations between categorical variables; where significant interactions were found, the standardised residuals and/or cell chi-square p-values are

reported. The 95% confidence intervals (the proportion of medical complaints expressed per 1000 cyclists that started the race) were analysed. The ratio of medical complaints was calculated by dividing the number of participants by the number of medical complaints.

## Results

### Participants

Twenty three thousand and fifty five cyclists started the race of which 17 520 were male and 5236 were female. The sex and age of the race participants are depicted in Table 2.

**Table 2 Number of participants per age category**

	Starters = 23 055			Overall Medical Complaints = 892		
Age Category	Male	Female	Sex not specified	Male	Female	Sex not specified
10-15	425	92		21	4	
16-22	915	332		47	12	
23-39	7 152	2 653		305	97	
40-49	5 230	1 470		162	61	
50+	3 798	689		102	26	
Age not specified	-	-	299	3	1	51
<b>Total</b>	<b>17 520</b>	<b>5 236</b>	<b>299</b>	<b>640</b>	<b>201</b>	<b>51</b>

### **Incidence of total complaints, adverse events and serious adverse events**

The incidence of medical complaints (all cyclists that received medical attention), of adverse events (cyclists that received medical attention and did not finish the race) and of serious

adverse events (cyclists requiring hospital admission) are depicted in Table 3. There was a statistically significant interaction between gender and the occurrence of a non-traumatic complaint versus a traumatic complaint ( $\chi^2_1 = 15.059$ ,  $p < 0.001$ ): significantly more women than expected, experienced traumatic injuries ( $p=0.0014$ ).

**Table 3 Incidence of total complaints, adverse events and serious adverse events**

	Total (n=23 055)			Male (n=17 520)			Female (n=5 236)			Sex not specified
	n	Per 1000 (95% CI)	Ratio	n	Per 1000 (95% CI)	Ratio	n	Per 1000 (95% CI)	Ratio	n
<b>Total MC</b>	892	38.69 (36.28 to 41.26)	1:26	640	36.52 (33.85 to 39.41)	1:28	201	38.39 (33.50 to 43.95)	1:26	51
<b>MC: Non-traumatic</b>	749	32.49 (30.27 to 34.86)	1:31	585	33.39 (30.83 to 36.16)	1:30	164	31.32 (26.92 to 36.41)	1:32	
<b>MC: Traumatic</b>	92	3.99 (3.25 to 4.90)	1:251	55	3.14 (2.41 to 4.09)	1:319	37	7.07 (5.10 to 9.75)	1:141	
<b>AE</b>	276	11.88 (10.64 to 13.46)	1:84	188	10.73 (9.31 to 12.37)	1:93	86	16.42 (13.30 to 20.26)	1:61	2
<b>Total SAE</b>	30	1.30 (0.90 to 1.86)	1:769	15	0.86 (0.51 to 1.43)	1:1168	14	2.67 (1.55 to 4.53)	1:375	1
<b>SAE: Traumatic</b>	12	0.52 (0.29 to 0.92)	1:1923	4	0.23 (0.07 to 0.61)	1:4380	8	1.53 (0.72 to 3.07)	1:654	0
<b>SAE: CVS</b>	9	0.39 (0.19 to 0.75)	1:2564	5	0.29 (0.10 to 0.69)	1:3504	3	0.57 (0.11 to 1.77)	1:1754	1

MC: Medical complaint

AE: Adverse event

SAE: Serious adverse event

CVS: Cardiovascular

95% CI: Confidence intervals (per 1000 cyclists who started the race)

Ratio: Number of medical complaints:Total number of participants

### Type of medical complaints and sex difference

The type of injuries and illnesses sustained by participants with recorded sex differences and the anatomical system involved are depicted in Table 4. There was a statistically significant interaction between male and female sex and the anatomical system involved ( $\chi^2_{10} = 32.772$ ,  $p < 0.001$ )<sup>#</sup>. Analysis of the standardised residuals and expected counts indicated that females

<sup>#</sup> Categories with low frequencies (Endocrine, ENT and General check) in Table 4 were merged for the statistical analysis to avoid inflating the chi-square statistic due to a large number of expected frequencies <5.



are more prone to central nervous system ( $p=0.0062$ ) and eye complaints ( $p=0.0107$ ) than males.

**Table 4 Anatomical systems involved by sex**

System	Total (n=841)	Male (n=640)	SR	Female (n=201)	SR
CVS	16	12	0	4	0.1
CNS	21	8	-1.5	13	2.7
Dermatological	56	38	0.7	18	1.3
Endocrine	1	1	0.3	0	-0.5
ENT	1	1	0.3	0	-0.5
Eyes	19	9	-1.4	10	2.6
GIT	22	16	-0.2	6	0.3
Musculoskeletal	678	537	0.9	141	-1.7
Respiratory	16	10	-0.6	6	1.1
General check	9	6	-0.3	3	0.6
Not specified	2	2	-	-	-

CVS: Cardiovascular

CNS: Central nervous system

ENT: Ear nose throat

GIT: Gastrointestinal

SR: Standardised residual

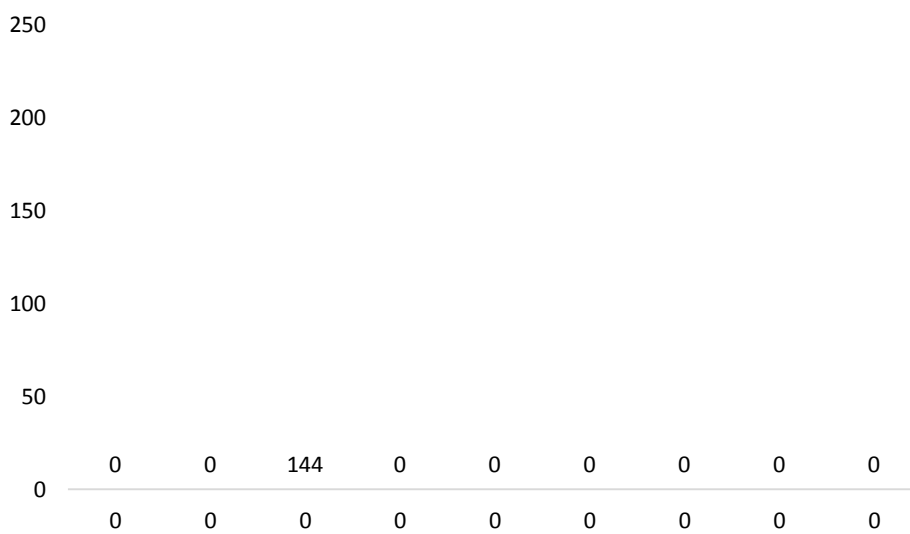
### Medical complaints according to age group

The interaction between traumatic vs. non-traumatic injuries and age group, was significant for males ( $\chi^2_4 = 20.4479$ ,  $p < 0.001$ ), but not for females ( $\chi^2_4 = 8.497$ ,  $p = 0.075$ ). Reviewing the standardised residuals and expected frequencies indicated that there were significantly

more traumatic injuries than expected in males under 16 years ( $p=0.0013$ ), in females aged 23 to 39 years ( $p=0.0336$ ) and in females older than 50 years ( $p=0.0002$ ).

### Medical complaints per medical point

The majority of medical complaints were reported at MP 6; the number of medical complaints per MP is represented in Figure 1 below.



MP: Medical point

**Figure 1 Number of medical complaints per medical point**

### Discussion

Results from this study on the 2014 Momentum 94.7 Cycle Challenge indicated that although there were a lot more male participants, females were more likely to sustain traumatic injuries and had more central nervous system and eye complaints. Most complaints were reported for the musculoskeletal system. There is a higher risk for males 10 to 15 years, females 23 to 39 and females older than 50 years to sustain traumatic injuries. The most serious medical

complaints that required hospital admission was for traumatic injuries followed by cardiovascular complaints.

### **Demographics**

In total 23 055 cyclists participated including 76% males and 23% females. These figures are in line with reports indicating that participation rates for males are often up to two-thirds higher than that of females [6]. In the current study one out of every twenty eight males and one out of every twenty six female starters respectively had medical complaints.

Comparative studies showed that males may represent up to 75-85% of injured cyclists [6].

### **Incidence of total complaints, adverse events and serious adverse events**

The incidence of total medical complications in the 2014 Momentum 94.7 Cycle Challenge was 38.69 per 1000 starters. The incidence of medical complications in available published injury surveillance reports on single amateur road races varies extensively, ranging from 5 to 116 per 1000 starters. [1,2,4]. Inexperience may be a contributing factor to the high number of participants requiring medical services in this study. The Momentum 94.7 Cycle Challenge has a large charity component with more than 8000 places for people riding for charities. Many cyclists entered as recreational charity riders, may not have extensive race or road cycling experience. This is in keeping with a study that reported that approximately 50% of participants at mass participating cycling events rated themselves as inexperienced riders [12]. The exact number of inexperienced cyclists wasn't established in this study.

One out of eighty four cyclists did not finish the race due to adverse events and 1/769 of all starters had serious adverse events that required hospital admission with a rate of 0.13%. A previously published injury surveillance report on a single day amateur race was conducted at

the Hamburg UCI Cyclocross in 2006, and reported a hospital admission rate of 0.3% [11]. In this study the serious adverse events included multiple upper limb fractures, shoulder dislocations, rib fractures, head injuries and myocardial infarctions. Although most of the medical complaints encountered in our study were non-traumatic, traumatic injuries accounted for the majority of hospital admissions. Cardiovascular complaints (1:2564 starters) were the second most important cause that required hospital admission. No studies could be found that reported the rate of acute cardiovascular complaints specifically during large scale endurance cycling events. Most studies that reported cardiovascular symptoms have been performed on mass participation events in long distance running. They reported a low overall risk of cardiac arrest and sudden death, mainly due to hypertrophic cardiomyopathy and acute coronary ischaemia, that occurs primarily amongst male participants [13,14]. One of the most important safeguards against exercise related cardiovascular events in adults is to sustain physical fitness with regular physical activity, since a disproportionate number of events occur in the least physically active subjects when performing unusual vigorous physical activity [15]. Other risk reducing strategies includes pre-participation screening, excluding high-risk patients from activity, reporting and evaluating prodromal symptoms and preparing facilities for cardiovascular emergencies [15].

### **Male and female difference in traumatic vs. non-traumatic complaints**

The current study's results indicated that women are more likely than men to sustain traumatic injuries (p-value = <0.001). Only two studies on road cycling have reported a sex difference and also found a greater risk of injury among women [2,3]. More studies on sex difference have been done in mountain bike events and indicated that, although there are more male participants, women can be nearly twice as likely as men to sustain an injury [6,7]. A hypothesis has been brought forward that, the higher mass of a male cyclist would generate

larger impact forces in a projectile type of injury, but a lighter female cyclist may be more easily ejected from her bicycle in response to an extrinsically applied force [7]. A relative deficit in upper body strength compared to men, resulting in less control of the bicycle, may also be a contributing factor towards women having a higher traumatic injury rate [7].

Therefore medical personnel at mass participation cycling events should be prepared for more women being injured, as this may imply the availability of different medical equipment.

Females need to be educated about risks and that an upper body strengthening program is recommended.

### **Type of medical complaints and sex difference**

One out of thirty one of all starters had non-traumatic medical complaints which comprises 3.25% of cyclists. Road race injury surveillance studies reported that non-traumatic complaints in participants can be as high as 87% [8,9]. Previous work has identified risk factors for overuse injuries, including participants cycling less than 42km per week, riding less than 800km a year, riding less than 64km during the longest ride of the year and riding less than 22.4km/h on average [4,9]. The training preparation in terms of duration and intensity for this race was entirely left to the discretion of each individual participant. Studies on injury surveillance at cycling events have also confirmed that non-traumatic injuries and illness is a major reason to require medical care, and that serious traumatic injuries fortunately appear to be less common during these events [2,4].

There were no fatal injuries during this race. Most deaths from cycling are due to head injuries [2]. The compulsory use of helmets and the protection from road traffic have been suggested as a reason for fewer traumatic injuries [2,4]. This race involved full road-closures where cyclists were completely protected from traffic and helmet use was compulsory.

Groups also had ample space to spread out since a large portion of the route took place on a 2-3 lane freeway. This could all be contributing factors for fewer traumatic injuries.

There was a vast range of different medical complaints during the day. The majority (80.6% n=678) of complaints involved the musculoskeletal system. The rest included the dermatological, gastrointestinal, cardiovascular, central nervous system, respiratory and endocrine system. Other studies on medical surveillance also reported a spectrum of traumatic, orthopaedic, cardiopulmonary, gastrointestinal, neurological and dermatological complaints [4,5,10,11,12]. Thus, medical personnel providing care at long distance cycling events must be prepared to handle various medical complaints ranging from basic non-acute medical conditions through to advanced life support and treating critically injured and ill patients. This study showed that women were more likely to sustain central nervous system and eye complaints than males. No other research was found that investigated the different type of medical complaints between sexes.

### **Medical complaints according to age group**

The majority of the medical complaints were in the 23-39 age group of both male and female participants. Males aged 10-15, females aged 23 to 39 and females >50 years of age, had a significant higher risk for traumatic injuries. No other studies could be found that compared age and cycling injuries.

### **Medical complaints per medical point**

The greater part of medical complaints (27% (n=241)) were reported at the 6th medical point which was at the 71.5km mark. This medical point was situated at the bottom of a steep climb, with the majority of the ascending sections of the race completed at this stage. Two

other studies on cycle events also reported that incidence of injuries and illness increases with event duration, and that more complaints occurred in the second half of the event [2,5]. This may indicate the role of fatigue as a contributing factor to injury and illness. The lowest number of medical complaints, 1% (n=9) was reported at the last en route medical point which was at the 87.5km mark, and it might be that cyclist that had medical complaints decided to finish the race and report at the end medical tent or to seek medical assistance elsewhere.

Several publications describe the medical coverage at large-scale cycling events and the reported patient presentation vary extensively among the studies. This can be due to the difference in duration, distance, elevation, weather and road conditions in the races [1-5]. Due to these differences it is difficult to make meaningful statements regarding the different patient presentation of previously published cycling events. Some of the previous studies that covered incidents at multi-day cycling races, also focused more on the amount of hospital admissions and had different data collection procedures than was used in this study. This study furthermore showed similar results as previous studies that even though the vast majority of incidents reported were for non-traumatic events, the traumatic events were more serious and required more hospital admissions, and that the injuries sustained by women were more traumatic [1-5].

The authors recognise the limitations of this study. Non-standardised diagnostic terminology and incomplete documentation by medical staff could lead to variability in determining diagnosis and the thoroughness of recording could have been diminished at very busy stations. All cyclists that sustained injuries may not have presented to the medical points. Details on training status and prior cycling experience as well as information on injury

mechanisms and circumstances might help in future to determine the impact of the previously reported risk factors.

## **Conclusion**

During the 2014 Momentum 94.7 Cycle Challenge, the second largest 1-day cycling event in South Africa, women (23 to 39 years old and older than 50 years) were more likely to sustain traumatic injuries followed by boys younger than 16 years. Females were also more prone to sustain central nervous system and eye complaints. Another important finding is that cardiovascular symptoms were a common medical reason for post-race hospital admission.

There was a wide spectrum of medical complaints encountered highlighting the need for medical personnel to be comfortable managing anything from minor to critical medical complaints. The majority were non-traumatic musculoskeletal complaints supporting that mandatory helmet use and protection from traffic may be an effective means of injury prevention for cyclists.

Most of the hospital admissions were for traumatic injuries suggesting that these were the more serious medical complaints. The majority of registered medical listings were reported during the second half of the race indicating the importance of fatigue as a contributing factor for medical complications. Future studies should include standardised diagnostic terminology and easy documentation. Race organisers of these types of events should take note that most medical complaints are recorded during the second half of the race hence there is an increased demand for emergency personnel at medical points later in the race. Results from this study may be used to encourage cyclists to be involved in personal injury prevention by undergoing an annual medical screening and to train intentionally for each race they participate in.



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