

## **A bibliometric analysis of research productivity on parasitic infections in children during the 15-year period**

### **Uma análise bibliométrica da produtividade da investigação sobre infecções parasitárias em crianças durante o período de 15 anos**

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**ABSTRACT**

Parasitic infections in children (PIC) represent an important public health issue regarding that children are more vulnerable to these infections and its consequences. Many countries have neglected PIC in their health agendas and budgets, which has hindered scientific production about it. In this sense, bibliometric analyzes have been useful to identify the panorama of scientific production for many diseases and thus assist in decision-making. Thus, this review aims to analyze the Brazilian and worldwide scientific production of PIC between 2006 and 2020. The terms “Parasitic diseases” and “Children” were used for search in Scopus database. The variables were organized and simple linear regression was applied using Graphpad Prism 7. Values of  $p < 0.05$  were considered statistically significant. was USA (18.5%), UK (8.9%) and Brazil (7.8%) were the countries that performed more scientific research on IPC. Among Brazil’s federal unities, São Paulo (34.3%), Rio de Janeiro (32%) and Minas Gerais (17.3%) published more scientific papers on PIC. The Brazilian research were mostly performed by public institutions, especially FIOCRUZ, USP and UFMG which published 19%, 16% and 10.6% of total Brazilian scientific production about PIC, respectively. There was a significant increase in scientific production about PIC over the 15 years analyzed, especially about schistosomiasis, giardiasis and trichuriasis. In addition, scientific journals from developed countries such as London School of Hygiene & Tropical Medicine and Plos Neglected Tropical Diseases were the main publishers of papers about PIC. Scientific production on PIC increased between 2006 and 2020 with participation of developed countries (USA and UK) and developing countries (Brazil). This increase in scientific production seems to be driven by the increase in studies on giardiasis, trichuriasis and especially schistosomiasis.

**Keywords:** children, parasitic infections, bibliometric analysis.

**RESUMO**

As infecções parasitárias em crianças (PIC) representam uma importante questão de saúde pública relativamente ao facto de as crianças serem mais vulneráveis a estas infecções e às suas consequências. Muitos países têm negligenciado o PIC nas suas agendas e orçamentos de saúde, o que tem dificultado a produção científica sobre o assunto. Neste sentido, as análises bibliométricas têm sido úteis para identificar o panorama da produção científica para muitas doenças e, assim, ajudar na tomada de decisões. Assim, esta análise visa analisar a produção científica brasileira e mundial do PIC entre 2006 e 2020. Os termos "Doenças parasitárias" e "Crianças" foram utilizados

para pesquisa na base de dados Scopus. As variáveis foram organizadas e a regressão linear simples foi aplicada usando o Prisma Graphpad 7. Os valores de  $p < 0,05$  foram considerados estatisticamente significativos. foram os EUA (18,5%), Reino Unido (8,9%) e Brasil (7,8%) os países que realizaram mais investigação científica sobre o IPC. Entre as unidades federais do Brasil, São Paulo (34,3%), Rio de Janeiro (32%) e Minas Gerais (17,3%) publicaram mais artigos científicos sobre o PIC. A investigação brasileira foi maioritariamente realizada por instituições públicas, especialmente FIOCRUZ, USP e UFMG que publicaram 19%, 16% e 10,6% do total da produção científica brasileira sobre o PIC, respectivamente. Houve um aumento significativo na produção científica sobre PIC ao longo dos 15 anos analisados, especialmente sobre esquistossomose, giardíase e trichuriasis. Além disso, revistas científicas de países desenvolvidos como a London School of Hygiene & Tropical Medicine e Plos Neglected Tropical Diseases foram as principais editoras de artigos sobre o PIC. A produção científica sobre o PIC aumentou entre 2006 e 2020 com a participação de países desenvolvidos (EUA e Reino Unido) e países em desenvolvimento (Brasil). Este aumento na produção científica parece ser impulsionado pelo aumento dos estudos sobre giardíase, trichuriasis e especialmente a esquistossomose.

**Palavras-chave:** crianças, infecções parasitárias, análise bibliométrica.

## 1 INTRODUCTION

Parasitic infections remain a relevant public health problem, with more than 1 billion people worldwide infected with helminths soil-transmitted (*Ascaris lumbricoides*, Hookworms and *Trichuris trichiura*) and *Schistosoma spp*, which can generate malnutrition and developmental delay<sup>1-3</sup>. These infections can mainly affect impoverished rural people, living in remote geographic areas or socially marginalized, which allows classifying them as neglected tropical diseases (NTDs)<sup>4,5</sup>. Among NTDs, schistosomiasis is considered the most relevant since occurs in approximately 78 countries, and its transmission is moderate in 52 locations<sup>6</sup>.

Children are more vulnerable to parasitic infections due to the immaturity of immune system, inadequate personal hygiene and health care practices<sup>7,8</sup>. In addition, since children present high energy demand, they are considered a susceptible group due to the malnutrition caused by parasitic infections<sup>9</sup>.

Although parasitic infections affect human's health, it does not present a massive mortality<sup>11</sup>, which makes many countries (mostly undeveloped ones) to neglect them on their health agendas and financial investments on public health. In this sense, developed countries seem to lead scientific production on parasitic infections. In addition, public costs on parasitic infections may be significantly decreased as well as scientific research increases, since it promotes better prevention strategies and treatments<sup>12</sup>.

Although uncommon, bibliometric analysis are effective to quantify scientific production on a group of diseases or a specific one<sup>13-16</sup>. Thus, taking into account the scarcity of publications on bibliometric analysis involving parasitic infections in children and its relevance to global health, the aim of this work is to analyze the Brazilian and worldwide scientific production about PIC in the last 15-year period, in order to compile scientific production on PIC and provide scientific reference on the subject. METHODS

This bibliometric study selected studies in Scopus database published from 2006 to 2020. Scopus database indexes numerous titles of quality academic documents, published with methodological rigor, which can be used as reference for other authors<sup>15,17</sup>.

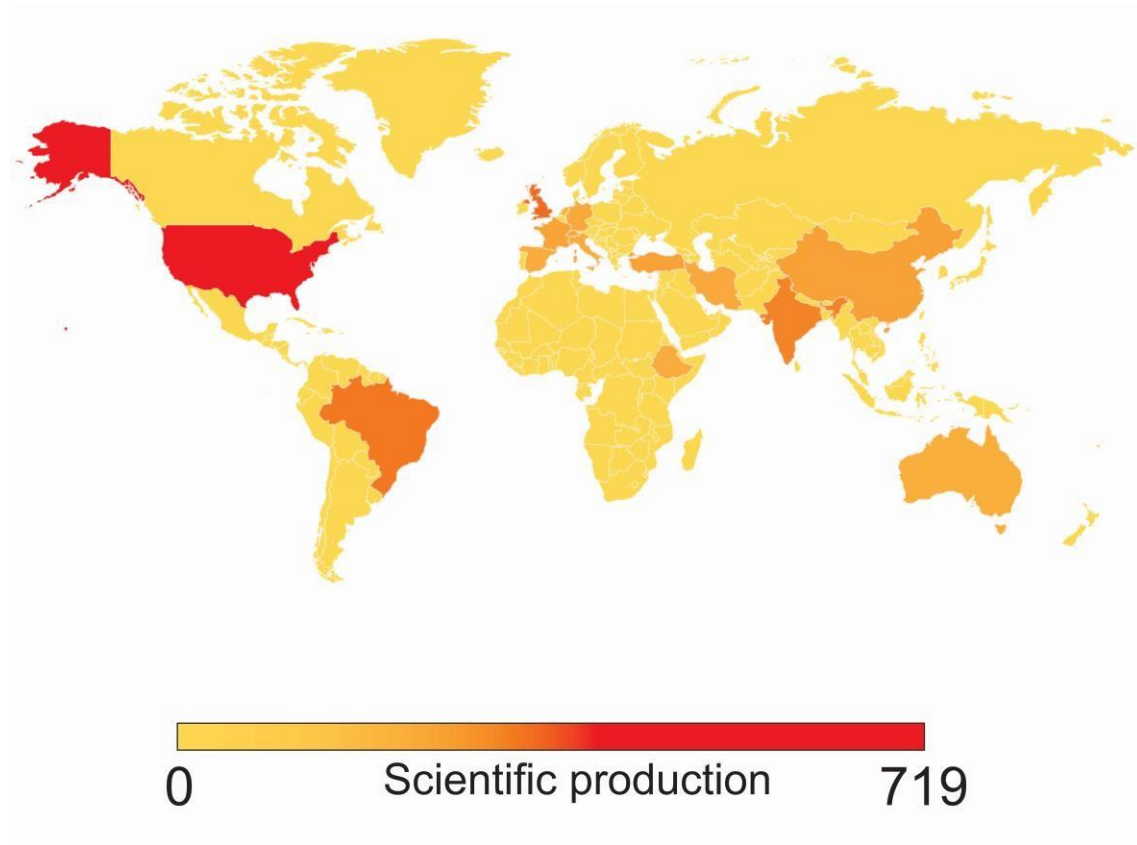
The following terms were used to search in Scopus database: ("Parasitic diseases") and ("Children"), according to the collection of descriptors in health sciences (DeCS/MeSH). Data collection and analysis were carried out in May 2021. The following variables were collected in each study: country of origin, parasites involved, year of publication, institution, publication modality, area of knowledge, journal, authors and unit of federation for Brazilian studies. Graphpad Prism 7 (Graphpad software, San Diego, CA, USA) was used to compile the data and carry out statistical analysis. Simple linear regression was applied to assess the temporal progression of research. The significance level was set at  $p < 0.05$ .

## 2 RESULTS

### 2.1 CHARACTERIZATION OF THE WORLD SCIENTIFIC PRODUCTION ON PARASITIC INFECTIONS IN CHILDREN (PIC)

A total of 3,870 studies on PIC were published in Scopus database between 2006 and 2020, from 149 different countries, regarding financial, technical and scientific resources. Among the countries, United States of America published more studies about PIC (n=719, 18.5%) followed by United Kingdom (n=346, 8.9%) and Brazil (n=300, 7.8%) (**Figure 1**). It is noteworthy that authors with the greatest scientific production on PIC worldwide are Jürg Utzinger, with 68 publications and 14,627 citations, followed by Hermann Feldmeier, with 28 studies and 3,589 citations.

Figure 1- Distribution of world scientific production on parasitic diseases in children from 2006 to 2020



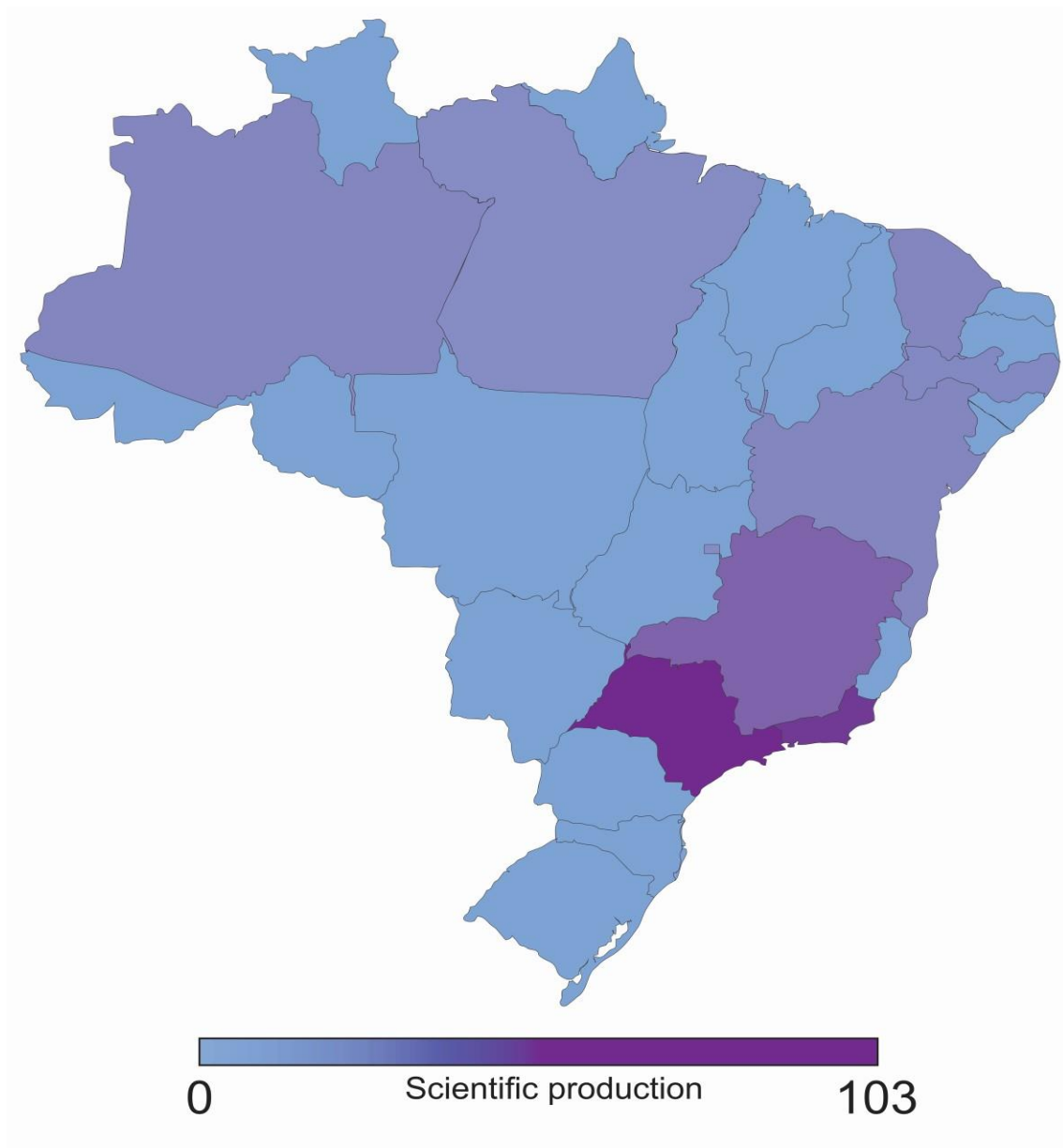
Each country on the map was colored in obedience a color scale related to the number of scientific works published. The scale of colors range from light yellow to red, with the greater the number of publications that country, the darker its color on the map.

## 2.2 CHARACTERIZATION OF BRAZILIAN SCIENTIFIC PRODUCTION ON PARASITIC INFECTIONS IN CHILDREN (PIC)

The contribution of each Brazilian unit of federation to national scientific production on PIC is represented in **figure 2**. São Paulo was the state that stood out the most, responsible for 34.3% (n =103) of the publications, followed by Rio de Janeiro, with 32.0% (n=96) and by Minas Gerais, 17.3% (n =52). It is important to highlight that the Brazilian states with less production about parasitosis in children are Maranhão and Roraima, which did not published studies about PIC according to Scopus. Among Brazilian studies, most of all were published by research groups linked to public institutions. Oswaldo Cruz Foundation published 19.0% (n=57) of the studies, followed by University of São Paulo, with 16.0% (n=48) and Federal University of Minas Gerais with 10.6% (n=32). Scopus data showed that considering the descriptors used (“Parasitic

diseases” and “Children”), no private institution has published scientific papers on PIC during the period evaluated.

Figure 2- Distribution of Brazilian scientific production on parasitic diseases in children from 2006 to 2020

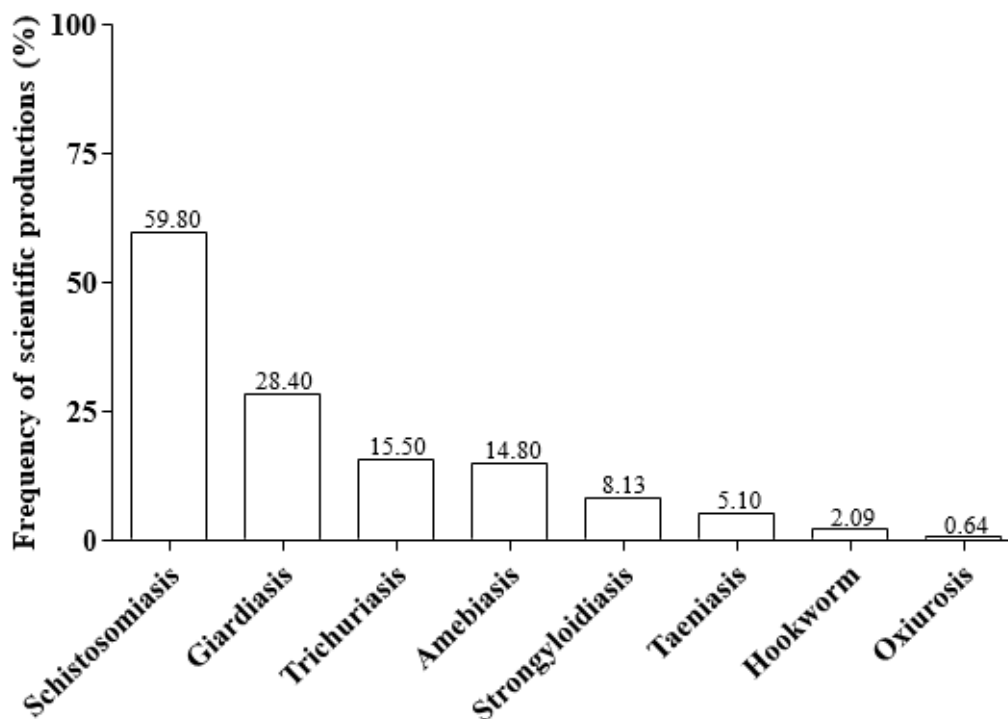


Each Federative Unit (UF) in Brazil was colored following a color scale related to the number of scientific works published. The color scale ranges from light blue to purple, the higher the number of scientific publications from that darker state will be its color on the map.

### 2.3 EVOLUTION IN THE NUMBER OF PUBLICATIONS ON PIC BETWEEN 2006 AND 2020.

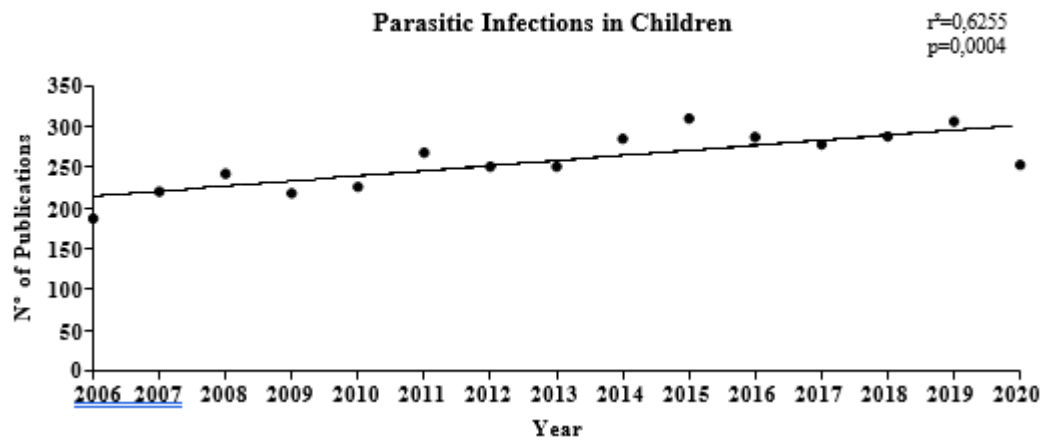
Our results pointed to schistosomiasis as the most commonly parasitic infection studied among children populations (n=2,317, 59.8%), followed by giardiasis (n=1,102, 28.4%), trichuriasis (n=603, 15.5%), amoebiasis (n=576, 14.8%), strongyloidiasis (n=315, 8.1%), taeniasis (n=199, 5.1%), hookworm (n=81, 2.1%) and oxyuriasis (n=25, 0.6%) (**Figure 3**). It is noteworthy that since some studies involve more than one parasitic infection, frequencies can exceed 100%. The evolution of scientific production according to data from Scopus revealed a significant increase in number of publications on PIC between 2006 and 2020 (**Figure 4**). Furthermore, among parasitic diseases, there is a significant increase in the number of studies on schistosomiasis (**Figure 5A**), giardiasis (**Figure 5B**) and trichuriasis (**Figure 5C**).

Figure 3 - Frequency of scientific productions according to infections parasitic among children



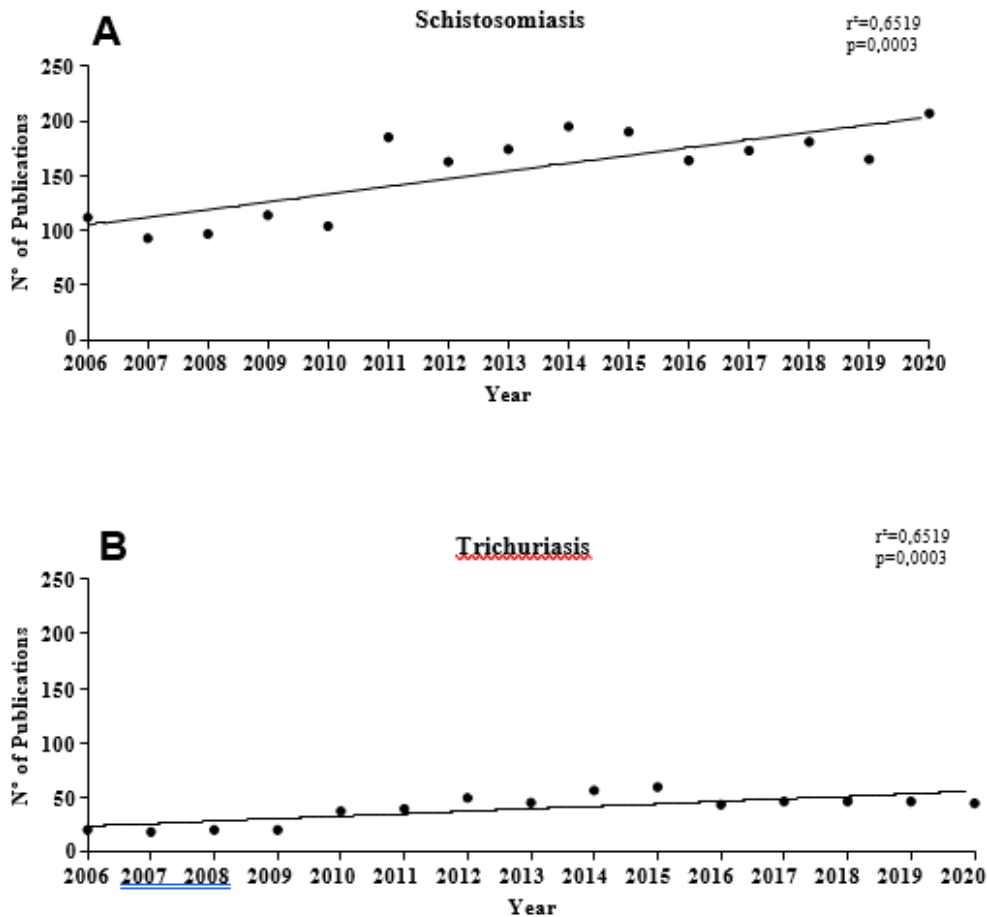
The relative frequencies of scientific productions are arranged on the y-axis and on the x-axis are the parasitic infections organized by descending order of frequency. Because some scientific works involve more than a parasitic infection, frequencies can exceed 100%.

Figure 4 - Temporal evolution of the number of scientific publications on infections parasitic inchildren

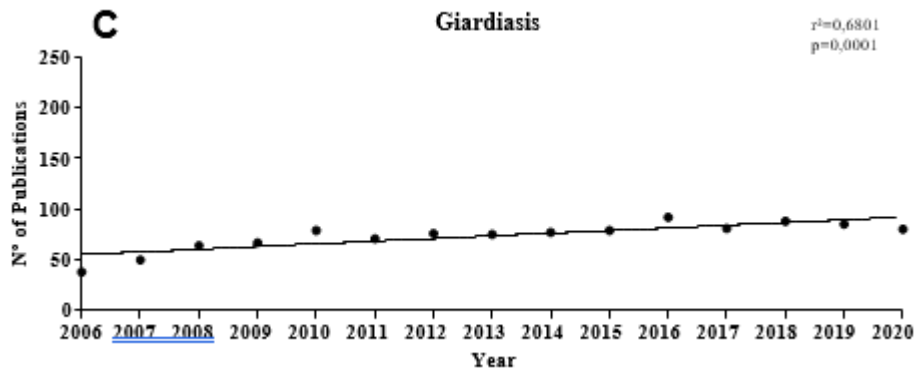


The number of scientific publications on parasitic infections in children carried out each year between 2006 and 2020. Of these values, linear regression analysis was performed and the results with p values <0.005 were considered statistically significant.

Figure 5 - Temporal evolution of the number of scientific publications on Schistosomiasis, Giardiasis and Trichuriasis







Linear regression analysis was performed at from the number of publications on specific parasitic infections (schistosomiasis, giardiasis and trichuriasis) between 2006 and 2020. The results with values of  $p < 0.05$  were considered statistically significant.

#### 2.4 CHARACTERIZATION OF STUDIES ACCORDING TO INSTITUTION, JOURNAL AND AREA OF KNOWLEDGE

London School of Hygiene & Tropical Medicine is the institution with the highest number of publications on PIC (n=102, 2.63%), followed by Swiss Tropical and Public Health Institute (n=98, 2.53%) and Centers for Disease Control and Prevention, (n=91, 2.35%). Among the periodicals, Acta Tropical has the largest number of publications (n=147, 3.7%), followed by Plos Neglected Tropical Diseases (n=137, 3.5%) and the American Journal of Tropical Medicine and Hygiene (n=114, 2.9%). Regarding area of knowledge, the most frequently associated to scientific publications on PIC are medicine (n=3,381, 87.4%), followed by immunology and microbiology (n=1,107, 28.6%), and agriculture and biological sciences (n= 396, 10.2%). Due to the possibility of framing a scientific study in more than one area of knowledge, the frequencies can exceed 100%.

### 3 DISCUSSION

The current study provide an overview of research about PICs in the last 15-year period. The increase on PIC research can contribute to strategies for its prevention and treatment, in order to cooperate with public health policies. Children in economic and social vulnerability represent an important risk group for parasitic infections<sup>7</sup>. According to WHO, parasitic infections are among the top three causes that increase disability-adjusted life years lost (DALY) in BRICS's countries (Brazil, Russia, India, China and

South Africa). Furthermore, approximately 30% of children at contamination risk by geohelminthiasis all over the world, come from these countries<sup>18</sup>.

Our results showed that developed countries such as United States and United Kingdom produce more scientific knowledge on PIC. The higher scientific research are justified by greater investment in research and development (R&D)<sup>10</sup>. The United States presents itself as the country with the highest number of scientific researches on infectious diseases, followed by China, England and France<sup>16</sup>. Despite the modest public R&D investment observed by developing countries, the BRICS present growing economic development, greater investments in R&D for neglected diseases and consequently, greater scientific production<sup>10</sup>. Our data showed Brazil as the third country in the world regarding the number of scientific production on PIC. Recent data evidenced that a rapid increase in Brazilian scientific production has been noticed over the years<sup>10</sup>. In addition, the United States and Brazil are the countries with greater number of scientific productions on soil-transmitted helminthiasis among all countries in the world and in Latin America and the Caribbean, respectively<sup>19</sup>. Our results confirm the leading role of developed countries in relation to dissemination scientific production on PIC. The London School of Hygiene & Tropical periodicals, Medicine Swiss Tropical and Public Health Institute and Centers for Disease Control and Prevention located in England, Switzerland and the United States, respectively, were the ones that stood out. In addition, Acta Tropical, Plos Neglected Tropical Diseases and American Journal of Tropical Medicine and Hygiene, from Netherlands and United States, respectively, were the periodicals with the highest number of publications on the subject. Due to the emphasis on the production and dissemination of scientific research, developed countries also play a considerable role in studies on therapeutics agents used for parasitic infections treatment over the years<sup>20</sup>. A recent bibliographic review on infectious diseases also identified a high level of scientific productivity by North American and United Kingdom institutions and journals<sup>16</sup>.

Regarding the Brazilian scientific production, public institutions lead publications on PIC, since they are the most involved on IPC field, and obtain the largest investments for research, mostly related to their graduate programs (master and PhD)<sup>21,22</sup>. This fact can be confirmed by our results, which showed that among Brazilian published studies, 100% were from public universities research groups. In Brazil, a small amount of private universities invest in research throughout graduate programs since they receive low investments from fomentation organizations, and cost for scientific research

is high. Taking into account this profile, despite the search for growth in the production area scientific, hardly able to compete in terms of production with universities public<sup>21</sup>.

In addition to the fact that public institutions stood out compared to private ones, the location of these institutions seems to be relevant since the Brazilian southeastern states have higher scientific productivity. The existence of traditional centers that develop research related to children's and adolescents health, the presence of institutions that historically have high productivity and greater concentration of CNPq (National Council for Scientific and Technological Development) scholarship researchers are some of the factors that may explain the greater scientific productivity of the southeast region<sup>23</sup>. Among the parasitic infections, there was an increased scientific production on schistosomiasis, giardiasis and trichuriasis. Schistosomiasis is the most frequent disease in published studies. Among NTDs, schistosomiasis has considerable relevance, as its prevalence is moderate to high in many countries<sup>6</sup>. According to Thomson Reuters Web and Science (WoS) Core Collection, between 2010 and 2019, schistosomiasis was the eighth subject with the highest number of scientific publications among tropical diseases neglected<sup>20</sup>. In Brazil, schistosomiasis has been subject of scientific studies since 1987 and the prevalence of this disease suffered a significant decrease compared to previous years, a fact that can be explained by investments in infrastructure as result from urbanization and systematic treatment of diagnosed cases<sup>24,25</sup>. Giardiasis is a prevalent disease in developing countries, since poor sanitary conditions favors water contamination and of food with cysts. Approximately 200 million people have giardiasis symptomatic in Asia, Africa and Latin America, and about 500,000 new cases are reported every year<sup>26</sup>. The first bibliometric study on giardiasis by Escobedo showed a constant growth of scientific production on the subject over 40 years (1971 to 2010). The evolution of the studies may have collaborated with the progressive improvement in sanitation and with the weakening of lethality due to giardiasis<sup>27</sup>. It is noteworthy that the scarcity of bibliometric analyzes on PIC can be used to illustrate how many countries have neglected these diseases when developing health agendas and budgets as they generally do not trigger a pandemic outbreak or massive mortality<sup>11</sup>. Furthermore, more bibliometric analyzes on IPCs are needed in order to provide increasingly accurate evidence on the topic. These analyzes can contribute to a more efficient management of resources in Research and Development, favoring adoption of measures for the diagnosis, prevention and treatment of these diseases, especially in groups of greatest vulnerability. In this way up both developed (USA and UK) and developing (Brazil) countries are

coming highlighting scientific production on parasitic diseases in children. Furthermore, giardiasis, trichuriasis and especially schistosomiasis are the themes that most contributed to the growth of scientific production on IPCs. Thus, this work highlights the importance of strengthening investment policies in research and development on PIC.

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### **AUTHORS' CONTRIBUTION**

AWDC, DMC e TARG conducted the data collection, statistical analysis and construction of graphs; AWDC, RSG e TARG were involved in writing the article; TCLP, MRL e BNE worked on editing and improving the manuscript. All authors discussed the final results and contributed to the final version.

### **CONFLICTS OF INTEREST**

The authors declare that they have no conflict of interest

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