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Cross-sectional Study

## Surgical research in Colombia part 1: Scientific and academic productivity of the Colombian research groups in surgery

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## ABSTRACT

**Introduction:** Global surgery has become the undisputed starting point for addressing a myriad of problems in surgery today. Therefore, it is necessary to constantly evaluate the scientific productivity in surgery, its behavior, validity and impact. In Latin America, specifically in Colombia, there are no studies that have analyzed this production.

**Methods:** A retrospective cross-sectional bibliometric study was carried out, in which the Colombian Ministry of Science database was consulted with the validated results up to July 2021. In the search section for research groups, the key word "Surgery" was used, and all associated GrupLAC (platform where the information of the research groups can be found) and their registered products were reviewed.

**Results:** 40 groups were included. Only 5 (12.5%) were registered in surgery as main line of research. The great majority of the groups were in the medium-low category, 50% in category C and 22.5% in category B. The vast majority of surgical groups are located in Bogotá (19; 47.5%). The first surgery group in the country was created in 1994 and the last one in 2017. In 27 years of surgical research, a total of 4121 registered scientific articles were found, 83 books, 713 book chapters, 2891 products associated with participation in scientific events, 1221 theses directed, and 1670 projects in Colombian surgical research groups. There was evidence of a high rate of underreporting of data, due to duplication of products and incomplete registration of data.

**Conclusions:** There is a high rate of underreporting of products and data in the GrupLAC of Colombian surgical research groups. Most of the production is located in the Andes region (Antioquia, Valle del Cauca and Bogotá), and is predominantly composed of scientific articles and products associated with participation in scientific events.

## 1. Introduction

Global surgery has become the undisputed starting point for addressing a myriad of problems in surgery today, from seeking access to

specialized services for the care of surgical diseases that generate a high burden of disease, to improving the quality of surgical evidence, and to promoting surgical education and practice [1–6]. Despite the emphasis of the 2030 global surgery targets set by The Lancet commission for

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global surgery in 2015, barriers have persisted over the years with respect to scientific output and improvement in available evidence, mainly in middle- and low-income countries [3,6]. Therefore, it is necessary to constantly evaluate the scientific productivity in surgery, its behavior, validity and impact. Among the items to be evaluated during the characterization of scientific production are authors, research groups, institutions or universities, as well as countries [7]. In Latin America, there are no studies that have analyzed this production, so it is not possible to state with certainty how much this continent contributes to global surgery, compared to other regions.

In Colombia, the Colombian Ministry of Science is the entity in charge of designing, reviewing and evaluating the country's scientific productivity and its different areas of knowledge [8]. The hierarchical organization of scientific validity is given by the reporting of research institutes or institutions of higher education, which, in turn, endorse the activity of research groups, which are a group of researchers with defined lines of research and reported to the public, who carry out research projects, participate in scientific events, serve as tutors for graduate students, among other activities. Depending on the volume and quality of productivity, these groups are categorized, which gives them prestige and a greater number of opportunities for access to funding and participation in science and technology [9]. However, periodically, the Ministry of Science provides global results on the country's productivity, but without discriminating the disciplines that make up an area of knowledge, for example, the area of health sciences is made up of many disciplines, such as medicine, nursing, dentistry, physiotherapy, among many others [9]. Thus, the results of a discipline within an area of knowledge, e.g., surgery from medicine, are not explicitly displayed.

Bibliometrics is a branch of scientometrics that allows evaluating the behavior of research and scientific publication. It allows to determine the distribution of authors, quality of evidence, relevance and impact of evidence, frequency and volume of authors and publications, correlating predictive factors of metric indicators and representativeness of a group, institution or country, in relation to a particular discipline [10,11]. It also makes it possible to observe the most important collaboration networks and journals of greatest interest to authors. Likewise, it identifies subregistrations and errors during the registration of data in academic databases and repositories. This is one of the most valuable tools for the analysis of secondary data, facilitating the monitoring of the evolution of scientific production in a discipline [10,11].

In this order of ideas, and recognizing the importance of determining the productivity of surgery in Colombia and Latin America, the objective of this study is to calculate, for the first time, the scientific and academic production of Colombian research groups in surgery, formally recognized and validated by the Ministry of Science of Colombia.

**2. Methods**

The study has been reported in line with the STROCSS criteria [12]. A retrospective cross-sectional bibliometric study was carried out, in which the Colombian Ministry of Science database was consulted with the validated results up to July 2021 [13]. In the search section for research groups, the key word "Surgery" was used, and all associated GrupLAC (platform where the information of the research groups can be found) were reviewed. Groups that declared as main or secondary line, general surgery or subspecialty, were included. Data from all research groups referring to other areas of medicine and branches other than general surgery and subspecialties, such as urology, orthopedics or plastic surgery, were excluded.

The following data were collected: name of the group, registered area of knowledge, main and secondary line of research, categorization of the group (according to the criteria stipulated in the conceptual annex by the Colombian Ministry of Science at the date of the study [14], they are: A1 [highest category], A, B, C [lowest category]; which depend on their scientific production in a time window of 1 or 2 years), year of creation of the group, name and categorization of the leader (this categorization

is also given by the fulfillment of certain criteria regarding the productivity of the researcher [14], which is: senior researcher [highest category], associate researcher, junior researcher [lowest category], institution associated to the group, geographic location in Colombia, number of members, training and extension (represents participation in master's and PhD graduate programs), production of scientific articles, book chapters, books, undergraduate or graduate theses directed, participation in scientific events and development of research projects.

Data were collected in Microsoft Excel and subsequently exported to IBM SPSS v25 software (Chicago, Illinois, USA), where nominal and ordinal variables were analyzed and expressed as percentages and frequencies, while discrete and continuous variables were expressed as mean and standard deviation or median and interquartile range (IQR), if they did not have a normal distribution. Ethical approval was not necessary for this study as it did not involve human or animal subjects, and the Colombian Ministry of Sciences database is open access.

**3. Results**

A total of 84 groups were identified, of which 40 met the inclusion criteria. Regarding the area of knowledge registered, 32 (80%) belonged to the area of clinical medicine, 4 (10%) to the area of medical and health sciences, 3 (7.5%) in the area of health sciences and 1 (2.5%) in medical sciences. According to the main line of research, only 5 (12.5%) were registered in surgery. The secondary line of research is highly variable, with the most frequent being general surgery (5 groups; 12.5%), followed by cardiovascular surgery in 4 groups (10%).

It was evident that the great majority of the groups were in the medium-low category, 50% in category C and 22.5% in category B. Most of the leaders of the surgical research groups were categorized as junior researchers (14; 35%) or were not categorized at all (13; 32.5%) (Table 1). The first surgery group in the country was created in 1994 and the last one in 2017 (Fig. 1). The vast majority of surgical groups are located in Bogotá (19; 47.5%), followed by Antioquia (4; 10%) and Valle del Cauca (3; 7.5%) (Fig. 2). The total number of members registered in surgical groups was 1601, with a median of 28 (IQR 34; 4–168).

A total of 4121 registered scientific articles were found with a median of 62.5 (IQR 90.25; 8–600), 83 books with a median of 1 (IQR 2; 0–37), 713 book chapters with a median of 5.5 (IQR 15.5; 0–202), 2891 products associated with participation in scientific events with a median of 36.5 (IQR 64.5; 0–404), 1221 theses directed with a median of 19.5 (IQR 40.25; 1–117), and 1670 projects with a median of 23 (IQR 28.5; 4–356) (Fig. 3). The TOP 3 groups with the highest scientific and academic production are summarized in Table 2.

There was evidence of a high rate of underreporting of data, due to duplication of products and incomplete registration of data. However, due to the heterogeneity and change in the platform, it was not possible to characterize it.

**4. Discussion**

The last two decades have seen a transition from traditional surgery to academic surgery [15]. This new discipline aimed to identify and

**Table 1**  
Distribution of the categorization of groups and group leaders with lines of research in surgery.

Group category, n (%)				
A1	A2	B	C	Not categorized
4 (10%)	1 (2,5%)	9 (22,5%)	20 (50%)	6 (15%)
Category of group leaders, n (%)				
Senior Researcher	Associated Researcher	Junior Researcher	Not categorized	
6 (15%)	7 (17,5%)	14 (35%)	13 (32,5%)	

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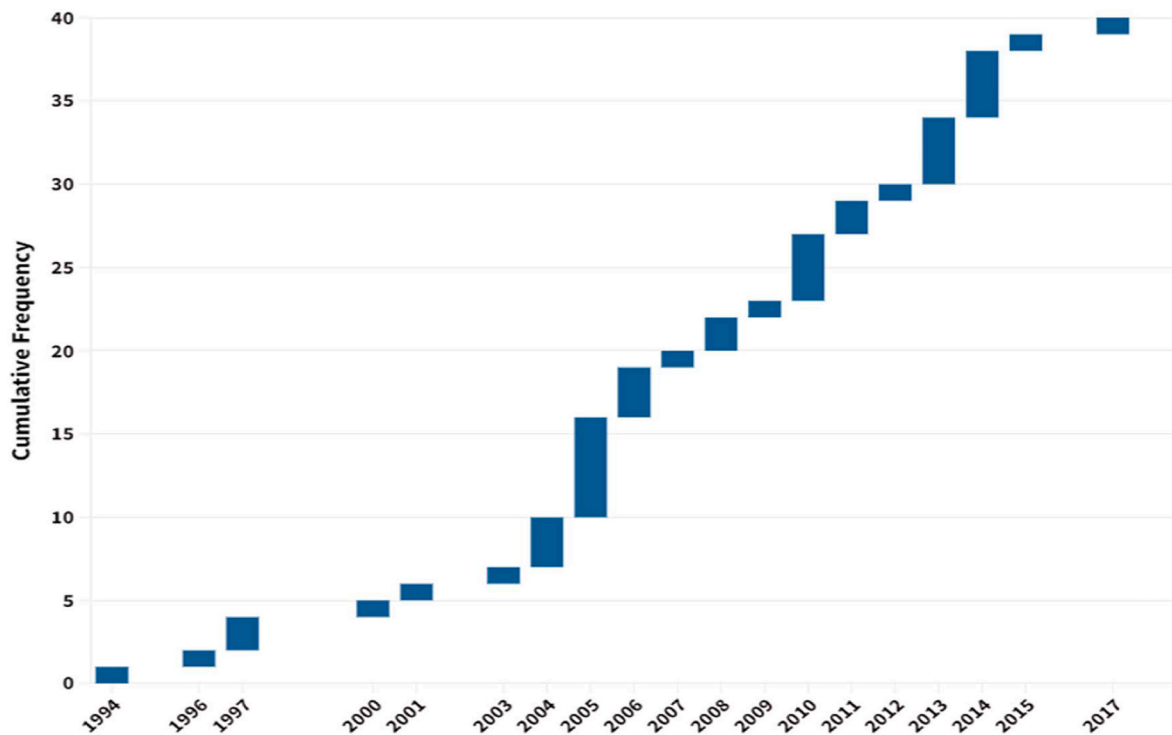


Fig. 1. Cumulative frequency representing chronology of the creation of Colombian research groups with research lines in surgery over the years.

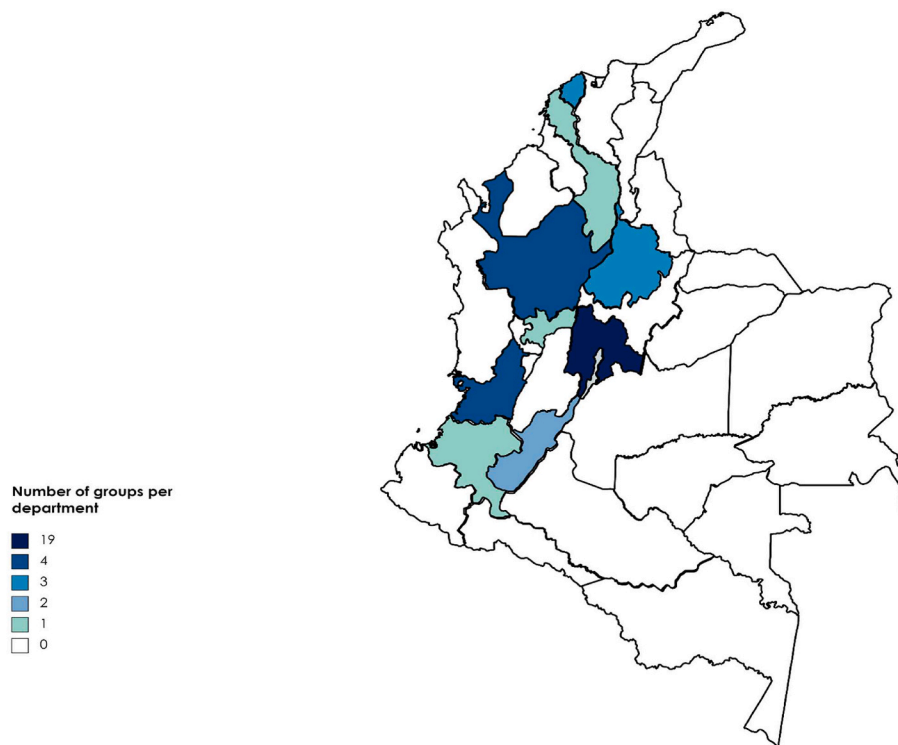


Fig. 2. Geographical distribution of the number of surgical research groups in Colombia.

raise issues related to the professional success and academic and scientific development of surgery; this involves both surgical and non-surgical concepts of the surgeon [16,17]. With the appearance of the 2030 global surgery objectives [2,3], this initiative was strengthened and its dissemination progressed, generating an advance in the production of constructive criticism on the limitations of current evidence,

researchers, and research groups and centers in surgery [18]. In low- and middle-income countries, such as those in Latin America, it has been specifically established that the most important items to develop are to increase opportunities for the training of surgeon-researchers and -educators, to strengthen funding, to propose studies of the highest possible quality, to provide as many primary data as possible for international

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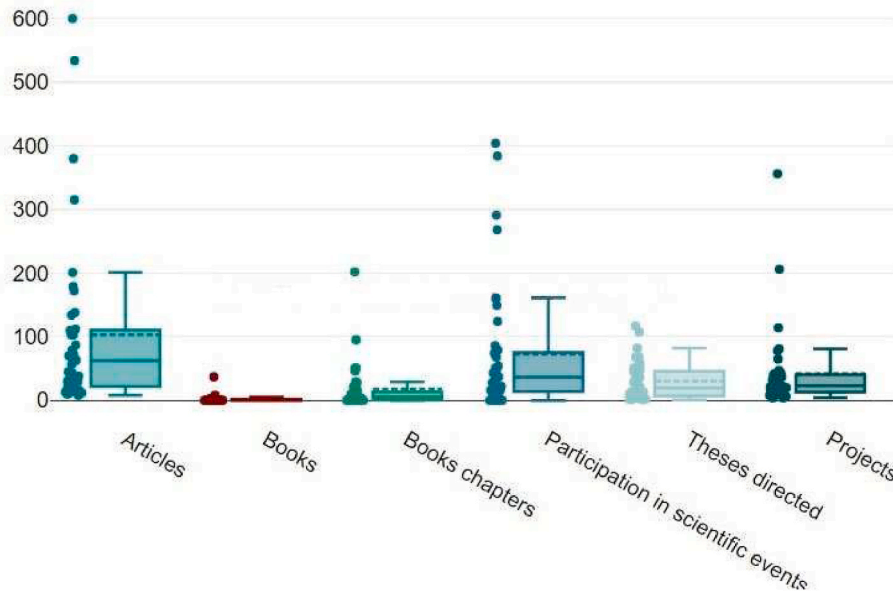


Fig. 3. Comparison of frequencies, means and medians of scientific and academic production of Colombian surgical research groups.

Table 2

Top 3 Colombian research groups with main or secondary line of research in surgery, with the highest scientific and academic production.

Top	Group name	Articles	Book chapters	Books	Research projects	Undergraduate/postgraduate theses directed	Participation in scientific events	Principal Partner Institution
1	Grupo de Investigación Clínica de la Fundación Valle del Lili	600	49	3	356	68	404	Fundación Valle del Lili
2	Grupo de Investigación Clínica en Enfermedades del Niño y del Adolescente - Pediaciencias	534	202	8	206	117	384	Universidad de Antioquia
3	Grupo de Investigación en Cardiología	380	51	3	114	82	291	Fundación Cardioinfantil

collaborations, and to improve the curriculum vitae [17]. These indicators are finally reflected in the production of training and new knowledge, given by research projects, scientific articles, training of new research surgeons and participation in the dissemination of scientific knowledge (scientific events). These ideals have their background in the search for the improvement and maintenance of the determinants of health, through equity and quality of health [16,17]. Health research is one of the most important bases to promote the health care of the population, and therefore, it is necessary to know strictly what is the behavior of this research [19]. Currently, within the TOP 20 countries with the highest biomedical scientific productivity, only Brazil stands out as a Latin American country (14th place) [17]. Recently, quantitative analyses of trends in scientific publication in surgery have not been published. However, emphasis is placed on improving the quality of surgical research [20]. Bibliometrics is a useful tool for the analysis of secondary data on the structure and content of scientific publications, and should be used frequently in the monitoring of academic surgery [21].

For the first time, this study characterized the scientific and academic production of Colombian research groups with lines of research in surgery, through a bibliometric analysis of the database of the governmental institution that regulates science in Colombia, the Colombian Ministry of Science. This database has records of the global production of the research groups and their members, most of which are affiliated with universities and hospitals. Therefore, these results reflect the productivity of these institutions and their respective surgical departments. There is really no similar evidence in the region with which these results can be contrasted. However, compared to the productivity reported by

authors from other continents, the disadvantage and fragmentation of the Colombian surgical scientific production is clearly observed [22–25]. Many research groups can be multidisciplinary, where they research on different branches of medical science. However, this study found that only 5 (12.5%) had registered general surgery as their main line of research; although this is not really the case, the value of groups exclusive to surgery is greater (evidenced by the secondary lines of research, registered articles and academic training of the members), but the underreporting does not reflect this aspect with certainty.

More than 70% of the research groups are in the medium-low category, according to the criteria of the Colombian Ministry of Science, which represent indicators of volume and quality of scientific production, considering the quartiles where scientific articles are published, books published by publishers indexed in high quality international databases, registration of meritorious and laureate theses, registration and development of research projects with technical support and international funding, production of patents and innovative techniques, participation in postgraduate research and organization and participation as speakers in scientific events. However, the fact that 7 out of 10 groups are in this category reflects few publications in Q1-Q2 journals, publication of books in non-indexed databases, registration of approved but not outstanding theses, planning and development of local or national projects, poor participation in master’s and PhD programs, and participation in scientific events, but mainly as attendees (which does not represent great value for the evaluation of the ministry).

More than 60% of the leaders of these groups are categorized as junior researchers or are not categorized at all. The categorization of Colombian researchers depends mainly on three items, their academic

training, the undergraduate/postgraduate theses directed (known as training products) and their scientific production. The fact that these leaders are in the lowest category or are not categorized at all represents either a very high rate of underreporting of data in their profiles, or that their scientific production is minimal; an aspect to be evaluated in greater depth in future studies. The centralization of Colombian research is clearly shown by the fact that approximately 50% of the groups with research lines in surgery are from Bogota (capital of Colombia). There are a large number of regions where there are no research groups in surgery, which may be due to the non-recognition of groups or definitely because they do not exist; this point reflects the heterogeneity of the results that Colombian surgery could exhibit, as it only has studies in a specific population, with sociodemographic, cultural and health characteristics totally different from other regions of the country.

Considering that the first research group with a research line in surgery was created in 1994, more than 25 years of national surgical research have passed, which has included more than 1600 researchers. However, it is expected that in a period of 5–10 years, the scientific production will be such that it will allow to meet the average criteria for categorization as researchers and to increase the global productivity indicators of the groups, so that the category of the groups will be in the highest level range (A1 - A). But, taking into account the total number of members included (1601) and the total number of scientific products according to their subtypes, we have then that for each researcher of a Colombian surgical group, an average of 2.5 articles (4121/1601), 0.05 books (83/1601), 0.44 book chapters (713/1601), 1.8 products associated with participation in scientific events (2891/1601), 0.76 directed theses (1221/1601), and 1 research projects (1670/1601) are produced. Taking into account the total number of groups that met the inclusion criteria (40), and the total number of scientific products according to their subtypes, we have that for each research group, on average 103 articles (4121/40), 2 books (83/40), 17.8 book chapters (713/40), 72.2 products associated with participation in scientific events (2891/40), 30 directed theses (1221/40), and 41 research projects (1670/40) are produced. Theoretically, the proportions of the production of the research groups would allow a medium-high categorization, but since this is not the case, it is presumed that there is a significant inequity between the production of multidisciplinary groups and exclusively surgical research groups. Similarly, the proportions of production per researcher are congruent with the results of the global categorization of the leaders found, which is only sufficient for the minimum categorization (which on average is obtained by professionals without postgraduate degrees or medical specialists with a short research career). Particularly, a high underreporting of data was evidenced, due to incomplete or duplicated information (which is not recognized by the Ministry of Science). The most common is to find that the registration of scientific articles does not have the DOI (Digital Object Identifier) (which is a necessary item for the recognition and categorization of the product) or that the group did not define its main line as surgery, even though it is an exclusive research group of general surgery or subspecialty. In this order of ideas, it is evident that the scientific production of general surgery and subspecialties is scarce and has many limitations.

Among the bibliometric studies that have analyzed the scientific production of research in Colombian surgery is the one conducted by Sánchez-Jaramillo et al. [22], who studied 20 years of publications on research in surgical education, finding only 63 studies, approximately 40% were published in journals not indexed in medium-high quality bases (ISI/SCOPUS), 20% in Q1 journals, and have an average of 10 citations per article [22]. Unlike what has been investigated in Colombia, other countries, mainly the United States, have shown a much higher productivity and better quality, represented by a higher percentage of participation in Q1-Q2 journals, better metrics and, in general, being the department with the highest contribution to surgery [22, 24]. Fortunately, evidence affirms that progress in global surgery productivity is substantial in low- and middle-income countries compared to high-income countries (71.5% vs. 28.5%,  $p < 0.001$ ), with a moderate

proportion of collaboration between these two groups of countries (32.9%), regardless of surgical subspecialty [25], which must continue to improve to meet the goals of global surgery.

The experience and evidence shared from other regions of the world, mainly from high-income countries, recommend that the early inclusion of students with an interest in surgery and surgical residents in interest groups and research groups in surgery, where the need to reinforce their concepts of academic surgery and evidence-based surgery is deepened, contributes substantially to the scientific production of these individuals in later years [26–34]. The challenges and principles to overcome the barriers to surgical education and research in low-income countries such as those belonging to Latin America are many. Above all, the interest of knowing the behavior of the scientific production of national surgical. At present, there are no massive studies on productivity evaluated through bibliometrics over time in this group of countries, which makes it difficult to contrast and define precise points on what needs to be improved. Therefore, it is suggested to work on the objectives of global surgery and the problems identified in other countries, such as inequity and lack of opportunities for women and minorities in surgery [31], development of randomized clinical trials and prospective multicenter studies with representative samples, among others [27,29,30]. International collaboration and the surgeon's initiative to pursue postgraduate research studies (MSc and PhD) are indispensable for the progress of surgical research [28]. More active participation is needed from surgical research groups in this type of programs, allowing the creation of novel lines such as translational surgery or evidence-based surgery, which allow the eco-epidemiological characterization of their populations to understand the evolution of diseases and outcomes in regions where no representative primary data are available [35]. Finally, it was possible to understand the behavior of Colombian surgical research groups, their productivity, representativeness and barriers to improve indicators.

As limitations, it was not possible to stratify the production over time, taking into account that the platform does not allow this type of filtering. Nor was it possible to characterize the quality of scientific production according to quartiles by products, according to international indexing databases. Similarly, the high presence of subregistrations does not allow for a true representation of the productivity of Colombian surgery, which is presumed to be much higher than that reported by the GrupLAC profiles.

## 5. Conclusions

There is a high rate of underreporting of products and data in the GrupLAC of Colombian surgical research groups. Most of the production is located in the Andean region (Antioquia, Valle and Bogotá), and is predominantly composed of scientific articles and products associated with participation in scientific events. The groups with the highest scientific and academic productivity are not groups with main line of research in surgery, but multidisciplinary, and correspond to Grupo de Investigación Clínica de la Fundación Valle del Lili, Grupo de Investigación Clínica en Enfermedades del Niño y del Adolescente, and Grupo de Investigación en Cardiología.

### Ethical approval

No ethical approval was needed for this research study.

### Sources of funding

No funding was received for this study.

### Author contribution

Ivan David Lozada-Martinez: Study conception and design; Acquisition of data; Analysis and interpretation of data; Drafting of



manuscript; Critical revision; approved the final version. Jeremías Carvajal-Bautista: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Yelson Alejandro Picón-Jaimes: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Gonzalo Dominguez-Alvarado: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Luis Felipe Cabrera-Vargas: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Lilian Torregrosa-Almonacid: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Oscar Guevara-Cruz: Analysis and interpretation of data; Drafting of manuscript; Critical revision; approved the final version. Alexis Rafael Narvaez-Rojas: Drafting of manuscript; approved the final version.

### Colombian Future Surgeons Collaborative Group

Acquisition of data; Analysis and interpretation of data; Critical revision; approved the final version.

### Registration of research studies

N/A.

### Guarantor

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### Declaration of competing interest

The authors declare that they have no conflicts of interest.

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See supplementary file for the detailed list of Colombian Future Surgeons Collaborative Group contributors.

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### Appendix A. Supplementary data

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