

## Profile and Scientific Production of CNPq Researchers in Cardiology

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### Abstract

**Background:** Systematic assessments of the scientific production can optimize resource allocation and increase research productivity in Brazil.

**Objective:** The aim of this study was to evaluate the profile and scientific production of researchers in the field of Cardiology who have fellowship in Medicine provided by the *Conselho Nacional de Desenvolvimento Científico e Tecnológico*.

**Methods:** The curriculum Lattes of 33 researchers with active fellowships from 2006 to 2008 were included in the analysis. The variables of interest were: gender, affiliation, tutoring of undergraduate, masters and PhD students, and scientific production and its impact.

**Results:** There was predominance of males (72.7%) and of fellowship level 2 (56.4%). Three states of the Federation were responsible for 94% of the researchers: SP (28; 71.8%), RS (4; 10.3%), e RJ (3; 9.1%). Four institutions are responsible for about 82% of researchers: USP (13; 39.4%), UNESP (5; 15.2%), UFRGS (4; 12.1%) e UNIFESP (3; 9.1%). During all academic careers, the researchers published 2.958 journal articles, with a mean of 89 articles per researcher. Of total, 55% and 75% were indexed at Web of Science and Scopus databases, respectively. The researchers received a total of 19648 citations at the database Web of Science, with a median of 330 citations per researcher (IQ = 198-706). The average number of citations per article was 13.5 citations (SD = 11.6).

**Conclusions:** Our study has shown that researchers in the field of cardiology have a relevant scientific production. The knowledge of the profile of researchers in the field of Cardiology will probably enable effective strategies to qualitatively improve the scientific output of Brazilian researchers. (Arq Bras Cardiol 2011; 97(3) : 186-193)

**Keywords:** Bibliometric indicators; scientific and technical publications; cardiology; education, medical, graduate; health sciences.

### Introduction

The development of scientific and technological infrastructure and expansion of the academic community are relatively recent events in Brazil. This process began in the 1950s and 1960s, when the most important public agencies of Science and Technology were founded<sup>1</sup>. In recent years, there has been a significant increase in the training of new researchers and Brazilian scientific production<sup>2</sup>. Concurrently, scientific publications by Brazilian researchers in indexed journals rose from 14,237 in 2003 to 30,415 in 2008, according to Thomson Reuters<sup>3</sup>.

Systematic evaluation of researchers, journals, universities, research institutions, regions and countries is an activity that, though controversial, has been relevant for scientists and administrators<sup>4</sup>. Moreover, development agencies need

systematic evaluations to optimize resource allocations and define strategies for research bodies, enabling the restructuring of research in specific areas, or increase research productivity in the country<sup>5</sup>. In this context the so-called fellowship of research productivity (PQ), offered by the National Council for Scientific and Technological Development (CNPq), becomes increasingly important, created in the 70's. This fellowship was conceived as a way to encourage researchers holding a doctor's degree, with outstanding scientific contributions in their fields for the appreciation of their work before their peers. Thus, the profile of current PQ fellows becomes of interest to the entire scientific community<sup>6</sup>.

Several studies have examined the profile and the scientific production of researchers from the National Council of Scientific and Technological Development (CNPq) in various areas of knowledge<sup>6-10</sup>.

Recently, we evaluated the profile of researchers in scientific productivity in the medical area, comparing various areas<sup>9,11</sup>. However, within the field of Cardiology, data are scarce.

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This cross-sectional study aimed to describe the demographic characteristics and the academic production of the CNPq fellows, whose primary area of practice is cardiology.

## Methods

### Participants

We have initially established a database of 411 researchers registered as CNPq fellows, according to a list provided by the federal agency for research funding in February 2009. We excluded from the database researchers who had their fellowships suspended, such as in cases of postdoctoral studies abroad and senior researchers<sup>11</sup>.

### Field of expertise

For this variable, we considered the area specifically assigned by the researcher on the Lattes website. When such information was missing, the authors of this study analyzed the scientific production in the last 05 years and assigned a field which prevailed among the studies published and/or advised. In specific cases of performance in well-defined subfields, such as pediatric cardiology, the researcher was inserted in the field of Cardiology and the sub-area of practice was considered in a separate variable. Following this methodology, we identified 33 researchers involved in the area of Cardiology.

### Study design. Cross-sectional study

#### Data collection protocol

From the identification of the fellows, those resúmenes publicly available on the Lattes Platform (CNPq) of all researchers were systematically consulted. From Lattes curricula, we built a database with information on the distribution of researchers by category (1A, 1B, 1C, 1D and 2), geographical and institutional distribution, time of completion of doctoral studies, scientific production (scientific papers) and human resources training (advising on undergraduate research, master's and doctor's). For analysis of scientific production, we considered all publications and advising over the researcher's career, defined as the period between the first scientific paper published up to December 2008. We also analyzed the publications and advising of the past 05 years, considering the period between 2004 and 2008.

### Variables of interest

The following variables were analyzed: gender, the researcher's institution, PhD duration, doctoral institution, category of the fellowship, grantees advising to students conducting undergraduate research (undergraduate research studies), master's and doctor's theses, and publications in journals.

As for advising and publications, we assessed the absolute values over the entire scientific career and those values for the period 2004-2008 as described on the Lattes platform. In addition, we assessed the advising and publications adjusted for the researcher's duration of PhD. We also searched the

databases of Web of Science Thomson - ISI - Institute for Scientific Information - (<http://apps.isiknowledge.com/>) and Scopus (<http://www.scopus.com/home.url>). Both were consulted through CAPES' website (<http://novo.periodicos.capes.gov.br/>). On these databases were searched the scientific papers published by the researchers listed in CNPq's database. The researcher's scientific name used in this investigation was the one provided in Lattes. A systematic research of possible variations of names to quote the researchers was also undertaken.

### Statistical analysis

The database and statistical analyses were performed using SPSS, version 18.0 for Windows. For the statistical analysis, for the categories of fellows, levels 1A and 1B were grouped as well as the levels 1C and 1D, because in the categories 1B and 1C, we found only one researcher at each level with an area of expertise in cardiology. Continuous data are reported using median and interquartile (IQ). The nonparametric Kruskal-Wallis (KW) test was used to analyze heteroskedastic or non-normal distribution data. In case of rejection of the hypothesis of equality of the categories, Mann-Whitney's test was used to compare between the categories two-to-two with level of significance correction by the Bonferroni method. Dichotomous variables or nominal variables were compared by chi-square test. We used a significance level of 5%.

## Results

Out of 411 researchers in medicine, 33 (8%) were identified as in the area of Cardiology (Figure 1). The distribution of 33 researchers by gender and category of the fellowship are summarized in Table 1. There was a predominance of males (72.7%) and fellows in category 2 (57.6%). There was no significant difference in the distribution of categories between genders ( $p = 0.40$ ). Three Brazilian states were responsible for approximately 94% of the researchers: São Paulo (22; 66.78%), Rio Grande do Sul (6; 18.2%), and Rio de Janeiro (3; 9.1%). Two states had one fellow each: Minas Gerais and Distrito Federal. As for the home institution, researchers of Cardiology spread over 11 different institutions in the country. However, 04 institutions are responsible for approximately 82.0% of the researchers: USP (13; 39.4%), UNESP (5; 15.2%), UFRGS (4; 12.1%) and UNIFESP (3; 9.1%).

The median duration of 33 PhD researchers was 13 years (IQ, 10 to 22.5 years). As for the doctoral institutions, 29 researchers obtained their degree in Brazil and 04 in institutions abroad (USA, Canada and Netherlands). Most researchers (18; 54.5%) have done post-doctoral studies abroad, mainly in U.S. institutions.

### Advising

Over their career, Cardiology researchers advised 324 undergraduate research students (URS), with a median of 4 (IQ = 0 - 14) per researcher, 242 master's dissertations (median 6, IQ = 2 - 13) and 199 Ph.D. theses (median 9, IQ = 0 - 9). As for the values adjusted by the time of doctor's studies, researchers advised 0.68 URS per year, 0.43 master's and 0.31 doctor's students. Comparing the values adjusted by the doctor's study duration, there was no significant difference

between the categories of fellows for advising URS students (KW = 1.2, p = 0.17). However, researchers at levels 1A-1B advised a significantly greater number of master's students (KW = 9.6, p = 0.008) and doctor's students (KW = 10.2, p = 0.006).

### Publications/Journals

Over their academic career, Cardiology researchers published 2,958 articles in journals, with an average of 89 articles per researcher (SD = 40, ranging from a minimum of 25 articles to a maximum of 219). Altogether, 1,617 articles indexed in the database Web of Science, approximately 55.0% of the total articles published (an average of 49 per researcher, SD = 31). In the database Scopus, 2,222 articles were indexed (an average of 67, SD = 32), equivalent to 75.0% of academic production. Considering the number of articles adjusted for career time, the average content was 4.4 articles per year (SD = 2.1). The adjusted average of articles published in the database Web of Science was 2.47 per year (SD = 1.7) and in the Scopus database, 3.40 per year (SD = 1.8).

Comparing the values adjusted by the PhD studies' duration, there was no significant difference between the categories of fellowships for the number of articles over their career (KW = 4.9, p = 0.30), of articles indexed in ISI (KW = 8.8, p = 0.06) and articles indexed in the database Scopus (KW = 5.6, P = 0.23). Figure 2 using box-plot illustrates the adjusted medians of articles published between categories of researchers.

Most researchers (30, 91%) increased their scientific production in the last 05 years, considering the average of articles published per year. This increase ranged from 17% to 203% with an average of 103.0% (SD = 61) increase in scientific

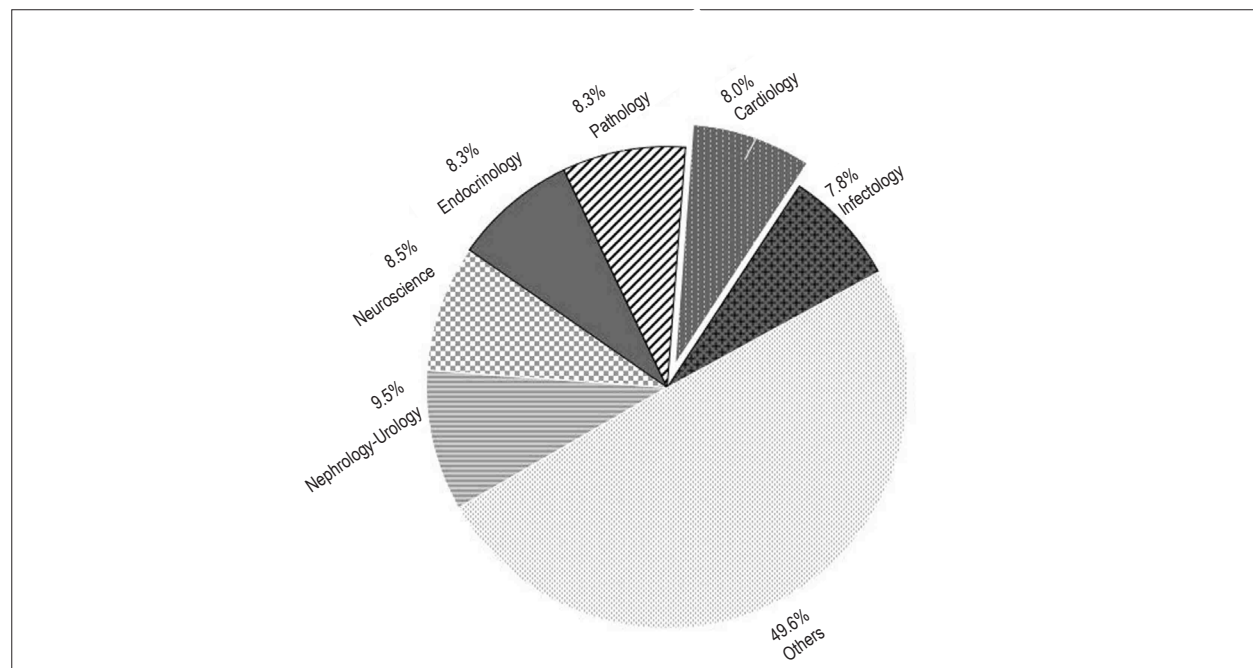
production. The average number of articles published in the scientific career of 33 researchers was 4.5 (SD = 2.2), while in the last 05 years, it reached 8.8 (SD = 4.8). Figure 3 illustrates the average of articles published throughout the scientific career and the average over the past 05 years for 33 researchers.

### Impact

Over their academic career, researchers in cardiology published in 587 journals. Out of this, we identified the Impact Factor (IF) of 340 journals (58%) in the database JCR 2009. The median IF was 2.65 (IQ = 1.67 to 3.96), ranging from 0.37 to 47.05. Regarding the distribution of the impact factor, 22 journals (6.4%) had FI smaller than one, 82 journals (24%) between one and two, 102 journals (30%) between two and three, 54 journals (16%) between three and 04, 24 journals (7%) between 4-5, and 56 journals (16.4%) with FI greater than 05.

**Table 1 - Distribution of research fellows in the field of Cardiology according to gender and category in CNPq (n = 33)**

Fellowship Category	Male	Female	Total
1A	6 (25.0)	0 (00.0)	6 (18.2)
1B	1 (4.20)	0 (00.0)	1 (3.0)
1C	1 (4.20)	0 (00.0)	1 (3.0)
1D	4 (16.7)	2 (22.2)	6 (18.2)
2	12 (50.0)	7 (77.8)	19 (57.6)
Total	24 (100)	9 (100)	33 (100)



**Figure 1 - Distribution of 411 medical research fellows of CNPq in December 2008, according to the field of expertise.**

Figure 4 illustrates the distribution of the IF of journals in which the 2,958 articles of researchers in cardiology have been published. Note that most articles were published in journals with IF between one and two. As for scientific journals, Tables 2 and 3 show, respectively, the 10 journals indexed and unindexed most used by fellows for their publications.

Over their academic career, researchers in cardiology received a total of 19,648 citations in the ISI database, with a median of 330 citations per researcher (IQ = 198 to 706, ranging from 83 to 2,870 citations). The average per article was 13.5 citations (SD = 16.8). In the database Scopus, we identified 24,512 citations to the researchers of Cardiology, with a median of 472 citations per researcher (IQ = 238 to 815, ranging from a minimum of 127 to a maximum of 4,222 citations). The average number of citations per article in the Scopus database was 9.9 (SD = 7.2).

The median index H in the ISI database was 10 (IQ, 8 - 14.5), ranging from a minimum of 6 to a maximum of 27. The corresponding value for the index H in Scopus was a median of 11 (IQ = 8.5 - 16), ranging from a minimum of 6 to a maximum of 35. There was a significant difference in the median of the H indexes, according to the category of researcher's fellowship in both databases: ISI (KW = 10.0,  $p = 0.006$ ) and Scopus (KW = 9.7,  $p = 0.008$ ). In the multiple comparison between groups, there were differences between the categories 1A, 1B and 1C-1D ( $p = 0.016$ ), 1A-1B and Category 2 ( $p = 0.001$ ). However, there was no significant difference between the categories 1C-1D and 2 ( $p = 0.49$ ).

The median M index, i.e., the H index corrected by the time of the researcher's academic career in the ISI database was 0.68 (IQ, 0.53 to 0.77), ranging from a minimum of 0, 21 to a maximum of 3. The corresponding value for the M index in Scopus database was the median of 0.67 (IQ, 0.51 to 0.89), ranging from a

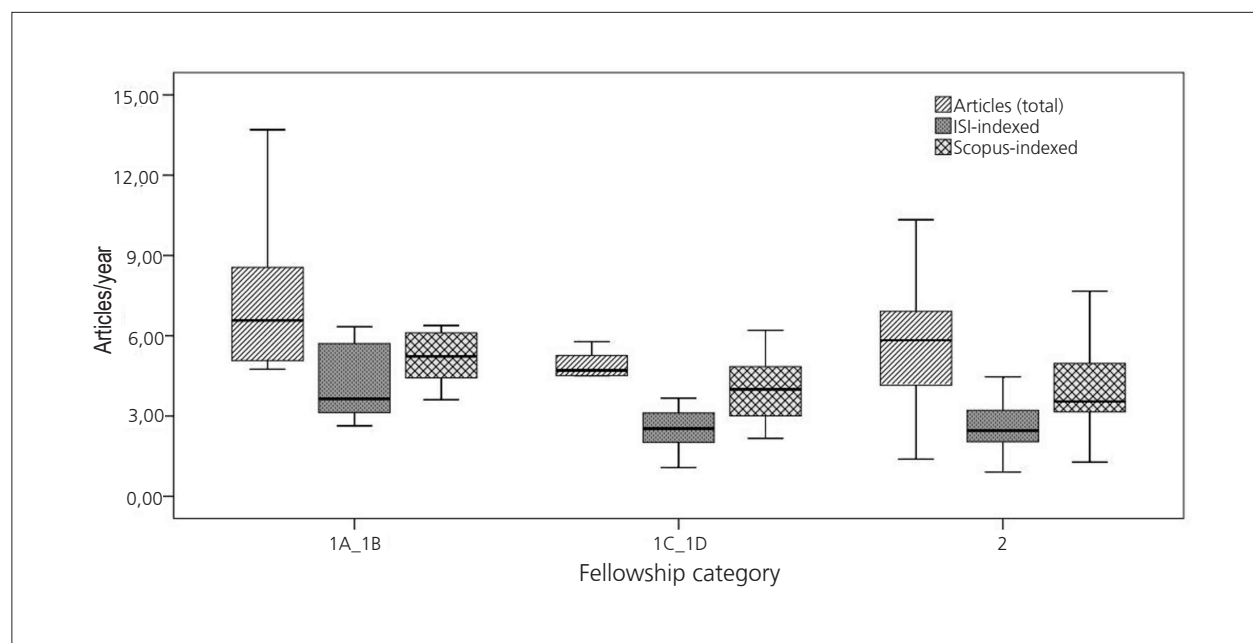
minimum of 0.14 to a maximum of 4.38. However, there was no significant difference for the M index for the fellows 'categories in both databases: ISI (KW = 3.6  $p = 0.16$ ) and Scopus (KW = 2.97,  $p = 0.22$ ). Figure 5 illustrates the distribution of indexes H (5A) and M (5B) in both databases, according to the category of the researcher's fellowship.

## Discussion

This cross-sectional study focusing on CNPq Cardiology researchers, showed a group of researchers with high

**Table 2 - Distribution of 10 journals indexed in the JCR most used for publication by researchers of CNPq in the field of Cardiology**

Journals Indexed	2009 Impact Factor	Articles	%
Arq Bras Cardiol	1.31	493	16.6
Braz J Med Biol Res	1.07	120	4.05
Int J Cardiol	3.46	81	2.73
Am J Cardiol	3.57	76	2.56
Circulation	14.81	52	1.56
J Am Coll Cardiol	12.53	46	1.55
J Am Soc Echocardiography	2.98	44	1.48
Atherosclerosis	4.52	33	1.11
Hypertension	6.61	33	1.11
Am Heart J	4.35	30	1.01

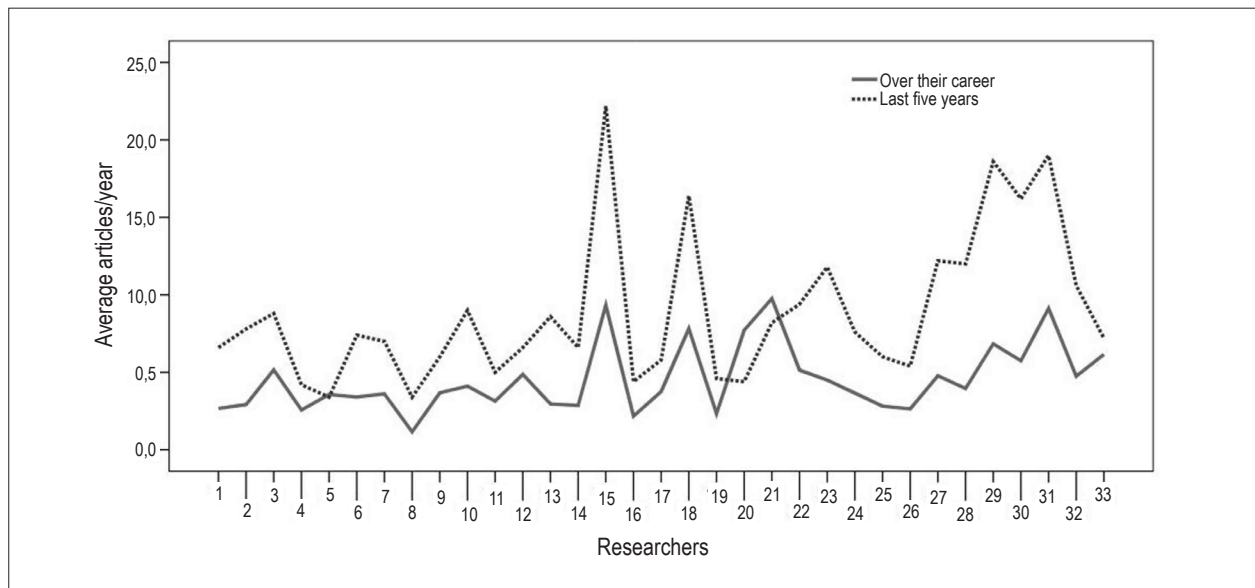


**Figure 2 - Average number of articles published annually by the researchers of CNPq with expertise in cardiology, according to the category of research fellowship throughout their career.**

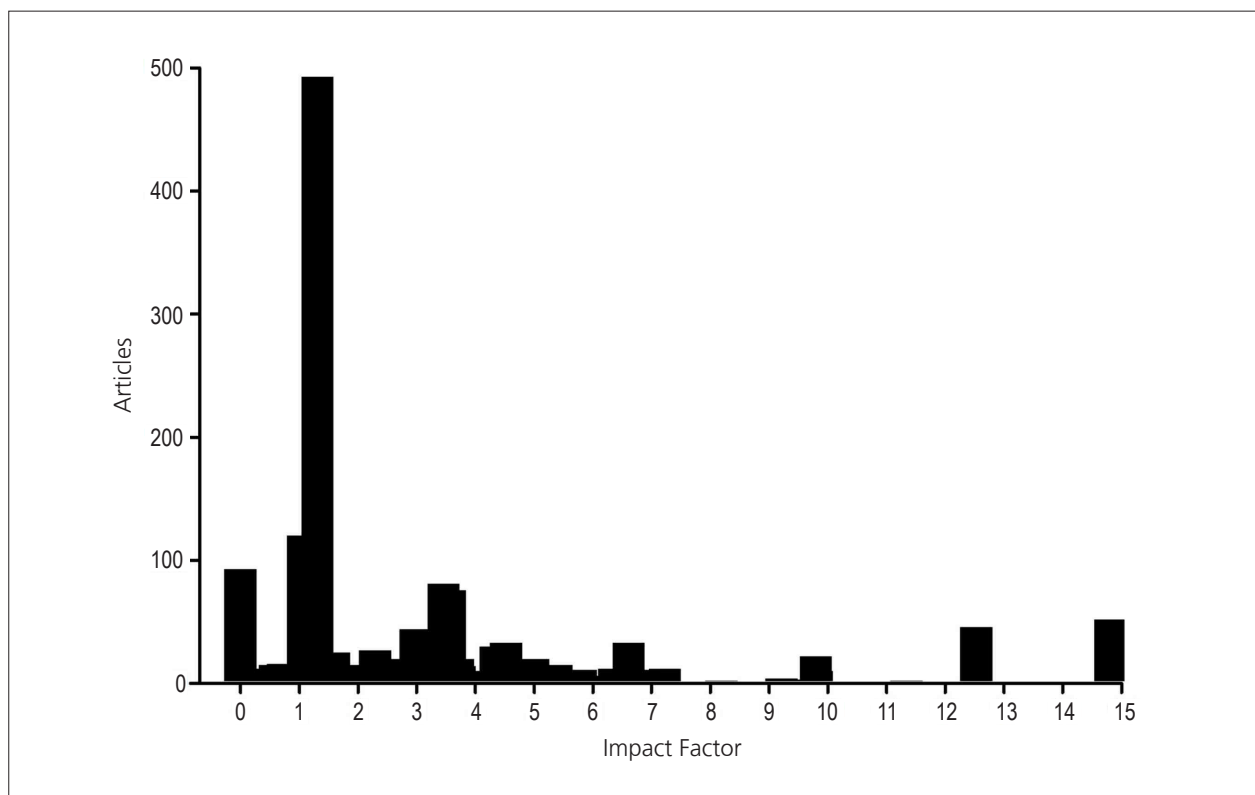
## Original Article

scientific productivity in terms of quantity and quality. In a comparative study, Rodrigues et al<sup>12</sup> showed that research on cardiovascular diseases is an area that can

be characterized as well established in our country, in contrast with research in other areas such as oncology and infectious diseases.



**Figure 3** - Average number of articles published annually by the researchers of CNPq with expertise in cardiology comparing two periods: the researcher's career and the period 2004-2008.



**Figure 4** - Distribution of impact factor of journals in which articles were published by researchers of CNPq with expertise in Cardiology. The figure shows the distribution of impact factor to the limit of 15. Eight journals with impact factors above 15 were excluded from the chart.

**Table 3 - Distribution of 10 journals not indexed in the JCR most used for publication by researchers of CNPq in the field of Cardiology**

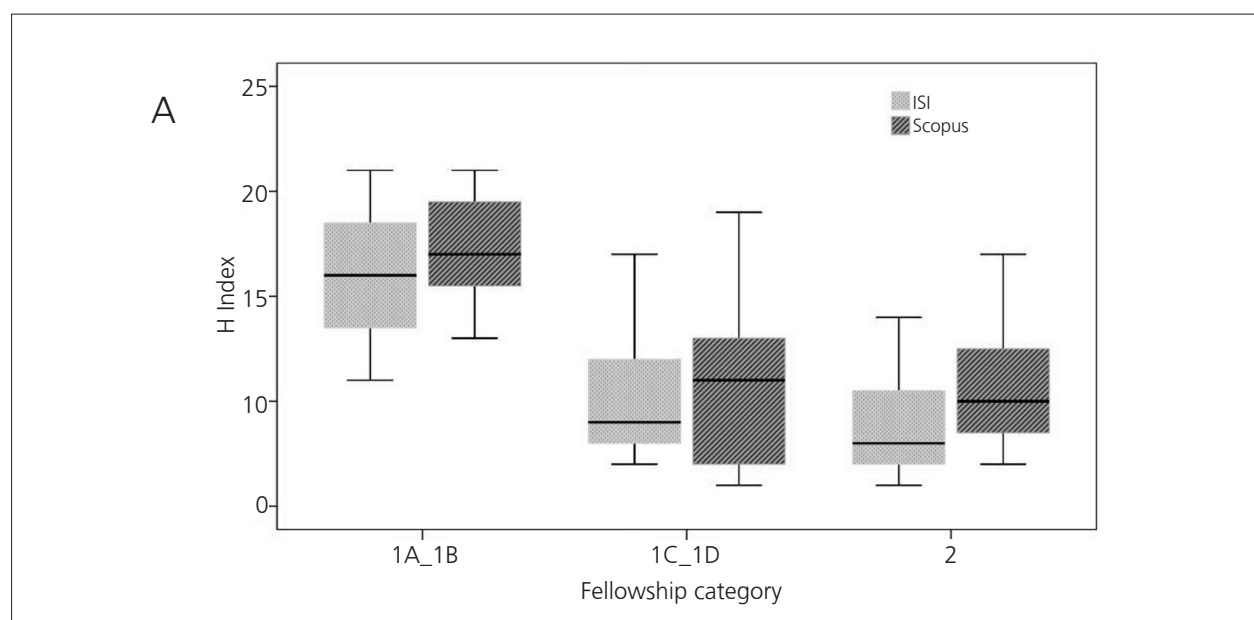
Journals not indexed	2009 Impact Factor	Articles	%
Rev Bras Hipertensão	-	93	3.14
Rev Soc Cardiol SP	-	80	2.70
Hipertensão (SP)	-	42	1.41
ECO	-	40	1.35
Rev Bras Cirurg Cardiovascular	-	37	1.25
Rev Soc Cardiol RGS	-	34	1.14
Revista do HCPA	-	23	0.77
Rev Bras Cardiologia Invasiva	-	21	0.70
Rev Bras Latino-Americana Marcapasso y Arritmia	-	21	0.31
Revista Brasileira de Ecocardiografia	-	15	0.50

However, our data show that there is a large concentration of research in a few institutions and few regions of the country. The findings of this study also show that three institutions in São Paulo (USP, UNESP and UNIFESP) are strong training centers and producers of scientific knowledge in the field of Cardiology in our country. This concentration observed in our analysis is also reported by other authors who assessed other areas of knowledge<sup>6</sup>. In our previous study, including all of the 441 researchers of Medicine, a large concentration of these in the Southeast was also observed (79%)<sup>11</sup>.

One fact that attracts attention in our study is that in a universe of approximately 12,000 cardiologists affiliated with the Brazilian Society of Cardiology, only 33 (<0.3%) are CNPq research fellows. It is interesting to note, however, that in our descriptive analysis of 411 CNPq medical research fellows, each major area of medical specialty accounted for approximately 8% to 12% of the researchers. Thus, we believe that the main problem is the lack of productivity fellowships (only around 450 for Medicine, currently). Despite CNPq's efforts to increase in the number of fellowships in recent years, it should be recognized that this number is still quite limited, making young researchers in cardiology and other fields of knowledge to face difficulty in competing and winning fellowships of productivity research.

The analysis of cardiology researchers showed significant production efforts with a significant number of scientific articles published in journals of medium to high impact factor. Over the academic career, the average was 89 articles per researcher, while the average of 411 researchers in medicine was 102 articles per researcher, but with a median of 87 articles<sup>11</sup>. It is noteworthy that approximately 55% of all published articles were indexed in the database Web of Science (ISI) and 75% in the Scopus database. It is interesting to note that these qualitative data are superior to those found in the overall analysis of medical researchers.

It is noteworthy that approximately 55% of all published articles were indexed in the database Web of Science (ISI) and 75% in the Scopus database. However, data obtained in the field of cardiology were similar to those of 39 CNPq researchers in the areas of Urology and Nephrology, which published an average of 82 articles over their academic career, with 58% and 69% indexed in the databases ISI and Scopus<sup>13</sup>, respectively.

**Figure 5 - H index (panel A) and M index (panel B) of CNPq researchers with expertise in cardiology, according to the category of productivity fellowship.**

Another issue to be emphasized in our study is the significant increase of scientific production in the last 05 years, as also observed in other areas such as Dentistry, Public Health and Physiotherapy<sup>6-8,10</sup>.

On average, the cardiology researchers of CNPq doubled the number of articles published, comparing the annual average throughout their career and in the last 05 years.

In the overall analysis of CNPq medical researchers, only 04 areas had increased production by more than twice in the period 2004-2008, comparing the average number of publications throughout their career: Cardiology, Ophthalmology, Internal Medicine, and Pneumology<sup>11</sup>. This quantitative increase in scientific production correlates with the general increase in scientific production in Brazil and possibly reflects the various inducing mechanisms established by various national agencies for research funding<sup>14</sup>.

Another relevant point that can be highlighted in our analysis is that 16.6% of the articles of the leading researchers in cardiology were published in the Brazilian Archives of Cardiology, demonstrating the importance of this journal for the dissemination of knowledge and scientific production in Cardiology in our country. It should be noted that, out of the 587 journals identified as being used by researchers in cardiology, 340 (58.0%) are indexed in the database Web of Science, with a median of 2.65 IF. It is noteworthy that approximately 16.0% of these journals have IFs greater than 05.

In the database Web of Science, 7,347 journals are currently registered and only 438 (6.0%) have an impact factor greater than or equal to 5, most of which in the area of basic science. The same database shows that out of 97 journals indexed in the field of cardiology, only 10 (10.5%) had IF greater than 05. These data further emphasize the quality of scientific production of this group of researchers. In spite of the recent criticism on the use of journal impact factor in the evaluation of institutions and researchers, this index is still adopted by many research funding agencies, such as CNPq itself<sup>5,15-21</sup>.

Among the many criticisms of the impact factor, we highlight studies by Seglen that demonstrate a poor correlation between the IF of a particular journal and the

citation rate of articles by researchers or research groups<sup>22,23</sup>. In this context, recent studies correlating various indicators of quality of scientific production may contribute to a more accurate assessment of Brazilian research in various areas of knowledge.

## Conclusion

In this research, we found that researchers in the field of cardiology, though in small percentage compared to professionals working in the country, present a relevant scientific production from a quantitative and qualitative viewpoint. Further studies are needed to assess the impact that scientific production in our country in the area of Cardiology represents in terms of international scientific production.

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## Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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## Study Association

This study is not associated with any post-graduation program.

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