

## Original Article



# Quarantine and Appendicitis: A Macro-Area Experience

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### Conflict of Interest

The authors have no financial conflicts of interest.

## ABSTRACT

**Purpose:** Appendicitis is the most frequent urgency in pediatric age; the aim of this study was to investigate the association of quarantine for severe acute respiratory syndrome coronavirus 2 pandemic and the incidence of pediatric appendicitis in a specific macro area.

**Methods:** We retrospectively analyzed the medical records of consecutive patients who underwent surgical exploration for acute appendicitis in the period March–April since 2014. This specific quarantine period was divided into two phases as indicated by National government. Patient data, demographics, characteristics and outcomes were studied and evaluated comparing patients treated during quarantine especially phase 1 vs. phase 2 (March–April 2020).

**Results:** After reviewing medical charts following the inclusion and exclusion criteria, 155 patients were studied; focusing on the final outcome, it is possible to show a decreased amount of appendicitis during phase 1 and a progressive increase during phase 2; respect to previous years, there was a statistical increase in severity of appendicitis during quarantine (gangrenous vs. phlegmonous appendicitis).

**Conclusion:** During this specific quarantine there was a reduction in appendicitis and a progressive increase during phase 2. These results offer new perspective among disease incidences during lockdown.

**Keywords:** Appendicitis; Treatment; Pandemic

## INTRODUCTION

The influence of sex, socioeconomic status and other factors, on outcomes from acute illness has been found recently with an increasing interest. Sex influences the progression of common medical conditions; in addition, sex appears to influence susceptibility to immune-based diseases [1,2].

Appendicitis is one of the most common urgencies in pediatric age; to date it has been postulated that the lifetime risk of developing appendicitis is about 9% for males and about 7% for females.

Based on hospital resources, due to coronavirus disease 2019 crisis, many hospitals stopped the elective surgical activity to avoid materials and devices wastefulness; during quarantine the governments decided for lockdown and therefore separation of persons. Recently, worldwide, the virus was destroying families and health care systems.

Among the common causes of appendicitis, two interesting theories has been reported: the dietary theory and the hygiene theory. The fact that appendicitis was common only in industrialized countries, led to hypotheses that it had dietary causes, with particular interest in fibers and sugar. It has been reported that the current percentage of appendicitis has a lower incidence in communities with high consumption of green vegetables tomatoes and fruit [1-5].

From 1950, the worldwide incidence of acute appendicitis declined due to year-by-year socioeconomic improvements. The resulting improvements in hygiene greatly reduced young children's exposure to enteric organisms, and it could thereby have altered their responses to infection [3-5].

Based on these data the aim of this study was to report our macro area experience during quarantine focusing on incidence of appendicitis.

## MATERIALS AND METHODS

This study is a macro area retrospective survey. University of Verona Internal Review Board (IRB) approved the study (IRB No. PFL 03/2020). A database of medical records of all children admitted to our Tertiary center for pediatric surgery was created in 2010. All children <15 years of age who underwent an appendectomy, were enrolled. The National Government has divided the quarantine into two phases: March 2020 (phase 1 with complete closure and lockdown, and phase 2 starting since half-April with progressive opening and contact between people). Our specific macro area (930,000 people) was one of the first red zone in Italy. During this specific period Hospital performed only emergencies and urgencies.

We recorded all cases treated for acute appendicitis during the period March–April 2014–2020 in our macro area. Among Hospitals, our Tertiary and a Secondary Hospital (out of 4 secondary Hospital) usually performed appendicitis in children.

Patients with abdominal pain, no other surgical diseases or comorbidities, no intestinal chronic disease, no other hospitalization for abdominal pain, no allergies nor endocrinological diseases were considered as inclusion criteria. Exclusion criteria were: patients lost to follow-up or patients with incomplete data. Race status was not considered for analysis. Suspected appendicitis treated without surgical approach were not considered.

Medical and surgical data were reviewed and patient demographics and surgical characteristics of appendicitis (phlegmonous or gangrenous) were also correlated. The surgical technique used was also recorded. In this study patients were stratified on the basis of sex and age. All patients underwent severe acute respiratory syndrome coronavirus 2 (Sars-CoV-2) swab before surgery. When results were not known, all patients were treated as positive (with the specific surgical checklist and procedures).

### Statistical analysis

Patient data were recorded in an Microsoft Excel 2007 (Microsoft, Redmond, WA, USA) database; Student's *t*-test was used to compare continuous variable and chi-square was used to compare categorical variables. Patients demographics including age in years and sex were also included for differences within these categories. A *p*-value less than 0.05 was considered as significant.

## RESULTS

During the study period 175 patients underwent appendectomies in the months of March and April in the interval 2014–2020. Twenty patients were excluded because doing not match the inclusion criteria or for incomplete data. Thus 155 patients, 100 male and 55 female aged between 4 and 15 years, were included in the study. A 90 cases were treated in the Tertiary Hospital while 65 cases in the secondary Hospital ( $p>0.05$ ). All patients treated during 2020 were negative for Sars-CoV-2.

There was a statistical difference between sexes prevalence and Hospitals: in the Tertiary hospital there were 64 male and 26 female while in the secondary hospital 36 male and 29 female ( $p<0.05$ ). Among patients there was not a statistical difference between age with males having  $10.4\pm 2.8$  years vs.  $10.8\pm 2.2$  years and females having  $10.1\pm 3.4$  years vs.  $11.5\pm 2.8$  years in Tertiary and secondary Hospital respectively ( $p>0.05$ ).

The distribution of appendicitis per grade was: 7 gangrenous appendicitis in the Secondary Hospital and 21 cases in the Tertiary Hospital, 58 cases of phlegmonous appendicitis in the secondary Hospital and 69 cases in the Tertiary Hospital; there was a statistical difference among severities ( $p<0.05$ ).

Focusing on age, there was not a statistical difference in sex and age range at surgery and there was not a statistical difference between months through the study period. An interesting data was the differences between gravity of appendicitis and age range: gangrenous appendicitis was more likely to be associated with age range ( $8.2\pm 2.8$  years) in the Tertiary Hospital and  $11.2\pm 3.0$  years in the secondary Hospital ( $p<0.05$ ). Among surgical techniques it was noted that in the secondary Hospital 16 (24.6%) cases were treated laparoscopically (12.5% male and 87.5% female) ( $p<0.05$ ), while in the Tertiary Hospital 87 (96.6%) cases were treated laparoscopically and 3 (3.4%) cases with standard open technique ( $p<0.05$ ) (**Table 1**).

**Table 1.** Patients clinical data

Cases	Tertiary hospital	Secondary hospital	<i>p</i> -value
100 M and 55 F	90	65	>0.05
M/F	64/26*	36/29	<0.05
Age (yr)	M $10.4\pm 2.8$ F $10.1\pm 3.4$	M $10.8\pm 2.2$ F $11.5\pm 2.8$	>0.05
Grade of APP (severity)	21 Gangrenous* 69 Phlegmonous	7 Gangrenous 58 Phlegmonous	<0.05
Gangrenous APP (yr)	$8.2\pm 2.8^*$	$11.2\pm 3.0$	<0.05
Technique (open vs. LT)	3 vs. 87	49 vs. 16	<0.05

Values are presented as number only or mean±standard deviation.

M: male, F: female, APP: appendicitis, LT: laparoscopic technique.

\*Statistical significant difference.

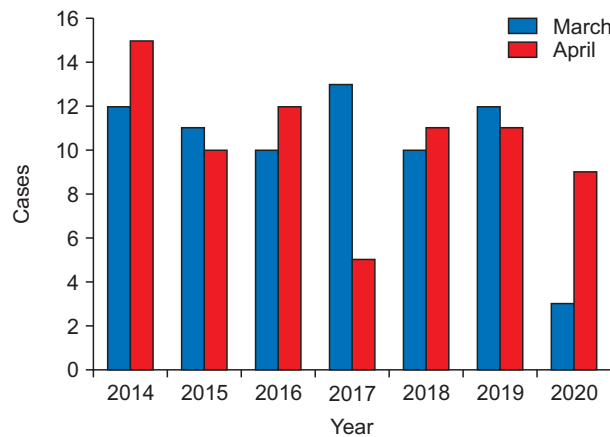


Fig. 1. Cases per period.

Overall, during the study period, the population-based incidence of appendectomies since 2014 was stable over time, per months and Hospitals; during March 2020 there was a statistical reduction in cases respect to others.

After reviewing medical charts, among hospitals appendicitis and their percentages respect to other urgencies during the month of March since 2014 were: 54.5% (12 appendicitis out of 22 urgencies), 47.8% (11 out of 23), 41.7% (10 out of 24), 50.0% (13 out of 26), 35.7% (10 out of 28), 44.4% (12 out of 27), 10.3% (3 out of 29) in 2020 respectively; the number of appendicitis and their percentages during April since 2014 were 44.1% (15 appendicitis out of 34 urgencies), 35.7% (10 out of 28), 42.9% (12 out of 28), 27.8% (5 out of 18), 40.7% (11 out of 27), 36.7% (11 out of 30) and 42.9% (9 out of 21) in 2020. There was a statistical difference between March 2020 and others ( $p < 0.05$ ) (Fig. 1).

It was interesting to note that the differences in percentage between months were stable during years, suggesting that seasonality is not a bias in both Hospitals. Cases during March–April 2020 showed the higher increase between years with higher percentage of gangrenous appendicitis ( $p < 0.05$ ).

Another interesting data was April 2017: during that period there were only 5 cases respect to March 2017. April 2017 was the month of opening of the new Tertiary Hospital with the progressive closure of the old one and all urgencies were treated in other hospitals by the same surgeons.

Again, among hospitals, there were no cases of appendicitis in patients having less than 9 years since half phase 2 (10th of April) ( $p < 0.05$ ).

During analysis, it was noted that in the secondary hospital there was less laparoscopy use and higher perforation rate in males. Sex characteristics offer an interesting point of view, suggesting that even if through the years male are affected more than female, during phase 1 quarantine there was not a statistical difference between sexes ( $p > 0.05$ ). Summarizing results, it is possible to show that there is not a statistical difference between percentages of appendicitis during the study period ( $37.3 \pm 12.9\%$  in March and  $36.9 \pm 4.9\%$  in April, excluding March 2020,  $p > 0.05$ ), with a sex prevalence through the years ( $5.2 \pm 0.9$  male vs.  $1.4 \pm 0.8$  female in March and  $4.8 \pm 0.9$  male vs.  $1.5 \pm 0.7$  female in April), excluding March–April 2020 ( $p < 0.05$ ) (Table 1).

## DISCUSSION

To better comment our results, some aspects should be postulated: first, all cases of appendicitis progress to perforation without treatment; second, appendicitis should not have any predisposing characteristics and that appendicitis should have a specific pathogenesis. What is known about these fields? What is known about appendicitis is that the risk of perforation increases by time and that this risk is relatively small in the first 36 hours of symptoms onset; this risk seems to be higher in males than females [2-4,6-9].

Recent studies have suggested that the major delay in acute appendicitis is the pre-hospital delay in presentation rather than the system time after presentation to the hospitalization; in fact, for all papers reported in literature, the main bias was the retrospective determination of the time of start of symptoms that continues to be a significant limitation. About the sex distribution, in the literature, it has been reported that there is an earlier perforation rate in males: this point adds a new aspect. This rate may be associated with differences in perception of pain or due to the influence of sex on the impact of many diseases [1-4,6-10].

How can quarantine influence the incidence of appendicitis? Probably for two reasons. First the hygiene theory seems to be essential: subjects without contact, especially preschool children and children, in general, are less susceptible for infections and have contacts only with parents. Second there is a different diet, and people (children) eat differently respect to school canteen [1-4,8,11-15].

Quarantine and social phase 2 offers some interesting perspectives: during quarantine (phase 1) there was a general reduction of appendicitis probably because decreased the predisposing factors but during the phase 2, with higher contact between people, infections increased, with the highest differences through the years (March vs. April). So, the reason why in March 2020 there were less cases respect to previous years, is that there were less predisposing cofactors. This point offers another interesting view: during quarantine there was a higher percentage of gangrenous appendicitis, suggesting an arrival to hospital delay. About the sex distribution we found that in secondary Hospital there was an earlier perforation rate in males: this point add a new aspect. This rate probably may be associated with differences in perception of pain or a protective role of sex in acute illness [2-4,6-9].

Even if our study is not a representative of annual incidence of appendicitis, our results demonstrate that quarantine had an interesting role, especially avoiding infections; progressive opening has generated more contacts between people and secondary infections.

In conclusion, appendicitis remains one of the most frequent urgency in pediatric age; our study demonstrates that social isolation and “quarantine” reduced contacts between people and reduced appendicitis. Acute appendicitis has predisposing factors, and if untreated, it will progress to perforation. Male sex is affected more than female, and this data is found especially during quarantine and during phase 2. Our results could offer interesting perspectives, especially about the influence of sex on different diseases in pediatric age and their incidence during quarantine.

## REFERENCES

1. McCrum ML, Leroux B, Fang T, Bulger E, Arbabi S, Wade CE, et al. PROPPR Study Group. Sex-based differences in transfusion need after severe injury: findings of the PROPPR study. *Surgery* 2019;165:1122-7. [PUBMED](#) | [CROSSREF](#)
2. Putnam LR, Tsao K, Nguyen HT, Kellagher CM, Lally KP, Austin MT. The impact of socioeconomic status on appendiceal perforation in pediatric appendicitis. *J Pediatr* 2016;170:156-60.e1. [PUBMED](#) | [CROSSREF](#)
3. Salö M, Ohlsson B, Arnbjörnsson E, Stenström P. Appendicitis in children from a gender perspective. *Pediatr Surg Int* 2015;31:845-53. [PUBMED](#) | [CROSSREF](#)
4. Akhtar-Danesh GG, Doumouras AG, Flageole H, Hong D. Geographic and socioeconomic predictors of perforated appendicitis: a national Canadian cohort study. *J Pediatr Surg* 2019;54:1804-8. [PUBMED](#) | [CROSSREF](#)
5. Sartelli M, Baiocchi GL, Di Saverio S, Ferrara F, Labricciosa FM, Ansaloni L, et al. Prospective Observational Study on acute Appendicitis Worldwide (POSAW). *World J Emerg Surg* 2018;13:19. [PUBMED](#) | [CROSSREF](#)
6. Inagaki K, Blackshear C, Morris MW, Hobbs CV. Pediatric appendicitis-factors associated with surgical approach, complications, and readmission. *J Surg Res* 2020;246:395-402. [PUBMED](#) | [CROSSREF](#)
7. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population-based analysis. *JAMA* 2001;286:1748-53. [PUBMED](#) | [CROSSREF](#)
8. Zampieri N, Scirè G, Mantovani A, Camoglio FS. Transumbilical laparoscopic-assisted appendectomy in children: clinical and surgical outcomes. *World J Gastrointest Endosc* 2014;6:101-4. [PUBMED](#) | [CROSSREF](#)
9. Zampieri N, Camoglio FS. Are we doing right suggesting a non-operative management for suspected appendicitis in children? *J Pediatr Surg* 2017;52:1702-3. [PUBMED](#) | [CROSSREF](#)
10. Fowler RA, Filate W, Hartleib M, Frost DW, Lazongas C, Hladunewich M. Sex and critical illness. *Curr Opin Crit Care* 2009;15:442-9. [PUBMED](#) | [CROSSREF](#)
11. Fowler RA, Sabur N, Li P, Juurlink DN, Pinto R, Hladunewich MA, et al. Sex-and age-based differences in the delivery and outcomes of critical care. *CMAJ* 2007;177:1513-9. [PUBMED](#) | [CROSSREF](#)
12. Beck AF, Florin TA, Campanella S, Shah SS. Geographic variation in hospitalization for lower respiratory tract infections across one county. *JAMA Pediatr* 2015;169:846-54. [PUBMED](#) | [CROSSREF](#)
13. Golz RA, Flum DR, Sanchez SE, Liu X, Donovan C, Drake FT. Geographic association between incidence of acute appendicitis and socioeconomic status. *JAMA Surg* 2020;155:330-8. [PUBMED](#) | [CROSSREF](#)
14. Smink DS, Finkelstein JA, Kleinman K, Fishman SJ. The effect of hospital volume of pediatric appendectomies on the misdiagnosis of appendicitis in children. *Pediatrics* 2004;113(1 Pt 1):18-23. [PUBMED](#) | [CROSSREF](#)
15. Augustin T, Cagir B, Vandermeer TJ. Characteristics of perforated appendicitis: effect of delay is confounded by age and gender. *J Gastrointest Surg* 2011;15:1223-31. [PUBMED](#) | [CROSSREF](#)