

Scientific production indicators and researchers training in the Brazilian Collective Health

Indicadores de produção científica e formação de pesquisadores na Saúde Coletiva brasileira
Indicadores de la producción científica y la formación de investigadores en la Salud Colectiva Brasileña

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ABSTRACT

Objective: To evaluate the scientific production, generation of patents and researchers training among Brazilian Collective Health professors who were awarded a Pq/CNPq productivity scholarship from 2000 to 2012 and to verify the existence of an association between these production modalities and the characteristics of the professors, such as gender, training and origin. **Method:** An analytical cross-sectional study was carried out from 2000 to 2012, and the Prevalence Ratio was calculated using Poisson regression. For the statistical analyzes, the SPSS[®] program was used. **Results:** Of particular note are regional and institutional concentration, consistent scientific output, important researchers training, and a primordial but still timid generation of patents. We found an association between the “scientific production”, “researchers training” outcomes, and the gender characteristics, such as the formation and origin of the Pq professor. **Conclusion:** These findings can guide the decision-making aimed at the deconcentration of scientific production and researchers training in the Brazilian Collective Health.

Descriptors: Scientific Production Indicators; Researchers; Development of Personnel; Incentive; Public Health.

RESUMO

Objetivo: Avaliar a produção científica, geração de patentes e formação de pesquisadores entre docentes da Saúde Coletiva brasileira que foram contemplados com bolsas de produtividade Pq/CNPq no período 2000-2012 e verificar a existência de associação entre estas modalidades de produção e características dos docentes, como gênero, formação e origem. **Método:** Foi realizado um estudo transversal analítico no período 2000-2012 e foi calculada a razão de prevalência por meio da regressão de Poisson. Para as análises estatísticas, utilizou-se o programa SPSS[®]. **Resultados:** Destacam-se a concentração regional e institucional, consistente produção científica, importante formação de pesquisadores e primordial, mas ainda tímida geração de patentes. Foi encontrada associação entre os desfechos “produção científica”, “formação de pesquisadores”, e as características de gênero, como formação e origem do docente Pq. **Conclusão:** Estes achados podem orientar a tomada de decisões voltadas para a desconcentração da produção científica e formação de pesquisadores em Saúde Coletiva no Brasil.

Descritores: Indicadores de Produção Científica; Pesquisadores; Desenvolvimento de Pessoal; Incentivo; Saúde Pública.

RESUMEN

El objetivo del trabajo fue evaluar la producción científica, la generación de patentes y la formación de investigadores entre docentes de la Salud Colectiva brasileña que fueron contemplados con becas de productividad Pq/CNPq en el período de verano y verificar la existencia de la asociación entre estas modalidades de producción; y las características de los docentes, como el género, la formación y el origen. **Método:** Se realizó un estudio transversal analítico en el período de referencia y se calculó la razón de prevalencia por medio de la regresión de Poisson. Para los análisis estadísticos se utilizó el programa SPSS[®]. **Resultados:** Se destacan la concentración regional e institucional, la consistente producción científica, la importante formación de investigadores; y la significativa, pero aún tímida, generación de patentes. Se encontró una asociación entre los resultados de la producción científica, la formación de investigadores y las características género, formación y origen del docente Pq. **Conclusión:** Esos hallazgos pueden orientar la toma de decisiones dirigidas a la desconcentración de la producción científica y la formación de investigadores en Salud Colectiva en Brasil.

Descriptorios: Indicadores de Producción Científica; Investigadores; Desarrollo de Personal; Incentivo; Salud Pública.

INTRODUCTION

Collective Health is an important field of action in the Brazilian Unified Health System (SUS – *Sistema Único de Saúde*), reaffirming a relationship between the area and the national health policy, in terms of historical construction and way of thinking and performing health⁽¹⁾. The origin of Brazilian Collective Health as a structured and structuring field of theoretical-political practices and knowledge was in the late 1970s, in a context in which Brazil was experiencing a military dictatorship. In this way, Collective Health is born, in this period, linked to the struggle for democracy and the Health Reform movement⁽²⁻³⁾. Health encompasses multidimensional aspects, so the practice of research in the field of Collective Health is built in an interdisciplinary way, reconciling concepts and methodologies of different disciplines⁽⁴⁾.

Collective Health can be understood as a scientific field where knowledge about health is produced and as the scope of practices where actions are carried out by several agents inside and outside the space conventionally recognized as a health sector⁽⁵⁾. With the development of Collective Health, there is also a need for researchers training and a well-established body of scientific production in this area⁽²⁾.

Collective Health designates a field of knowledge that refers to health as a social phenomenon of public interest. In the professional field, Collective Health proposes a new way of organizing the work process in health, emphasizing the promotion of health, the prevention of risks and aggravations and the improvement of the quality of life, favoring changes in the ways of life and in the relations between the subjects involved in health care⁽⁶⁾. In the doctrinal field, Collective Health presents bases in Social Medicine and adds socio-economic, political and cultural components, allowing the integration of different knowledge and practices that propose actions aimed at the satisfaction of social needs in Health⁽⁷⁾. Thus, as a field of theory and practice, Collective Health seeks, in reality, the means and the tools of intervention in the epidemiological profiles of the population of a given territory⁽⁸⁾.

Collective Health is of fundamental importance in the construction of the Brazilian public health system, since Brazil has a recognized tradition of action in this area, and Collective Health professionals have played a prominent role in the creation and implementation of SUS⁽⁹⁻¹⁰⁾.

In the last decades, the literature on Collective Health and training in Graduate Programs in this area has increased considerably, mainly encouraged by the growth of Graduate Programs in this field of knowledge in the country, although it is also a reality the regional concentration in relation to the training and development of personnel in the Brazilian Collective Health⁽⁹⁻¹⁰⁾. In 2013, there were 75 graduate programs in Brazilian Collective Health. These programs are larger in the Southeast (51%), Northeast (22%) and South (18%) regions and have a lower presence in the North (2%) and Center-West (7%) regions⁽¹⁰⁾. In view of this concentration, the Coordination of Improvement of Higher Level Personnel (Capes - *Coordenação de Aperfeiçoamento de Pessoal de nível Superior*) in its specific documents of areas, recognizing that there is still a need for incremental researchers training in the Brazilian Public Health to deepen the debate and

to training in this area to the demands of the implementation of SUS, proposes three directions for Graduate Programs in Brazilian Collective Health: Geographic deconcentration, training in strategic issues for which the country still has limited capacity, and deepening of partnership with others countries, with a view to sharing experiences⁽¹⁰⁾.

As a tool to encourage the Brazilian researcher and foster national Graduate studies, the Brazilian National Council of Scientific and Technological Development (CNPq - *Conselho Nacional de Desenvolvimento Científico e Tecnológico*) adopts a financing modality called Productivity scholarship in Research (Pq), aimed at researchers that stand out among their pairs. Among the criteria for granting the Pq scholarship we can find scientific production, training and development of researchers, and effective contribution to the research area⁽¹¹⁾.

Scientific and technological production and researchers training has gained increasing prominence in academic and governmental spaces. Scientific indicators are increasingly used to evaluate the development of thematic areas of knowledge and the development process of nations⁽¹²⁾, so it is important to evaluate the scientific and technological production and researchers training in Collective Health, in order to contribute for a better knowledge about the profile of this production and to point out information that contribute to a discussion about the need for policies aimed at the deconcentration of scientific production in the country.

OBJECTIVE

To evaluate the scientific production, generation of patents and researchers training in Brazilian Collective Health among professors who had been awarded Pq/CNPq scholarships in the period known as the “scientific production” and “researchers training” and characteristics of the professors, such as gender, training and origin.

METHOD

Ethical aspects

This work did not involve research with human beings, so it was not necessary for approval by the Research Ethics Committee. The data of scientific and technological production and researchers training by the Pq/CNPq fellows of Brazilian Collective Health, analyzed and discussed in this article, are available on the *Lattes* platform, in the *Curriculum Lattes* of the researcher, and are in the public domain of access unrestricted. The information contained in the article does not contain identification of individuals; the compilation of information contained in the study, as well as the statistical analyzes carried out, refers to the group of Pq/CNPq fellows of Brazilian Collective Health.

Design, place of study and period

This is a cross-sectional, analytical study with Brazilian Collective Health professors with Pq/CNPq scholarships awarded in the historical series 2000-2012.

Population and criteria of inclusion and exclusion

The population/universe of the study was the set of 296 Professors of Public Health contemplated with productivity scholarship (Pq) of CNPq from 2000 to 2012. The inclusion criterion was to be a scholarship holder in the area at CNPq, with Pq scholarship in the period of the study interest. The criterion of exclusion was not included in the list of Pq fellows of the Collective Health on the CNPq website that provides information about this universe.

Data source

The data source was the CNPq website⁽¹¹⁾, which provides the Pq list of scholarship holders from year to year and Curriculum Lattes (CL)⁽¹³⁾ from the Pq scholarship professor.

Methodological procedures

Three production modalities were evaluated: scientific production, production of technology and researchers training. It was considered as scientific production the publication of scientific articles, books and book chapters. As researchers training, scientific initiation guidelines, Master's Degree guidelines, Doctorate studies and Postdoctoral supervision were considered. As a production of technology, the generation of patents was considered. These three modes of production were evaluated separately. For the accomplishment of the study, Pq/CNPq researchers of Collective Health were divided into two groups: Group of higher production and group of lower production. In order to classify the Pq professors in these two groups, a general survey of the production of the entire Pq group of this area was carried out and the second tercile (66.7%) of the production quantitative. In the case of scientific production, in the lowest production group, production varied between 0 and 58 products, equivalent to 66.7% of the professors. In the group of higher production, it ranged from 59 to 328 products, equivalent to 33.3% of the Pq professors. In the case of the researchers training, in the lower training group, researchers training ranged from 0 to 23 guidance sessions, equivalent to 66.7% of the professors. In the group with the highest training, it ranged from 24 to 75 guidance sessions, equivalent to 33.3% of the professors.

Despite the greatness related to the production of patents among the group studied (four Collective Health professors with a Pq scholarship produced 6 patents in the period of interest), especially considering the financial cost, excessive bureaucracy involved in the innovation process and the search Besides the workload of Pq/CNPq scholarship holders, who are generally very involved in Graduate studies in this country, and the small investments that are made in Brazil in this area, it was not possible to carry out statistical tests for the outcome "technology production", depending on the, important but low numbers.

Variables of interest

The variables analyzed for all study participants were: I) gender and level (gender of the professor and level of the scholarship);

II) geographical location: region, state and institution of origin of the scholarship professor Pq/CNPq; III) training: institution and country where these scholarship holders Pq performed Doctorate and Postdoctoral; IV) scientific production (articles, books and book chapters) published by them; V) production of technology (patents generated); VI) researchers training (guidelines for scientific initiation, Master's Degree, Doctorate and Postdoctoral supervision) carried out by the Pq professors.

Statistical analysis

For the statistical analyzes, a database was built in SPSS® for Windows, version 20.0. Through this program, the frequency distributions of all investigated variables were constructed, and descriptive measures were calculated for the numerical variables (Mean and Standard Deviation). In order to evaluate the existence of an association between the dependent variables (scientific production and researchers training) and some characteristics of Pq scholars (gender, origin and training), the Prevalence Ratio was calculated by Poisson regression⁽¹⁴⁻¹⁵⁾.

RESULTS

Evolution of the number of Pq/CNPq professors

In the year 2000, the Brazilian Collective Health was contemplated with 134 professors Pq in the CNPq, evolving to 214 Pq in the year of 2012, representing an important growth of 59.7% from 2000 to 2012. It should be pointed out that although there is no quota of scholarships per area of knowledge in CNPq, the growth in the number of scholarships of this nature is related to the growth of the Graduate and scientific production of each area and, consequently, demand for this type of incentive, in addition to having to do with the financial capacity of this development institution, CNPq. In the case of Collective Health, the growth in the number of Pq scholarships in the period studied is related to the growth of Graduate Programs in this branch of activity in the country in recent years. Corroborating this information, it is noteworthy that in the period from 1998 to 2008 there was a growth of 203% in the Graduate Programs in the Brazilian Collective Health⁽¹⁰⁾.

Distribution of Productivity scholarship in Research fellows by gender and regional and institutional origin

The majority (52%) of the Pq/CNPq Collective Health professors in the period were women. The Southeast region accounted for 70.9% of these professors, with the cities of Rio de Janeiro and São Paulo accounting for 63.5% of them. The South region participated with 13.9% (41), the Northeast region with 10.8% (32), the Center-West region with 4.4% (13) and the North region represented a void, since it was not found in this region none Pq professor/CNPq of Collective Health in those 13 years. In terms of institutional origin, the Pq/CNPq professors in this area are distributed in 42 institutions, however, six of them are home to more than half (64.3%) of them: FIOCRUZ (24%), USP (19.3%), UFBA (6.1%), UFMG (5.4%), UERJ (5.1%) and UNIFESP (4.4%).

Scientific production, patents and researchers training

Table 1 presents the descriptive measures of scientific production, patents and researchers training by the Collective Health Pq/CNPq professors. As a scientific production, these Pq scholars published 12,106 scientific articles (mean=40.9), 509 books (mean=1.7) and 2,229 book chapters (mean=7.5). In the case of technology production, they produced 06 (six) patents (mean=0.02). As for the researchers training, they guided 1,381 students of scientific initiation (mean=4.7), 2,311 Master's Degree students (mean=7.8), 1,741 Doctorate students (mean=5.9) and supervised 166 Postdoctoral students (mean=0.6) (Table 1).

Figures 1 and 2 show the performance of the Brazilian Collective Health professors in relation to scientific production and researchers training carried out from 2000 to 2012. The study reveals a positive variation in all modes of production of these professors. The number of articles ranged from 472 in 2000 to 1,415 in 2012. The number of books ranged from 34 in 2000 to 44 in 2012. The number of book chapters ranged from 130 in 2000 to 157 in 2012 (Figure 1).

Table 1 - Descriptive measures of scientific production, technological production and researchers training of the Collective Health Pq/CNPq professors from 2000 to 2012

Variable	Modalities of Production	Quantity	Mean	Standard Deviation
Scientific Production	Scientific articles	12,106	40.9	40.0
	Books	509	1.7	2.6
	Chapters of Books	2,229	7.5	10.0
Total		14,844	50.15	46.5
Researchers training	Scientific Initiation Guidance	1,381	4.7	6.9
	Master's Degree Guidance	2,311	7.8	6.2
	Doctoral Guidance	1,741	5.9	5.7
	Postdoctoral Supervision	166	0.6	1.4
Total		5,599	18.9	14.6
Production Technological	Patents	6	0.02	0.2
Total		6	0.02	0.2

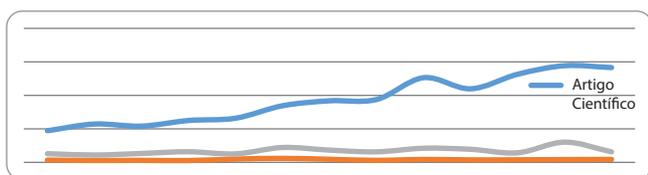


Figure 1 - Performance of scientific production (scientific articles, books and book chapters) of the Collective Health Pq/CNPq professors, from 2000 to 2012

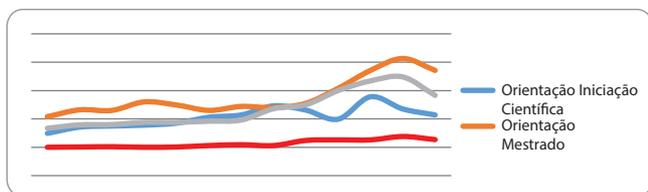


Figure 2 - Performance of the researchers training of the Collective Health Pq/CNPq professors, from 2000 to 2012

The researchers training by the Collective Health Professors also evolved a lot. Scientific initiation guidelines ranged from 49 in 2000 to 114 in 2012. Master's Degree guidance ranged from 108 in 2000 to 271 in 2012. Postdoctoral guidance ranged from 67 in 2000 to 183 in 2012 and Postdoctoral supervisions from 0 in 2000 to 27 in 2012 (Figure 2).

It should be noted that the reduction observed in Figures 1 and 2 in all modes of production from 2011 to 2012 occurred because only one semester production in 2012 was recorded.

Association between scientific production and characteristics of Productivity scholarship in Research professors

In Table 2 there are frequencies of the scientific production of Collective Health Pq/CNPq professors, according to independent variables (gender, origin and training), as well as the associations found among the investigated variables.

Important differences were found in the scientific production of the professors of Collective Health. The study revealed an existence of association between the outcome "scientific production", and the independent variables such as gender, state, region, training and institution of origin of the Pq professor.

The highest scientific production among male Collective Health Pq professors was 1.41 times (41% higher) when compared to the female gender. Although the number of female scholarship recipients was higher (154=52%) than the male (142=48%), the percentage of Pq students in the higher-producing group was higher among men (39.4%) than among women (27.9%) (Table 2).

It was found an association between scientific production and regional origin of the Pq professor. The highest scientific production among the professors of Collective Health

in the state of Rio de Janeiro was 2.02 times (102% higher), the state of Bahia was 1.94 times (94% higher), the state of São Paulo was 1.48 times (48% higher), from the state of Minas Gerais, was 1.46 times (46% higher) and the state of Rio Grande do Sul was 1.43 times (43% higher), when compared to the Pq professors Collective of the other states of the federation. This concentration of higher scientific production in Rio de Janeiro occurs not only because it was the one that presented the highest number of professors of the collective Health, but also because of all the states, it was the one that presented the highest percentage of scholars in the group with the highest scientific production (41.7%) (Table 2).

The association between scientific production and the origin of the Pq professor becomes even more evident when one takes advantage of the regional view. The highest scientific production among the Pq professors of the Southeastern region was 2.29 times (129% higher), among those in the Northeast region was 2.23 times (123% higher) and among those in the South region

was 1.90 (90% higher) when compared to the Pq professor of the Center-West Region Collective Health. It is important to note that the Southeast region, besides housing 70.94% of the professors in this area, was still the one with the highest percentage of scholars in the group with the highest scientific production (35.2%). The Northeast region, on the other hand, although it has a smaller

did a doctorate abroad (73) is much lower than those who did a doctorate in Brazil (221), almost half of those who did a doctorate abroad (45.2%) production. Regarding Postdoctoral studies, the study shows that the highest scientific output among the Pq professors who did Postdoctoral studies was 1.27 times (27% higher) than those who did not do Postdoctoral studies (Table 2).

Table 2 - Frequencies of the scientific production of Pq/CNPq professors of the Collective Health from 2000 to 2012, according to the independent variables and associations found among the investigated variables

Independent Variables	< Scientific Production n (%)	> Scientific Production n (%)	Total n (%)	Prevalence Ratio (PR)*
Gender				
- Male	86 (60.6)	56 (39.4)	142 (100.0)	1.41
- Female	111 (72.1)	43 (27.9)	154 (100.0)	1.00
State				
- São Paulo	64 (69.6)	28 (30.4)	92 (100.0)	1.48
- Rio Janeiro	56 (58.3)	40 (41.7)	96 (100.0)	2.02
- Rio Grande do Sul	24 (70.6)	10 (29.4)	34 (100.0)	1.43
- Minas Gerais	14 (70.0)	6 (30.0)	20 (100.0)	1.46
- Bahia	12 (60.0)	8 (40.0)	20 (100.0)	1.94
- Other states	27 (79.4)	7 (20.6)	34 (100.0)	1.00
Region				
- Southeast	136 (64.8)	74 (35.2)	210 (100.0)	2.29
- South	29 (70.7)	12 (29.3)	41 (100.0)	1.90
- Northeast	21 (65.6)	11 (34.4)	32 (100.0)	2.23
- Center-West	11 (84.6)	2 (15.4)	13 (100.0)	1.00
Where Attended Doctorate Classes**				
- Abroad	40 (54.8)	33 (45.2)	73 (100.0)	1.54
- Brazil	156 (70.6)	65 (29.4)	221 (100.0)	1.00
Postdoctoral				
- Attended postdoctoral classes	96 (62.7)	57 (37.3)	153 (100.0)	1.27
- Did not attend postdoctoral classes	101 (70.6)	42 (29.4)	143 (100.0)	1.00
Origin Institution				
- FIOCRUZ	42 (59.2)	29 (40.8)	71 (100.0)	1.60
- USP	37 (64.9)	20 (35.1)	57 (100.0)	1.38
- UFBA	11 (61.1)	7 (38.9)	18 (100.0)	1.53
- UFMG	10 (62.5)	6 (37.5)	16 (100.0)	1.47
- UERJ	8 (53.3)	7 (46.7)	15 (100.0)	1.83
- UNIFESP	10 (76.9)	3 (23.1)	13 (100.0)	0.91
- Other institutions	79 (74.5)	27 (25.5)	106 (100.0)	1.00
Fellow's Level				
Level 1 (A,B,C,D)	28 (27.5)	74 (72.5)	102 (100.0)	4.57
Not identified***	63 (92.6)	5 (7.4)	68 (100.0)	0.46
Level 2	106 (84.1)	20 (15.9)	126 (100.0)	1.00
Total	197 (66.6)	99 (33.4)	296 (100.0)	---

Note: * The Prevalence Ratio (PR) refers to the highest scientific production; ** 02 (two) Pq professors did not do a doctorate and were excluded from this analysis in the training question; *** The study involved 296 Pq/CNPq CH professors who were fellows during the historic series. However, the CNPq only informs the scholarship level of who is currently a professor. 68 of the CH professors studied were Pq at some point in the historical series, but they are no longer at present and therefore refer to the level not identified in this analysis.

number of scholars (32) than the South (41), was the second with the highest percentage of professors in the group with the highest scientific production (34.4%) (Table 2).

The findings of the study reveal the existence of an association between professor training and scientific production. The highest scientific output among the Pq professors who did a doctorate abroad was 1.54 times (54% higher) when compared to the professors in this area who did a doctorate in Brazil. It is important to note that, although the number of professors who

The association between scientific production and the institutional origin of the professor is also evident, since the highest scientific production of collective health professors was 1.83 times (83% higher) among the professors of UERJ, 1.60 times (Doctorate60% higher) among those of FIOCRUZ, 1.53 times (53% higher) among UFBA, 1.47 (47% higher) between UFMG and 1.38 times (38% higher) when compared to the Pq professors of the Collective Health of the other institutions of the country. It is observed that two institutions located in Rio de Janeiro (UERJ and FIOCRUZ) presented the highest percentage of researchers in the group with the highest scientific production, 46.7% and 40.8%, respectively (Table 2).

There is also an association between the level of the professor's scholarship and the scientific production, since the highest scientific production among the Professors of Collective Health level 1 was 4.57 times (357% higher) when compared to the professors of level 2. The study shows that a significant percentage (72.5%) of the level 1 professors of Collective Health was in the group with the highest scientific production (Table 2).

Association between researchers training and characteristics of Productivity scholarship in Research professors

In Table 3 there are frequencies of Pq/CNPq researchers training in Collective Health according to the independent variables (gender, origin and training), as well as the associations found among the investigated variables.

Similar to what occurred with scientific production, the study found an association between the "researchers training", and independent variables, such as gender, state, region, training (doctorate and Postdoctoral) and institution of origin of the professor (Table 3). The largest researchers training among the male professors of Collective Health was 1.13 times (13% higher) when compared to female professors. It was observed that although the number of women was higher in the group of Collective Health Pq professors (154=52%), the male participation was higher in the group that carried out most guidance sessions(35.2%) (Table 3).

Table 3 - Frequencies of the researchers training of the Pq/CNPq Professors of the Collective Health from 2000 to 2012, according to the independent variables and associations found among the investigated variables

Independent Variables	< Researchers Training n (%)	> Researchers Training n (%)	Total n (%)	Prevalence Ratio (PR)*
Gender				
- Male	92 (64.8)	50 (35.2)	142 (100.0)	1.13
- Female	106 (68.8)	48 (31.2)	154 (100.0)	1.00
State				
- São Paulo	69 (75.0)	23 (25.0)	92 (100.0)	0.77
- Rio Janeiro	65 (67.7)	31 (32.3)	96 (100.0)	0.99
- Rio Grande do Sul	18 (52.9)	16 (47.1)	34 (100.0)	1.46
- Minas Gerais	11 (55.0)	9 (45.0)	20 (100.0)	1.39
- Bahia	12 (60.0)	8 (40.0)	20 (100.0)	1.24
- Other states	23 (67.6)	11 (32.4)	34 (100.0)	1.00
Region				
- Southeast	146 (69.5)	64 (30.5)	210 (100.0)	1.32
- South	23 (56.1)	18 (43.9)	41 (100.0)	1.90
- Northeast	19 (59.4)	13 (40.6)	32 (100.0)	1.76
- Center-West	10 (76.9)	3 (23.1)	13 (100.0)	1.00
Where Attended Doctorate Classes**				
- Abroad	43 (58.9)	30 (41.1)	73 (100.0)	1.36
- Brazil	154 (69.7)	67 (30.3)	221 (100.0)	1.00
Postdoctoral				
- Attended postdoctoral classes	99 (64.7)	54 (35.3)	153 (100.0)	1.15
- Did not attend postdoctoral classes	99 (69.2)	44 (30.8)	143 (100.0)	1.00
Origin Institution				
- FIOCRUZ	51 (71.8)	20 (28.2)	71 (100.0)	0.81
- USP	43 (75.4)	14 (24.6)	57 (100.0)	0.70
- UFBA	11 (61.1)	7 (38.9)	18 (100.0)	1.11
- UFMG	8 (50.0)	8 (50.0)	16 (100.0)	1.43
- UERJ	7 (46.7)	8 (53.3)	15 (100.0)	1.53
- UNIFESP	9 (69.2)	4 (30.8)	13 (100.0)	0.88
- Other institutions	69 (65.1)	37 (34.9)	106 (100.0)	1.00
Fellow's Level				
Level 1 (A,B,C,D)	49 (48.0)	53 (52.0)	102 (100.0)	1.82
Not identified***	59 (86.8)	9 (13.2)	68 (100.0)	0.46
Level 2	90 (71.4)	36 (28.6)	126 (100.0)	1.00
Total	198 (66.9)	98 (33.1)	296 (100.0)	---

Note: * The Prevalence Ratio (PR) refers to higher researchers training; **02 (two) Pq professors did not do a Doctorate and were excluded from this analysis in the training question; ***The study involved 296 Pq Collective Health professors who were fellows during the historical series. However, the CNPq only informs the level of the scholarship of the Pq professor at the present time. 68 of the Collective Health Pq professors studied were Pq at some point in the historical series, but they are no longer at present and therefore refer to the level not identified in this analysis.

The largest researchers training among the Collective Health Pq professors in the state of Rio Grande do Sul was 1.46 times (46% higher), among those in Minas Gerais, 1.39 times (39% higher) and among Bahia, was 1.24 times (24% higher) when compared to the Pq professors of the Collective Health of the other states of the federation. It is observed that the states of Rio Grande do Sul (34=11.5%), Minas Gerais (20=6.8%) and Bahia (20=6.8%), although they had Pq shares in Collective Health lower than in São Paulo and Rio de Janeiro, were those that presented the highest percentage of Pq professors in the group known as the group of higher researchers training or that have greater participation in the guidelines of scientific initiation, Master's Degree, Doctorate and postdoctoral (Table 3).

Looking at the regional perspective, it is possible to verify that the largest researchers training among the Collective Health Pq professors in the South region was 1.90 times (90% higher), among those in the Northeast region was 1.76 times (76% higher) and among those in the Southeast region was 1.32 times (32%

higher) when compared to the Collective Health Pq professors in the Center-West region (Table 3). In the case of professor training, it is verified that the largest researchers training among the Pq professors who did a Doctorate abroad was 1.36 times (36% higher) when compared to those who did a Doctorate in Brazil, and higher researchers training among the Pq professors who did Postdoctoral studies was 1.15 times (15% higher) when compared to those who did not do Postdoctoral studies (Table 3).

It was also found an association between the institutional origin of the professor and the researchers training. The largest researchers training among the professors of UERJ's Collective Health was 1.53 times (53% higher), among those at UFMG it was 1.43 times (43% higher) and among UFBA was 1.11 times (11% higher) when compared to the Professors of Collective Health of the other institutions of the country. Although FIOCRUZ and USP are the universities with the highest number of professors in this area, 71 and 57 respectively, the Prevalence Ratio does not accuse the concentration of high researchers training in these two institutions, precisely because these two institutions were the ones that (71.8% and 75.4%, respectively), while in UERJ and UFMG, about half of the professors were in the higher training group of researchers, or else participates in this training (Table 3).

Regarding the level, the study reveals that the largest training of researchers among Level 1 Collective Health Professors was 1.82 times (82% higher) when compared to Level 2 professors. This is because more than half (52 %) of the level 1 professors of this area were in the group of higher researchers training (Table 3).

DISCUSSION

The significant growth of 59.7% in the number of Collective Health Pq/CNPq professors during the period known as this study is consistent with the growth of Graduate in this branch of knowledge in Brazil. From 1998 to 2008, there was a growth of 203% in the graduate programs in Collective Health in the country, and from 2002 to 2008, Capes' investment in scholarships in graduate programs in this area varied by 206%^(10,16). In 2009, there were 50 graduate programs in Collective Health in the country, rising to 75 in 2013, representing growth of 50%. The Graduate course in Public Health is in full development in Brazil^(9-10,16-17).

There is a predominance of women (52%) in the universe of Collective Health Pq/CNPq professors. This is consistent with the reality of Graduate Program in this area in Brazil, since the number of female professors in Graduate Programs in Brazilian Public Health in seven years rose from 47% to 55%. Feminization is also notable in the body of Doctorate and Master's Degree students of the courses of this field of knowledge⁽¹⁷⁾. However, this predominance of women in the Pq universe of Collective Health contrasts with the results of other studies that show a greater presence of men among Pq professors in other areas of knowledge⁽¹⁸⁻²³⁾. CNPq data indicate that in 2002 there were 0.84 women registered in the Directory of Research Groups for each man, and that ratio decreased greatly in the grant of productivity scholarship. In that year, for each male professor who was contemplated with this scholarship, there were 0.48 women in the same situation⁽²⁴⁾. This study reveals, at least in the case of Collective Health, that this relationship has been modified in favor of women who, even with the late insertion in the system of science and technology⁽²⁴⁾, has occupied a prominent place in the collective health setting scientific production or researchers training. This increase in the insertion of women in the Pq/CNPq system is a result of the greater entry of women into the C&T system, especially in Graduate Programs⁽²⁴⁾.

In relation to the concentration of Collective Health Pq/CNPq professors in the Southeast region (70.9%), it is important to point out that several studies whose universe are Pq/CNPq professors of other branches of knowledge point to this same reality⁽¹⁸⁻²³⁾. The main reasons for the concentration of Pq professors in the Southeastern region are the Graduate concentration of this area in this region of the country^(10,16), the infrastructure available and the large research centers that exist in the academic institutions of this region which make them more attractive^(12,18,22-23), the existence of a lower number of professors in the institutions located in the regions of lower productivity, which causes that professors of these institutions end up having bigger commitments in the undergraduate courses, diminishing the time available to invest in research⁽²³⁾, and finally, the existence of a Graduate concentration in all areas of knowledge in the Southeast region of the country⁽²⁵⁾. The fact that more than half (64.3%) of the Collective Health Pq/CNPq professors came from six institutions in the country (FIOCRUZ, USP, UFBA, UFMG, UERJ and UNIFESP) reveals another type of concentration: Institutional concentration. Almost a third of these professors (32.4%) are in universities in Rio de Janeiro, which may be related to the existence of important training centers and producers of scientific knowledge in Collective Health in this state, such as FIOCRUZ/*Escola Nacional de Saúde Pública* (ENSP), which is one of the largest scientific production institutions in Latin America, as well as being one of the pioneers in the study of tropical diseases⁽²⁶⁾.

The robust scientific production presented by the Professors of Collective Health (12,106 articles, 509 books and 2,229 book chapters), as well as their important participation in researchers training (1,381 scientific initiation guidelines, 2,311 Masters' Degree guidance, 1,741 Doctorate guidance and 166 Postdoctoral supervisions) indicates an important contribution of Collective Health in the production of new C&T indicators in Brazil. Several studies point to the Graduate course in Collective Health as a consolidated and expanding area in Brazil^(10,16-17,27-28), which ends

up being a factor inducing scientific production in this field of knowledge. On this issue, it is important to highlight that from 2011 onwards, there is a major change in the C&T term in Brazil with the inclusion of the item innovation, extending this language to CT&I. Considering the robust scientific production and researchers training by the Collective Health professors, it can be considered that the Public Health area has contributed to the country's Science, Technology and Innovation system, since this contribution adds to the national CT&I system.

On the other hand, the important but still timid technology production of the group of Pq/CNPq professors of Collective Health (six patents in the studied period of 13 years) portrays the mismatch between knowledge production and technology production and innovation in Brazil, resulting from the late character of industrialization and the creation of universities and research institutions in the country⁽²⁹⁻³²⁾ and the disconnection in the innovation system in the health sector in Brazil⁽³²⁾. The disconnect between science, technology and innovation is vastly reported in the literature and can be illustrated by demonstrating that the relative share of health in the articles (ISI) reaches the mark of 46%, while only 7% of resident patents in Brazil, according to the National Institute of Industrial Property (INPI – *Instituto Nacional da Propriedade Industrial*), refer to the technological domains related to Health⁽³²⁾. However, it is important to point out that, although timid, the participation of Brazilian Collective Health in this universe of patent production is very important, for all the reasons already mentioned.

The productivity differentials between the Pq/CNPq professors of Collective Health revealed in the scientific production and in the researchers training are explained, because the majority of professors in this branch of knowledge (66.7%) are in the lowest production group. On this issue, studies point to a concentration of very few highly successful scientists compared to many others with low productivity⁽³³⁻³⁴⁾. The gender-related productivity differentials identified in this study were also revealed in other studies, although there is a suggestion that these differences in productivity by gender tend to be attenuated over the professors' career⁽³⁵⁻³⁶⁾.

The productivity differentials related to the origin of the professor Pq revealed in this study, marked by the regional concentration, is not a Brazilian peculiarity, since they are also present in the international setting⁽³⁷⁾. The productivity differentials related to professor training are consistent with studies that suggest a positive relationship between Graduate professor training and scientific productivity⁽³⁶⁾. The productivity differentials related to the institutional affiliation of the professor revealed in this study reinforce the spatial and institutional concentration of Brazilian scientific production, an issue that is widely highlighted in other studies⁽¹⁸⁻²³⁾. Studies point to two sets of factors that contribute to this heterogeneity/differentials: The unobservable factors related to the ability and motivation of the scientist to produce and the observable factors related to gender, origin, training and other institutional conditions^(34,38). In the case of Collective Health, this study reveals that observable factors are responsible for existing productivity differentials, although unobservable factors may also be influencing. Another argument for productive inequality among professors suggests the existence of a cumulative advantage in the research and publication process, a phenomenon in which the hierarchically more relevant professor tends to obtain greater

credit than the less eminent which would induce the productivity of a group given this cumulative advantage⁽³⁹⁾.

Study limitations

Because this is a cross-sectional study, the results should be treated with some caution. Although the study revealed the existence of an association between the “scientific production” and “researchers training” outcomes, and the independent variables such as gender, state, region, training and origin institution of the Pq/CNPq professor of Collective Health, this relation of association does not necessarily suggest a causal relation, or cause and effect, that is, it is difficult to establish a temporal relation between the events and to consider with a greater degree of certainty if the relation between them is causal or not. Moreover, the study universe was restricted to a single area of knowledge (Collective Health). If on the one hand this allows a more detailed knowledge of the profile of the scientific production of this branch of knowledge, on the other hand, this in turn makes the possibility of comparisons with other areas of knowledge impossible, which may be the subject of other studies.

Contributions of the study to the sectors of Health or Public Policy

This research evaluated the scientific production, generation of patents and researchers training by Brazilian Collective

Health professors who were awarded Pq/CNPq scholarships in 2000, verifying the existence of an association between scientific production and researchers training and some characteristics of the professors, such as gender, training and origin, as well as revealing a geographical and institutional concentration of both scientific production and researchers training in this area of knowledge. To know the profile, the scientific and technological production and the researchers training of the Brazilian Collective Health professors can subsidize the Government, the scientific community and the foment institutions in the elaboration of policies aimed at the deconcentration of scientific production, innovation and researchers training in this area of knowledge in the country, which, consequently, can oxygenate the CT&I system and health services in Brazil.

CONCLUSION

The study reveals a significant scientific production, an important researchers training and an important but still timid patent production among the Pq/CNPq professors of Brazilian Collective Health, although it also reveals a regional and institutional concentration of this production/training. The deconcentration of scientific production and researchers training in this area of knowledge that is so important in the setting of the national health system, the SUS, is an important condition for boosting both the system and public health care services, as well as contributing to the implementation of SUS in the country.

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