International Journal of Medicine and Medical Research
2021, Volume 7, Issue 2, p. 20-25

DOI 10.11603/ijmmr.2413-6077.2021.2.12423

EPIDEMIOLOGY AND SEASONAL VARIATION OF APPENDICITIS – A SINGLE CENTER RETROSPECTIVE STUDY FROM NORTH-EAST INDIA

***R. Kumar[1], T.B. Singh[2], R. Pandey[1], S. Bhalla[1], O. Singh[3]**
1 – BASE HOSPITAL TEZPUR, ASSAM, INDIA
2 – MILITARY HOSPITAL AMBALA, HARYANA, INDIA
3 – COMMAND HOSPITAL, KOLKATA, WEST BENGAL, INDIA

Background. *Acute appendicitis is the most common surgical emergency presenting in emergency department, and appendectomy is one of the most common surgeries. There is a wide variation in the incidence of acute appendicitis reported for different countries, different regions, race, sex, age and also seasons.*

Objective. *The aim of this study was to understand the epidemiological trend and the seasonal variation of appendicitis in the northeast region of India.*

Methods. *It was a retrospective hospital-based study conducted in Jan 2016 – Dec 2020 at a Tertiary Care Teaching Hospital in the northeast region of India. The patient data were obtained from the Medical Record Department of the hospital and the data regarding the weather was obtained from the Indian Meteorological Department (IMD) and the website www.worldweather.com. The statistical analysis was done using SPSS software version 24.0, and the seasonal variation was studied using Kruskal Wallis test.*

Results. *Acute appendicitis affected both the sexes equally with a marginal higher incidence in males. It also had higher peak during the second and third decade of life in both the sexes. The incidence of acute appendicitis was high in the pre-monsoon and monsoon season with peak in the monsoon season.*

Conclusions. *Acute appendicitis is more common during the pre-monsoon and monsoon season, a period known for humidity, high incidence of bacterial and viral infections.*

KEYWORDS: acute appendicitis (AA), pre-monsoon season, monsoon season, Indian Meteorological Department (IMD).

Introduction

Acute appendicitis (AA) is the most common surgical emergency presenting in emergency department, and appendectomy is one of the most common surgeries [1]. AA has an increased incidence among the males as compared to the females. The lifetime risk of developing appendicitis is 8.6% for males and 6.7% for females [2, 3]. The aetiology of appendicitis is still unclear, hence various possible causes for AA are elucidated that include mechanical obstruction, inadequate dietary fiber, smoking, air pollution and familial susceptibility [3, 4, 5, 6, 7, 8, 9]. AA presents throughout the year but incidence is increased in some particular months [10, 11, 12, 13, 14, 25, 26]. Various studies were performed to determine the seasonal variation of acute appendicitis but with variable results. Some of them have concluded increased incidence in a particular month with no clear rationale behind it.

**Corresponding author: Ranjan Kumar, Assistant Professor, Department of Surgery, Base Hospital Tezpur, Assam, India. E-mail: drranjansurgeon@gmail.com*

Although numerous epidemiological studies on appendicitis, most focused on Western populations and relatively few epidemiological studies on the Asian populations. These studies were mainly concerned with the monthly variation in the incidence of acute appendicitis and the volume-outcome relationship of acute appendicitis. There is very sparse research regarding seasonal variation of acute appendicitis in Indian sub-continent and more so from the north-east region. The rationale of our study was to understand the epidemiological trend and the seasonal variation of AA in the northeast region of India.

Methods

Study Design

A retrospective hospital-based study was conducted to assess the demographic profile, incidence and seasonal variation in all patients admitted with diagnosis of acute appendicitis, who underwent operative management, in Jan 2016 – Dec 2020, at a Tertiary Care Teaching Hospital in the northeast region of India. The

pathologically proven negative appendectomy patients were excluded from this study.

Data Source and Statistical Analysis

Patient data including demographic details, operative notes and final histopathology were obtained at the Medical Record Department of the hospital. The data by Indian Meteorological Department (IMD) and the website www.worldweather.com was used to obtain information regarding the weather of the place where our study was conducted. According to the IMD there are four seasons in north-eastern region of India, i.e. winter (Jan–Feb), pre-monsoon (Mar–May), monsoon/rainy season (Jun–Sep) and post-monsoon (Oct–Dec). The raw data was entered into Microsoft Excel worksheet and analysis was performed using SPSS 24.0 software. The seasonal variation was studied regarding males and females, and inter-seasonal variation was assessed using Kruskal Wallis test. P-value less than 0.05 was taken as significant seasonal variation.

Results

During the study period a total of 405 patients underwent emergency appendectomy; all the cases were confirmed histologically as AA. There were 240 males (59.26%) and 165 females (40.74%) with male to female ratio of 1.45:1 (Table 1).

The age-specific incidence of AA followed a similar pattern for both the sexes, but males had a higher rate at virtually all ages with the highest male to female ratio in the third decade; gradually this ratio declined and was equal by the 7th decade (Fig 1). The incidence of acute appendicitis was the highest in both the sexes in the third decade (Fig 1).

The overall mean age was 25.05 years (Males – 24.68 years and females – 25.42 years). Only 6% of the cases were recorded in the first decade of life, while 65.9% occurred in the age group of 11-30 years old (Table 1).

The combined incidences of the disease were higher in the pre-monsoon and monsoon season (67.9 %, $p<0.0078$ as per Kruskal Wallis test, H statistics was 16.8029), with peaks in June, July, and August (monsoon season) corroborating with the maximum rainfall and the maximum temperature of the year (Fig. 2, 3) The incidence of the disease started declining from October (post monsoon period), with the lowest in December, followed by gradual minimal increment from January (winter season).

Table 1. Demographic trend of Acute Appendicitis

Age group (Years)	Number of cases	Percentage of the total cases	Male cases (M)	Female cases (F)	M:F Ratio
0-10	19	4.69	11	8	1.38
11-20	114	28.15	69	45	1.53
21-30	138	34.07	84	54	1.55
31-40	101	24.94	58	43	1.35
41-50	16	3.95	9	7	1.29
51-60	9	2.22	5	4	1.25
>60	8	1.98	4	4	1.00

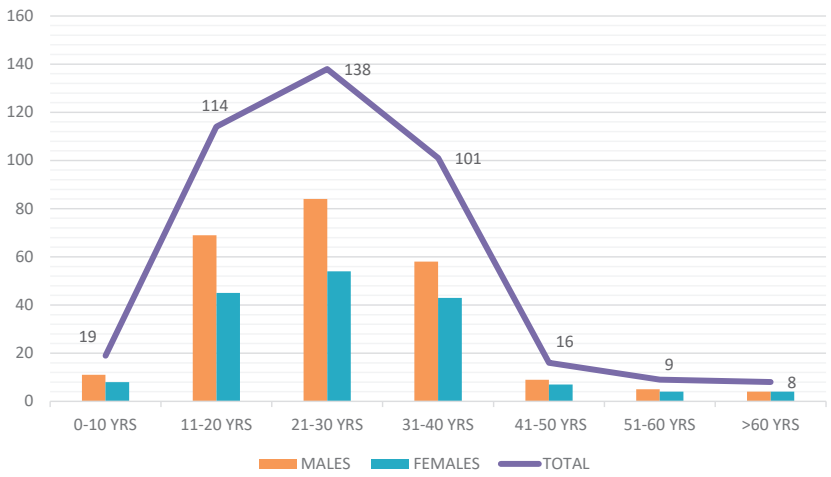

Fig. 1. *Age related distribution of acute appendicitis.*

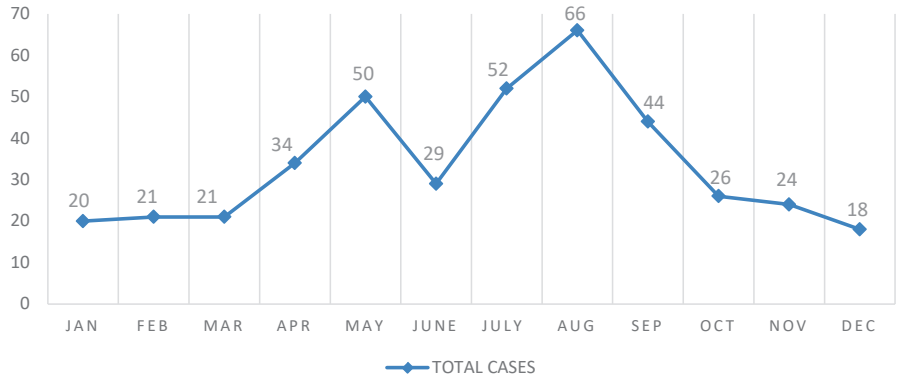

Fig. 2. *Monthly incidence of acute appendicitis in Jan 2016 – Dec 2020.*

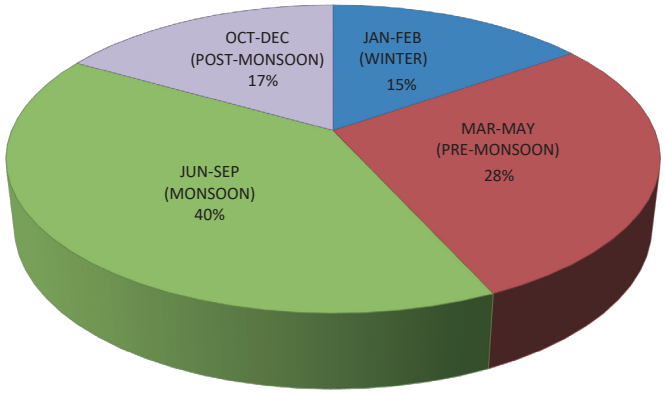

Fig. 3. *Seasonal variation of the incidence of acute appendicitis.*

Discussion

AA is a common clinical condition and appendectomy counts for about 1% of all the surgical operations [1]. It is estimated that in about 6-7% of the general population appendicitis will develop during their lifetime [15]. The incidence of appendicitis varies substantially by country, geographical region, race, sex, age, and seasons. The predisposing factors for appendicitis are multifactorial and include inadequate dietary, smoking, air pollution, infections, stress, vascular disorders and inadequate childhood breast feeding [6, 8, 9, 14, 17, 18, 19, 27].

The obstruction of the lumen due fecalith or hypertrophy of lymphoid tissue or tumorigenesis is proposed as the main etiologic factor in acute appendicitis [3, 4, 5, 6, 11, 17, 19]. The obstructive pathology in age group <40 years is due to regional lymph node enlargement secondary to infections while in patients >40 years luminal obstruction is more likely to be caused by fecalith or neoplasia because lymphoid tissue atrophies with age [4, 5, 11]. Acute appendicitis is relatively rare in infants and becomes increasingly common in childhood and early adult life [20]. The highest incidence of appendicitis is found in the second and third decades of life [2, 3]. After 30 years of age, the incidence declines, but appendicitis can occur in individuals of any age [21]. Thus, it was established that the maximum incidence of the disease is in the third decade of life.

Acute appendicitis has an increased incidence among the males compare to the females. The lifetime risk of appendicitis is 8.6% for males and 6.7% for females [2, 3]. Among the teenagers and young adults, the male to female ratio is about 3:2. After 25 years old, the ratio gradually declines until the sex ratio is equal by the mid-30s [21]. Similar findings were noted in our study cohort. There is no definite explanation for high incidence of appendicitis in males but, genetically determined differences in the immune function as well as the variation in the concentration of sex hormones can account for this difference [22]. Hormonal differences, however, do not explain the gender differences of the incidence of the disease in preadolescents and among the elderly [22].

The seasonal variation in the incidence of acute appendicitis has been discussed in many studies but there is no definite explanation for it. The heterogeneous extrinsic factors like humidity, sun radiation, bacterial and viral infections are important in the etiogenesis of appendicitis. Appendicitis is more common during the rainy reason, a period of high humidity which is the peak period of bacterial intestinal infestations and parasitic infestation. These intestinal infestations cause intestinal lymphoid hyperplasia that leads to obstruction of the appendix lumen. The reduction of sun radiation and vast fluctuations in air temperature has also been postulated in the incidence of appendicitis [3, 12, 23, 25, 26]. Air pollution has also been found to have a significant effect on the incidence of appendicitis in the summer months [9, 11]. The high ambient temperature has been found to contribute to air pollution and hence short-term exposure to air pollution may trigger appendicitis [9, 11]. The allergic reaction to pollen from flowers, palm and maize may also account for some cases of appendicitis, as the pollens trigger immunological response in the form of lymphoid hyperplasia [24]. We have found higher incidence of AA in the monsoon and pre-monsoon season in the north-east region of India, the seasons of maximum rainfall and temperatures (Fig 4).

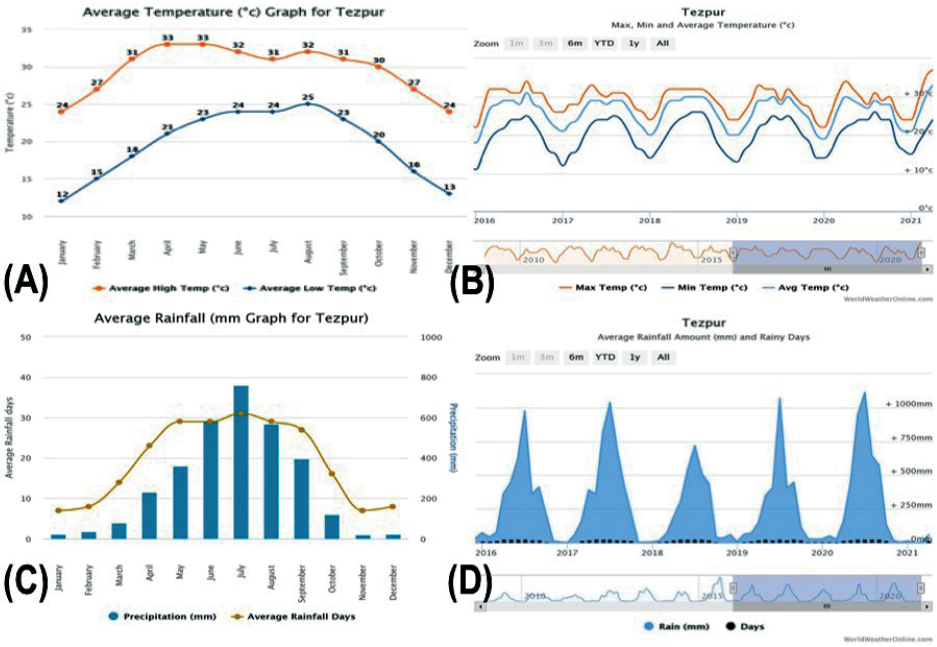

Fig. 4. *www.worldweather.com data showing weather of Tezpur, Assam, during the study period.*
(A) Average temperature graph, (B) Maximum, minimum and average temperature, (C) Average rainfall graph, (D) Average rainfall amount.

Conclusions

Acute appendicitis is still one of the most common abdominal emergencies treated by general surgeons. It affects both the sexes equally with a marginal higher incidence in the males. The disease has a higher peak during the second and third decade, the period of highly responsive lymphoreticular system. Appendicitis is more common during the pre-monsoon and monsoon season, a period known for humidity, high incidence of bacterial and viral infections.

Limitation of the study

The study population was not a true representation of the society as most of the patients were military background and the study was conducted in the north-east region of India. A larger prospective study needs to be undertaken across different geographical locations in India in order to confirm our findings of seasonal variation of AA in this sub-continent.

Conflict of Interests

Authors declare no conflict of interests.

Author's Contributions

Ranjan Kumar, Biswajit Singh Thokchom – conceptualization, methodology, formal analysis, writing – original draft, writing – reviewing and editing; *Rahul Pandey* – data curation, writing – reviewing and editing; *Sandeep Bhalla*, *Onkar Singh* – investigation, formal analysis.

ЕПЕДЕМІОЛОГІЯ ТА СЕЗОННІСТЬ АПЕНДИЦИТУ – РЕТРОСПЕКТИВНЕ ДОСЛІДЖЕННЯ З ПІВНІЧНО-СХІДНОЇ ІНДІЇ

***R. Kumar[1], T.B. Singh[2], R. Pandey[1], S. Bhalla[1], O. Singh[3]**
1 – BASE HOSPITAL TEZPUR, ASSAM, INDIA
2 – MILITARY HOSPITAL AMBALA, HARYANA, INDIA
3 – COMMAND HOSPITAL, KOLKATA, WEST BENGAL, INDIA

Вступ. *Гострий апендицит є найбільш частим хірургічним невідкладним станом у відділенні невідкладної допомоги, а апендектомія є однією з найпоширеніших операцій. Захворюваність на гострий апендицит, зареєстрована в різних країнах та різних регіонах, у людей різної раси, статі, віку, а також у різних сезонах, значно відрізняється.*

Мета. *Метою цього дослідження була оцінка епідеміологічних тенденцій та сезонних змін захворюваності на апендицит в північно-східному регіоні Індії.*

Методи. *У статті описується ретроспективне лікарняне дослідження, яке проводилося з січня 2016 року по грудень 2020 року в університетській лікарні третинного рівня медичної допомоги в північно-східному регіоні Індії. Дані про пацієнтів були отримані з медичного архіву лікарні, а дані про погоду – з Індійського метеорологічного відділу (IMD) та веб-сайту www.worldweather.com. Статистичний аналіз проводили за допомогою програмного забезпечення SPSS версії 24.0, а сезонні зміни досліджували за допомогою тесту Краскела-Уолліса.*

Результати. *Гострим апендицитом хворіли в однаковій мірі обидві статі з незначно вищою захворюваністю у чоловіків. Він також мав більш високий пік переважно на другому-третьому десятку років у обох статей. Захворюваність на гострий апендицит була високою в передмусонний сезон і сезон мусонів з піком у сезон мусонів.*

Висновки. *Гострий апендицит частіше зустрічається під час передмусонного сезону та сезону мусонів, у період з характерною високою вологістю та високим рівнем захворюваності бактеріальними та вірусними інфекціями.*

КЛЮЧОВІ СЛОВА: Гострий апендицит (АА); сезон перед мусонами; сезон мусонів; Індійський метеорологічний відділ (IMD).

Information about the authors

Ranjan Kumar – Assistant Professor, Department of Surgery, Base Hospital Tezpur, Assam, India.
ORCID 0000-0002-4573-2446, e-mail: drranjansurgeon@gmail.com

Thokchom Biswajit Singh – Assistant Professor, Department of Surgery, Military Hospital Ambala, Haryana, India.
ORCID 0000-0001-5849-5999, e-mail: bishwajitsingh6068@gmail.com

Rahul Pandey – Assistant Professor, Department of Surgery, Base Hospital Tezpur, Assam, India.
ORCID 0000-0003-2624-5113, e-mail: rahuladviksimpy@gmail.com

Sandeep Bhalla – Consultant Community Medicine and Commandant, Base Hospital Tezpur, Assam, India.
ORCID 0000-0001-9027-0001, e-mail: bhallasap@gmail.com

Onkar Singh – Professor, Command Hospital Kolkata, West Bengal, India.
ORCID 0000-0001-7806-0263, email: onkarnoor@yahoo.co.in

References

1. Sihrah BH, Shirah HA, Shirah HA et al. Challenges in the management of subhepatic acute appendicitis in the emergency setting. Int J Cur Res Rev 2016 Mar;8(6)

2. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol. 1990 Nov;132(5): 910-925.
https://doi.org/10.1093/oxfordjournals.aje.a115734.

3. Brunicardi FC, Anderson DK, Billiar TR. The Appendix. In: Liang MK, Anderson RE, Jaffe BM et al. Schwartz's Principle of Surgery.10th ed. Mc Graw Hill Education Medical. 2015. p. 1241-1262.

4. Jones BA, Demetriades D, Segal I, et al. The prevalence of appendiceal fecaliths in patients with and without appendicitis: A comparative study from Canada and South Africa. Ann Surg. 1985 Jul;202(1):80-2.
https://doi.org/10.1097/00000658-198507000-00013

5. Nitecki S, Karmeli R, Sarr MG. Appendiceal calculi and fecaliths as indications for appendectomy. Surg Gynecol Obstet 1990 Sep;171(3):185-8. PMID: 238510

6. Wangensteen OH, Dennis C. Experimental proof of the obstructive origin of appendicitis in man. Ann Surg. 1939 Oct;110(4):629–647.
https://doi.org/10.1097/00000658-193910000-000111.
7. Burkitt DP, Walker AR, Painter NS. Effect of dietary fibres on stool and transit times, and it's role in the causation of the disease. Lancet 1972 Dec 30;2(7792):1408-12.
https://doi.org/10.1016/s0140-6736(72)92974-1.
8. Oldmeadow C, Wood I, Mengerson K, Visscher PM, Martin NG, Duffy DL. Investigation of the relationship between smoking and appendicitis in Australian twins. Ann Epidemiol 2008 Aug;18(8):631-6.
https://doi.org/10.1016/j.annepidem.2008.04.004.
9. Kaplan GG, Dixon E, Panaccione R, et al. Effect of ambient air pollution on the incidence of appendicitis. CMAJ 2009 Oct 27;181(9):591-7.
https://doi.org/10.1503/cmaj.082068.Epub 2009 Oct 5.
10. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: racial, gender, and seasonal variation. Epidemiology 1991;2(5):323-30.
https://doi.org/1097/00001648-1991000-00003.
11. Wei PL, Chen CS, Keller JJ, et al. Monthly variation in acute appendicitis incidence: A 10-year nationwide population-based study. J Surg Res. 2012 Dec;178(2):670-6.
https://doi.org/10.1016/j.js.2012.06.034.Epub 2012 Jul 6.
12. Khaeval AA, Birkenfeldt RR. Nature of the relation of acute appendicitis morbidity to meterological and heliogeophysical factors. Vestn Khir Im I I Grek 1978 Apr;120(4):67-70. PMID: 654016
13. Stein GY, Rath-Wolfson L, Zeidman A et al. Sex differences in the epidemiology, seasonal variation, and trends in the management of patients with acute appendicitis. Langenbecks Arch Surg 2012 Oct;397(7):1087–1092.
https://doi.org/10.1007/s00423-012-0958-0.
14. Singh TB, Ratan R. Acute appendicitis: Epidemiological trends and seasonal variation in subset of South western part of India. IJSR 2018(Oct) Vol-7:10
15. Townsend CM, Beauchamp RD, Evers BM, et al. The Appendix. In: Maa J, Kirkwood KS. Sabiston Textbook of Surgery. 19th ed. Philadelphia: Elsevier; 2012. p.1279-1293.
16. Badmos KB, Komolafe AO, Rotimi O. Schistosomiasis presenting as acute appendicitis. The East African Med J 2006;83(10):528-32.
https://doi.org/10.4314/eamj.v83i10.9464
17. Wangensteen OH, Buirge RE, Dennis C, et al. Studies in the etiology of acute appendicitis: the significance of the structure and function of the vermiform appendix in the genesis of appendicitis. Ann Surg. 1937 Nov;106(5):910–942.
https://doi.org/10.1097/00000658-193710000-00007
18. Alves JG, Figueiroa JN, Barros I. Does breast feeding provide protection against acute appendicitis? A case control study. Trop Doct 2008 Oct;38(4):235-6.
https://doi.org/10.1258/td.2008.070404.
19. Pearnteau WH, Smink DS. Appendix, Meckel's, and other small bowel diverticula. In: Michael J. Zinner, Stanley W. Ashley,eds. Maingot's Abdominal Operations. 12th ed. Mc Graw Hill Medical; 2013. p. 585-610.
20. Williams NS, Bulstrode CJK, O'Connell PR. Bailey and Love's Short practice of Surgery. 26th ed. Boca Raton; CRC Press, 2013. Chapter 71: The vermiform appendix; p. 1199-1214.
21. Fasen G, Schirmer B, Hedrick TL. Appendix. In: Charles J. Yeo, Samuel D. Gross, eds. Shackelford's Surgery of the Alimentary Canal. 8th ed. Philadelphia: Elsevier; 2018. p. 1950-56Noudeh YJ, Sadigh N, Ahmadnia AY. Epidemiologic features, seasonal variations and false positive rate of acute appendicitis in Shahr-e-Rey, Tehran. Int J Surg 2007:5:95-8.
22. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: Racial, gender, and seasonal variation. Epidemiology 1991;Sep;2(5): 323-30.
https://doi.org/10.1097/00001648-199109000-00003.
23. Jangra B, Jangra MS, Rattan KN et al. Seasonal and day of week variations in acute appendicitis in north Indian children. J Indian Ass Plastic Surgeon. 2013(Jan-Mar);Vol 18:1.
24. Kwaasi AA, Tipirnemi P, Harfi H, Parhar RS, Alsedairy ST. Date palm (Phoenixdactylifera L) is a potent allergen. Ann Allergy 1992;68:78.
25. Oguntola A S, Adeoti M L, Oyemolade TA. Appendicitis: Trends in incidence, age, sex, and seasonal variations in south-Western Nigeria. Ann Afr Med Oct-Dec 2010;9(4):213-7.
https://doi.org/10.4103/1596-3519.70956.
26. Noudeh YJ, Sadigh N, Ahmadnia AY. Epidemiologic features, seasonal variations and false positive rate of acute appendicitis in Shahr-e-Rey, Tehran. Int J Surg 2007 Apr;5(2):95-8.
https://doi.org/10.1016/j.jisu.2006.03.009.
27. Gomez-Alcala AV, Hurtado-Guzman A. Early breastfeed weaning as a risk factor for acute appendicitis in children. Gac Med Mex. Nov-Dec 2005;141(6): 501–4.

Received 8 October 2021; revised 11 November 2021; accepted 3 December 2021.