

Injury Prevention in Marathon Runners

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ABSTRACT

More people run today than ever before with participation in marathons becoming increasingly popular. Injury rates in those training for a marathon can be as high as 90%. 89 individuals running for Arthritis Research UK were followed up before and after running the London Marathon. All were asked to complete two online questionnaires, one before the marathon asking for demographic information, previous history of running injury and training habits and one after regarding how the run went and recovery time. The mean response rate across both surveys was 62%. There is a significant association between time and injury whilst running the London Marathon ($p = 0.003$). This is supported by the fewest percentage of runners who sustained an injury are those who ran the marathon in less than 4 hours (13%). This report indicates how difficult it is to determine who will sustain an injury whilst running a marathon. It highlights that there are many risk factors for incurring injury but few proven by scientific research. It does suggest a relationship between marathon time and injury.

There is a need for guidelines for all marathon runners to help reduce injury

KEY WORDS

marathon, run, prevention

INTRODUCTION

GROWTH IN NON-ELITE MARATHON RUNNERS

Since the 1980s marathon running has ceased to be a sport only for elite athletes and began to attract mass participation by non-elite 'fun runners' (Satterthwaite et al., 1996). The big city marathons in London, New York and Boston attract tens of thousands of runners. These courses also stage a main race where elite athletes compete. (Spellman, 1996) Over the last 10 – 15 years there has been a dramatic increase in popularity and participation in marathons. (Fredericson and Misra, 2007) It would be interesting to consider what the reason for this increase may be.

INCREASE IN HEALTH CONSCIOUSNESS

Medical advice recommends a healthy running distance of 10 – 25km per week or 1 – 2 hours of endurance exercise. In the last 10 – 15 years there has been a greater emphasis on balanced diets and choosing running programmes which lead up to marathon distances. (Nicholl et al., 1995) One may expect that the increase in individuals taking up running may impact the rates of injuries, a factor that needs to be further investigated.

IMPACT IN GROWTH OF MARATHON RUNNING ON RATES OF INJURY

During the course of a year two thirds of long distance runners sustain an injury that interrupts their training programme. (Lysholm and Wiklander, 1987) In this study long distance runners were defined as those who trained for at least one hour for 21 days of the month. Among this group of runners lower extremity injuries are particularly common. (Lysholm and Wiklander, 1987) Unfortunately this data is limited; as it considers runners by the amount of time they spend running per month, not by distance covered, such as marathon runners.

Although this connection seems relatively sensible it still does not explain why some individuals are more prone to injuries than others. It also does not explain why a correlation between distance covered in training and rates of injury has been found.

INJURIES ASSOCIATED WITH MARATHON RUNNING

COMMON INJURIES

The most common overuse injury is patellofemoral pain syndrome. (Ballas et al., 1997, Pinshaw et al., 1984) Iliotibial band friction syndrome, plantar fasciitis, meniscal injuries and patellar tendinopathy

are the other common acute injuries experienced by runners.(Taunton et al., 2002)

The knee is the most common site of both acute and overuse injury. Other injury sites include the foot/ankle, lower leg, hip/pelvis, achilles/calf, upper leg and lower back.(Pinshaw et al., 1984) It is unsurprising that the knee is most commonly associated with injuries as it is the main joint taking the impact whilst running.

Additional acute complaints include thigh muscle soreness, blistered feet, chaffing, malaise, ankle sprains and extreme exhaustion.

Non-musculoskeletal injuries including light-headedness, nausea, stomach upsets, headaches and diarrhoea will not be considered in the study. These are commonly due to dehydration.(Fredericson and Misra, 2007)

LONG-TERM COMPLICATIONS

One of the most common associations is between marathon running and predisposition to osteoarthritis (OA) later in life but the connection is still unknown.

Reports have shown that the type of sport has a significant impact on the degree of risk. The sports that have a high recognised risk are those that involve repetitive, high intensity, high impact forces through the affected joint(Conaghan, 2002). One Finnish study found that the prevalence of radiographic osteoarthritis in long distance running, football, weightlifting and shooters were 14%, 29%, 31% and 3% respectively(Kujala et al., 1995). This study did not state the distance covered by long distance runners and whether they were marathon runners or not. In addition it did not state whether the radiographic findings correlated to symptoms of pain.

One retrospective cohort study in 1973 and 1988 examined former athletes of whom 27 were long distance runners who averaged 60 miles per week. Radiographic evidence of OA of the hip was found in 19% of runners.(Marti et al., 1989) A conflicting study by Lane and colleagues presented a series of reports from a prospective cohort of subjects from a long distance recreational running club.(Lane et al., 1986, Lane et al., 1993, Lane et al., 1998) The report concluded that there were no differences in clinical or radiographical findings of OA after five years compared with nine years follow up. The mechanism of repetitive, high weight-loading exercise causing OA is still unclear. It is surprising that the link is so well known despite there being insufficient evidence to support it.(Spector et al., 1996)

RISK FACTORS PREDISPOSING MARATHON RUNNERS TO INJURY

These can be categorised into four groups; demographic, systemic, training / running related factors and health and lifestyle factors.

DEMOGRAPHIC FACTORS:

Gender and Age - Patterns of injuries have been assumed to be more sport specific than gender specific and previous studies have found similar overall injury rates in men and women. (Lanese et al., 1990) These studies do not specify what proportions of these include marathon runners compared to other sports and therefore no significant conclusion can be made. Conn et al assessed sports related injuries in a population of ages 5 – 24 years old in the United States. They found that injuries were twice more common in males than females. (Conn et al., 2003) As the anatomy of males and females differ it is unsurprising that sites of acute injury may vary. In females hip, lower leg and shoulder related injuries are more common (Satterthwaite et al., 1999). Whilst thigh related injuries have been found to have a higher incidence amongst males compared with females.(Sallis et al., 2001) Again these studies were not exclusive to marathon runners. Satterthwaite et al found that specifically amongst male marathon runners there was a greater risk of hamstring and calf injuries than in females (Satterthwaite et al., 1999). Taunton et al found that an age less than 34 years old was a risk factor for developing patellofemoral pain in both sexes. In addition it showed that young age is a protective factor against meniscal injuries(Taunton et al., 2002). Conflicting reports by Jacobs and Berson (Jacobs and Berson, 1986), Macera et al (Macera et al., 1989) and Walter et al (Walter et al., 1989) reported that age was not significantly related to incidence of running injuries although one study of military recruits with a uniform training regime showed a positive correlation of injury with increasing age.(Neely, 1998) Therefore it is difficult to conclude whether age has an impact upon rates of injury, as reports seem to contradict one another.

Height and Weight – As mentioned previously, there are contradictions in conclusions drawn by different studies and equally there does not seem to be any consistency proving that height or weight significantly impacted incidence of injury in marathon runners.

Although BMI has shown to be a valid estimate of body composition for the general public it is uncertain whether a relationship can be found on its im-

impact on rates of injuries in runners.

The limitations and inconsistency of the above reports suggest that it may be difficult to determine whether simple demographics impact injury rates. In addition the lack of inclusion of marathon runners makes it hard to draw any significant conclusion or association. It may be useful to investigate other factors that could predispose a marathon runner to injury.

SYSTEMIC FACTORS:

Anatomical Factors - Certain anatomical factors have been associated with running injuries. These can be separated into congenital factors and those that result from biomechanical, postural or gait abnormalities.

Individuals born with cavus feet have biomechanically shown to be more rigid and sustain a higher impact. (Hespanhol Junior et al., 2012). The population involved in this study were recreational runners who were not training for a marathon distance. In a population of athletes leg length inequality has also been suspected as a factor in hip, pelvis, iliotibial band syndrome (ITB) and lower back injury. This study found a specific association of leg length discrepancy and recurrent stress fractures of the lower limb in all groups (Korpelainen et al., 2001). Hip muscle weakness is suggestive of overall injury risk in the lower extremity, particularly ITB where vastus medialis has been the key deficit area. (Niemuth et al., 2005)

RUNNING / TRAINING RELATED FACTORS

Certain factors associated with training have been indicated to affect incidence of injury. However, rapid increase in mileage covered was the only factor shown to significantly affect injury incidence.

Macera et al and Walter et al support that training in excess of 40 miles per week is a significant risk factor for injury in males (Macera et al., 1989, Walter et al., 1989), whilst only one study supports this association in females (Walter et al., 1989). It is still unknown whether inexperience predisposes an individual to hamstring, knee or foot injuries (Satterthwaite et al., 1999). There is no association between the use of warm up and prevention of lower extremity injuries. (Macera et al., 1989) Training terrain has not shown to affect incidence of injury (Wen et al., 1998).

HEALTH AND LIFESTYLE FACTORS

History of a previous lower extremity running injury is a significant risk factor for a recurrence (Wen et al., 1998, Macera et al., 1991, Macera, 1992, Walter

et al., 1989). It has been suggested that this is because the original cause of injury may be unknown and repaired tissue may function less well as a protective barrier.

SUMMARY OF INTRODUCTION

More people run today than ever before and the participation in marathons is becoming increasingly popular. Injury rates in those training for a marathon can be as high as 90%. (Satterthwaite et al., 1996)

With increasing participation there is an ever-increasing need for knowledge for both the runner and the health care profession into factors that predispose runners to injuries. The literature research presented above shows a variable, although somewhat contradictory range of opinions regarding factors that may contribute to injury.

There is also a need to exclusively investigate injuries in marathon runners and factors associated. Different studies define long distance runners differently and this project will only investigate individuals training for and competing in the London marathon (26.2 miles)

AIMS

To investigate the factors that may predispose marathon runners to injury. These will be; number of marathons completed in the past, time taken to complete the London Marathon, previous history of injury, following a marathon training plan, experience of pain whilst running during training, age, sex and number of training runs per week. Each factor will be compared with injury sustained whilst running the London Marathon.

METHOD

Survey Monkey, an online survey website was used to generate each questionnaire which then produced a unique link which was sent out to all runners via email. Survey Monkey limited each questionnaire to ten questions. The first questionnaire consisted of more than ten questions and was separated into two parts, generating two separate links to be sent out. Thus requiring both parts to be completed to fully answer the first survey. Runners were asked demographic information regarding their year of birth and sex. They were then asked about previous history of running injury and if so, which part of their body was affected. Individuals were asked how many marathons they have completed in the past and what distance they have covered / intended to cover in their training in March and April. This survey then

asked whether individuals follow a training plan and if they take any medication for pain experienced whilst running.

An employee of ARUK sent out the first survey via email on Tuesday 10th April, before the London Marathon, which occurred on Sunday 22nd April 2012. All 89 ARUK runners were emailed. Two follow up emails were sent and individuals were then telephoned from the office. All individuals were given the opportunity to opt out of the survey.

The same person then sent out a second survey on Monday 28th May via the same method as the first. This consisted of fewer questions and only required one link.

The second questionnaire asked about the runners experience on the day of the marathon and whether there was any time during the run that they had to

stop due to an injury. They were then asked for the time they completed the marathon and whether they thought their training was sufficient. If they did not they were asked why and if they had any advice to give future marathon runners. Runners were then asked how long it took them to feel free of any aches or pains and how long it took them to return to running.

RESULTS

RESPONSE RATE

Below is a table that shows the number of individuals who completed each survey. This has also been represented as a percentage of the total number of runners. As the first survey was spread over two parts these have been represented by 1A and 1B, whilst the second questionnaire 2.

Survey	Total Number of runners (n)	Total Completed (% of total runners)	Males Completed (% of total males)	Females Completed (% of total females)
1A	89	53 (60)	36 (65)	17 (50)
1B	89	56 (63)	36 (65)	17 (50)
2	89	55 (62)	33 (60)	22 (65)

Figure 1 - Table representing total number of questionnaires completed

This data shows that 15% more males completed the first survey compared with females. However 5% more females completed the second survey compared with men. Despite the first survey being online for a month longer than the second it does not seem to have had an effect on the response rate.

STATISTICAL ANALYSIS PLAN

Chi squared was chosen, as it is best suited for analysis of data where sample size is relatively small. Using the described analytical technique this study will determine whether there is any statistical significance between selected factors and suffering an injury on the day of the London Marathon. The second questionnaire asked participants whether they endured an injury on the day of the marathon. This was defined as any time during the run that an individual needed to stop. This did not include toilet breaks.

As mentioned in the methodological limitations section, some individuals completed the first questionnaire and not the second or visa versa. Therefore if a category from the first questionnaire is being compared to injury on the day of the marathon (questionnaire 2) only the individuals who filled out the both questionnaires can be included.

FIRST TIME RUNNERS AND INJURY DURING THE LONDON MARATHON

No statistical significance was found between individuals running the marathon for the first time and incidence of injury ($p = 0.688$).

PREVIOUS RUNNING INJURY AND INJURY DURING THE LONDON MARATHON

In this study, 'previous injury' was defined as any injury whilst training or running a marathon, which was sufficient enough to stop training and seek medical advice. There was no statistical significance found between previous injury and injury endured on the day. ($p = 0.947$)

Out of the 54 individuals that completed the first survey 33 had sustained an injury.

MARATHON TIME AND INJURY WHILST RUNNING THE LONDON MARATHON

A p value of 0.003 suggests a statistical significance between running time and injury on the day. This is supported by only 13% of runners who completed the marathon in less than 4 hours sustaining an injury. Whilst this was significantly higher in those who finished between 4 - 5 hours and over 5 hours at 70% and 47% respectively; their mean time was

4hrs and 36 minutes.

FOLLOWING A TRAINING PLAN AND SUSTAINING AN INJURY DURING THE LONDON MARATHON

Training plans are often known to be essential preparation for individuals training to run a marathon. It is unsurprising that they help individuals to cover the necessary distance however one might suggest that following a training plan may help prevention of injury. There was no statistical significance to support this ($p = 0.601$). 68% of runners in this survey followed a training plan and 43% of those sustained an injury.

PAIN WHILST TRAINING AND INJURY DURING THE LONDON MARATHON

No statistical significance was found ($p = 0.204$) between injury during the London Marathon and runners who suffered from pain whilst training. Runners who experienced pain whilst training were asked if they took anti-inflammatory medication, paracetamol or both to help regulate the pain. Out of 56 runners who completed the question 32 (57%) stated that they regularly suffered from pain whilst running. Of that total 27 (84%) took anti-inflammatories, paracetamol or both.

AGE AND INJURY WHILST RUNNING THE LONDON MARATHON

Again only individuals who completed both surveys could be included. No significance was found between age and injury sustained whilst running the London Marathon ($p = 0.376$). The average age for males was 40 and females 42.

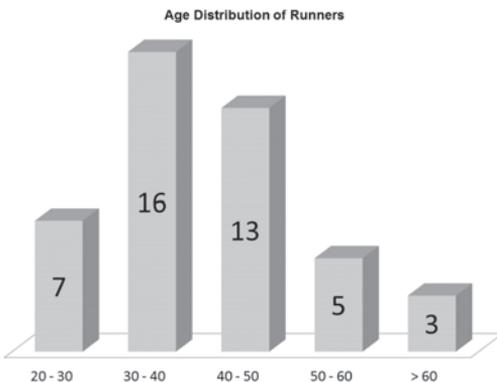


Figure 2- age distribution of runners

MALE OR FEMALE SEX AND INJURY WHILST RUNNING THE LONDON MARATHON

There is no statistically significant correlation between gender and injuries incurred in males and females ($p = 0,138$).

NUMBER OF RUNNING SESSIONS PER WEEK AND INJURY DURING LONDON MARATHON

Participants were asked how many times per week they trained. The answers ranged from one to six runs per week. This factor was not found to affect the number of runners who sustained an injury ($p = 0.770$).

The graph below shows the range in number of times individuals ran per week.

DISCUSSION

Running injuries are frequently experienced when training for a marathon. Prevention of these running injuries would allow the positive benefits of running to be enjoyed. This report systematically investigates possible factors that may be implicated in predisposing marathon runners to injury. It investigates whether there is any relationship between these factors and injuries sustained whilst running the London Marathon.

SUMMARY OF MAIN FINDINGS

There is a significant relationship found between time and injury whilst running the London Marathon ($p = 0.003$). This is supported by the fewest percentage of runners who sustained an injury ran the marathon in less than 4 hours (13%).

There was no association found between; previous history of injury and reoccurrence ($p = 0.947$), number of marathons previously run ($p = 0.688$), following a training plan ($p = 0.601$), pain whilst running during training ($p = 0.204$), age ($p = 0.376$), gender ($p = 0.138$) and number of training runs per week ($p = 0.770$) and injury whilst running the London Marathon.

RESPONSE RATES OF RUNNERS

Although the first survey was online for one month more than the second, response rates were almost equal. One may suggest this is because people intend to complete the survey or not and trying to chase an individual to do so is futile. However it may be that some individuals have every intention to complete the survey but simply forget to. Therefore sending another email or telephoning the individuals may be beneficial but doing this more than once is often not, and can lead to people becoming irritated.

The average response rate in males is slightly higher than females. One suggestion for this difference could be that male marathon runners more frequently experience injury over females and are therefore more likely to take part in a questionnaire aiming to prevent injury in marathon runners. However this association is not supported by the report ($p = 0.138$). Another reason could be that as more men

ran for ARUK word of mouth between male runners could have lead to more completing the survey. However as the difference is only by 5% it is difficult to make any significant conclusion.

INTERPRETATION OF RESULTS

PREVIOUS INJURY AND REOCCURRENCE WHILST RUNNING THE LONDON MARATHON

The relationship between past history of injury in marathon runners and reoccurrence is well recognised by Ballas et al (Ballas et al., 1997), Macera et al (Macera et al., 1991), Wen et al (Wen et al., 1998) and Machera et al (Macera, 1992). However this is not consistent with the results found in this study. The most likely explanation for the literature written is previous injury results in a weakness of the area that makes the runner more prone to a second injury. One could also consider that it is a result of an underlying anatomical problem predisposing the individual to injury. If an individual is following an incorrect training method i.e. a rapid increase in mileage over a short space of time it could be the cause. (Walter et al., 1989) Although this study does not support the associated made it did find that the knee is the most common anatomical site of injury, a result that is consistent with previous literature. This supports the idea that during running the majority of force passes through the knee and it is subsequently more prone to injury than other areas. (Pinshaw et al., 1984)

MARATHON TIME, PREVIOUS NUMBER OF MARATHONS RAN AND RELATIONSHIP WITH INJURY WHILST RUNNING THE LONDON MARATHON

Participants completing the marathon in less than four hours are less likely to sustain an injury ($p = 0.003$) and the lowest incidence of injury (13%) is in runners who completed the marathon in less than 4 hours.

There are fewest novices present in the group of runners who complete the marathon in under 4 hours. In addition fewest novices were present in this group. Experienced level has been identified as a risk factor for injury. In first time marathon runners, hamstring and knee injuries were more common. (van Gent et al., 2007) Machera et al reported that runners with an experience fewer than 3 years had an odds ratio of 2.2 for injury (Macera, 1992).

OTHER DETERMINANTS OF INJURY

Various papers support the findings of this study that there is no relationship between age and sex with incidence on injury whilst running a marathon. (Lanese et al., 1990, Satterthwaite et al., 1999)

It is interesting to consider why this may be. Although Conn et al found an overall increase in injuries in males compared to females this was not exclusive to marathon runners and therefore most likely to be determined by the different sports that males and females participate in.

There is no relationship between following a training plan and injury whilst running the London Marathon. However training plans have been shown to, if designed effectively help to prevent a new injury or prevent reoccurrence. (Hespanhol Junior et al., 2012)

Self-reported pain is not considered as an actual injury in this study, or in other literature as pain is a subjective phenomenon that is difficult to measure and compare between individuals, this makes it an unspecific and unreliable factor to consider when considering marathon injuries, (Borg, 1998)

OTHER FINDINGS

The majority of individuals ran a total of 100 – 150 miles in March ($n=23$), the month preceding the London Marathon. An even distribution was found in the other ranges, 50 – 100 ($n=10$), 150 – 200 ($n=8$) and over 200 miles ($n=11$). This is interesting as it shows the variation in distance covered by people training for a marathon. It is also interesting to note that two people were injured and did not run at all during March but were still able to complete the marathon.

All individuals tapered down their distances in April, the month of the London Marathon, and this is recommended by most training plans and experienced runners. Mujika et al found that a 6-day tapering down period in 800 metre runners where their intensity was decreased by 80% showed significant performance gains. (Mujika et al., 2002) It would be interesting to also test this in marathon runners exclusively.

The longest runs completed by trainees were between 15 and 23 miles and the mean run was 20.5 miles. Most runners stated that their longest run was 20 miles ($n=21$) and few ran distances less or more than 20 miles. This is interesting as most training for a marathon are aware of the length that their longest run should be. Although this varied in runners it did not have an impact on them completing the marathon or sustaining an injury. This highlights that most training is specific to the individual and that it is difficult to generate a gold standard.

It is somewhat concerning that a third of runners felt their training was not sufficient and most mentioned that next time they would complete more longer runs. This highlights the need for training guidelines by organisations that have individuals running for them in a marathon. These should aim to provide all

runners with information regarding injury prevention, the common injuries and what to do if one feels they have sustained an injury.

Evidence found in this study would suggest that most runners are able to return to running shortly after the marathon demonstrating that the acute after effects on physical health are minimal. The mean time that runners took to feel ache or pain free was three days, and most returned to running in a week. This suggests that injuries sustained by most runners during a marathon are not serious enough to cause significant long-term complications.

Anecdotal evidence suggests that many marathon runners have always aimed to complete a marathon, but that one marathon is sufficient to achieve this goal. Only 10 out of 55 people who completed the questionnaire said they do not intend to run another marathon. This reinforces the idea that marathon running is “a bug” and runners are keen to continue once they have completed a marathon, perhaps to improve on their completion time.

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CONCLUSION

This report finds that there is a connection between running a marathon in less than 4 hours and reduced rates of injury. This report investigates various factors that may contribute to an individual experiencing injury during running a marathon but none are found to have a significant effect on injury.

These results highlight how difficult it is to determine who gets an injury whilst training for or running a marathon and there is a lot of uncertainty regarding factors that affect injuries. There is also a lack of scientific evidence for many anecdotal associations between marathon running and injury such as early onset of Osteoarthritis and more frequent lower limb injuries. Therefore there is increased need for scientific evidence proving or disproving these theories.

It is important to consider and further to understand factors contributing to injury and if these are identifiable to provide guidelines to those training for a marathon to help prevention and improve enjoyment.

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