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MEDICAL COMPLAINTS FOLLOWING A MARATHON RUN IN COOL  
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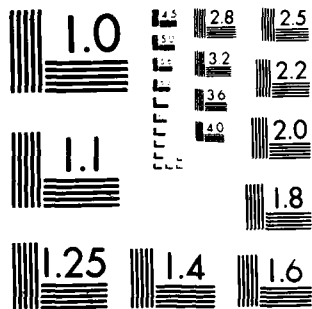
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Medical Complaints  
Following a Marathon Run in Cool Weather

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*9 July 1984*

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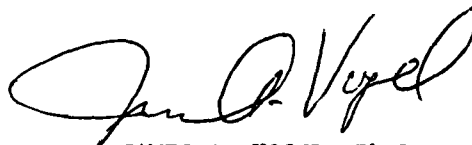
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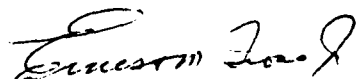
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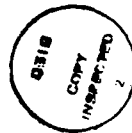
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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

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ABSTRACT

Little information is available on medical complaints following marathons run in cool weather. To obtain such information, medical records were maintained on every runner requesting medical attention following the Bostonfest Marathon, run October 30, 1983. The weather race day was cool and sunny with an average dry-bulb temp of 9.6°C, and average wet-bulb-globe temp of 7.9°C. One hundred and sixty-four (11.5 percent) of the runners finishing the race requested medical attention at the finish line. Another 37 casualties were treated on the course. Men and women requested attention with equal frequency, while the younger (20 to 30 years old) and faster (sub-3-hour) runners sought medical attention more often than the older (30 years and over) and slower (over-3 hour) runners counterparts. The complaints and symptoms of runners following this cool weather marathon were similar to those of runners following hot weather races with the exception that no one complained of feeling "hot". These data suggest that numerous medical complaints can be expected following a marathon, even in cool weather.



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## Medical Complaints

### Following A Marathon Run in Cool Weather

A great deal of attention has been directed towards documenting the medical complications of running in warm weather. Hyperthermic conditions - heat stroke, and heat exhaustion - have been well documented in the literature (1,2,3,4,5) and guidelines for prevention and treatment of heat injuries are well established (6, 7, 8, 9, 10, 11, 12). In contrast, very little attention has been devoted to the adaptive response and medical complaints associated with races run in cool or cold weather. The experience of the authors has been that runners can collapse even in cool weather, and that many will require medical attention regardless of the ambient temperature, especially following a marathon. Anecdotal accounts of hypothermia during distance races exist but the condition is poorly documented and its etiology in runners is not understood. There is a need to study the nature of medical complaints other than heat injuries during long distance races in cool and cold weather.

In order to acquire more insight into the nature and spectrum of medical complaints incurred during cool weather distance racing, records were kept on every runner requesting medical attention at the finish line medical station of the Bostonfest Marathon, on October 30, 1983.

## METHOD

The course for the Bostonfest marathon ran out and back through Boston over relatively flat terrain. The 26.2 miles (42 kilometers) was certified by The Athletic Congress. Weather conditions during the race were noted and temperatures (dry bulb, wet bulb, and globe) were measured with a Reuter-Stokes temperature meter. Temperatures were monitored at 30 min intervals for the first 3 hr of the race, and at 4 hr 30 min, the official race cut off. Wet bulb globe index (WBGT) was calculated using the equation,  $WBGT = (0.7 \times \text{Wet bulb temp}) + (0.2 \times \text{Black globe temp}) + (0.1 \times \text{Dry bulb temp})$ .

Medical records were kept on all runners requesting medical attention at the finish line during and after the race. Special Forms were used to identify all runners requesting medical attention, and to facilitate rapid data collection. The forms were divided into 3 parts: 1) an entry level data section including, subject name, age, sex, race number, race finish time, best previous time, time of arrival at the medical area and triage category. 2) a medical data section including vital signs, symptoms, diagnosis and treatment (Figure 1), and 3) a physical (musculoskeletal) injuries section recording location and diagnosis (Figure 2). Additionally, the time at which the runner departed the treatment area was recorded. Each section was printed on a separate 5 inch by 7 inch sheet of paper, and the three sheets were stapled to a 5 inch by 7 inch cardboard card to provided a firm surface for writing. Records could be hung around each runners neck by a string as they entered the medical area. Thus, the records were easily visible, and readily available to the medical personnel.

The medical staff at the finish line consisted of 25 medical



professionals (podiatrists, athletic trainers, physical therapists, physicians and nurses), and 5 medical records administrators. The American Red Cross provided personnel to administer first aid at stations on the race course.

The finish line medical facility contained three treatment areas, medical, musculoskeletal and observation. On entrance to the medical facility a record packet was hung around the neck of each ill or injured runner. While intake data was recorded, each casualty was triaged by a medical officer to one of the three treatment areas. Medical personnel recorded treatment and diagnostic data as they worked with casualties in their respective treatment areas. The completed records were collected when casualties were discharged from the treatment area.

#### DATA ANALYSIS

Differences in distribution of injuries between genders, age groups and competitive categories were tested with a Chi-square test for "goodness of fit". A probability of 0.05 was chosen as the level of statistical significance.

#### RESULTS

Weather conditions during the marathon were sunny and cool. Dry bulb temperatures (DB) averaged  $9.6^{\circ}\text{C}$  ( $7.9^{\circ}$  to  $10.8^{\circ}\text{C}$ ). The highest DB,  $10.8^{\circ}\text{C}$ , occurred at the start of the race at 11:00 AM. The WBGT index averaged  $7.9^{\circ}\text{C}$  ( $6.4^{\circ}\text{C}$  to  $8.9^{\circ}\text{C}$ ) and the average calculated relative humidity was 39 percent (36 to 45 percent).

Approximately 1800 runners started the race, and 1430 runners finished including 1350 official entrants, and 80 unregistered finishers. Eighty-seven percent of the official finishers were males and 13 percent females. One hundred sixty-four runners, 11.5 percent of the finishers, requested

treatment at the finish line medical facility. Another 37 runners were cared for at Red Cross aid stations along the course (data from these 37 casualties are not included in the analysis below). Of those runners requesting medical attention at the finish line, 89 percent were males and 10 percent were females (based on the 158 for whom sex was recorded). The distribution of men and women among the injured runners was not significantly different from their distribution in the entire race population (Figure 3), suggesting that men and woman are injured with the same frequency.

Age appeared to influence the likelihood of a runner seeking medical attention. The average age of all casualties was  $31.3 \pm 8$  yrs. The average age of male casualties was  $32.2 \pm 8$  yrs, and for female casualties  $26.1 \pm 4$  yrs. Sixteen point nine percent of those under 30 years requested medical attention, while 10.3 percent of those 30 to 39 years old and 8.5 percent of those over 40 years did so. When compared to the age distribution in the race population as whole, the age distribution among the casualties revealed a significant deviation from their expected distribution (Figure 4).

Like age, level of running proficiency appeared to influence the likelihood of injury. The frequency of injuries for the faster runners (those completing the race under 3 hours) was significantly higher than for the slower ones (those completing the race over 3 hours) based on their distribution in the race population (Figure 5). Of the faster runners 15.5 percent requested medical care versus 10.7, for the slower ones.

Most of the runners seeking medical attention were found to require only observation. Eighty-five runners were triaged to the observation area, 41 casualties were triaged to the medical treatment area, while 37 were sent to the musculoskeletal treatment area. Thus 52 percent of those requesting attention required only minimal assistance and rest, while 25 percent needed

close medical monitoring or treatment and 23 percent required treatment for acute musculoskeletal injuries.

The duration of treatment was calculated from arrival and departure times of 90 runners. The average duration of stay for all treatment groups was  $21 \pm 18$  mins (n=90), and the average time between finishing and reporting for treatment was  $17.5 \pm 14$  min (n=60). The average duration of stay in the medical treatment area was  $27 \pm 25$ min (n=33), while that for those triaged to the musculoskeletal treatment area was  $15 \pm 14$  mins (n=25). The average length of stay for those needing only observation was  $21 \pm 14$  mins (n=32). Two factors seemed to be predictive of a longer duration of stay, heart rate (HR) greater than  $100 \text{ b} \cdot \text{min}^{-1}$  and vomiting. Those triaged to the medical area who had HR above  $100 \text{ b} \cdot \text{min}^{-1}$  or vomiting were treated for an average of  $38 \pm 27$  min and  $45 \pm 33$  min, respectively.

It was not possible to take vital signs (VS) on all runners in any treatment area, so the following averages should be interpreted with this in mind. The most complete VS were for those casualties triaged to the medical treatment area. Vital signs from these medical casualties averaged: HR= $82 \pm 17 \text{ b} \cdot \text{min}^{-1}$  (n=26),  $T_{s1} = 35.5 \pm 1.3^{\circ}\text{C}$  (n=18), and BP= $113 \pm 16$ mmHg systolic and  $52 \pm$  mmHg diastolic (n=35). Some of the runners sent to the musculoskeletal area had VS recorded, these averaged: HR= $95 \pm 13 \text{ b} \cdot \text{min}^{-1}$  (n=13),  $T_{s1} = 34.7 \pm 2.1^{\circ}\text{C}$  (n=5). For those in the observation area only HR were recorded with average HR =  $89.4 \pm 18 \text{ b} \cdot \text{min}^{-1}$  (n=25).

The most commonly reported medical symptoms at triage were lightheadedness (n=19), muscle cramps (n=17), cold (n=16), fatigue (n=13), weakness (n=11), nausea (n=8), vomiting (n=4) and headache (n=1). Also, five runners collapsed at the finish line and needed to be carried to the medical area by stretcher, and several others showed signs of disturbed sensorium

(confusion, disorientation, incoherence, stuporonsness). The fruity odor characteristic of ketones was noted on the breath of several runners as well.

Hypothermia was by far the most common diagnosis (n=33) listed on the medical records, followed by exhaustion (n=12), and dehydration (n = 10). These tentative diagnoses were based primarily on subjective complaints and degree of prostration. Despite appearing ill, most casualties recovered quickly with oral rehydration, rewarming with "survival blankets", and changing into dry clothes. In all, five runners required intravenous fluids to assist recovery, while four casualties (all medical) were sent to the hospital by ambulance.

The most common locations of musculoskeletal complaints (excluding blisters) were the foot (n=10), ankle (n=4), leg (n=5), knee (n=5), and thigh (n=7). Most leg and thigh injuries were diagnosed as muscle cramps, while most of the injuries to the ankle and knee were diagnosed as sprains. Seven runners were treated for blisters.

#### DISCUSSION

It is clear from these data that medical complaints following a marathon in cool weather are common. The percent of runners with medical complaints reported here are consistent with estimates of 10 percent at the Boston marathon over the last several years (Casey, personal communication) and the 7.8 percent reported after the New York marathon in 1983, (13).

In regards to the distribution of medical complaints among different groups, it is difficult to state with certainty why one group suffered more injuries than another. The literature on running injuries provides little insight, since there are no epidemiological reports of the full spectrum of acute medical problems encountered following a marathon. Of the groups examined, those based on age, and running speed (level of proficiency)

appeared to influence the incidence of injury, while gender did not (Figure 3). Runners under 30 years of age reported more complaints than those 30 to 39 years of age, and those over 40, which was unexpected (Figure 4). It may be that the older participants ran more conservatively, however, and were therefore less likely to push themselves to their physiological limits. The converse may be why the faster (sub 3 hr) runners suffered a higher percentage of complaints (Figure 5) i.e., they may have extended themselves closer to the limit of their physiological and biomechanical capabilities. In any case, further study is needed to confirm these results, and to determine the factors responsible for greater incidence of injury among some groups.

The difference in duration of treatment for the three triage categories suggests that the more severe metabolic derangements were triaged to the medical treatment area and took longer to recover. Runners assessed as having less severe complaints went to the observation area, and generally recovered more rapidly. Individuals with musculoskeletal problems stayed only as long as it took to treat their specific complaints, and had the shortest duration of stay of all groups.

The only factors identified which seemed to be of prognostic value in terms of duration of stay were HR greater than  $100 \text{ b}\cdot\text{min}^{-1}$  and vomiting, probably because they are indicative of more severe circulatory and/or metabolic stress. We suspect that body temperature was not found to be of prognostic value because of the moderate to cool weather, which negated hypothermia as a factor. However, we did feel that some individuals may have been mildly hypothermic, especially those who had to walk the last few miles of the race. The combination of lower metabolic rate while walking, and wet clothes may have predisposed runners who walked to become colder than others.

But, because oral temperatures after exercise are not representative of core temperature (14, 15), we feel the temperature data of this study should be viewed with caution.

It is interesting that the vital signs for medical casualties were not more abnormal, especially in some cases where other clinical symptoms and signs i.e. inability to walk unassisted, vomiting, confusion, disorientation appeared relatively severe. Blood pressure, especially diastolic pressures were low, but did not help distinguish between those staying longer or shorter times. It is possible that the orthostatic response of EP might help identify those who are dehydrated, but this was not examined. More data of this kind from marathons run during a variety of weather conditions is necessary to put these data in clearer perspective.

With the exception of symptoms of being "cold", the complaints after this cool weather marathon were similar to those reported for hot weather events(1,3,4,5). Most medical problems of runners discussed in the literature are attributed to the effects of vigorous exercise in the heat. However, the data from this study suggest that there may be factors other than environmental heat load which predispose marathoners to physical collapse.

It was reassuring that most of the medical casualties of this marathon recovered with no intervention other than to encourage oral rehydration and a change into dry clothes. A few individuals required intravenous (IV) fluids to aid recovery. The rationale for the use of IV fluids was based on experience from the Boston Marathon. We suspect that all runners finishing a marathon are relatively dehydrated, even in cool weather. Indeed, data collected by other investigators during this same race found that 50 runners weighed immediately before and after the marathon lost an average of 2.9 percent of their body weight (Knapik, personal communication) which was

attributed to water loss. Because of our suspicion, we felt that fluids were one of the most important factors in recovery of most runners triaged to the medical and observation areas. Individuals who could not take fluids orally - those with nausea and/or vomiting, or disturbed sensorium - were given IV fluids. Runners with severe muscle cramps which prohibited ambulation and which could not be relieved with massage were also given IV fluids. Although, we have no data to substantiate it, we feel that IV fluids speeded the recovery of those with severe muscle cramping.

In regard to the most serious medical complaints, we were unable to retrieve data on 3 of the 4 individuals sent to the hospital by ambulance. These three were sent immediately to the hospital because of "physical collapse" or disturbed sensorium. The fourth was sent to the hospital because he failed to recover enough to leave the medical area without assistance after 60 mins and 1500cc of 5 percent dextrose in half normal saline solution given intravenously.

While more severe medical casualties were seen than expected, we saw fewer musculoskeletal injuries than anticipated. This may have been because of the relatively flat nature of the course, and the cool dry weather conditions. We suspect that more musculoskeletal injuries are likely to occur on hilly courses, because biomechanical stress may be greater running down hill. We, also, feel that cool, dry weather may have helped prevent musculoskeletal injuries by preventing blisters normally associated with wet shoes and socks caused by excess sweat or wet weather. Because blisters cause a runner to alter his stride which may in turn predispose him to other injury, the low incidence of blisters (only 7 treated) may have contributed to the low incidence of other musculoskeletal injuries. In any case, none of the musculoskeletal injuries required more than simple first aid treatment.

The most important conclusion that can be drawn from these data is that many runners will require medical attention following a marathon even in cool weather. However, the potential seriousness of these injuries during cool weather races has not been established. For this reason we feel that medical surveillance is necessary at marathons run in cool, as well as warm weather.



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FIGURE 1 - Facsimile of Medical Records data sheet for the 1983 Bostonfest Marathon. HR = Heart rate, BP = Blood pressure, T<sub>sl</sub> = Oral (sublingual temperature)

## Medical Data (metabolic/physiologic complaints)

Vital signs: HR, BP, T<sub>sl</sub>

Symptoms:

exhaustion/fatigue  
weakness  
nausea  
vomiting  
lightheadedness  
cramps (abdominal)  
headache  
chilling  
fever  
rapid HR  
other (specify): \_\_\_\_\_

Diagnosis:

dehydration  
hyperthermia  
hypothermia

Treatment:

I.V. fluids/volume, other: \_\_\_\_\_

FIGURE 2 - Facsimile of Physical Injury data sheet for the 1983 Bostonfest Marathon. L= left, R = right.

## Physical Injury Data (Musculoskeletal complaints)

Location (circle):

foot	L	R
ankle	L	R
leg	L	R
knee	L	R
thigh	L	R
hip	L	R
back		
other:	_____	

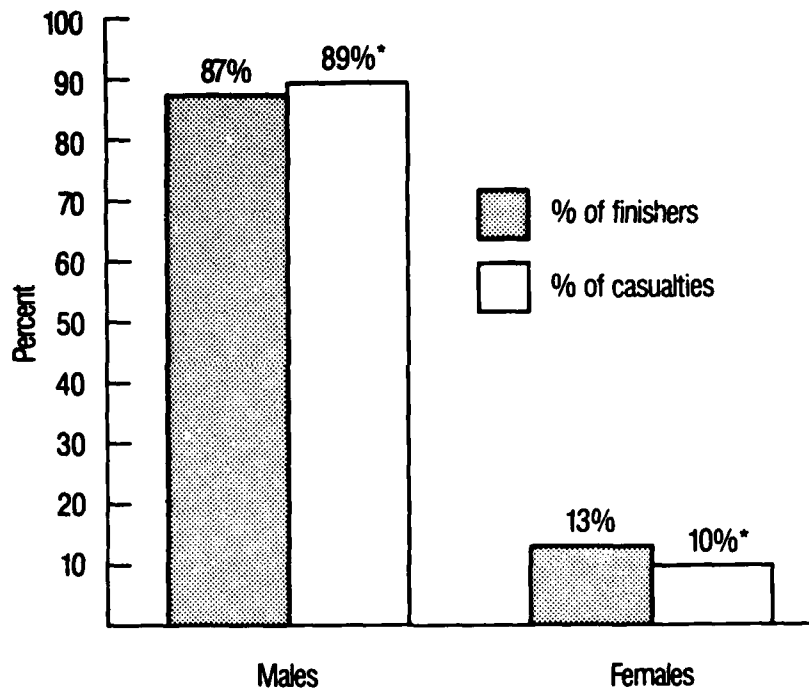
Tissue (circle):

muscle  
tendon  
ligament  
bone  
other: \_\_\_\_\_

Diagnosis:

blisters  
strain  
sprain  
tendonitis  
cramp (ms)  
other: \_\_\_\_\_

FIGURE 3 - Percent of marathon finishers who were males or females compared to the percent of casualties who were males or females



\*No significant difference

FIGURE 4 - Percent of marathon finishers in three age groups (less than 30 yrs, 30-39 yrs, over 40 yrs) compared to the percent of casualties from these age groups.

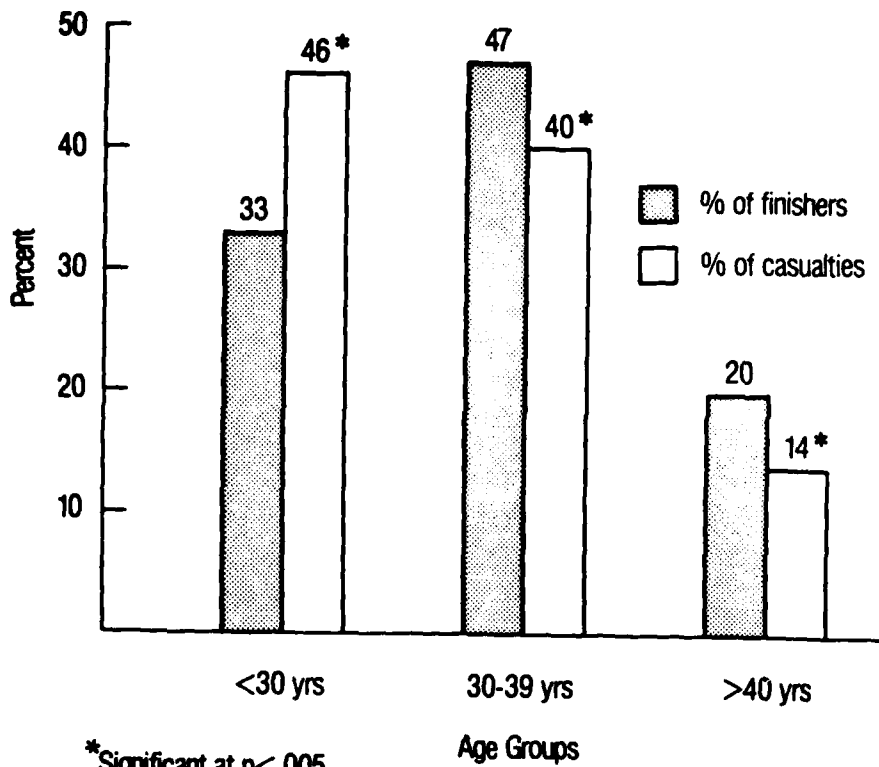
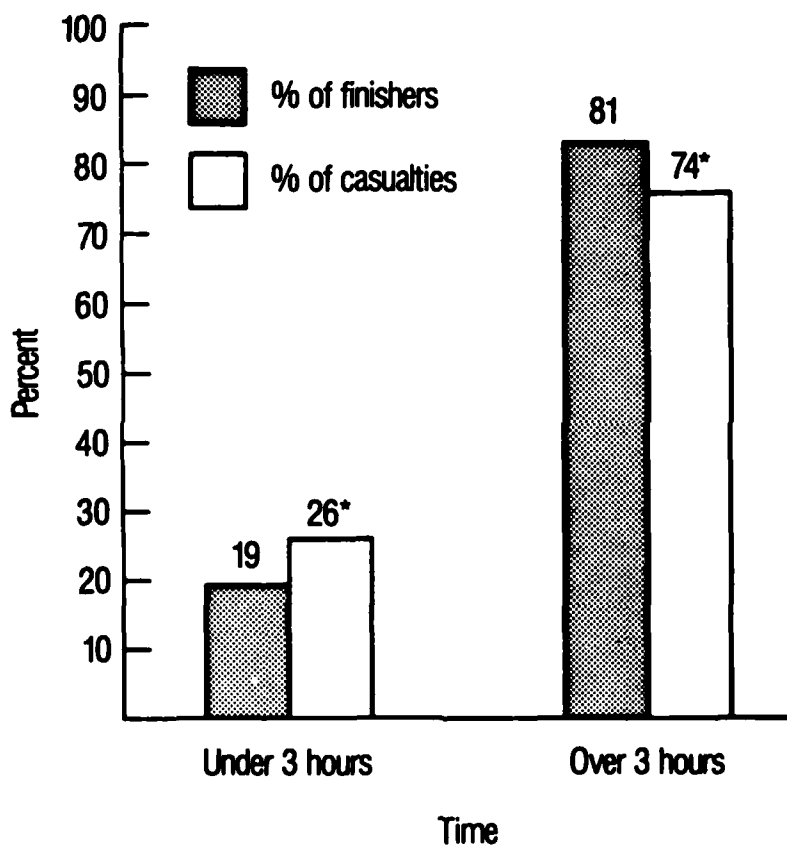


FIGURE 5 - Percent of marathoners running under 3 hours and over 3 hours compared to the percent of casualties from these 2 groups.



\*Significant at  $p < 0.05$

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