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Original Research Article

A Retrospective Study of Seasonal Variations of Acute Appendicitis

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Abstract:

Introduction: Acute appendicitis is one of the most common surgical emergencies and appendectomy is one of the most common operations. The incidence of acute appendicitis ranges from 8.6 to 11 cases per 1000 persons/year. Lifetime risk of developing acute appendicitis is about 8.6% in males and 6.7% in females. There is no unifying hypothesis regarding aetiology of acute appendicitis.

Aims: The study aimed to analyze the seasonal variations in the incidence of acute appendicitis. It also sought to identify patterns that could help in predicting peak periods and optimizing healthcare resource allocation.

Materials & Methods: This was a retrospective study conducted at Midnapore Medical College and Hospital, Midnapore, from 1st September 2021 to 31st August 2022. The study included a total of 380 patients diagnosed with acute appendicitis.

Result: Out of 380 patients who underwent appendectomy for acute appendicitis, the highest incidence was observed in the summer season (June–August) with 132 cases (34.74%), followed by spring (March–May) with 101 cases (26.58%), autumn (September–November) with 93 cases (24.47%), and the lowest in winter (December–February) with 54 cases (14.21%). The seasonal variation was statistically significant ($p < 0.0001$). The incidence in summer was 20.53% higher than winter, 10.27% higher than autumn, and 8.16% higher than spring.

Conclusion: We concluded that acute appendicitis incidence is increased significantly in the summer season. This seasonal variation is associated with various causes like dehydration, dietary habits, environmental factors like temperature, rainfall, humidity, hours of sunshine, air pollution and increased incidence of GI infections.

Keywords: Acute appendicitis, Seasonal variation, Appendectomy, Seasonal variation.

Introduction

Acute appendicitis is one of the most common surgical emergencies and appendectomy is one of the most common operations. [1] The incidence of acute appendicitis ranges from 8.6 to 11 cases per 1000 persons/year. Lifetime risk of developing acute appendicitis is about 8.6% in males and 6.7% in females. [2] There is no unifying hypothesis regarding aetiology of acute appendicitis.[3]

The disease has been attributed to a variety of possible causes including mechanical obstruction, decreased dietary fibre [4] and increased consumption of refined carbohydrate, air pollution, poor hygiene, and family susceptibility, aging between late teens and early fifties [5].

Acute appendicitis presents throughout the year but there is growing evidence that suggests the incidence of acute appendicitis displays seasonal variation [6, 7], with more cases occurring between May and August in northern Europe than at other times of the year. Some studies have shown increased incidence in summer months [8]. Although few epidemiological studies on seasonal variation of acute appendicitis have been conducted mostly focusing on western population [9], relatively few studies are conducted on Asian population specifically India. The goal of our study was to determine whether or not significant variation in acute appendicitis can be established in a country like India with variable weather conditions and limited existing research. Incidence of complicated appendicitis with seasonal variation can also be addressed.

Study Aims: The study aimed to analyze the seasonal variations in the incidence of acute appendicitis. It also sought to identify patterns that could help in predicting peak periods and optimizing healthcare resource allocation.

Materials and Methods

Type of Study: A retrospective study.

Place of Study: Midnapore Medical College and Hospital, Midnapore.

Study Duration: 1st September, 2021 to 31st August, 2022.

Sample Size: A total of 380 patients with acute appendicitis were included.

Inclusion Criteria

- Patients of all ages and both sexes diagnosed with acute appendicitis.
- Patients who underwent surgical intervention for acute appendicitis.
- Patients admitted to the hospital during the study period.
- Patients with complete medical records documenting clinical presentation, diagnosis, and date of admission.

Exclusion Criteria

- Patients with chronic or recurrent appendicitis without an acute episode.
- Patients managed conservatively without surgical intervention.
- Patients with incomplete or missing medical records.
- Patients with appendiceal pathology other than acute appendicitis
- Patients who refused consent for use of their medical data in research.

Study Variables

- Age
- Sex
- Presenting symptoms
- Postoperative complications

Methodology: The decision to operate was based on the overall clinical diagnosis of the patients, supported by laboratory investigations and abdominal ultrasonography (USG). Surgeries were performed by consultants and residents of the General Surgery Department. The diagnosis of acute appendicitis was subsequently confirmed by histopathological examination (HPE). To assess seasonal variation, patients presenting across the four distinct seasons— Autumn (September to November), Winter (December to February), Spring (March to May), and Summer (June to August)—were compared.

A total of 380 patients were included in the analysis, with data collected on the date of operation, gender, and age. Monthly enrolment of acute appendicitis cases was recorded to examine seasonal trends. As most patients originated from the Midnapore district and surrounding areas, additional analysis was conducted using data from the India Meteorological Department to determine the district's average rainfall, number of sunshine hours, and temperature.

Statistical Analysis: Data were entered into excel and analyzed using spss and graph padprism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values $\leq$ 0.05 were considered statistically significant.

Result

Table 1: Demographic Characteristics of the Study Population

	Characteristic	Number (n)	Percentage (%)	p- value
Gender	Male	222	58.42%	< .00001
	Female	158	41.58%	
Age	Age Range (years)	4 – 84	_	_

Table 2: Seasonal Distribution of Acute Appendicitis Cases

Season	Months	Number of Patients (n)	Percentage (%)	p- value
Autumn	September – November	93	24.47%	< .00001
Winter	December – February	54	14.21%	
Spring	March – May	101	26.58%	
Summer	June – August	132	34.74%	

Table 3: Seasonal Distribution of Acute Appendicitis Cases and Comparative Incidence

Season	Months	Patients (n)	Percentage (%)	Increase Compared to Summer (%)	p- value
Winter	December – February	54	14.21%	-20.53%	<.00001
Autumn	September – November	93	24.47%	-10.27%	
Spring	March – May	101	26.58%	-8.16%	
Summer	June – August	132	34.74%	—	

Table 4: Optional Table: Month with Highest and Lowest Incidence

Month	Number of Cases (n)	Percentage (%)	Observation	p- value
January	14	3.68%	Lowest incidence	< .00001
August	55	14.47%	Highest incidence (peak)	

Table 5: Seasonal Distribution of Complicated Appendicitis Cases (n = 58)

Season	Complicated Cases (n)	Percentage of Complicated Cases (%)	p- value
Summer	23	39.65%	< .00001
Autumn	13	22.41%	
Spring	12	20.68%	
Winter	10	17.24%	
Total	58	100%	

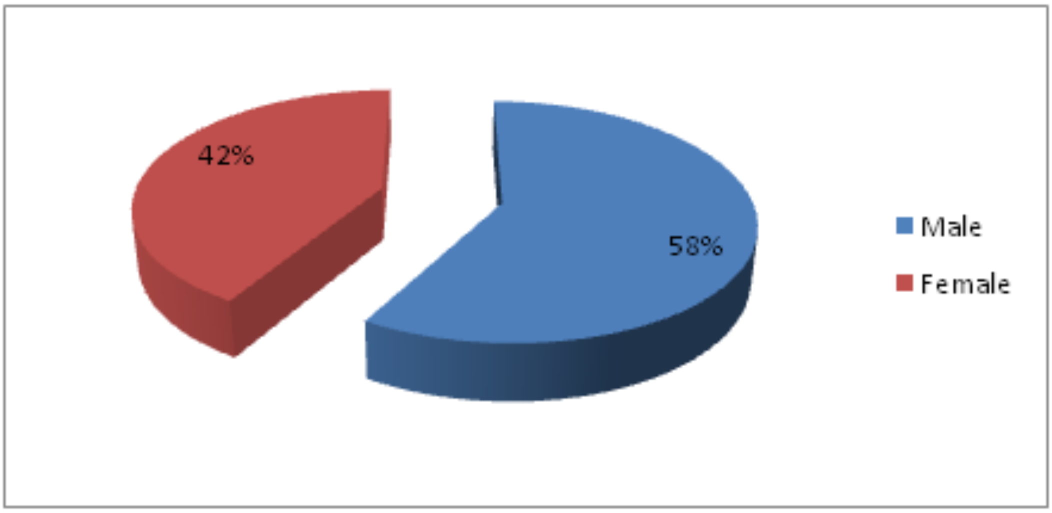

Figure 1: Demographic Characteristics of the Study Population

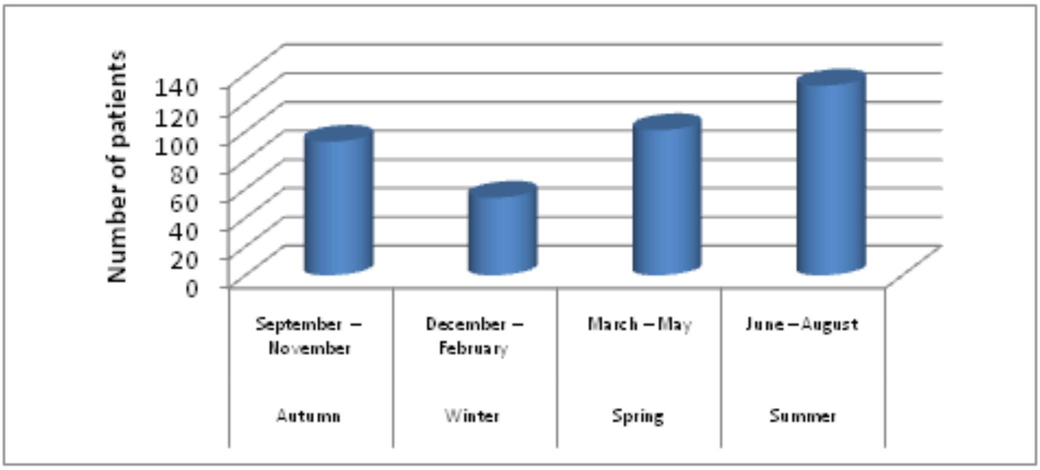

Figure 2: Seasonal Distribution of Acute Appendicitis Cases

In our study all the 380 patients, 222 (58.42%) were males and 158 (41.58%) were females. Male to female ratio was almost 1.5:1. It statistically significant ($p<0.001$). Age distribution ranges from 4 - 84 years. Majority of the patients belonged to the second and third decades of life. Out of 380 patients, in autumn season (September to November) 93 patients (24.47%), in winter (December to February) season 54 (14.21%), in Spring Season (March to May) 101 (26.58%) in summer season (June to August) 132 (34.74%) patients presented with acute Appendicitis and appendectomy was done. It statistically significant ($p < 0.0001$). Incidence increased in summer almost by 20.53% as compared to the winter, 10.27% as compared to autumn and 8.16% as compared to spring season. It statistically significant ($p < 0.0001$). January was found to have the lowest observed incident cases of acute appendicitis with only 14 cases occurring in that month while in August the highest no of appendicitis cases were observed (55 patients).

It statistically significant ($p < 0.0001$). Out of 380 cases, 58(15.26%) patients presented with complicated appendicitis, of which 23 (39.65%) presented in Summer while 10 (17.24%) patients presented in Winter, 12 (20.68%) patients presented in spring and 13 (22.41%) patients in autumn. It statistically significant ($p < 0.0001$).

Discussion

As could be expected, the average sunlight hours and temperatures were found to be highest during summer months and lowest during the winter months. This was found to correlate with incidence of appendicitis as it is highest in summer and lowest in winter.

Table 6: Temperature Overview (°C / °F)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record High (°C / °F)	36.1 (96.3)	37.9 (100.2)	42.8 (109.0)	45.6 (114.1)	47.0 (116.6)	47.2 (117.0)	39.8 (103.6)	38.0 (100.4)	37.4 (99.3)	36.1 (97.0)	35.2 (95.4)	32.2 (90.0)	47.2 (117.0)
Average High (°C / °F)	25.3 (77.5)	29.2 (84.6)	34.0 (93.2)	36.5 (97.7)	40.1 (104.2)	36.5 (97.7)	32.5 (90.5)	32.0 (89.6)	32.9 (91.2)	32.1 (89.8)	28.0 (82.4)	26.0 (78.8)	32.6 (90.7)
Average Low (°C / °F)	13.7 (56.6)	14.3 (57.7)	17.5 (63.5)	21.5 (70.7)	26.1 (79.0)	26.9 (80.4)	26.1 (79.0)	25.7 (78.3)	25.3 (77.5)	21.2 (70.2)	14.7 (58.5)	13.7 (56.6)	20.2 (68.4)
Record Low (°C / °F)	6.0 (42.8)	5.6 (42.1)	11.1 (52.0)	16.0 (60.8)	18.6 (65.5)	20.0 (68.0)	23.0 (73.4)	22.5 (72.5)	21.5 (70.7)	15.0 (59.0)	9.4 (48.9)	6.3 (43.3)	3.6 (38.5)
Avg Rainfall (mm / in)	10.5 (0.41)	25.3 (1.00)	51.1 (2.01)	65.1 (2.56)	138.0 (5.43)	288.6 (11.36)	356.5 (14.04)	329.5 (12.96)	259.5 (10.22)	110.3 (4.34)	18.9 (0.74)	5.9 (0.23)	1,658.9 (65.31)
Avg Rainy Days	1	1.3	2.8	4.9	7.6	12	15.4	16.3	12.2	5	1.1	0.4	79.8
Avg Relative Humidity (%)	54	47	44	55	62	75	83	84	83	75	65	59	66

As most of our patients are from poor socio-economic tribal areas and work as labourers, they might be exposed to air pollution and spend many working hours in the sun. Patients in this area are mainly of mixed diet habit with high fibre content but during summer there is increased consumption of meat & alcohol with low fibre food particularly when individuals are likely to be out, which can lead to constipation and subsequently to appendicitis.

Figure 3:

In our study comprising 380 patients diagnosed with acute appendicitis, there was a distinct male predominance, with 222 (58.42%) males and 158 (41.58%) females, yielding a male-to-female ratio of approximately 1.5:1, which was found to be statistically significant ($p < 0.001$). The age of the patients ranged from 4 to 84 years, with the majority belonging to the second and third decades of life, consistent with the established epidemiological trend of acute appendicitis affecting young adults as highlighted by Kaplan et al. [8] and Anderson JE et al. [10].

A significant seasonal variation was evident in the present study. The maximum incidence was recorded during summer (132 cases, 34.74%), followed by spring (101 cases, 26.58%), autumn (93 cases, 24.47%), and the least during winter (54 cases, 14.21%) ($p < 0.0001$). The incidence of appendicitis in summer was higher by 20.53% compared to winter, 10.27% compared to autumn, and 8.16% compared to spring. On monthly analysis, the highest incidence occurred in August (55 cases), while January recorded the lowest (14 cases) ($p < 0.0001$). This pattern closely resembles findings from Jangra B et al. [11] in India, who reported maximum cases in August and minimum in January, and Ahmed W et al. [12] in Pakistan, who also documented peak incidence during summer.

Among the total cases, 58 (15.26%) patients presented with complicated appendicitis, and seasonal clustering was also noted. The majority occurred in summer (23 cases, 39.65%), followed by autumn (13 cases, 22.41%), spring (12 cases, 20.68%), and winter (10 cases, 17.24%) ($p < 0.0001$). These findings support the hypothesis proposed by Fares [13], who attributed higher summer incidence to factors such as dehydration and dietary habits leading to reduced bowel motility, as well as infectious agents causing lymphoid hyperplasia and subsequent luminal obstruction.

Our findings are in agreement with several international studies that confirm seasonal variation in acute appendicitis. Kaplan et al. [8] suggested that air pollution exposure during summer may contribute to the occurrence, particularly in males. Anderson JE et al. [10] in the United States, Ahmed W et al. [12] in Pakistan, Gallerani et al. [14] in Italy, and Rai et al. [15] in Nepal all observed a higher incidence of acute appendicitis during warmer months. Pediatric-specific studies further substantiate this variation. Hsu YJ et al. [16] in Taiwan reported that fecalith-associated appendicitis cases were lower in summer, attributing this to lymphoid hyperplasia linked with seasonal enterovirus outbreaks. Similarly, Zhang et al. [17] noted that pediatric appendicitis correlated with higher temperatures, lower humidity, and reduced sunshine, while Saps et al. [18] found the highest incidence in summer and the lowest in winter. Ilves I et al. [19] in Finland also demonstrated increased incidence during summer, whereas Lee et al. [20] in South Korea highlighted monthly variations in disease occurrence.

Taken together, our study confirms a distinct seasonal variation in the incidence of acute appendicitis, with peak cases occurring during summer and the least in winter. This pattern is comparable to both regional and global studies [8,16–20]. The variation is likely multifactorial, involving dehydration, dietary influences, humidity, sun exposure, allergens, air pollution, and seasonal viral and bacterial infections.

Conclusion

We concluded that acute appendicitis incidence is increased significantly in the summer season. This seasonal variation is associated with various causes like dehydration, dietary habits, environmental factors like temperature, rainfall, humidity, hours of sunshine, air pollution and increased incidence of GI infections. Preventive measures can be taken during the summer season to reduce morbidity and mortality associated with acute appendicitis and to improve the current standard of risk assessment and workload planning.

References

1. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: racial, gender, and seasonal variation. Epidemiology. 1991 Sep 1:323-30.
2. Madenci AL, Peranteau WH, Smink DS. Appendix and small bowel diverticula. In: Zinner MJ, Ashley SW, editors. Maingot's Abdominal Operations. 13th ed. New York: McGraw-Hill Medical; 2019. Chapter 41.
3. Mulsow J. The vermiform appendix. In: Williams NS, Bulstrode CJK, O'Connell PR, editors. Bailey & Love's Short Practice of Surgery. 27th ed. Boca Raton (FL): CRC Press; 2018. p.1301-1302.
4. Arnbjörnsson E. Acute appendicitis and dietary fiber. Archives of surgery. 1983 Jul 1;118(7):868-70.
5. Mawhinney JA, Wormald JC, Ng M, Furniss D, Lane JC. Epidemiology of acute flexor tendon injury and an analysis of outcomes–a study of 91,239 patients in England and Wales. Journal of Hand Surgery (European Volume). 2025 May 27:17531934251342419.
6. Nshuti R, Kruger D, Luvhengo TE. Clinical presentation of acute appendicitis in adults at the Chris Hani Baragwanath academic hospital. International journal of emergency medicine. 2014 Dec;7(1):12.
7. Nshuti R, Kruger D, Luvhengo TE. Clinical presentation of acute appendicitis in adults at the Chris Hani Baragwanath academic hospital. International journal of emergency medicine. 2014 Dec;7(1):12.
8. Kaplan GG, Dixon E, Panaccione R, Fong A, Chen L, Szyszkowicz M, Wheeler A, MacLean A, Buie WD, Leung T, Heitman SJ. Effect of ambient air pollution on the incidence of appendicitis. Cmaj. 2009 Oct 27;181(9):591-7.
9. Ergul E. Heredity and familial tendency of acute appendicitis. Scandinavian Journal of Surgery. 2007 Dec;96(4):290-2.
10. Anderson JE, Bickler SW, Chang DC, Talamini MA. Examining a common disease with unknown etiology: trends in epidemiology and surgical management of appendicitis in California, 1995–2009. World journal of surgery. 2012 Dec;36(12):2787-94.
11. Jangra B, Jangra MS, Rattan KN, Kadian YS. Seasonal and day of week variations in acute appendicitis in north Indian children. Journal

of Indian Association of Pediatric Surgeons. 2013 Jan 1;18(1):42-3.
12. Ahmed W, Akhtar MS, Khan S. Seasonal variation of acute appendicitis. Pakistan Journal of Medical Sciences. 2018 May;34(3):564.
13. Fares A. Summer appendicitis. Annals of medical and health sciences research. 2014;4(1):18-21.
14. Gallerani M, Boari B, Anania G, Cavallesco G, Manfredini R. Seasonal variation in onset of acute appendicitis. La Clinica Terapeutica. 2006 Mar 1;157(2):123-7.
15. Rai R, D'Souza RC, Vijin V, Sudarshan SH, Aithala PS, Ramakrishna PJ, Kamath P, Fernandes AM. AN EVALUATION OF THE SEASONAL VARIATION IN ACUTE APPENDICITIS. Journal of Evolution of Medical and Dental Sciences. 2014 Jan 13;3(2):257-61.
16. Hsu YJ, Fu YW, Chin T. Seasonal variations in the occurrence of acute appendicitis and their relationship with the presence of fecaliths in children. BMC pediatrics. 2019 Nov 16;19(1):443.
17. Zhang Y, Lyu FX, Kang Q, Dong ZX, Zhao TX, Xie SN, Luo Q. Association of meteorological factors with pediatric acute appendicitis in China: a 7-year retrospective analysis. Medicine. 2018 Oct 1;97(42):e12913.
18. Saps M, Blank C, Khan S, Seshadri R, Marshall BM, Bass LM, Di Lorenzo C. Seasonal variation in the presentation of abdominal pain. Journal of pediatric gastroenterology and nutrition. 2008 Mar;46(3):279-84.
19. Ilves I, Fagerström A, Herzig KH, Juvonen P, Miettinen P, Paajanen H. Seasonal variations of acute appendicitis and nonspecific abdominal pain in Finland. World Journal of Gastroenterology: WJG. 2014 Apr 14;20(14):4037.
20. Lee JH, Park YS, Choi JS. The epidemiology of appendicitis and appendectomy in South Korea: national registry data. Journal of epidemiology. 2010 Mar 5;20(2):97-105.