

# Demographic characteristics and seasonal variations of acute appendicitis



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## Demographic characteristics of and seasonal variations of acute appendicitis

**BACKGROUND:** *The most common disease required emergency surgical operation is acute appendicitis. Appendectomy is the most common surgical procedure in the world and remains important due to be an efficient treatment method. We aimed to determine seasonal variations of acute appendicitis in our regions and identify the demographical and regional differences.*

**METHODS:** *We analyzed retrospectively data of the patients who were admitted to the Afyon Kocatepe University hospital and Sivrihisar State hospital between 2003 and 2012. 839 patients' data were analyzed.*

**RESULTS:** *Mean age of the all patients was  $33 \pm 14.7$  year. Acute appendicitis was seen more frequent in autumn and spring ( $P > 0.05$ ). There was no significant difference between seasons in Afyon Kocatepe university hospital, while appendicitis was seen more common in autumn than winter in Sivrihisar state hospital ( $P < 0.05$ ). There was not any relationship with the monthly average temperature, humidity, total precipitation amount and frequency of appendicitis ( $P > 0.05$ ).*

**CONCLUSION:** *Although appendicitis has a seasonal variation, other environmental factors and impact of nutritional habit should not be ignored. Etiology of appendicitis is still multifactorial. In the future multiparameter nationwide studies can present country-specific etiology of appendicitis.*

**KEY WORDS:** Appendectomy, Appendicitis, Seasonal variations

## Introduction

The most common disease required emergency surgical operation is acute appendicitis. Acute appendicitis simply can be described as an inflammation of appendix.

The prevalence of appendicitis is nearly 7%<sup>1</sup>. Lumen obstruction is the most frequent reason of appendicitis. Bacterial infection, fecoliths, food debris, lymphoid growth and intestinal parasites can promote the lumen obstruction. Fecoliths is the most suspected and frequent reason of the obstruction and more common in perforated appendicitis. A vicious circle starts with the lumen obstruction and mucosal damage brings out bacterial translocation. As a result of these events, perforation of appendix can occur. Appendectomy is the most common surgical procedure in the world and remains important due to be an efficient treatment method. Appendectomy is a safe and reliable surgical procedure with low mortality and morbidity rates in uncomplicated cases. The prevalence of appendicitis has difference cause of age,

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gender, ethnic origin and geographical region. Some other minor factors such as seasonal variations, latitude and humidity have suspected and been material of recent studies<sup>1-8</sup>. Etiology of appendicitis remains unclear due to multifactorial affects. In this study, we aimed to determine the seasonal variations of acute appendicitis in our regions and identify the demographical and regional differences.

## Methods

We analyzed retrospectively data of the patients who were admitted to the Afyon Kocatepe University hospital and Sivrihisar State hospital between 2003 and 2012. Demographics, patients' complaints, surgical procedure and patients' sheets if needed were collected from the hospital database. Under 18 years old patients, false diagnosis and patients undergo elective appendectomy were excluded from the study. 839 patients' data were analyzed; 610 cases from Afyon Kocatepe University hospital and 229 cases from Sivrihisar State hospital. 130 cases were excluded from the study and 709 patients' data were statically analyzed. Age, gender, surgery seasons, initial diagnosis and performed surgical procedures data were analyzed with the statistical software SPSS 15.0 for Windows (SPSS, Inc, Chicago, IL, USA). Patients were divided into four age groups of 20 years (Under 20 years, 21-40 years, 41-60 years and over 61 years). We provided the weather data of cities from the Turkish state meteorological service (<http://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx>) and <http://www.myweather2.com> internet site. Monthly average humidity, monthly average total precipitation amount and monthly average temperature dataset was collected. We analyzed the relationship between weather data and appendicitis frequency according to the cities. Initial diagnoses were classified acute abdomen, diagnosed acute appendicitis alone and acute appendicitis with concomitant diseases. Open appendectomy, laparoscopic appendectomy, hemicolecotomy and appendectomy accompanying surgical procedures composed surgical procedures of this study. The distributions of variables were determined by using histogram and Kolmogorov-Smirnov test. Mann-Whitney U Test was used as a non-parametric test for sta-

tistical evaluation. Indication of significant difference was accepted as  $P < 0.05$ .

## Results

In this study, we examined 709 patients' data retrospectively. 45.4% of patients were male ( $n = 322$ ) and 54.6% of patients were female ( $n = 387$ ). According to the hospitals, there were 279 (39.4%) male and 325 (45.8%) female patients approved to the study from the Afyon Kocatepe university hospital while 43 (6.1%) male and 62 (8.7%) female patients enrolled from Sivrihisar state hospital. Mean age of the all patients was  $33 \pm 14.7$  year. Male mean age was  $33.95 \pm 15.2$  year and female mean age was  $32.2 \pm 14.4$  year. The most of patients were in 20-40 y. age group with the frequency of 61.4% ( $n = 435$ ) and mean age of this group was  $28 \pm 5.5$  y. There were 56 (7.9%) patients over 60-year-old and mean age was calculated as  $70. \pm 6.8$  y. There were 110 patients under 20-year-old (15.5%, mean age =  $18.8 \pm 0.84$ ). In 40-60 year-old group, 108 patients were included (15.2%, mean age =  $48.42 \pm 5.6$ ). There was a similar distribution between hospitals in age groups and mean ages as shown in Table I.

We also investigated the seasonal variations of acute appendicitis. Acute appendicitis was seen more frequent in autumn and spring ( $P < 0.05$ ). 26% of all cases were seen in spring ( $n = 184$ ) and appendicitis was diagnosed in 187 patients (26.4%) in autumn; however, there was no significant difference between autumn and spring ( $P > 0.05$ ). Also, we determined that frequency of appendicitis was similar for winter and summer ( $P > 0.05$ ). Number of cases in winter was 167 (23.6%) while there were 171 cases in summer (24.1%). Acute appendicitis was more frequent in male patients in autumn ( $n = 92$ , 13%) whereas female cases were more common in winter ( $n = 100$ , 14.1%) as shown in Fig. 2. By contrast, the least seen season of male patients was winter ( $n = 67$ , 9.4%). Autumn was the least seen season for the female patients ( $n = 95$ , 13.4%) as depicted in Table II. There was a seasonal variation in age groups (Fig. 1). Under 20-year-old patients, there was a similar frequen-

TABLE I - Case distribution of age groups and sex in seasons.

		Winter		Spring		Summer		Autumn		Total	
Age	Under 20 y	48	6.8%	8	1.1%	49	6.9%	5	0.7%	110	15.5%
	20-40 y	102	14.4%	99	14.0%	109	15.4%	125	17.6%	435	61.4%
	40-60 y	5	0.7%	53	7.5%	5	0.7%	45	6.3%	108	15.2%
	Over 60 y	12	1.7%	24	3.4%	8	1.1%	12	1.7%	56	7.9%
	Total	167	23.6%	184	26.0%	171	24.1%	187	26.4%	709	100.0%
Sex	Male	67	9.4%	90	12.7%	73	10.3%	92	13.0%	322	45.4%
	Female	100	14.1%	94	13.3%	98	13.8%	95	13.4%	387	54.6%
	Total	167	23.6%	184	26.0%	171	24.1%	187	26.4%	709	100.0%

TABLE II - Age and sex differences according to the hospitals

		University Hospital		State Hospital		Total	
		N.	Mean ± SD	N.	Mean ± SD	N.	Mean ± SD
Age	Under 20 y	83	18.80 ± 0.82	27	18.70 ± 0.91	110	18.77 ± 0.84
	20-40 y	375	27.89 ± 5.49	60	28.70 ± 5.65	435	28.00 ± 5.51
	40-60 y	93	48.86 ± 5.67	15	45.67 ± 4.06	108	48.42 ± 5.57
	Over 60 y	53	70.23 ± 6.86	3	67.33 ± 5.51	56	70.07 ± 6.79
	Total	605	33.58 ± 15.23	105	29.66 ± 11.43	709	33.00 ± 14.79
Sex	Male	279	43	322			
	Female	325	62	387			

Mean: Mean age SD: Standard derivation

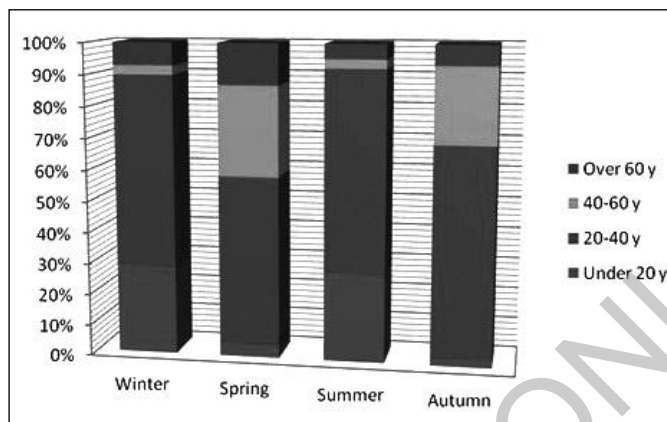


Fig. 1: Age distribution and seasonal variations of appendicitis.

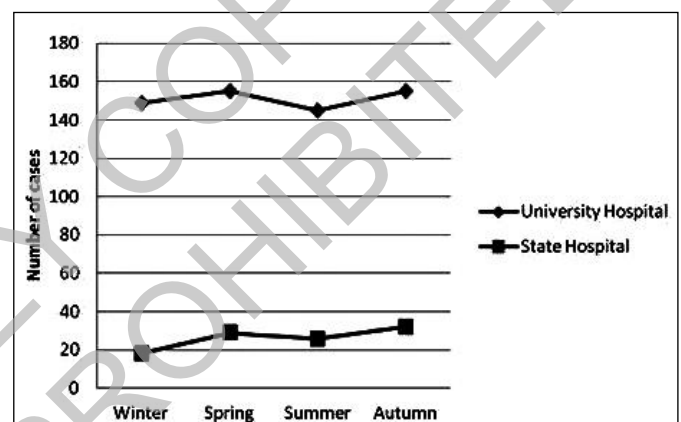


Fig. 3: Seasonal distribution of cases according to the hospitals.

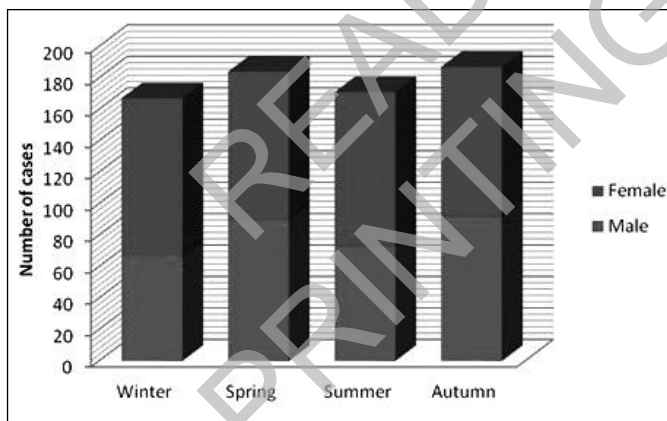


Fig. 2: Seasonal distribution of cases according to gender.

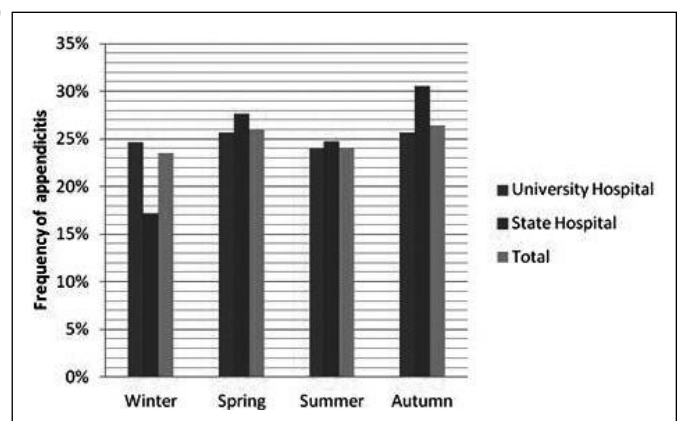


Fig. 4: Seasonal frequency of cases according to the hospitals.

cy between winter (6.8%) and summer (6.9%) but more frequent than spring (1.1%) and autumn (0.7%), ( $P < 0.05$ ). There was significant higher rate of 20-40 y. group in autumn ( $n = 125, 17.6\%$ ). Conversely, under 20-year-old group and 20-40 y. group, we determined that more frequent acute appendicitis was in spring ( $n = 53, 7.5\%$ ) and autumn ( $n = 45, 6.3\%$ ) than win-

ter and summer ( $P < 0.05$ ). Over 60-year-old patients, there was a high rate of appendicitis in spring ( $n = 24, 3.4\%$ ) as demonstrated in Table II. There was no significant difference between seasons in Afyon Kocatepe university hospital (Fig. 3). Therefore, appendicitis was seen more common in autumn than winter in Sivrihisar state hospital ( $P < 0.05$ ), (Fig. 4).

TABLE III - Distribution of the preoperative diagnoses and surgical procedures of the all patients

Diagnosis	N.	Surgical Procedure	N.
Acute Appendicitis	480	Appendectomy	636
Acute Abdomen	216	Laparoscopic Appendectomy	51
Apandicitis + Pregnancy	7	Ceuceum resection	4
Apandicitis + Hernia	2	Hemicolectomy	3
Apandicitis + cholelithiasis	2	Appendectomy and cholecystectomy	4
Apandicitis + Meckel Disease	1	Appendectomy and Herniagraphy	3
		Appendectomy and Meckel excision	2
		Other surgical procedures	6

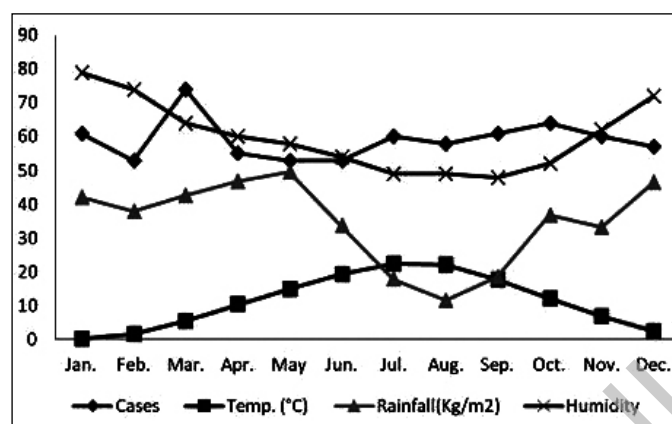


Fig. 5: Monthly change of weather data and appendicitis.

The distribution of the cases according to the months showed us that there was a meaningful increase in March ( $P < 0.05$ ,  $n = 74$ ). Monthly average temperature, humidity and total precipitation amount were compared between Afyon and Sivrihisar. Also, the distribution of the cases can be seen in the chart (Fig. 5). Humidity level was more in Sivrihisar than Afyon; however, there was not any difference in temperature and total precipitation amount ( $P > 0.05$ ). There was not any relationship between the weather data and frequency of appendicitis ( $P > 0.05$ ). Maximum average temperature was during July with  $22.3^{\circ}\text{C}$  in Afyon, minimum temperature was during January with  $-0.2^{\circ}\text{C}$  in Sivrihisar. The highest total precipitation amount measured  $49.5\text{ kg/m}^2$  during May in Afyon, minimum total precipitation amount was  $8.2\text{ kg/m}^2$  during August in Sivrihisar. The most humid month was December with %84 ratio in Sivrihisar while minimum humidity ratio was seen in Afyon with %48 during September (Fig. 5).

In 480 patients, preoperative diagnose was acute appendicitis. 216 patients underwent surgery because of acute abdomen. The rest of the patients had other diagnoses. Open appendectomy was performed to the most of the patients ( $n = 636$ ). We performed laparoscopic appendectomy in 51 cases. Other surgical procedures were performed beside the appendectomy in 22 patients. Diagnoses and distribution of the surgical procedures are listed in Table III.

## Discussion

We analyzed the incidence of appendicitis by age, gender, seasonal variations, region and hospital. Higher incidences of males reported in previous studies<sup>2,5,9</sup>. In contrast to the literature, a female dominance was determined in this study. In both hospitals, the frequency of females was higher. Acute appendicitis is seen generally in younger ages especially in the second and the third decade of life. Stein et al.<sup>5</sup> reported that mean age of acute appendicitis was 37.4 year in a large study of 3,736 patients. Mean age of all patients was 33 years in our study. In a recent study from our county, mean age was reported as 20.9 years<sup>2</sup>. The difference occurs since we excluded patients under 18-year-old from the study. Also, mean age was similar in university and state hospital. Incidence of appendicitis is less in elderly patients; therefore, perforation and surgical morbidity are more common. In this study, additional surgical procedures were performed in elderly patients concordant to literature. There is a higher prevalence of appendicitis in spring and autumn. No difference was determined between these seasons. Various researchers investigated the seasonal variation of appendicitis and demographic differences<sup>1-8,10-14</sup>. Wei et al. have reported a significant higher rate of appendicitis in May, June and July in a large nationwide study from Taiwan. In the current study, incidence of appendicitis was found higher in March. Certainly, appendicitis occurs due to multiple factors. Environmental factors have a role on evolution of appendicitis. One of the most important factors is climatic factor. Wei et al. evaluated temperature, humidity, atmospheric pressure, amount of rainfall and time of sunshine. Ambient temperature has been correlation with the appendicitis incidence.<sup>14</sup> Based on this information, we have included monthly average humidity, total precipitation amount and temperature dataset in the study nevertheless there was no significant effect of climatic factors. Fares reviewed eleven articles about seasonal variations of appendicitis. Summer appendicitis was seen more often in eight studies. Bacterial infection and parasite infestation were suspected as the reason of increasing rate of appendicitis in summer. Lymphoid hyperplasia occurs as a result of infection. The most common reason of

summer appendicitis is widespread gastrointestinal infection and parasite infestation<sup>3</sup>. There are two studies reported winter appendicitis, where one of them is from Turkey<sup>2</sup> and the other is from Nigeria<sup>6</sup>. As a result, all of the studies investigated the seasonal variations of appendicitis merged with same reason that seasonal increase of infections. Also, we know that weather conditions and climatic factor have a little impact on etiology of appendicitis. Ethnic and genetic predisposition has role in etiology. Hygiene and life style indirectly effects frequency of appendicitis by increasing infection. Nutritional habit is one of the environmental factors. Food culture varies by countries or even by region. Dietary factors ranging low fiber diet<sup>15</sup>, alcohol consumption, inadequate fluid intake, high-carbohydrate diet and sugary food have negative effects<sup>16-19</sup>. Air pollution and allergic pollen are the other suspected environmental factors<sup>3,20</sup>. Stressful life style and smoking have an unfavorable impact<sup>21</sup>.

## Conclusions

As a result of our data, appendicitis has a high prevalence in spring and autumn. This disease has a female dominancy in our region. There was a peak in the third decade of life. Additional to seasonal variation of appendicitis, we investigated the monthly distribution and determined a meaningful rise in March. In investigation of correlation between climatic factors and frequency of appendicitis, we did not find any significant relationship. Demographical data of variant hospitals showed similar results. Although appendicitis has a seasonal variation, other environmental factors and impact of nutritional habit should not be ignored. Etiology of appendicitis is still multifactorial. In the future, multiparameter nationwide studies can present country-specific etiology of appendicitis.

## Riassunto

L'appendicite è la patologia che più comunemente richiede un intervento chirurgico in emergenza, e l'appendicectomia è il procedimento chirurgico più comune in tutto il mondo, importante in quanto rappresenta un trattamento efficace. Il nostro scopo è stato quello di determinare le variazioni stagionali dell'appendicite nella nostra regione e di indentificare le differenze demografiche e regionali, e per questo abbiamo analizzato retrospettivamente I dati dei pazienti ricoverati nell'ospedale universitario Afyon Kocatepe e nell'ospedale statale Sivrihisar State tra il 2003 ed il 2012, cioè 839 pazienti. L'età media di tutti i pazienti era di  $33 \pm 14.7$  anni, e la maggior frequenza dell'appendicite acuta è risultata in autunno e nella primavera ( $P > 0.05$ ). Non si sono osservate differenze significative stagionali nell'ospedale uni-

versitario Afyon Kocatepe, mentre l'appendicite si è manifestata più frequentemente in autunno che non in inverno nell'ospedale statale Sivrihisar ( $P < 0.05$ ). non c'è stata nessuna relazione con la temperatura media mensile, l'umidità, l'entità delle precipitazioni e la frequenza dell'appendicite ( $P > 0.05$ ).

In conclusion, sebbene l'appendicite presenta una variazione stagionale, altri fattori ambientali e l'impatto delle abitudini alimentari non vanno ignorate. L'etiologia dell'appendicite è comunque multifattoriale, e nei futuri studi multiparametrici nell'intero territorio nazionale potrebbero evidenziarsi delle etiologie territorio-specifiche di questa patologia.

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