Impact of the COVID-19 pandemic on the number of radiological studies performed in Colombia

Impacto de la pandemia de COVID-19 en la cantidad de estudios radiológicos realizados en Colombia

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Summary

Objective: To characterize the impact of the COVID-19 pandemic on the number of radiologic studies performed in Colombia. ***Materials and methods:*** A retrospective analysis of radiological studies performed between 2015 and 2021 was performed by reviewing the Ministry of Health databases. The number of procedures during the prepandemic period, and between 2020 and 2021 was compared, as well as the initial months and each of the three peaks of the COVID-19 pandemic. We analyzed all studies in general, the imaging modality used, the anatomical region studied, the setting in which the study was performed and in particular, chest CT scans. ***Results:*** Between 2015 and 2019 the total number of procedures grew 82.86 % (from 8,130,001 to 14,866,163), but in both 2020 and 2021 there was a reduction compared to 2019 (-28.24 % and -11.99 %, respectively). The sharpest reductions occurred both in the first months of the pandemic (-37.52 %), and in the first two peaks (-44.37 % and -49.65 %); the reduction in the third peak was smaller despite coinciding with a higher number of cases (-10.88 %). Chest CT had a different behavior compared to general radiology, increasing +22.70 % in 2020, and +51.84 % in 2021, and had increases in each of the three peaks, parallel to the number of cases (+26.51 %, +34.63 %, +86.09 %, respectively). ***Conclusion:*** Changes in the number of radiologic studies performed during the pandemic depended on multifactorial determinants, and understanding them contributes to planning responses to future emerging contingencies.

Resumen

Objetivo: Caracterizar el impacto de la pandemia de COVID-19 sobre la cantidad de estudios radiológicos realizados en Colombia. ***Materiales y métodos:*** Se hizo un análisis retrospectivo de los estudios radiológicos realizados entre 2015 y 2021, mediante la revisión de las bases de datos del Ministerio de Salud. Se comparó el número de procedimientos durante el periodo previo a la pandemia y entre 2020 y 2021, así como los meses iniciales y los tres picos de la pandemia por COVID-19. Se analizaron todos los estudios en general, la modalidad de imagen utilizada, la región anatómica estudiada, el ámbito en el que se realizó el estudio y, en particular, las TAC de tórax. ***Resultados:*** Entre 2015 y 2019 el número total de procedimientos creció 82,86 % (pasó de 8.130.001 a 14.866.163), pero tanto en 2020 como en 2021 hubo reducción con respecto a 2019 (-28,24 % y -11,99 %, respectivamente). Las reducciones más marcadas ocurrieron en los primeros meses de la pandemia (-37,52 %) y en los dos primeros picos (-44,37 % y -49,65 %); la reducción en el tercer pico fue menor a pesar de haber coincidido con un mayor número de casos (-10,88 %). La TAC de tórax tuvo un comportamiento diferente al de la radiología general, pues aumentó +22,70 % en 2020 y +51,84 % en 2021, y tuvo aumentos en cada uno de los tres picos, paralelo al número de casos (+26,51 %, +34,63 %, +86,09 %, respectivamente). ***Conclusión:*** Los cambios en la cantidad de estudios radiológicos realizados secundarios a la pandemia dependieron de determinantes multifactoriales y entenderlos aporta a la planeación de respuestas ante futuras contingencias emergentes.

Introduction

The COVID-19 pandemic started in the Chinese city of Wuhan, where the SARS-CoV-2 virus was first detected, on December 1, 2019 (1). On March 11, 2020, WHO declared the pandemic, for the fifth time since the 1918 influenza (2). In Colombia, the first case of COVID-19 was reported on March 6, 2020, in Bogotá (3).

Due to the high transmissibility of SARS-CoV-2, health authorities in almost all countries decreed a state of health emergency and imposed measures, such as social distancing and quarantines, in order to limit

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contagion (4). Similarly, faced with the growing number of patients suspected of having COVID-19, health institutions reorganized their personnel and health resources towards general medicine and critical care services (5, 6). Many screening programs and most non-urgent elective tests and procedures were postponed, while visits to emergency departments for reasons other than suspected COVID-19 were reduced, as a consequence of patients' fear of contracting the virus (7, 8).

In the area of radiology, these measures had a significant impact on the number of studies performed, reducing it considerably, as shown in several investigations (9, 10). However, the impact varied depending on the imaging modality used, the anatomical region examined or the timing of the pandemic at the local level. As the pandemic progressed, changes occurred, such as improved safety protocols, increased availability of health resources, reduced restrictions, availability of vaccines and the consequent reduction in patients' concern about contracting the virus, factors that probably influenced the number of radiological studies performed (11).

The present study seeks to characterize and compare the volume of radiological studies performed in the years before and during the COVID-19 pandemic in Colombia, according to the imaging modality used, the anatomical region studied and the ambulatory, emergency department or hospital setting of the procedures performed, using the CUPS (Unique Classification of Health Procedures), obtained from the SISPRO (Integral Information System of Social Protection) databases.

Materials and Methods

Study design

Descriptive, ecological study, which used as reference the SISPRO databases, which were accessed through the dynamic tables of the Microsoft Excel program. Using CUPS code "15" corresponding to imaging procedures, all imaging studies performed in Colombia between January 1, 2015 and December 31, 2021 were retrospectively included. Nuclear medicine studies were excluded from such choice. Since this was a secondary analysis of anonymized, publicly available information, the approval of a research ethics committee was not considered necessary.

Definition of the periods

The period between January 1, 2015 and December 31, 2019 was defined as the pre-pandemic period, while the period between January 1, 2020 and December 31, 2021 was defined as the pandemic period. Additionally, based on National Institute of Health data of confirmed new cases of SARS-CoV-2 infection from the pandemic period, four important moments of COVID-19 incidence were identified: 1) the onset of case reporting and subsequent upward curve between March and April 2020; 2) the first peak between July and September 2020; 3) the second peak between November 2020 and January 2021; and 4) the third peak between April and July 2021.

Data analysis

For each year analyzed, the number of radiological studies was grouped into different categories according to imaging modality (magnetic resonance imaging [MRI], computed tomography [CT], general radiology, diagnostic ultrasonography, Doppler studies, and interventional radiology), the anatomic region studied (head, face and neck, spine, thorax, abdomen and pelvis, and extremities) and the scope of the procedure performed (outpatient, in-hospital or emergency), as well as the particulars of chest X-ray and chest CT, according to CUPS codes.

Initially, the trend of change in the number of radiological studies performed in Colombia during the pre-pandemic period (2015-2019) was evaluated in general and according to the previously defined categories.

Subsequently, only the data corresponding to the number of studies performed during 2019 was used as the pre-pandemic period, which was compared with the number of studies performed annually and according to the previously defined categories during the pandemic years (2020-2021). Additionally, a similar comparison was made between the relevant COVID-19 incidence periods and the months of 2019 corresponding to those periods.

Results

When evaluating the period prior to the pandemic (2015-2019) (Table 1), it was observed that the number of radiological studies performed in Colombia had been growing significantly, from 8,130,001 studies in 2015 to 14,866,163 in 2019, a growth of 82.86 % in the total number of studies performed, for an average annual growth of 13.23 %. MRI was the imaging modality that grew the most, with 122.37 %. By anatomical region, head, face and neck studies increased the most (90.21%). Hospital studies were the area of study that grew the most (81.72%). Finally, ultrasound scans of extremities and joints were the imaging studies with the greatest growth (265.12 %), while the increase in chest CT scans was 137.39 %.

With the arrival of the pandemic this upward curve was reversed; in the first year of the pandemic (2020) there was a reduction in the number of procedures of 28.24 % with respect to 2019. According to the imaging modality used, in all of them there was a reduction; general radiology had the highest reduction (32.63 %), while in CT this was the lowest (18.78 %).Regarding the anatomical regions studied, a decrease was observed in all of them: head, face and neck studies showed the greatest reduction (22.93 %), while in chest studies it was the least (4.01 %).When analyzing the data according to the setting in which the studies were performed, a greater reduction was observed in those performed in the emergency department (33.57%), while hospital studies showed a smaller reduction (15.96%).

When evaluating the 2021 data against the 2019 data, the total number of radiological studies continued to decrease (11.99 %). However, in 2021 there was an increase of 16.25 % over 2020. When evaluating the data by imaging modality used, general radiology was the modality with the largest reduction (17.37 %), while interventional radiology studies increased 2.57 %. Regarding the anatomical regions studied, all presented a reduction; head, face and neck studies had the highest reduction (22.93 %), while chest studies, the lowest (4.01 %), approaching those performed in 2019. When analyzing the data according to the setting in which the imaging was performed, in studies performed in the emergency department there was the highest reduction (31.68 %), while in hospital studies it was the lowest (3.63 %), approaching those performed in 2019 (Table 2).

Figure 1 shows the monthly variation of studies performed during 2019, 2020 and 2021.

Table 1. Change in the number of radiological studies performed during the prepandemic period (2015-2019)

Criteria	2015 (*n*)	2019 (*n*)	Change (%)
Radiological studies	8,130,001	14,866,163	82.86
Imaging modality			
General radiology	3,793,159	6,504,286	71.47
Interventional radiology	419,837	775,809	84.79
CT SCAN	631,831	1,299,409	105.66
Ultrasound	2,771,167	5,200,010	87.65
Doppler	230,290	455,741	97.90
MRI	283,717	630,908	122.37
Anatomical localization			
Head, face and neck	1,232,185	2,343,684	90.21
Spine	555,799	973,808	75.21
Thorax	2,243,856	4,091,260	82.33
Abdomen	2,244,332	4,022,523	79.23
Extremities and joints	1,853,829	3,434,888	75.21
Scope of the study			
Ambulatory	4,417,044	7,854,844	77.83
Hospital	550,080	999,627	81.72
Emergency room	1,264,076	2,017,768	59.62
Chest CT	85,148	202,136	137.39
Chest X-ray	1.138,804	2,021,632	77.x52

CT: computed axial tomography; MRI: magnetic resonance imaging.

The beginning of the pandemic

When comparing the average of the data from the period of onset of disease case reporting, which occurred between March and April 2020, with the average of the data from the same months of 2019, a reduction in the total number of studies performed was evident (-37.52 %) (Figure 2). All imaging modalities decreased, interventional radiology presented the highest reduction (-47.71 %), while Doppler studies had the lowest (-30.07 %). Studies of all anatomical regions studied were reduced, with spine studies showing the greatest reduction (-45.59 %) and abdominal studies the least (-29.91 %). Similarly, all study settings decreased, but outpatient studies showed the greatest reduction (-40.71 %); inpatient studies the least (-26.18 %).

Table 2. Comparison between the number of radiological studies performed in the pre-pandemic period (2019) and the pandemic period (2020-2021)

Criteria	Pre-COVID-19 (n)	COVID-19 n (relative change)	
	2019	2020	2021
Radiological studies	14,866,163	10,667,673 (-28.24 %)	13,083,568 (-11.99 %)
Imaging modality			
General radiology	6,504,286	4,381,749 (-32.63 %)	5,374,779 (-17.37 %)
Interventional radiology	775,809	594,367 (-23.39 %)	795,773 (+2.57 %)
CAT SCAN	1,299,409	1,055,433 (-18.78 %)	1,254,291 (-3.47 %)
Ultrasound	5,200,010	3,855,507 (-25.86 %)	4,676.775 (-10.06 %)
Doppler	455,741	337,629 (-25.92 %)	426,369 (-6.44 %)
MRI	630,908	442,988 (-29.79 %)	555,581 (-11.94 %)
Anatomical localization			
Head, face and neck	2,343,684	1,524,734 (-34.94 %)	1.806.199 (-22.93 %)
Spine	973,808	646,495 (-33.61 %)	854.051 (-12.30 %)
Thorax	4,091,260	3,122,098 (-23.69 %)	3.926.997 (-4.01 %)
Abdomen	4,022,523	3,051,999 (-24.13 %)	3.580.158 (-11.00 %)
Extremities and joints	3,434,888	2,322,347 (-32.39 %)	2.916.163 (-15.10 %)
Scope of the study Anatomical localization			
Ambulatory	7,854,844	5,684,962 (-27.62 %)	6.873.881 (-3.63 %)
Hospital	999,627	840,043 (-15.96 %)	963.310 (-12.49 %)
Emergency room	2,017,768	1,340,425 (-33.57 %)	1.378.623 (-31.68 %)
Chest tomography	202,136	248,018 (22.70 %)	306.915 (+27.23 %)
Chest X-ray	2,021,632	1,471,171 (-27.23 %)	1.811.910 (-10.37 %)

CT: computed axial tomography; MRI: magnetic resonance imaging.

First peak

When comparing the average data of the first peak incidence of COVID-19, which occurred between July and September 2020, with the average data for the same months of 2019, a reduction in the total number of studies performed was evident (-44.37 %). All imaging modalities decreased, general radiology presented the highest reduction (-50.16 %), while CT the lowest (-29.61 %). Studies of all anatomical regions studied were reduced, with head, face and neck studies showing the greatest reduction (-51.47 %) and chest studies the least (-29.61 %). All study areas showed a reduction, the greatest in emergency studies (-50.36%) and the smallest in hospital studies (-30.44%).

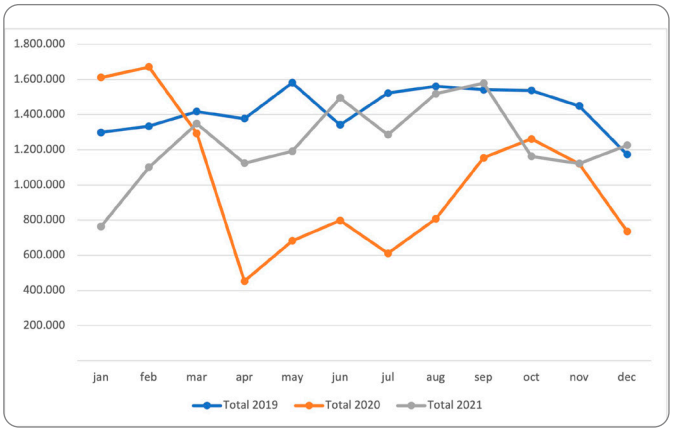


Figure 1. Monthly variation in the number of radiological studies performed in the pre-pandemic period (2019) and in the pandemic period (2020 and 2021).

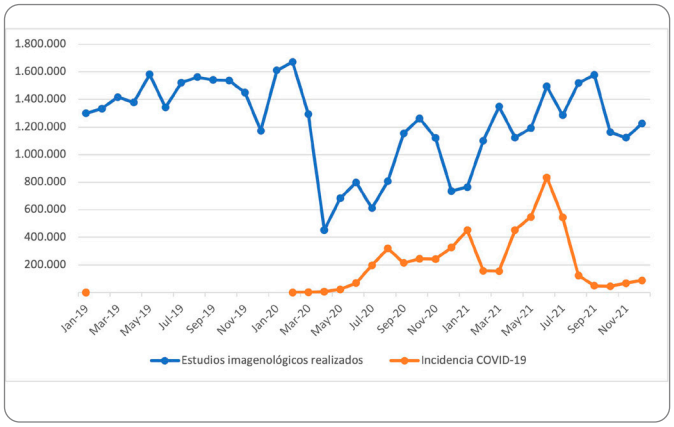


Figure 2. Monthly variation in the number of radiological studies performed and in the incidence of COVID-19 in Colombia between 2019 and 2021.

Second peak

Comparing the average data from the second peak of COVID-19 incidence, which occurred between November 2020 and January 2021, with the average number of studies performed in the same months of 2019, showed a greater reduction in the number of studies performed (-49.65 %) than that of the first peak. All imaging modalities decreased, general radiology presented the highest reduction (-37.84 %), while interventional radiology the lowest (-13.56 %). There was a reduction in all anatomical areas studied, head, face and neck studies presented the highest reduction (-69.99 %), while chest studies, the lowest (-35.32 %). All the study areas decreased, outpatient studies presented the greatest reduction (-45.86 %), while inpatient studies had the lowest (-29.84 %).

Third peak

Finally, when comparing the average number of studies performed during the third peak of COVID-19 incidence, which occurred between April and July 2021, with the average number of studies performed in the same months of 2019, a much smaller reduction in total studies performed (-10.88 %) than that of the first two peaks was evident. General radiology was the study modality with the largest reduction (-18.03 %), while interventional radiology studies increased slightly (+0.53 %). Studies of all anatomical regions decreased, with head, face and neck studies showing the greatest decrease (-23.88 %), while chest studies showed the smallest decrease (-1.30 %), almost equal to the studies performed before the pandemic. Emergency department studies showed the greatest reduction (-34.69 %), while hospital studies increased slightly (+1.66 %).

When analyzing chest radiography data, there was a decrease in both 2020 (-27.23%) and 2021 (-10.37%) compared to those performed in 2019. When comparing chest radiographs during the periods of importance throughout the pandemic, with the average of those performed during the months of 2019 corresponding to each period, it was evident that there was a reduction both in the onset of reporting of COVID-19 cases and in the three peaks of incidence of the disease (onset of case reporting, -34.06 %; first peak, -41.96 %; second peak, -22.96 %; third peak, -7.02 %).On the other hand, when analyzing chest CT data, there was an increase with respect to studies performed in 2019 in both 2020 (+22.70 %) and 2021 (+51.84 %).Likewise, when comparing the average chest CT scans performed during those periods of importance with the average of those performed during the same months of 2019, there was a reduction in the period of onset of COVID-19 case reporting (relative change [CR]: -7.06 %), while there was an increase in the three peaks of COVID-19 incidence (first peak, +26.51 %; second peak, +34.63 %; third peak, +86.09 %) (Table 3).

Table 3. Average relative change (RC) of the number of radiological studies performed in the relevant periods according to the incidence of COVID-19 with respect to those performed on average in 2019

Start of report			
	Pre-pandemic (n)	**Pandemic (n)**	**Change (%)**
Radiological studies	1,397,385	873,078	-37.52
Chest CT	18,548	17,238	-7.06
Chest X-ray	200,649	132,306	-34.06
Peak 1			
Radiological studies	1,541,712	857,652	-44.37
Chest CT	20,690	26,176	26.51
Chest X-ray	213,345	123,831	-41.96
Peak 2			
Radiological studies	1,307,105	873,446	-49.65
Chest CT	18,182	24,478	34.63
Chest X-ray	184,184	141,894	-22.96
Peak 3			
Radiological studies	1,429.491	1,273,976	-10.88
Chest CT	19,657	36,579	86.09
Chest X-ray	211,765	196,901	-7.02

CT: computed axial tomography; MRI: magnetic resonance imaging.

Discussion

The increase in the number of radiological studies performed documented in the present study is a phenomenon that has been evidenced in multiple populations (12,13). Among the factors to which this phenomenon has been attributed are the increased availability of better technologies that result in a lower threshold for their use and the increased request by treating physicians, secondary to the increased access to health services by the population. These factors in Colombia could be due to government policies, such as Law 100 of 1993, the unification of the Health Benefits Plan (previously contributors to the system had better options than those in the so-called subsidized regime) and the 2015 Statutory Health Law, which have led to universal health coverage (14).

The decrease evidenced in the number of studies performed during 2020, especially during the period when the reporting of COVID-19 cases began, is to be expected. The COVID-19 pandemic affected several Asian and European countries before reaching Colombia (15,16), which allowed preventive measures to be taken, such as social distancing, mandatory quarantines, and distribution of health resources, before COVID-19 had a relevant impact in the country. This caused a decrease in the number of medical care regardless of the setting, as well as in other medical services deriving from this care, as occurred in other countries (17-20).

From the perspective of radiology services in Colombia, this was evidenced by a marked decrease in radiological studies performed during the initial months of the pandemic, with respect to those performed in 2019, without having yet coincided with a significant increase in the incidence of COVID-19. Although all study settings declined in this period, ED and outpatient studies declined more than inpatient studies.

Once COVID-19 cases increased, the total number of radiological studies further decreased from the studies performed in 2019. The first and second peaks of COVID-19 incidence presented a greater reduction than the baseline period. Likewise, the total reduction in studies performed was greater in the second peak than in the first peak, which was accompanied by a higher incidence of COVID-19 in this second peak. Studies performed in the ED were consolidated as the study setting with the greatest reduction in the first two peaks of the pandemic, but with a greater reduction in the first peak than in the second.

During the third peak of COVID-19 in Colombia, there was a significantly lower reduction in the total number of radiological studies performed than in the first two peaks, despite the fact that the increase in the incidence of COVID-19 cases during the third peak was substantially higher than in the first two peaks. Similarly, there was a divergence in the reduction of radiological studies according to the settings in which they were performed, with respect to the behavior observed in the first two peaks, as inpatient studies returned to their pre-pandemic values and, although studies performed in the emergency department and on an outpatient basis continued to decrease, their reduction was less than that presented during the first two peaks, particularly in the case of outpatient studies. This behavior can probably be explained by the gradual decrease in the measures implemented in 2020 to reduce the contagion and transmissibility of the virus, such that on August 25, 2020, the general quarantine in Colombia ended (21), due to the beginning of the progressive reactivation of different productive sectors of the country (22), as well as the beginning of vaccination and the progressive increase in the number of people with complete vaccination schedules. Between April and July 2021, the percentage of the Colombian population with complete vaccination schedules increased from 0.65% to 23.48% (23), which probably allowed for an increase in medical care in the inpatient and outpatient settings and the health care processes that derive from these, including imaging studies.

Chest CT was the imaging modality that showed the greatest divergence from the overall behavior of radiological studies performed during the COVID-19 pandemic, being the only type of study that increased in both years of the pandemic with respect to 2019. The above is explained by the role that chest CT played during the pandemic, being the imaging gold standard for diagnosis, detection of complications and determination of prognosis of patients with COVID-19 (24-26). This explains why the behavior of chest CT scans performed during the relevant periods in COVID-19 incidence showed a slight reduction during the onset of COVID case reporting, a period in which incidence remained low, whereas during peak COVID-19 incidence, the increase in COVID-19 cases paralleled the increase in chest CT scans with respect to those performed in 2019. Thus, June 2021 was the month in which both the peak incidence of COVID-19 and the peak in the performance of chest CT scans occurred.

On the other hand, chest radiographs did not show a behavior similar to that of chest CT during the pandemic, since they had a reduction both by years and by periods of relevance of COVID-19 incidence similar to that of all radiological studies. This can probably be explained by the fact that although chest radiography is a widely used study for the initial evaluation of low respiratory infection of moderate and high severity, such as COVID-19 (27), it is the imaging study initially requested in most of the consultations of patients with clinical symptoms of probable thoracic origin in any care setting (28), which, as mentioned, were reduced during the entire pandemic.

Regarding the main limitations of this study, it should be noted that, unlike studies conducted in other populations, the data were obtained from the databases of the Colombian Ministry of Health, which depend on the information filled in by the health workers responsible for the procedures performed, and are susceptible to errors in the registry.

In conclusion, the analysis presented in this study allows showing that the COVID-19 pandemic significantly influenced the number of radiological studies performed in Colombia and in a variable manner according to the time of the pandemic, as well as the imaging modality used, the anatomical region studied, the setting in which the studies were performed and the particular radiological study, depending on multifactorial external factors. Understanding the change presented may prove to be of great importance for planning future multifactorial responses to emerging contingencies, such as the COVID-19 pandemic.

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