ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Seasonal Changes in the Incidence of Appendicitis in Diyarbakır, Turkey: Retrospective Study

Diyarbakır, Türkiye'de Apandisit İnsidansında Mevsimsel Değişiklikler: Retrospektif Çalışma

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ABSTRACT Objective: The most common cause of acute abdomen requiring surgical intervention worldwide is appendicitis (AP). This study aimed to investigate the relationship between seasonal changes and the incidence of AP in Diyarbakır. **Material and Methods:** Patients who underwent an appendectomy with an AP diagnosis between January 1, 2016 and December 31, 2019 were evaluated retrospectively. The patients were divided into the following three groups on the basis of the general surgeons' findings during AP surgery: Group 1, acute appendicitis (AA); Group 2, plastron appendicitis (PLA); and Group 3, perforated appendicitis (PA). The patients were evaluated in terms of age, gender, and season of the year. **Results:** A total of 1,937 patients who participated in the study were divided into three groups: Group 1 (n=1,828), Group 2 (n=24), and Group 3 (n=85). AA was diagnosed most frequently in summer (28.1%). PLA (1.2%) and PA (4.4%) were diagnosed most frequently in fall (1.2%). The seasonal evaluation indicated that the number of patients was significantly higher in summer than in the other seasons (p=0.049). **Conclusion:** Seasonal changes were observed in the frequency of AP diagnoses. The incidence of AA increased in parallel with the increase in air temperature in the city. It was highest in summer.

Keywords: Appendicitis; age; gender; seasonal distribution

ÖZET Amaç: Dünyada cerrahi müdahale gerektiren akut karının en sık nedeni apandisittir (AP). Bu çalışma, Diyarbakır ilinde mevsimsel değişiklikler ile AP insidansı arasındaki ilişkiyi araştırmayı amaçlamıştır. **Gereç ve Yöntemler:** 1 Ocak 2016-31 Aralık 2019 tarihleri arasında AP tanısı ile apendektomi yapılan hastalar geriye dönük olarak değerlendirildi. AP cerrahisi sırasında genel cerrahın bulgularına göre hastalar 3 gruba ayrıldı: Grup 1 akut apandisit (AA); Grup 2 plastron apandisit (PLA) ve Grup 3 perfore apandisit (PA). Hastalar; yaş, cinsiyet ve mevsimsel olarak değerlendirildi. **Bulgular:** Çalışmaya katılan 1.937 hasta Grup 1 (n=1.828), Grup 2 (n=24) ve Grup 3 (n=85) olmak üzere 3 gruba ayrıldı. AA en sık yaz aylarında (%28,1) teşhis edildi. PLA (%1,2) ve PA (%4,4) en sık sonbaharda (%1,2) teşhis edildi. Mevsimsel değerlendirme yaz mevsiminde hasta sayısının diğer mevsimlere göre anlamlı derecede yüksek olduğunu göstermiştir (p=0,049). **Sonuç:** AP tanı sıklığında mevsimsel değişiklikler gözlendi. AA insidansı kentte hava sıcaklığının artışına paralel olarak arttı. Yaz aylarında en yüksek oldu.

Anahtar Kelimeler: Apandisit; yaş; cinsiyet; mevsimsel dağılım

Acute appendicitis (AA) is the most common cause of acute abdomen requiring surgical intervention worldwide. The lifetime risk for appendicitis (AP) has been reported as 7%.[1] Early diagnosis and treatment are important for preventing complications. AP can be simply defined as inflammation of the appendix vermiformis. Luminal obstruction is the most common cause. Bacterial infections, fecalites, food residues, lymphoid growths, and intestinal parasites in AP may cause luminal obstruction. It is usually observed in adolescents and young adults. The incidence of AP varies by country, geographic region, race, gender, age, food culture, and season.[2]

Although AP is a common disease requiring emergency surgery, its etiology is not fully understood. It can be caused by factors such as genetic pre-

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disposition, infection, vascular disease, stress, and smoking. Studies have indicated that the incidence of AP is affected by age, gender, and seasonal changes.[3] However, the reasons for these differences are not yet fully known. Studies on etiology and risk factors have revealed interesting seasonal diagnostic patterns. Climatic factors can affect the incidence and prevalence of infections, as well as the region of occurrence. Short-term air temperatures affect the markers of inflammation in potentially susceptible individuals.[3-5]

Studies have reported a higher incidence of AP in summer than in winter around the world.[6] The reason is not yet clear. The relationship between climatic factors and the incidence of AP has been studied for many years. AP is more likely to be seen during summer; thus, a direct relationship with factors such as dietary changes, relative humidity, and travel is suspected.[7]

Studies have suggested a possible relationship with seasonal viral, bacterial, and parasitic infections; however, the reasons for this phenomenon are still unclear. A study in two Turkish cities with different altitudes and climates found that AP was diagnosed more frequently in summer in the lower-altitude city and in winter in the higher-altitude city.[6] The present study aimed to investigate the relationship between seasonal changes in Diyarbakır and the incidence of AP.

MATERIAL AND METHODS

Patients who underwent surgery for a pre-diagnosis of AA in the Gazi Yaşargil General Surgery Clinic between January 1, 2016 and December 31, 2019 were included in this study. The diagnosis of AP was made on the basis of clinical history, examination, and imaging. Patients who underwent incidental appendectomy, those who were younger than 15 years old, and those whose records were not available were excluded from the study. A total of 1,937 patients were included. A common database was created by examining the patient files and records in the hospital information system. This facilitated the retrospective evaluation of the patient data. This study was conducted following the principles of the 2008 Helsinki Declaration and approved by Gazi Yaşargil Training and Research Hospital Ethics Committee (05.03.2021/E-686).

The patients were divided into three groups on the basis of the findings of the clinical observations during surgery: Group 1 AA; Group 2 plastron appendicitis (PLA); and Group 3 perforated appendicitis (PA). The patients were also divided into three groups by age: 15-39, 40-60, and >60 years. Age and gender were examined in relation to the season during which the operation was performed. In addition, the age and gender distribution by climate was examined in separate groups.

The study was conducted in Diyarbakır city in the Southeast Anatolia Region in Turkey. It has an altitude of 675 meters, and the city center has a predominantly continental climate. The summers are hot and dry, and the winters are cold and snowy. Weather data from the Meteorological Service of the Republic of Turkey (https://mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx) indicate the following seasons, which are in accordance with those in the Northern Hemisphere: winter (December to February), spring (March to May), summer (June to August), and fall (September to November). Therefore culturally hot solid food is served in winter, in addition, vegetables and fruits are preferred due to the extremely hot summer months in the southeast of Turkey.

STATISTICAL ANALYSIS

IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA) was used for the data analysis. The categorical measurements are presented as frequencies and percentages, and the continuous data are presented as means and standard deviations (median and minimum-maximum where necessary). The chi-square test was used to compare the categorical variables. For the continuous variables, the Shapiro-Wilk test was used for the normal distribution assumption. One-way analysis of variance of more than 2 variables was used to compare continuous measurements by controlling distributions between groups. Statistical significance was set at 0.05 in all tests.

RESULTS

The files of 1,937 patients [1,073 (55.4%) men; 864 (44.6%) women] were analyzed retrospectively. The data indicated that 1,443 (74.5%) of the patients were aged 15-39 years, 374 (19.3%) were aged 40-60 years, and 120 (6.2%) were aged >60 years (Table 1). The hospitalizations were as follows: 507 (26.2%) in 2016, 528 (27.3%) in 2017, 509 (26.3%) in 2018, and 393 (20.3%) in 2019.

On the basis of the general surgeons' observations during AP surgery, the patients were divided into three groups: Group 1 AA (n=1,828, 94.4%); Group 2 PLA (n=24, 1.2%); and Group 3 PA (n=85, 4.4%; Table 1). The mean age of the patients with AA was 30.8±11.7 years, the mean age of those with PA was 70.4±11.7, the mean age of those with PLA was 29.6±14.2, and the mean age of all patients was 32.56±9.7 years. The mean age of the patients in the PA group was statistically significantly higher than that of those in the AA and PLA groups (p=0.001).

The analysis of the yearly seasonal temperatures in Diyarbakır indicated that the lowest temperatures occurred in winter. The temperatures increased in spring, and the highest temperatures were measured in summer. The analysis of the monthly air temperatures between 1929 and 2019 indicated that the lowest were in January and the highest were in August (Figure 1).[8]

The number of patients followed up by month was as follows: 172 (8.9%) in December, 121 (6.2%) in January, 123 (6.4%) in February, 208 (10.7%) in March, 140 (7.2%) in April, 161 (8.3%) in May, 194 (10.0%) in June, 186 (9.6%) in July, 165 (8.5%) in August, 149 (7.7%) in September, 162 (8.4%) in October, and 156 (8.1%) in November (Table 2).

The monthly number of AP diagnoses among hospitalized patients was investigated. The lowest numbers were found in January, and the highest were recorded in June. (Figure 2)

The seasonal analysis of admissions to the clinic indicated the following: 509 (26.3%) patients in spring, 545 (28.1%) in summer, 467 (24.1%) in fall and 416 (21.5%) in winter (Figure 2). As the temperatures increased, so did the number of hospitalizations for AP (Figure 2, Figure 3).

The seasonal analysis of the diagnosis of AA revealed that the lowest numbers were in winter. The numbers increased in spring, with the highest number recorded in summer. The differences were statistically significant (p=0.049). There was an inverse relationship between the number of AP diagnoses and the average rainfall and moisture. No statistically significant difference was found between the seasonal changes and the mean patient age (p=0.69). The comparison of the seasonal variations and the gender ratio of the patients indicated that there was no statistically significant difference (p=0.67).

TABLE 1: General information of inpatient appendicitis patients.

Group	Sub-group	Number	Percent
Sex	Men	1,073	55.4%
	Women	864	44.6%
Age	15-39	1,443	74.5%
	40-60	374	19.3%
	>60	120	6.2%
Appendicitis	Group 1 AA	1,828	94.4%
	Group 2 PLA	24	1.2%
	Group 3 PA	85	4.3%
Avarege of age	AA	30.8	SD 11.759
	PA	70.5	SD 11.774
	PLA	29.7	SD 9.752

AA: Acute appendicitis; PLA: Plastron appendicitis; PA: Perforated appendicitis; SD: Standard deviation.

TABLE 2: Number of patients with seasonal appendicitis.

Season	Month	Number of patient	Percent	Total percent
Summer	June	194	10.0	
	July	186	9.6	
	August	165	8.5	Total: 28.1%
Autumn	September	149	7.7	
	October	162	8.4	
	November	156	8.1	Total: 24.1%
Spring	March	208	10.7	
	April	140	7.2	
	May	161	8.3	Total: 26.3%
Winter	December	172	8.9	
	January	121	6.2	
	February	123	6.4	Total: 21.5%
	Total	1,937	100.0	100.0%

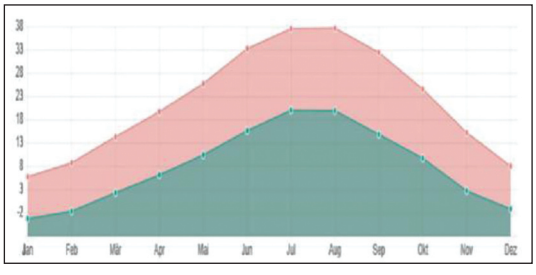

FIGURE 1: Climate for Diyarbakır, average day time, and night time temperatures.

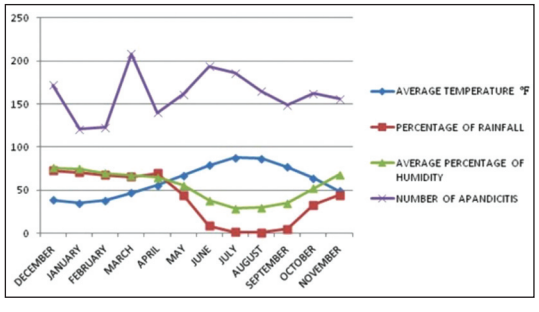

FIGURE 2: The relationship of the 2016-2019 seasonal temperature (Fahrenheit) and the number of appendicitis.

DISCUSSION

The incidence of AA varies by age, gender, geographical region, country, race, socioeconomic status, hygiene, eating habits, and seasons.[9,10] In the series in this study, the highest incidence in all three groups was in patients between the ages of 15 and 39 years. The gender distribution of the AP cases was consistent with that in previous studies; thus, there was a higher number of men.[6] In all three groups, there was no statistically significant difference in the seasonal gender distribution.

The overall incidence of perforation was 4-12% and the PA rate was 4.4%.[11,12] The average age of the PA group was the highest of all the groups in each season. The incidence in men was higher in all three groups. It is possible that the increasing incidence of perforation in advanced age might be related to factors such as nonspecific symptoms and laboratory findings, misdiagnosis or delayed diagnosis, delays in hospitalization, communication problems, and socioeconomic levels.

Previous studies have found seasonal variations in AA diagnoses.[13-17] A recent analysis, which has pro-

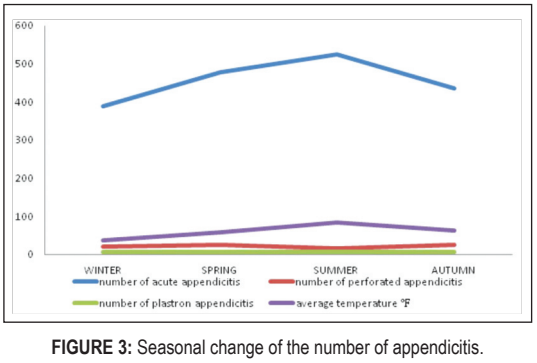

FIGURE 3: Seasonal change of the number of appendicitis.

vided some of the strongest evidence, found that nine of 11 studies reported the highest incidence in summer.[18] Very little research has been conducted in Turkey. Previous studies have not shown clear annual changes.[19] This study reveals important evidence of a relationship between AA and seasonal changes in Diyarbakır, the incidence of acute appendicitis was lowest in January, started to increase in March and April, and reached its peak in June. In March 2016, most of the patients in our province applied to our hospital because there were problems in transportation to Dicle University Faculty of Medicine and Selahaddin Eyyubi Hospital.[20]

AA is a common disease that occurs year round worldwide. A higher incidence has been associated with certain months; however, the months vary by location. For more than 10 years, Jangra et al. found that the highest number of cases in India occurred in summer months, especially August, and the lowest number occurred in winter.[21] Ilves et al. found that a higher incidence of AA was associated with summer months in Finland.[16] Lin et al. found that the AP rates in Taiwan were 11.76% higher in summer than in winter.[22] In a retrospective study of AP patients at Gazi Yaşargil Training and Research Hospital from January 2006 to March 2014, Akbulut et al. found a higher diagnostic rate (25.9%) in summer. These results are parallel to those of the present study.[23]

The relationship between high humidity and a high fecalitis rate is one of the hypotheses about the seasonal changes in the incidence of AA. It is hypothesized that dehydration would increase because of the higher humidity in summer, and this could increase stool stagnation. Brumer et al. found a statistical relationship between AA presentations and humidity; however, a relationship with temperature was not found.[24] Diyarbakır city has high temperatures and low humidity. The low humidity did not prevent an increase in the number of AP patients. Thus, the results of this study are not consistent with those of Brumer et al.

The high prevalence of intestinal parasites and bacterial infections has been associated with some AA cases. A high prevalence of intestinal parasites and bacterial infections was found in an examination of the distribution of diarrhea cases admitted to the province's Bağlar, Batıkent, Yenikapı and Şehitlik health centers of the Diyarbakır in the summer.[25] This indicates that intestinal pathogens (e.g., *Salmonella*, *Escherichia coli*, *Entamoeba histolytica*, Ascaris lumbricoides, Enterobius vermicularis, and Strongyloides stercoralis), which are associated with the pathogenesis of AA, cause peaks in infection in the summer.[26] In the United States, Canada, Iran, and South Africa, the highest incidence of AA was observed during the warmer months.[27] These results are similar to those of the present study.

Bacteria and parasites have been found to be responsible for acute gastroenteritis in developing countries.[28] The incidence typically increases in the summer. With the higher temperatures in the summer in the Diyarbakır, access to clean water and personal hygiene decreases, and viral and bacterial infections increase. Since the consumption of fruits and vegetables that have not been washed with clean water increases in Diyarbakır in summer, the incidence of diarrheal diseases and AP has been increasing. The results of the present study confirm those of Petroianu et al. regarding the influence of diet, hygiene, climate, and infections.[29]

LIMITATIONS

The most important limitation of this study was its retrospective design.

CONCLUSION

The results of this study suggest that temperature may be a causative factor for the seasonal changes in the incidence of AA. A significant positive correlation between temperature and incidence was observed. A reduction in the incidence was observed in winter. Access to clean water was found to be a protective factor. The increased incidence of gastroenteritis infections and environmental pollution, along with reduced rainfall and higher temperatures in summer, increased the likelihood of developing AP. The role of temperature relative to other factors and as an independent risk factor needs to be resolved by larger studies.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Ebral Yiğit;* ***Design:*** *Yasemin Demir Yiğit;* ***Control/Supervision:*** *Ebral Yiğit;* ***Data Collection and/or Processing:*** *Ebral Yiğit;* ***Analysis and/or Interpretation:*** *Yasemin Demir Yiğit;* ***Literature Review:*** *Ebral Yiğit;* ***Writing the Article:*** *Ebral Yiğit;* ***Critical Review:*** *Yasemin Demir Yiğit;* ***References and Fundings:*** *Ebral Yiğit;* ***Materials:*** *Ebral Yiğit.*

REFERENCES

1. Turner JR. The gastrointestinal tract. In: Kumar V, Abbas A, Aster JC, Fausto N, eds. Robbins and Cotran Pathologic Basis of Disease. 8th ed. Philadelphia: Saunders; 2010. p.870-1. [Link]
2. Karanikolić A, Karanikolić V, Djordjević L, Pešić I. Correlation between the season, temperature and atmospheric pressure with incidence and pathogenesis of acute appendicitis. Srp Arh Celok Lek. 2016;144(7-8):402-7. [Crossref] [PubMed]
3. Alegbeleye BJ, Adisa CA, Keskin H. Epidemiologic features of acute appendicitis in a tropical African population. WW Med. 2019;1(6): 202-11. [Link]
4. Arslan S, Aydogdu B, Arslan MS, Zeytun H, Okur MH, Basuguy E, et al. Analysis of risk factors for appendicitis in children: a multicenter epidemiological study. Dicle Med J. 2016;43(4):556-60. [Link]
5. Gao X, Colicino E, Shen J, Kioumourtzoglou MA, Just AC, Nwanaji-Enwerem JC, et al. Impacts of air pollution, temperature, and relative humidity on leukocyte distribution: an epigenetic perspective. Environ Int. 2019;126: 395-405. [Crossref] [PubMed] [PMC]
6. Sulu B, Günerhan Y, Palanci Y, Işler B, Cağlayan K. Epidemiological and demographic features of appendicitis and influences of several environmental factors. Ulus Travma Acil Cerrahi Derg. 2010;16(1):38-42. [PubMed]
7. Sato Y, Kojimahara N, Kiyohara K, Endo M, Yamaguchi N; Appendicitis study group of Mobi-kids Japan. Association between climatic elements and acute appendicitis in Japan. J Surg Res. 2017;211:64-9. [Crossref] [PubMed]
8. WorldData.info [Internet]. © WorldData.info. Climate of Diyarbakır (Turkey). (Erişim tarihi: 10.05.2021). Available from: [Link]
9. Al-Omran M, Mamdani M, McLeod RS. Epidemiologic features of acute appendicitis in Ontario, Canada. Can J Surg. 2003;46(4):263-8. [PubMed] [PMC]
10. Uludağ Ö, Çağ S, Sabancı Ü, Kuşderci H, Abdullayev R. Apandisitin mevsimsel dağılımı [The seasonal distribution of appendicitis]. Sakarya Med J. 2016;6(3):120-3. [Crossref]
11. Bulut T, Arduçoğlu Merter A. İki bin üç yüz yetmiş altı apendektomi materyalinin retrospektif analizi [The retrospective analysis of 2376 appendectomy specimens]. F.Ü. Med J Health Sci. 2017;31(3):105-9. [Link]
12. Hanson KA, Jacob D, Alhaj Saleh A, Dissanaike S. In-hospital perforation risk in acute appendicitis: age matters. Am J Surg. 2020; 219(1):65-70. [Crossref] [PubMed]
13. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: racial, gender, and seasonal variation. Epidemiology. 1991; 2(5):323-30. [Crossref] [PubMed]
14. Körner H, Söndenaa K, Söreide JA, Andersen E, Nysted A, Lende TH, et al. Incidence of acute nonperforated and perforated appendicitis: age-specific and sex-specific analysis. World J Surg. 1997;21(3):313-7. [Crossref] [PubMed]
15. Ahmed W, Akhtar MS, Khan S. Seasonal variation of acute appendicitis. Pak J Med Sci. 2018;34(3):564-7. [Crossref] [PubMed] [PMC]
16. Ilves I, Paajanen HE, Herzig KH, Fagerström A, Miettinen PJ. Changing incidence of acute appendicitis and nonspecific abdominal pain between 1987 and 2007 in Finland. World J Surg. 2011;35(4):731-8. [Crossref] [PubMed]
17. Stein GY, Rath-Wolfson L, Zeidman A, Atar E, Marcus O, Joubran S, et al. Sex differences in the epidemiology, seasonal variation, and trends in the management of patients with acute appendicitis. Langenbecks Arch Surg. 2012;397(7):1087-92. [Crossref] [PubMed]
18. Fares A. Summer appendicitis. Ann Med Health Sci Res. 2014;4(1):18-21. [Crossref] [PubMed] [PMC]
19. Gök M, Topal U, Öz AB, Akyüz M, Dal F, İslam DG, et al. Seasonal pattern of acute appendicitis in central anatolia. Erciyes Med J. 2020;42(2):207-12. [Link]
20. Göç İzleme Derneği. 2015-2020 dönemi sokağa çıkma yasakları; veri derleme ve medya izleme raporu. İstanbul: TMM Ajans Reklam Matbaa; 2020. [Link]
21. Jangra B, Jangra MS, Rattan KN, Kadian YS. Seasonal and day of week variations in acute appendicitis in north Indian children. J Indian Assoc Pediatr Surg. 2013;18(1):42-3. [Crossref] [PubMed] [PMC]
22. Lin KB, Lai KR, Yang NP, Chan CL, Liu YH, Pan RH, et al. Epidemiology and socioeconomic features of appendicitis in Taiwan: a 12-year population-based study. World J Emerg Surg. 2015;10:42. [Crossref] [PubMed] [PMC]
23. Akbulut S, Şener Bahçe Z, Öztaş T, Gümüş S, Söğütçü N, Sakarya H, et al. Assessment of demographic, clinical and histopathological features of patients who underwent appendectomy due to a presumed diagnosis of acute appendicitis. Ulus Travma Acil Cerrahi Derg. 2021;27(3):315-24. [Link]
24. Brumer M. Appendicitis. Seasonal incidence and postoperative wound infection. Br J Surg. 1970;57(2):93-9. [Crossref] [PubMed]
25. Nabi B. Acute diarrhea control in primary care. [Erişim tarihi: 05.10.2016]. Erişim linki: [Link]

26. Naumova EN. Mystery of seasonality: getting the rhythm of nature. J Public Health Policy. 2006;27(1):2-12. [Crossref] [PubMed] [PMC]

27. 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 J Surg. 2012;36(12): 2787-94. [Crossref] [PubMed]

28. Fletcher SM, McLaws ML, Ellis JT. Prevalence of gastrointestinal pathogens in developed and developing countries: systematic review and meta-analysis. J Public Health Res. 2013; 2(1):42-53. [Crossref] [PubMed] [PMC]

29. Petroianu A, Oliveira-Neto JE, Alberti LR. Incidência comparativa da apendicite aguda em população miscigenada, de acordo com a cor da pele [Comparative incidence of acute appendicitis in a mixed population, related to skin color]. Arq Gastroenterol. 2004;41(1):24-6. [Crossref] [PubMed]