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Review article

Gastrointestinal (GIT) symptoms in athletes: A review of risk factors associated with the development of GIT symptoms during exercise

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Abstract

Gastrointestinal tract (GIT) symptoms commonly affect endurance athletes. Although a number of risk factors for the development of GIT symptoms during exercise have been proposed, scientific evidence in support of these factors is limited. In this review article, the risk factors associated with the development of GIT symptoms during exercise will be critically reviewed.

An extensive literature review was conducted using an evidence-based approach. Using selective keywords (gastrointestinal tract symptoms, exercise, risk factors, athletes, triathletes) a search was undertaken using the PubMed database to identify all research publications that relate to the development of GIT symptoms during exercise.

There is strong evidence from a limited number of studies to support significant dehydration (body weight loss >4% during or after exercise) as a risk factor for GIT symptoms during exercise. However, more research studies are still needed to support this finding. There is some, but limited scientific evidence, to support the following as risk factors for GIT symptoms during exercise: female gender, younger age, high intensity exercise, vertical impact sport and medication use. Poor conditioning, dietary factors and previous abdominal surgery are risk factors for GIT symptoms that are not well supported and evidence is considered weak in these areas.

Therefore, further research studies of greater power, such as case control and prospective cohort studies are needed in order to evaluate risk factors adequately. Subject selection needs to be random and subjects should not be self-selected. Data needs to be collected in



an objective manner not relying on subject recall. Measurement parameters also need to be standardised. In conclusion, there is very little evidence-based research to support the majority of the currently suggested risk factors for GIT symptoms in endurance athletes and further research is essential. **Keywords:** gastrointestinal tract, symptoms, athletes, risk factors, review

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Introduction

Gastrointestinal tract (GIT) symptoms are common in athletes, especially in endurance athletes^{3,10}. GIT symptoms are usually mild and self-limiting; however, symptoms can become severe and incapacitating for the athlete^{2,3}. These symptoms can be very frustrating for the athlete as they can occur during training and race conditions^{11,12}. The unexpected nature of the symptoms can be embarrassing to the athlete, can result in medical complications e.g. fluid and electrolyte loss, and may also impair the performance of the athlete¹¹. However, in most instances, GIT symptoms are mild and only result in an inconvenience to the athlete^{1,3,13}. Therefore some athletes consider GIT symptoms almost as a normal part of exercise^{1,14}. GIT symptoms can also be more severe and disabling, forcing athletes to stop racing or abandon training sessions [3]. In one questionnaire that was completed by 279 marathon runners, 20% of athletes felt that GIT

symptoms interfered with their performance¹¹.

Several studies have investigated the prevalence of GIT symptoms in runners^{9,10,11,15}. It has been shown that GIT symptoms are very common in runners and lifetime prevalence rates as high as 83% have been reported¹⁰. However, most studies show lifetime prevalence in the range of 20-50% of athletes reporting some form of GIT symptom associated with running⁶. There are limited studies investigating the incidence of GIT symptoms in triathletes during a race. In one cross-sectional study of 110 triathletes, the incidence of GIT symptoms during a triathlon was reported as 50%¹

GIT symptoms have been classified into upper and lower GIT symptoms^{4,5}. Upper GIT symptoms include nausea, vomiting and heartburn. Lower GIT symptoms include diarrhoea, abdominal cramps, urge to pass stool, bloating and blood in the stool.



In most studies, it has been shown that lower GIT symptoms are more common than upper GIT symptoms, and this is particularly evident in runners.

A number of risk factors for GIT symptoms associated with exercise have been identified and are listed in Table 1^{3-6,9,10}. The risk factors have been divided into intrinsic and extrinsic risk factors.

Table 1: Intrinsic and extrinsic risk factors for GIT symptoms associated with exercise

INTRINSIC RISK FACTORS	EXTRINSIC RISK FACTORS
Younger age	High intensity exercise
Female gender	Dehydration
Previous abdominal surgery	Vertical impact sport (running)
Irritable bowel syndrome	Poorly conditioned athlete
Lactose intolerance	Medication
	Dietary factors

The risk factors for the development of GIT symptoms associated with exercise will now be reviewed. Evidence-based medicine (EBM) criteria have been used to evaluate the strength of the evidence for each risk factor¹⁷.

Intrinsic risk factors for GIT symptoms associated with exercise

Female gender

It has been reported in a number of studies that female athletes are more likely to be affected by GIT symptoms during exercise than male athletes^{5,9,10,11,19}. In particular, it has been reported that lower GIT symptoms are more common in female than in male athletes⁹. However, scientific evidence for female gender as a risk factor for the development of GIT symptoms is limited.

Four cross-sectional studies have made use of a questionnaire to determine prevalence of GIT symptoms associated with exercise^{5,9,10,11}. All four of these studies showed female gender to be a risk factor for GIT symptoms. However, all four studies are limited by self-selection bias, small numbers, and relatively small numbers of female athletes compared to male athletes in the sample. In one study, female subjects only made up 8% of the sample¹⁰.

There has been one prospective cohort study which followed runners over an 18 months period as they prepared for a marathon¹⁹. At the 12 months mark the subjects ran a 25km race. During this race female gender was shown to be a risk

factor but during the marathon at 18 months, GIT symptoms were experienced equally by both male and female athletes.

In summary, there is some, but generally limited, scientific evidence that female gender is a risk factor for developing GIT symptoms during exercise.

Younger age

A second intrinsic risk factor for GIT symptoms in endurance athletes is younger age. In a number of studies, it has been suggested that younger athletes are more likely to suffer from GIT symptoms than older athletes^{5,9,10,18}. Furthermore, the postulated explanations for this observation are that younger athletes (1) may perform exercise at a higher relative intensity than older athletes¹⁰, (2) have a poorly "conditioned" GIT compared to older athletes¹⁰, or (3) may be more prone to dehydration due to lack of experience⁴.

Research results are mixed. Five cross-sectional studies made use of questionnaires to collect data^{3,5,9,10,11}. Each study was limited by the self-selection of subjects and recall bias. Only three of the cross-sectional studies showed that younger age is a significant risk factor for GIT symptoms^{5,9,10}.

Two prospective cohort studies investigated GIT bleeding in marathon runners by assessing pre- and post race stool samples for occult blood^{18,20}. The results from these two studies were not consistent. Thus younger age as a risk



factor for GIT symptoms is supported by very limited research.

Previous abdominal surgery

Previous abdominal surgery has been proposed as an intrinsic risk factor for the development of GIT symptoms during exercise⁵. In a single cross-sectional study, the incidence and possible risk factors for GIT symptoms in six endurance sports was investigated. In this study, 1158 randomly selected athletes responded to a questionnaire survey and the results showed that the development of upper GIT symptoms was associated with a history of previous abdominal surgery. There is no association between the development of lower GIT symptoms and a history of previous abdominal surgery⁵. This is the only study to have reported previous abdominal surgery as a possible intrinsic risk factor for upper GIT symptoms during exercise and therefore further research in this area is needed.

Irritable bowel syndrome and lactose intolerance

Irritable bowel syndrome and lactose intolerance have been suggested to be associated with the development of GIT symptoms associated with exercise⁷. A questionnaire was completed by 425 runners participating in a 10km running race as part of a cross-sectional study investigating the prevalence and possible risk factors for the development of diarrhoea associated with running¹⁶. The incidence of lactose intolerance and irritable bowel syndrome in this population was found to be comparable to that of other populations (13-16%). Both conditions were shown to be associated with predominantly pre-race GIT symptoms. It was also shown that irritable bowel syndrome was associated with an increase in the urge to defaecate while running. Lactose intolerance was not shown to increase the risk of GIT symptoms during exercise¹⁶.

There is limited research to support the association between these two conditions and the development of GIT symptoms during exercise and therefore further research is needed in this area.

Extrinsic risk factors for GIT symptoms associated with exercise

High-intensity exercise

The association between high-intensity exercise and the development of GIT symptoms during exercise among endurance athletes stems from athletes reporting that they experience "tummy troubles" after a "hard" training session or during races¹⁰. It has also been reported that athletes who are suffering with new onset GIT symptoms relate this to a recent increase in training mileage or increased exercise intensity²³. Others have also observed that GIT symptoms tend to occur more frequently when exercise is performed at a higher intensity^{1,10,11,18}, and that athletes with GIT symptoms appear to benefit from a reduction in training intensity, followed by a more gradual increase to the desired level of training. These anecdotal reports indicate that increased exercise intensity is a possible extrinsic risk factor for the development of GIT symptoms during exercise²³.

An analysis of the published literature shows that this association was studied using either cross-sectional study designs (4 studies)^{1,9,10,11} or prospective cohort study designs (4 studies)^{18,19,21,24}. These studies varied considerably in their methodology, mainly in defining and measuring exercise intensity, and this makes comparison of results between studies difficult.

There is some but limited evidence that high-intensity exercise is a risk factor for the development of GIT symptoms during exercise. The main reasons for this are that (1) the measure of intensity differs between studies, (2) many studies rely on a subjective assessment of exercise intensity, (3) a number of studies are limited by recall bias and (4) in studies where finishing times were recorded, these times do not equate to exercise intensity and cannot be used as an accurate assessment of exercise intensity. In studies where an objective measure of exercise intensity, such as heart rate during exercise relative to maximum heart rate or percentage of VO_{2max} was used, no association between exercise intensity and the development of GIT symptoms



during exercise was demonstrated. Therefore further studies using more objective and reproducible measures of exercise intensity are needed in order to identify whether high-intensity exercise is a significant risk factor for GIT symptoms associated with exercise.

Dehydration

It has been postulated that GIT symptoms that develop during exercise occur more frequently in the dehydrated athlete^{19,22}. It has also been suggested that the observation that GIT symptoms during running are more common compared with cycling, may be related to the fact that drinking while running is more difficult than while cycling^{8,25}. However, there is little scientific evidence that dehydration may be related to the development of GIT symptoms during exercise, and only two studies^{19,22} have investigated this relationship. A prospective cohort study showed an increase of GIT symptoms from 50% to 80% once dehydration exceeded 4-5%¹⁹. In a randomised cross-over study, exercise associated with dehydration was found to be significantly associated with the development of GIT symptoms²². Therefore it appears that there is strong evidence to support dehydration as an extrinsic risk factor for GIT symptoms associated with exercise.

Vertical impact sport

It has been suggested that vertical impact sports, such as running, are associated with more GIT symptoms than non-impact sports^{1,5,26}. Running is the third component of a triathlon, and confounding factors, such as the development of fatigue or dehydration, could also explain the increased number of GIT symptoms during running, rather than running (vertical impact) alone.

The scientific evidence is mainly from cross-sectional studies. Results of these three cross-sectional studies support the association between impact sports, i.e. running, and GIT symptoms^{1,5,27}. However, in most of these studies, selection bias, recall bias, as well as inability to control for other confounding variables, limits the strength of the evidence. In one intervention trial, (double blind cross-over study) running was associated with a greater incidence of GIT

symptoms during exercise compared with cycling²⁶.

Poor conditioning

It has been suggested that poor conditioning (being "unfit") is a risk factor for GIT symptoms during exercise^{10,11,20}. It has been postulated that this may be due to inadequate adaptation of the GIT to the physiological stresses of exercise training³. There is weak evidence that poor conditioning [expressed as number of years of training, amount of training per week (time or distance)] is associated with the development of GIT symptoms during exercise. Two cross-sectional studies used questionnaires to obtain training history from runners but did not show an association between training and GIT symptoms^{10,11}. A prospective cohort study was unable to show an association between GIT bleeding and training history²⁰. Furthermore, studies mostly relied on subjective recall of training history, which may not be accurate, and no objective measure of training is reported.

Non-steroidal anti-inflammatory drugs (NSAIDs)

The use of non-steroidal anti-inflammatory drugs for soft tissue and musculoskeletal injury in endurance athletes is common¹⁸. It has been suggested that the use of NSAIDs may be a risk factor for GIT symptoms associated with exercise²⁰, while others have proposed that the use of NSAIDs may protect against GIT symptoms⁷. Four prospective cohort studies, using similar methodology, looking at GIT bleeding associated with NSAIDs use in endurance runners, have been reviewed. Two studies showed no association^{18,29}, one study showed a positive association²⁰ and one study showed a negative association with the use of NSAIDs and GIT bleeding²⁸. Therefore results are inconsistent and further research is needed.

Dietary factors

Dietary factors, such as type of food^{6,27}, timing of the last meal before exercise¹, caffeine intake^{14,30} and other dietary factors^{31,32}, may be associated with the development of GIT symptoms during exercise.



Two cross-sectional studies investigated the effect of type of pre-race food in the development of GIT symptoms in triathletes by means of a questionnaire^{1,27}. High fibre, fat and protein meals were shown to be associated with GIT symptoms. However, both studies relied upon subjective recall of pre-race meal, meal constituents and GIT symptoms.

Another cross-sectional study showed that with the commencement of training, eating habits frequently changed¹¹. These changes included increased intake of fibre, vegetables and cereals, and a decrease in the intake of fat, sugar and meat. However, these alterations in eating habits did not significantly alter the risk of developing GIT symptoms associated with exercise. Data from this study also relied on accurate recall and subjective reporting.

The timing of the last meal prior to exercise was found to be associated with GIT symptoms in two studies (retrospective cross-sectional²⁷ and cross over cohort study³³). However, in a prospective cohort study of marathon runners the timing of the pre-race meal was not found to be significant¹⁹. Therefore results are inconsistent and further research is needed

A single cross-sectional study showed caffeine to be associated with GIT symptoms, however the timing and amount of caffeine was not specified¹.

Vitamin C³¹ and alcohol^{1,14} have also been suggested to be associated with the development of GIT symptoms but there is no evidence to support this.

In summary, a number of dietary factors have been postulated as risk factors for the development of GIT symptoms during exercise. These include the type of food consumed and the timing of the meals in relation to the exercise. In general, there are not enough research studies that have investigated these dietary factors, and there is not enough evidence to support the role of dietary factors in the development of GIT symptoms during exercise. This area requires further investigation.

Summary of intrinsic and extrinsic risk factors for the development of GIT symptoms associated with exercise

In general, scientific research studies that have investigated intrinsic and extrinsic risk factors for the development of GIT symptoms during exercise are limited. Scientific evidence in support of these intrinsic and extrinsic risk factors for the development of GIT symptoms during exercise has been reviewed using an evidence-based approach (classified as strong, limited or weak). In Table 2, the evidence for these risk factors is summarised.

Table 2: Summary of the level of evidence for intrinsic and extrinsic risk factors for GIT symptoms associated with exercise

RISK FACTOR	LEVEL OF EVIDENCE
Female gender	Limited
Younger age	Limited
Irritable bowel syndrome and lactose intolerance	Weak
Previous abdominal surgery	Weak
High intensity exercise	Limited
Dehydration	Strong
Vertical impact sport (running)	Limited
Poorly conditioned athlete	Weak
Medication	Limited
Dietary factors	Weak

There is strong evidence from a limited number of studies to support significant dehydration (body weight loss > 4% during

or after exercise) as a risk factor for GIT symptoms during exercise. However, more research studies are still needed to



support this finding. There is some, but limited scientific evidence, to support the following as risk factors for GIT symptoms during exercise: female gender, younger age, high-intensity exercise, vertical impact sport and medication use. Poor conditioning, dietary factors and previous abdominal surgery are risk factors for GIT symptoms that are not well supported and evidence is considered weak in these areas.

Therefore further research studies of greater power, such as case control and prospective cohort studies are needed in order to evaluate risk factors adequately. Subject selection needs to be random and subjects should not be self-selected. Data needs to be collected in an objective manner not relying on subject recall. Measurement parameters also need to be standardised. In conclusion, there is very little evidence-based research to support most of these suggested risk factors and further research is essential.

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