

# Summer Appendicitis

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## Abstract

Acute appendicitis has been reported to be present throughout the year, but some particular months are associated with higher incidences. The aim of this study was designed to review previous studies and analyze the current knowledge and controversies related to seasonal variability of acute appendicitis, to examine whether appendicitis has an annual seasonal pattern. A search of the MEDLINE databases for English language publications over the period from 1970 to 2012 was conducted. This list was extended by including also references from a recent review of appendicitis epidemiology. We selected the studies, which were published in an English-language peer-reviewed journal, did not have intervention, were conducted for at least one year and had the outcome of histologically-confirmed appendicitis and those which reported case data temporally. A total of 30 titles and abstracts were screened for eligibility. Of these, 11 studies from 8 countries conducted across from 1970 to 2012 met the selection criteria and contributed to the systematic review. A seasonal pattern of appendicitis with a mostly predominant peak is seen during the summer months in all the countries (except Nigeria and Turkey). Appendicitis is more common in summer months. The existence of a seasonal pattern in the onset of appendicitis may be due to exposure to air pollution, decreasing fiber diet and increase in the incidence of gastrointestinal infections in summer.

**Keywords:** Appendicitis, Periodicity, Seasons

## Introduction

Several acute diseases exhibit a circannual pattern. Acute appendicitis has been reported to be present throughout the year, but some particular months are associated with higher incidences.<sup>[1]</sup> Cases of appendicitis have been reported by many researchers to be associated with summer months.<sup>[2]</sup> The exact reason why acute appendicitis cases present in summer more than other seasons is still not clear, several researchers have suggested that the heterogeneous extrinsic factors such as gastrointestinal infection,<sup>[3-5]</sup> air pollution<sup>[2]</sup> and low fiber diet, during summer months could be contribute to the higher incidence of appendicitis.<sup>[1,6]</sup>

The present study was aimed to verify the possible existence of seasonal variability in the onset of acute appendicitis in various parts of the world, by describing intensively the data available

on the incidence of appendicitis during specific seasons of the year and by summarizing the critical sequences that need to be expressed for clinical presentations of appendicitis at the different periods of the year. The identification of the reasons for seasonality may offer the possibilities for preventive measures.

## Materials and Methods of Literature Search

To examine the global trends in the seasonality of appendicitis, we reviewed the results of epidemiological studies of acute appendicitis from a wide range of countries on the seasonal and monthly incidence rates. The studies were identified from a MEDLINE search of papers published over the period from 1970 to 2012, using the following keywords: “Periodicity” “Seasons” and “Appendicitis.” This list was extended by including also references from a recent review of appendicitis epidemiology. Studies were included if (i) they had been conducted continuously for a minimum of a full year to cover all seasons, (ii) the outcome was histological confirmed diagnosis of appendicitis, (iii) the study reported case data temporally (day, week, month), (iv) the study was written in English and published in a peer reviewed journal and (v) study design did not include intervention trials.

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As a majority of the data in this review came from countries in the Northern Hemisphere, seasons were defined based on their occurrence in the Northern Hemisphere: Winter (December-February), spring (March-May), summer (June-August) and autumn (September-November). Only one study in this review was conducted in tropical region (Nigeria). In tropical and subtropical regions, it is more common to speak of the rainy, wet or monsoon season versus the dry season. The rainy season (winter) lasts from April to November and the dry season (summer) from November to March. Data on countries climate status and season periods were obtained from two main Internet databases; Map of world (<http://www.mapsofworld.com>) and Photos (<http://www.photius.com>).

## Results

A total of 30 studies were identified from the initial PubMed search. Of these articles, 11 studies were met the inclusion criteria [Table 1]. The studies differed in many aspects of their design, patient characteristics and duration (range: 1-7 years; 8 studies were continued for more than 1 year). The studies were conducted between 1970 and 2012 and included data on surveillance populations that ranged in size from 321 to 310,961 patients. In some studies, enrolment was strictly limited to children; in others, adult and children of all ages were included. Comprehensive results from these studies show that the appendicitis in most of the countries included in this review reflect a summer peak, only two studies from Turkey and Nigeria was noted the high number of hospital admission for appendicitis in winter months. There were no seasonal variations in rates of admission to hospital for appendicitis was seen in Wales.

## Discussion

This review discloses the facts that the seasonal pattern of acute appendicitis in most the subject countries are predominant

during the summer season.<sup>[2,7,9-12,16,17]</sup> the exact reason why acute appendicitis case notification rates high in summer is unknown, although several factors have been suggested to give a plausible explanation.<sup>[1]</sup>

The increasing number of “fast food” restaurants where mainly high-carbohydrate, low-fiber diets, confectionaries and sweets are served, when individuals were most likely to be outside in summer, could have contributed to the increase in the incidence of appendicitis.<sup>[1]</sup> In a case-control study conducted in Greek, to investigate the role of fiber in the etiology of acute appendicitis, 203 consecutive appendectomized children with histologically proved appendicitis and 1922 controls were compared. The study emphasized that children with appendicitis had a lower fiber intake than the children in the control group. the patients were much more likely to have had a history of chronic constipation than the controls.<sup>[6]</sup> In another case-control study conducted in USA found that children in the upper 50<sup>th</sup> percentile for fiber intake had a 30% lower risk of developing appendicitis compared with children in the lowest quartile.<sup>[18]</sup> In a glycohistochemical analysis of human appendix vermiformis shows the glycosylation of goblet cell mucus play a role in the inflammatory processes in acute appendicitis.<sup>[19]</sup> One can hypothesize a low fiber diet and large consumption of sweets and sugary diets can lead to constipation and increase exposure to infection, which can lead to appendicitis. However, further studies are needed to examine trends in the incidence of appendicitis in populations eating traditional diets with both high and low fiber content as well as sweets and sugary diets.

Alcohol has been linked to an increased risk of constipation. Interestingly, summer time has been observed to be associated with the highest alcohol consumption.<sup>[20]</sup> This could be contributed in emergency presentation of appendicitis in summer.

Allergic reaction to pollen from flowers and palm produce and increase in incidence of infection during the rainy period has been proposed as a pre-disposing factor to appendicitis in Nigeria, which appear as lymphoid hyperplasia leading to appendix lumen obstruction.<sup>[1]</sup> Furthermore, a role of altitude and temperature in the seasonal variation of the appendicitis rate has suggested explaining winter peak of appendicitis in Turkey.<sup>[8]</sup> As the altitude increased, peak incidence of appendicitis moved from winter to summer months. This finding seems to be inconsistent with other studies, which found an increase in appendectomy rates during the summer in low altitude regions.<sup>[2,11,14]</sup> This inconsistent may be explained by a number of different factors such as delayed diagnosis, delayed admission to hospital, socio-economic factors, food culture and the effect of migration for touristic purposes during the summer. In the contrast, almost no seasonal variations exist in wales, this may be due to differences in the incidence of appendicitis or alternatively, to differences in admission policy and the availability of hospital facilities.<sup>[15]</sup>

**Table 1: Seasonal patterns of appendicitis**

References	Study period	Patients no.	Country	Season peak
[2]	1999-2006	5191	Canada	Summer
[1]	2003-2008	321	Nigeria	Winter
[7]	1997	31,457	USA	Summer
[8]	2004-2007	1871	Turkey	Winter
[9]	2005-2007	310,961	South Korea	Summer
[10]	1996-2004	1093	Iran	Summer
[11]	1998-2004	1331	Italy	Summer
[12]	1991-1998	65,675	Canada	Summer
[13]	1983-1986	102,546	USA (California)	Summer-autumn
[14]	NA	12,686	USA (New Jersey)	Spring-summer
[15]	1976	5038	UK (Wales)	No season
[16]	2000-2009	237,760	Taiwan	Summer
[17]	1995-2009	608,116	USA (California)	Summer

NA: Not available

Outdoor air pollution has been suggested as one of several factors that influence the incidence of appendicitis. In one study conducted in Canada found that the incidence of appendicitis was significantly associated with short-term exposure to air pollution.<sup>[2]</sup> The effect of air pollution was greatest in the summer months, when people were more likely to be outside. This finding is consistent with the result of this review. The mechanisms by which air pollution may increase the risk of appendicitis are unknown. Increase expression of cytokines such as tumor necrosis factor as a pro-inflammatory response has been demonstrated in the histological examination of acute appendicitis specimens.<sup>[21]</sup> The link between air pollution and increased levels of tumor necrosis factor in animals and human experiment has been approved by some studies. Furthermore, Animals fed diesel particles experienced oxidative damage in colonic mucosa.<sup>[22-24]</sup> In addition, exposure to air pollution has been shown to increase susceptibility to bacterial and viral infections through impairment of microbial defence.<sup>[25-27]</sup> However, further studies to determine the link between air pollution and appendicitis is highly recommended.

Several studies have explored the connection between ulcerative colitis and the appendicitis. A history of appendectomy is rare in patients with ulcerative colitis. The mechanisms mediating the association between appendectomy and ulcerative colitis it is not fully understood. It has been suggested that inflammation in one site of the large intestine may trigger ulcerative colitis at a different site in pre-disposed individuals.<sup>[28]</sup> Interestingly, the seasonal peak of ulcerative colitis incidence it has been found to be higher in summer.<sup>[29]</sup> According to these results, one could conclude that patients with ulcerative colitis have a higher risk of appendicitis, particularly in summer months. Further investigation of the possible role of ulcerative colitis and appendicitis is expected to open new fields for basic scientific research and may lead to the improvement of our understanding for the disease pathogenesis.

The high prevalence of intestinal parasites infestations and bacterial infections have been account for some cases of appendicitis as it has been noticed to be initiated by or associated with them.<sup>[1]</sup> Infection causes lymphoid hyperplasia leading to appendix lumen obstruction. Seasonal peak of infection by campylobacteriosis, salmonellosis, *Escherichia coli*, cryptosporidiosis,<sup>[3]</sup> *Entamoeba histolytica*, and *Ascaris lumbricoides*, *Trichuris trichiura*, *Taenia saginata*, *Enterobius vermicularis* and *Strongyloides stercoralis*<sup>[4,5]</sup> that has been implicated in appendicitis pathogenesis, exhibits a summer peak in some countries.<sup>[30,31]</sup> This may give us an explanation about the findings of this review regarding the role of infection in the pathogenesis of appendicitis, particularly in summer season.

## Conclusion

Seasonal patterns of acute appendicitis is quite clearly demonstrated by the epidemiological data; showing mostly

a peak during the summer months. The exact reason why acute appendicitis cases present in summer more than other seasons is still not clear, several extrinsic factors such as, gastrointestinal infection, air pollution and low fiber diet, during summer months could be contribute to the higher incidence of appendicitis. Further prospective studies are required to define more accurately the possible association between these factors and seasonal occurrence of appendicitis.

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