Original Article

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Profile and scientific production of Brazilian researchers in dental materials

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Abstract

Aim: To describe the demographic characteristics and academic production of the National Council for the Development of Science and Technology (CNPq) researchers whose areas of expertise focus on dental materials. **Methods:** Secondary data were obtained from the details of dentistry researchers registered as receiving a CNPq grant for scientific productivity. Variables such as gender, category of scientific productivity grant, time of completion of PhD program, geographical distribution and affiliated institution, scientific production and human resources training were analyzed. Data from 2007-2009 triennium were considered. Mann-Whitney and chi-square tests compared the variables. **Results:** Researchers in categories 1A + 1B are those who completed their PhD program more than 14 years ago. All (100%) of dental material researchers are dentists and affiliated to universities, being approximately 92% of those affiliated to public institutions. Male gender (62.2%) and category 2 grant (40.5%) are prevalent, and a high concentration of CNPq grantees in the southeastern region (75.7%) was observed. In general, there was a predominance of publications in CAPES Qualis B journals (59.0%), but a predominance of publications by new doctors in CAPES Qualis A2 and B1 journals was found. A higher mean of publications of book chapters (0.97) compared with full publications of books (0.43) per researcher was observed. Annually, researchers supervised more scientific initiation grants (median = 0.45), followed by doctoral (mean = 0.36) and master students (median = 0.30). **Conclusions:** There is a high concentration of researchers in the southeastern region, predominance of male gender and scholars in grant category 2. Publications are mainly in CAPES Qualis B journals. and researchers in grant categories 1C and 1D and with less time doctoral produce more publications. The publication of books chapters is larger than entire books. The researchers supervised more undergraduate students, followed by PhD and master's degree students annually.

Keywords: scientific production indicators, dental materials, health sciences.

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Introduction

Increasingly, science and technology and educational qualifications are seen as fundamental pillars of economic, technological and industrial development of established and recently developed nations, and the essential foundation of a virtuous cycle that underpins the growing socioeconomic progress of these countries[1]. The development of infrastructure in science and technology has

boosted quantitative indicators in science, technology and innovation since 2000[2-3].

In general, the rise of Brazilian scientific production constitutes a high percentage compared with other countries, as confirmed by data from ISI (Institute for Scientific Information) and SciELO (The Scientific Electronic Library Online), and national scientific production ranks thirteenth in the world[4], accounting for approximately 2% of total world scientific production, surpassing countries such as Switzerland (1.42%), Taiwan (1.72%) and Netherlands (1.99%) and approaching the output of the Australia (2.72%) and South Korea (2.56%)[5].

In Brazil there are two main federal science funding agencies, CAPES (Coordination for the Improvement of Higher Education Personnel, part of the Ministry of Education) and CNPq (National Council for the Development of Science and Technology, part of the Ministry of Science and Technology). CNPq is the funding agency that evaluates and funds researchers, and CAPES evaluates and supports graduate programs. CNPq funds research based on peer evaluation of the merits of the candidate and their proposals. CNPq also provides a particular form of funding for research, scientific productivity fellowships. Researchers are currently classified in two main categories for this fellowship: researcher category 1 and researcher category 2, in a decreasing order of value and prestige. Category 1 includes only researchers of notorious scientific productivity and is subdivided into four levels: 1A, 1B, 1C and 1D, category[6].

State foundations for research support in the Brazilian states were created from the Constitution of 1988[7]. Currently, these foundations have been organized into a National Council of Research Foundations. These state articulations and their interaction with the ministries and agencies at the federal level have integrated programs, added resources, and catalyzed actions countrywide. All this creates an environment of encouragement that can produce significant changes that place Brazil in a position to keep up with global competition[8].

As the profile of these researchers has begun to interest the scientific community in recent years, several studies have examined the profile and the scientific production of researchers from the CNPq in various knowledge areas[9-13]. Recent studies, especially in health sciences, have revealed the profile of medical researchers, comparing it with various other areas[4,9-13]. Apart from the study by Cavalcanti *et al.* (2008)[11] data for dentistry are scarce.

This cross-sectional study describes the demographic characteristics and the academic production of CNPq researchers whose areas of expertise are primarily focused on dental materials. The hypothesis was that CNPq researchers are geographically concentrated in the southeastern region of Brazil, are linked to educational institutions and have completed a PhD in the last two decades.

Material and methods

Study design

This study, used cross-sectional and descriptive secondary data, obtained from details of CNPq researchers in health sciences and dentistry and the Lattes curriculum vitae platform available on the CNPq website[14].

Population and sample

First, 187 researchers registered as receiving a CNPq scientific productivity grant were included in the database, according to the list provided by the CNPq in September 2010[15]. The researcher's specific area as described on the Lattes[16] platform was used to determine the area of expertise focus. When such information was lacking, the researcher's scientific production in the 2007-2009 triennium was assessed and the predominating area was determined based on the journals the authors has published, the main topic of the research and/or supervised themes at-tributed to the researcher. This methodology identified 37 researchers in the area of dental materials.

Inclusion and exclusion criteria

The researchers in this study were those whose CNPq scientific productivity grant was still valid when the data were collected for dental materials researchers. Not included in the analysis were researchers who had their scholarship suspended, as in cases of post-doctoral students living abroad.

Data collection protocol:

The researchers' area of action was identified by reading the text supplied by the author in the Lattes curriculum, also publicly available on the electronic site in September 2010. If, however, the information contained in the text was not enough to provide identification of the area in which there was a predominance of published and/or supervised issues, the researcher's productions during the last five years was assessed.

Variables of interest

The following variables for the CNPq researchers were analyzed: gender, category of scientific productivity grant (2, 1A, 1B, 1C, 1D and senior), time of completion of PhD program, geographical distribution and category of institution to which the researchers were affiliated, scientific productions (scientific papers, book chapters, entire books and patents) and human resources training. Analysis of scientific production included only publications of scientific papers in journals and supervisions were restricted to the 2007-2009 triennium. To classify the papers, the Qualis System[17] was adopted - A1, A2, B1, B2, B3, B4, B5 or C, taking into account the impact factor of the journal citation reports[15,18]. Lattes curricula were consulted between September and November 2010.

Statistical analysis

After construction of the database using the statistical software SPSS 18.0 for Windows (SPSS, Chicago, IL, USA), a descriptive and univariate statistical analysis of the data obtained was performed. Continuous data were reported with median and interquartile range between 25 and 75 percentiles.

The nonparametric Mann-Whitney test was used to compare these variables. Dichotomous or nominal variables were compared by chi-square tests.

Results

There was a predominance of male gender (62.2%) and grant category 2 (40.5%) (Table 1). The distributions of the 37 researchers by gender and grant category are summarized in Table 2, where a significant association (p= 0.01) with the time of completion of PhD program can also be observed: most researchers in categories 1A and 1B are those who completed their PhD program more than 14 years ago. Also, in relation to the time of completion of the PhD program, dental materials researchers mean time was 14.49 years (standard deviation= 7.17), with a maximum of 42 years and a minimum of 5 years. The median time was 13 years (interquartile range = 9.5 to 17.5 years). All (100%) dental materials researchers are dentists.

Table 1 also shows the geographical origin of CNPq dental materials researchers. Two Brazilian states accounted for approximately 86% of the researchers (São Paulo and Rio Grande do Sul), with the majority in São Paulo state (73%). About 75% of these researchers are affiliated to state institutions, being 16.2% to federal institutions and only 8.1% to private institutions. Regarding affiliation, the dental materials researchers are distributed over 12 different institutions in the country and three institutions accounted for approximately 70% of them: USP (29.7%), UNICAMP (27%) and UNESP (13.5%).

Table 3 presents the scientific production and supervisory work of CNPq dental materials researchers. As regards their academic career, the researchers supervised 209 scientific initiation grants, with a median of six (IQ = 2-7) for researchers, 199 master's dissertations (median of four, IQ = 2.5 - 6) and 192 PhD theses (median of five, IQ = 3.5 - 7.5). The median of the values set by the time of completion of PhD program shows that researchers supervised 0.45 BIC (IQ =0.22-0.64), 0.30 master's dissertations (IQ = 0.16 - 0.48) and 0.36 PhD theses (IQ= 0.25 - 053) annually are also presented in Table 3.

In terms of the 2007-2009 triennium, the CNPq dental materials researchers published 1110 papers, with a median of 26 papers/researcher (IQ = 19-38). The median of the values adjusted by the time from completion of the PhD program showed researchers published 2.21 (IQ = 1.14 - 4.02) papers annually (Table 3). Overall, there was a predominance of publications in Qualis B journals, compared with those in Qualis A and Qualis C, respectively (Table 4). Among the stratifications, there was a predominance of

Table 1. Distribution of researchers according to gender, grant category, affiliated institution, Brazilian region of origin, Brazilian State and institution category.

Variables	n	%
Gender		
Male	23	62.2
Female	14	37.8
Grant category		
1A	3	8.1
1B	5	13.5
1C	4	10.8
1D	10	27.0
2	15	40.5
Affiliated Institution		
USP	11	29.7
UNICAMP	10	27.0
UNESP	5	13.5
UFPEL	2	5.4
UEPG	2	5.4
SL Mandic	1	2.7
UFPA	1	2.7
UFSC	1	2.7
UFSM	1	2.7
UFU	1	2.7
ULBRA/RS	1	2.7
UPF	1	2.7
Brazilian region of origin		
Southeastern	28	75.7
South	8	21.6
North	1	2.7
Brazilian State		
São Paulo	27	73.0
Rio Grande do Sul	5	13.5
Paraná	2	5.4
Minas Gerais	1	2.7
Pará	1	2.7
Santa Catarina	1	2.7
Institution category		
State	28	75.7
Federal	6	16.2
Private	3	8.1

Table 2. Bivariate analysis between grant categories and gender, Brazilian region of origin, affiliated institution and time since completion of PhD program.

	Grant category			
	1A + 1B	1C + 1D	2	*p* value
Gender				
Female	2 (25.0)	6 (42.9)	6 (40.0)	0.69
Male	6 (75.0)	8 (57.1)	9 (60.0)	
Brazilian region of origin				
Southeastern	5 (62.5)	10 (71.4)	13 (86.7)	0.30
Southern	2 (25.0)	4 (28.6)	2 (13.3)	
Northern	1 (12.5)	0 (0.0)	0	
Institution category				
State public	5 (62.5)	11 (78.6)	12 (80.0)	0.91
Federal public	2 (25.0)	2 (14.3)	2 (13.3)	
Private	1 (12.5)	1 (7.1)	1 (6.7)	
Time since completion of PhD program				
1 to 13 years	1 (12.5)	11 (78.6)	8 (53.3)	0.01
More than 14 years	7 (87.5)	3 (21.4)	7 (46.7)	

Table 3. Descriptive analysis of scientific production and supervisions of CNPq dental material researchers in absolute numbers and set by year of completion of PhD program.

	Total (Min-Max)		Mean (DP)		Median (iQ)	
	Absolute	Set by	Absolute	Set by	Absolute	Set by
Scientific productions						
Total number of publications (papers)	1110 (4-67)	98.2 (0.1-8.0)	30.0 (15.39)	2.6 (1.8)	26.0 (19.0-38.0)	2.2 (2.8)
A1	174 (0-14)	15.7 (0-1.7)	4.7 (3.81)	0.4 (0.4)	4.0 (2.0-7.5)	0.3 (0.4)
A2	271 (0-17)	26.3 (0-3.0)	7.3 (4.66)	0.7 (0.6)	7.0 (4.0-9.5)	0.5 (0.6)
B1	204 (0-17)	17.4 (0-1.1)	5.5 (4.43)	0.4 (0.3)	5.0 (2.0-7.5)	0.3 (0.6)
B2	142 (0-13)	12.8 (0-2)	3.8 (3.40)	0.3 (0.4)	3.0 (1.0-6.0)	0.2 (0.4)
B3	126 (0-17)	10.4 (0-1.3)	3.4 (4.49)	0.2 (0.3)	2.0 (0.5-4.5)	0.1 (0.3)
B4	143 (0-11)	11.7 (0-1.0)	3.8 (3.11)	0.3 (0.2)	4.0 (1.0-6.0)	0.2 (0.3)
B5	37 (0-9)	2.6 (0-0.6)	1.0 (1.76)	0.0 (0.1)	0.0 (0.0-1.5)	0.0 (0.1)
C	8 (0-3)	0.6 (0-0.2)	0.2 (0.58)	0.0 (0.0)	0.0 (0.0-0.0)	0.0 (0.0)
Other	5 (0-4)	0.3 (0-0.3)	0.1 (0.67)	0.0 (0.0)	0.0 (0.0-0.0)	0.0 (0.0)
Total number of published book chapters	36 (0-9)	2.5 (0-0.4)	0.9 (2.08)	0.0 (0.1)	0.0 (0.0-1.0)	0.0 (0.1)
Total number of published books	16 (0-5)	1.5 (0-0.6)	0.4 (1.14)	0.0 (0.1)	0.0 (0.0-0.0)	0.0 (0.0)
Human resources training						
Scientific initiation grants supervisions	209 (0-20)	19.9 (0-4)	5.6 (3.8)	0.5 (0.6)	6.0 (2.0-7.0)	0.4 (0.4)
Master dissertation supervisions	199 (0-38)	18.6 (0-4.2)	5.3 (6.7)	0.5 (0.8)	4.0 (2.5-6.0)	0.3 (0.3)
Doctoral thesis supervisions	192 (0-12)	14.8 (0-0.8)	5.1 (2.9)	0.4 (0.0)	5.0 (3.5-7.5)	0.3 (0.2)

publications in Qualis A2 journals, with a median of seven papers/researcher (IQ = 4 - 9.5), and Qualis B1 journals, with a median of five papers/researcher (IQ = 2 - 7.5) (Table 3). Table 4 compares the number of papers published for variables such as grant category, time since completion of PhD program, affiliated institutions and region of origin. It is possible to observe that researchers in category 1C and 1D (p = 0.02) who completed their PhD program more recently (p = 0.056) produce more papers and their publications are mainly in Qualis A2 journals (p = 0.03) and B1 (p = 0.056). Publication rate in Qualis C journals is higher at private institutions (p = 0.04).

Also, as regards indicators of scientific output, there was an upper mean of publications of book chapters (0.98, SD = 2.08) compared with full publications of books/researcher (0.43, SD = 1.14) (Table 3). There was a statistically significant difference in the number of books (p = 0.00) and book chapters (p = 0.05) published for institutions to which the CNPq researchers are affiliated, with more publications by researchers working in private institutions than those in public institutions (Table 5). As regards the geographical region where the institutions are located,

Table 4. Number of published papers by year of completion of PhD program and grant categories, time since completion of PhD program, affiliated institution and Brazilian region of origin.

	A1	A2	**B1**	**B2**	B3	B4	**B5**	C	OUTRAS	**TOTAL**
Grant Category										
1A + 1B	19.3	18.3	**20.0**[ab]	**20.3**[ab]	24.0	21.5	**24.7**[a]	18.2	18.0	**21.6**[ab]
1C + 1D	21.2	21.0	**25.0**[b]	**24.2**[b]	19.9	17.7	**21.1**[ac]	18.5	20.6	**23.8**[b]
2	16.7	17.4	**12.8**[a]	**13.40**	15.4	18.7	**13.9**[b]	19.8	18.0	**13.0**[a]
p value	0.53	0.65	**0.01**	**0.02**	0.16	0.73	**0.02**	0.84	0.19	**0.02**
Time from completion PhD program										
1 to 13 years	19.6	**22.5**	**22.1**	21.0	19.4	18.4	18.6	19.6	18.9	**22.1**
More than 14 years	18.2	**14.8**	**15.3**	16.5	18.5	19.6	19.3	18.2	19.0	**15.3**
p value	0.71	**0.03**	**0.056**	0.22	0.79	0.75	0.85	0.73	0.99	**0.05**
Institution category										
State	19.6	19.7	20.8	18.9	17.6	17.8	17.5	**18.6**[a]	19.3	19.2
Federal	18.7	20.4	14.3	19.5	27.4	19.5	23.5	**16.0**[ac]	18.0	20.0
Private	13.8	9.1	11.0	18.1	15.0	28.5	23.5	**28.0**[b]	18.0	14.6
p value	0.68	0.25	0.16	0.98	0.09	0.26	0.27	**0.04**	0.72	0.76
Brazilian region of origin										
Southeastern	17.8	18.7	20.2	19.4	17.9	18.7	18.0	18.6	19.3	18.6
Southern	25.1	21.9	17.5	19.3	23.3	21.8	20.5	20.5	18.0	22.6
Northern	2.5	1.5	2.0	3.5	13.5	4.0	33.5	16.0	18.0	1.0
p value	0.07	0.20	0.24	0.34	0.39	0.28	0.25	0.73	0.72	0.16

differences were observed in the production of books between the southern and southeastern regions, with the largest number of books published in the southern region (p = 0.00) (Table 5).

Table 5. Number of published book chapters and entire books and grant categories, time since completion of PhD program, affiliated institution and Brazilian region of origin.

	Book Chapter	Books
Grant category		
1A + 1B	17.5	18.3
1C + 1D	20.0	19.8
2	18.7	18.5
p value	0.82	0.83
Time since completion of PhD program		
1 to 13 years	19.5	19.5
More than 14 years	18.3	18.3
p value	0.75	0.75
Institution category		
State	**17.9**[a]	**16.5**[a]
Federal	**17.8**[ab]	**22.6**[ab]
Private	**31.3**[b]	**34.1**[b]
p value	**0.05**	**0.00**
Brazilian region of origin		
Southeastern	19.0	**16.5**[a]
Southern	17.5	**27.8**[b]
Northern	28.5	**16.0**[ab]
p value	0.52	**0.00**

Discussion

This cross-sectional study, focusing on CNPq researchers in dental materials, showed that there is a significant geographic concentration of research in this area of knowledge: the southeastern region accounts for over seventy-five percent of researchers in this area. In particular, the São Paulo state, with its three state public schools and one private school, accounts for 73% of them. The current findings also show a large imbalance between the types of institution to which these researchers are affiliated, 75.7% being linked to state institutions, 16.2% to federal institutions and only 8.1% to private institutions. The concentration of dental research described here is also recognized in similar studies where other subject areas were surveyed [4,12-13].

Even in terms of geographical and institutional distribution, it was observed that all researchers investigated are linked to universities and none of them are linked to research institutes, hospitals or foundations. These features corroborate the observations of Contini and Séchet (2005)[19] about the large gap that still exists between science and technology in Brazil, although it is clear from the survey that there has been some progress in Brazilian scientific production and the growth of private institutions participation[4].

Considering the number of grants of scientific productivity in the area of dental material per million inhabitants, the national mean was 0.19. The southern and southeastern regions showed the top means, 0.36 and 0.29, whereas the northern region showed a mean much lower than the national mean (0.06). These indicators are also similar to those collected by Martelli-Junior *et al.* (2010)[4] and Santos *et al.* (2010)[12], who found that the national mean is lower compared with the means of the southeastern and southern regions.

Another important feature of scientific activity refers to the formation of qualified human resources, especially masters and doctors. This research found a significant involvement of the CNPq researchers in training new researchers. The medians of supervision set by the time since completion of PhD programs were 0.36 and 0.30 per year for masters' dissertations and PhD theses, respectively. These values are similar to those found by Martelli-Junior *et al.* (2010)[4] in an analysis of CNPq researchers in the medical field. When, however, we considered the production of the CNPq researchers in the 2007-2009 triennium, the means of supervisions were 5.19 and 5.38 for dissertations and theses respectively. These values, compared with the results of Cavalcante *et al.*[11] in their study on the profile of CNPq researchers in the area of dentistry in 2003-2005 (2.2 PhDs and 3.6 masters) show a significantly increased productivity, possibly reflecting the impact of CAPES and other funding agencies on the production of qualified human resources at postgraduate level in recent years[4].

According to Santos *et al.* (2009)[13], bibliometric indicators highlight the dramatic changes in the panorama of scientific research in the last 10 to 15 years. Although on the one hand more than 70% of the world belongs to the axis United States/European Community/Japan, on the other there has been a dramatic growth in countries like Ireland and China and other impacts such as the decline in Britain. Invariably, the expansion in international and Brazilian scientific production has led to a considerable increase in competition for research funding and reduced public resources for this purpose[20].

Despite some dental material researchers have published some of their articles together, thus incurring in a double-counting of papers, events like these constitute limitations of the this study that reveals 1110 articles published in journals in the three years from 2007 to 2009, with a median of 26 articles per researcher in total or articles 2.21 annually, which shows that scholarship holders in the category 1C and 1D who completed their PhD more recently produce more articles and publications, mainly in Qualis A2 and Qualis B1 journals. Similar findings are presented in other studies that have looked more broadly at the areas of dentistry, public health and physical therapy[9-13,21-23]. This quantitative increase in scientific production in the area of dental materials accompanies the general increase in scientific production in Brazil and possibly reflects the various inductor mechanisms established by various national funding agencies. Among these, the system for evaluation of graduate students stands out, which, through an analysis by CAPES, prioritizes the number and quality of published papers to conceptualize national programs[24]. In this context, this research also shows

that the production of papers in Qualis C journals is higher among grantees affiliated to private institutions, as well as most of the publications of books and book chapters.

The own scientific productivity grant signals another induction mechanism that promotes competition among peers, and encourages the training of new researchers as well as encourages the search for impact publications. The result is a qualitative increase of Brazilian scientific production, gaining greater international integration of production, and is proof of the superiority of publications in Qualis A2, B1 and A1 journals in the three years evaluated by this research. For these reasons, this study suggests that knowing the profile of researchers can define more effective strategies to encourage scientific production and thus the demand for funds to support research projects. In the present study, it was observed a high concentration of researchers with CNPq productivity grants in the southeastern region of the country.

Although distributed in 12 States of the federation, an absolute predominance of the São Paulo state was observed, which could be explained due to the actions of its state foundation for research support, as well as due to the higher number of state universities. Also, there was a quantitative predominance of males and scholars in category 2. All researchers are affiliated to universities, and are graduates in dentistry who completed their PhD program 14.49 years ago on average.

The scientific production indicators point to a predominance of publications in Qualis A2 and B1 journals, and the total dominance of stratification in Qualis B. Although it was observed that the stock categories 1C and 1D and less time doctoral produce more papers and other publications, these are mainly in Qualis A2 journals. Even on indicators of scientific production, the publication of books chapters by the researchers showed to be about three times larger than the publication of entire books. As regards the training of human resources, the researchers supervised more undergraduate students, followed by PhD and master's degree students annually. Researchers in category 1C and 1D, and with less time from completion of PhD program have done more supervisions.

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