

Research themes of family and community physicians in Brazil

Temas de pesquisa dos médicos de família e comunidade no Brasil

Leonardo Ferreira Fontenelle¹, Stephani Vogt Rossi², Miguel Henrique Moraes de Oliveira³, Diego José Brandão⁴, Thiago Dias Sarti⁵

¹ Universidade Federal do Espírito Santo (UFES), Vitória, Espírito Santo, Brasil. ORCID: <https://orcid.org/0000-0003-4064-433X>

² Prefeitura Municipal de Itapoá, Itapoá, Santa Catarina, Brasil. ORCID: <https://orcid.org/0000-0001-9720-6926>

³ Prefeitura Municipal de Ubaporanga, Ubaporanga, Minas Gerais, Brasil. ORCID: <https://orcid.org/0000-0001-9720-6926>

⁴ Universidade Vila Velha (UVV), Vila Velha, Espírito Santo, Brasil. ORCID: <https://orcid.org/0000-0002-5000-3256>

⁵ Universidade Federal do Espírito Santo (UFES), Vitória, Espírito Santo, Brasil. ORCID: <https://orcid.org/0000-0002-1545-6276>

Mail to/Autor para correspondência/Correo a: Leonardo Ferreira Fontenelle, leonardof@leonardof.med.br

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Abstract

Introduction: research capacity in primary care varies worldwide, and bibliographic databases such as MEDLINE, Scopus and Web of Science do not index most primary care research coming from Latin America. Our objective was to investigate the research themes of family and community physicians in Brazil, and to correlate the articles' research themes with their authors' trajectories in postgraduate education. **Method:** we compiled a national list of family and community physicians, retrieved their curricula from the Lattes Platform, compiled a list of journal articles, and obtained their keywords from LILACS and MEDLINE. Treating journal articles and their keywords as the two node types in a bipartite network, we derived research themes using the dual-projection algorithm, combining the Leiden algorithm with hierarchical clustering. **Results:** we found two research themes to be the largest, most developed, and most central ones: human health and primary care. Authors with a master's or PhD in collective health (public health, epidemiology, and social sciences and humanities in health) were as likely as those with no postgraduate degree to publish articles on primary care. On the other hand, authors with a postgraduate degree in medicine were more likely to publish articles on human health. **Conclusions:** after discussing the findings in light of previous research and methodological aspects, we conclude there's a relative divide between primary care and clinical research, and the highlight policy implications.

Keywords: Health information; Covid-19; Covid kit; Webometrics; Google Trends.

Resumo

Introdução: a capacidade de pesquisa em atenção primária varia mundialmente, e bancos de dados bibliográficos como o MEDLINE, Scopus e Web of Science não indexam a maior parte da pesquisa em atenção primária proveniente da América Latina. Nosso objetivo foi investigar os temas de pesquisa dos médicos de família e comunidade no Brasil, e correlacionar os temas de pesquisa dos artigos com as trajetórias de seus autores na pós-graduação estrito senso. **Método:** compilamos uma lista nacional de médicos de família e de comunidade, recuperamos seus currículos da Plataforma Lattes, compilamos uma lista de artigos de periódico, e obtivemos suas palavras-chave da LILACS e MEDLINE. Tratando os artigos e suas palavras-chave como os dois tipos de nó em uma rede bipartite, derivamos temas de pesquisa usando o algoritmo de dupla projeção, combinando o algoritmo de Leiden com o agrupamento hierárquico. **Resultados:** dois temas de pesquisa foram os maiores, mais desenvolvidos e mais centrais: saúde humana e atenção primária à saúde. Os autores com mestrado ou doutorado em saúde coletiva (saúde pública, epidemiologia, ciências sociais e humanidades em saúde) se mostraram tão propensos quanto aqueles sem pós-graduação a publicar artigos sobre atenção primária à saúde. Por outro lado, os autores com mestrado e/ou doutorado em medicina eram mais propensos a publicar artigos sobre saúde humana. **Conclusão:** após discutir os resultados à luz de pesquisas anteriores e aspectos metodológicos, concluímos que há uma relativa separação entre a atenção primária e a pesquisa clínica, e destacamos implicações para política.

Palavras-chave: Médicos de família e comunidade - Brasil; Bibliometria; Pesquisa biomédica; Análise por conglomerados; Educação de pós-graduação.

INTRODUCTION

Family and community physicians, also called family doctors or general practitioners, provide comprehensive, patient-centered healthcare to individuals of all age groups, regardless of the affected organs (including mental health) (Arya et al., 2017; Freeman & McWhinney, 2016; Gupta, Gray, Landes, Sridharan, & Bhattacharyya, 2021; Romano, 2008). They became a separate specialty during the second half of the 20th century, with the increased recognition of primary health care as a cornerstone of effective health systems (Bonet, 2005; Falk, 2004; Pires-Alves & Paiva, 2021; Ponka et al., 2015; Rodrigues, 2007; Romano, 2006). In primary health care, patients are enrolled in healthcare services where they have timely access to comprehensive healthcare (Starfield, Shi, & Macinko, 2005). Because different stakeholders emphasize different aspects of primary health care, the

expression “primary care” is often preferred for the more clinical aspects (Gupta et al., 2021; Muldoon, Hogg, & Levitt, 2006; Ponka et al., 2015). Here, though, we use both terms interchangeably.

Primary care research embraces diverse research methods and paradigms, and encourages collaboration with disciplines such as public health and behavioral science (Freeman, 2012; Goodyear-Smith & Mash, 2016b; McWhinney, 1996). Besides clinical practice, primary care research comprises research in health services, health systems, medical education, and research methodology (Beasley et al., 2004; Beasley, Starfield, van Weel, Rosser, & Haq, 2007). Four decades ago, English-language journals of family and community medicine published more research about primary care than in primary care (Freeman, 2012), and two decades ago McWhinney (McWhinney, 2001a, 2001b) lamented how family and community physicians did little clinical research. Since then, primary care research acquired a clinical focus - at least in Western countries. Looking on the most-often cited papers in English-language journals, Freeman (2012) derived six research themes: “clinical issues”, “epidemiology in family practice”, “patient experiences”, “research methods”, “physician issues”, and “conceptual”. More recently, (López-Torres Hidalgo, Basora Gallisà, Orozco Beltrán, & Bellón Saameño, 2014; López-Torres Hidalgo, Párraga Martínez, Martín Álvarez, & Tranche Iparraguirre, 2020) surveyed primary care research in Spain and found that two-thirds of it focused on clinical aspects.

Historically, research capacity in primary care follows the academic presence of family and community medicine, which in turn follows its recognition as a medical specialty (Beasley et al., 2004; Goodyear-Smith & Mash, 2016a). To this day, there is wide international variation in the research capacity of family and community medicine. In the UK and the Netherlands, for example, most primary care is provided by family and community physicians, and most or all universities have departments dedicated to primary care (van der Zee, Kroneman, & Bolívar, 2003). These countries happen to be some of the top performers in primary care research (Glanville, Kendrick, McNally, Campbell, & Hobbs, 2011). In many countries, though, family and community medicine is still struggling for recognition (Arya et al., 2017), and primary care research is inexpressive.

Brazil is an intermediate case. Together with China, India and South Africa, the country is home to a large share of the world’s population, and is committed to strengthening primary health care, even though it is not quite there yet (Mash, Almeida, Wong, Kumar, & von Pressentin, 2015). In Brazil, family and community medicine is formally recognized as a medical specialty and there is an increasing number of medical residency programs, but most medical providers in primary care are not family and community physicians (Mash et al., 2015). Furthermore, neither family and community medicine, nor primary health care is officially recognized as a distinct research area for the purposes of funding research or assessing postgraduate programs (masters’ and PhDs) (Wenceslau, Sarti, & Trindade, 2020). As a consequence, most family and community physicians in Brazil earn their postgraduate degrees in collective health (Fontenelle, Rossi, Oliveira, Brandão, & Sarti, 2020), a discipline in Latin America comprising public health, epidemiology, and humanities and social sciences in health (Osimo & Schraiber, 2015; Vieira-da Silva & Pinell, 2014). Family and community physicians in Brazil also publish predominantly in collective health journals (Fontenelle, Rossi, & Oliveira, 2021b), or “public health” journals, as the US National Library of Medicine categorizes them.

As in other developing countries (Domínguez et al., 2016; Escobar, Rivera, Martínez, & Ortega, 2018; Ortega, Velasco, Coria, & Prato, 2016; Sparks & Gupta, 2004), primary care research in Brazil has been hindered by low access to funding and postgraduate education, as well as obstacles to practice-based research. As a consequence, primary care research in Brazil has been described as low-volume, low-quality, of little consequence, relying too much on descriptive studies, and being published in Portuguese in journals not even indexed in LILACS, the Latin American and Caribbean Health Sciences Literature database (Almeida, Gusso, & Trindade, 2016; Harzheim et al., 2005).

This dire situation might be changing, though. MacAuley (2011, p. 173) argues “Brazilians have the potential to be future leaders in primary care”, based on the scale and youth of the Brazilian Conference on Family and Community Medicine. Scale and youth indeed: in late 2018, half the family and community physicians in Brazil had entered the specialty in the previous 10 years (Fontenelle et al., 2020). Furthermore, Brazilian family and community physicians increasingly publish in journals from other countries, suggesting their research is increasingly of international relevance (Fontenelle, Oliveira, Rossi, Brandão, & Sarti, 2021).

As we write this paper, there are no journals from Latin America in the “primary health care” category of Web of Science, the “family practice” subject area of Scopus, or the “primary health care” broad subject term of MEDLINE (except for one internal medicine journal from Colombia). Fortunately, Brazil’s Lattes Platform provides an excellent data source (Lane, 2010). Created in 1999, it is the Brazilian information system on science, technology and innovation. Curricula in the Lattes Platform must be kept reasonably complete and up to date, as they are used for decisions on research funding and on recruitment, promotion and tenure. Furthermore, these curricula must be reasonably honest, seeing as they are publicly available and researchers are accountable for the information they provide. In this research paper, we make use of the Lattes Platform to investigate the research themes of family and community physicians in Brazil, and correlate these themes with their authors’ trajectories in postgraduate education.

METHODS

This was an exploratory study, using administrative data from multiple sources, as part of the Trajetórias MFC project (Fontenelle, Oliveira, et al., 2021; Fontenelle et al., 2020). The project was approved by the Research Ethics Committee of Universidade Vila Velha (report n. 3.033.911). The anonymized dataset is open (Fontenelle, Rossi, & Oliveira, 2021a), and the underlying datasets are available upon request (Fontenelle, Rossi, & Oliveira, 2019, 2021b).

Data Source

In Brazil, there are two ways for a physician to be recognized as a specialist: to conclude postgraduate training in the specialty (medical residency) or to pass a certification exam. Accordingly, a nationwide list of family and community physicians as of late 2018 was compiled from two data sources, as described in Fontenelle et al. (2020): the information system for medical residency (SisCNRM) and a list of certified physicians provided by the Brazilian Society of Family and Community Medicine (Sociedade Brasileira de Medicina de Família e Comunidade, SBMFC). The physicians' genders were inferred from their first name, using data from the 2010 Brazilian Census. Data on their stricto sensu postgraduate education (masters' and doctorates) were obtained from their curricula in the Lattes Platform and the Sucupira Platform, which is the Brazilian information system on postgraduate programs (Siqueira, 2019).

The list of journal articles published by family and community physicians was obtained in August 2019 from their curricula in the Lattes Platform, as described in Fontenelle, Rossi, and Oliveira (2021b). After identifying them in the curricula, we looked the journal articles up in CrossRef, MEDLINE (through PubMed) and LILACS (through Pan-American Health Organization's Virtual Health Library [VHL]), from late 2019 through early 2020. Furthermore, we looked journals up in the catalog of the US National Library of Medicine (NLM), and settled any doubts by looking them up in the ISSN International Center ROAD (Directory of Open Access scholarly Resources) and the VHL Serials in Health Sciences (SeCS). The data were verified for internal inconsistencies throughout the entire process, often resulting in the deletion of a duplicated entry or a minor adjustment of citation data, but we defaulted to trusting our data sources.

Measures

Unless otherwise specified, all results refer to articles published during or after the year of specialization in family and community medicine. For physicians with both a medical residency and certification, we considered the earliest of the two years. For descriptive purposes, publication dates were grouped in five-year periods, with the first period having an unbounded beginning (any year, up to 1998). Physicians were considered female when their first name had $\geq 50\%$ probability of belonging to a woman, and male otherwise. We categorized the knowledge area of the postgraduate degrees (masters' and PhDs) as "none" (no postgraduate degree, or no degree yet), "medicine", "collective health" and "other".

Articles were weighted by harmonic counting of authorship, with the last author receiving equal weight as the first one (Hagen, 2008). Harmonic counting weights authorship according to the author's position in the byline, and closely fits authorship credit perceived by peers (Hagen, 2010, 2013). In our study, articles weighted less than 1 if not all authors were family and community physicians. If an author specialized only after publishing an article, we did not count this as an authorship by a family and community physician.

The articles' subject was described using the Health Sciences Descriptors (DeCS), for articles found in LILACS, or US NLM's Medical Subject Headings (MeSH), for articles found in MEDLINE. DeCS is a superset of MeSH, with the addition of contextually relevant subject headings. We opted for DeCS when an article was indexed in both MEDLINE and LILACS, and excluded articles not indexed in either. In this paper, we use "headings", "descriptors" and "keywords" interchangeably.

Data Analysis

We analyzed our data as an undirected bipartite network, with articles and keywords being the two node types, and edges being the occurrence of keywords in articles. For each article, the weight of the edges to the corresponding keywords was the inverse of the number of keywords. As a consequence, each article had a strength centrality (Barrat, Barthélemy, Pastor-Satorras, & Vespignani, 2004) of 1. The weight of the keywords was the weight of their edges, multiplied by the weight of the corresponding articles (as in Measures), then summed. As a consequence, the sum of the keyword weights was the same as the sum of the article weights.

The articles and keywords were clustered into research themes using the dual-projection algorithm (Arthur, 2020; Everett & Borgatti, 2013; Melamed, 2014). The first step of the algorithm consisted in obtaining a "top" (keyword co-occurrence) and a "bottom" (articles as nodes, shared keywords as edges) projection of the bipartite network. Both projections were normalized with an improved version of the association strength (Steijn, 2021), so that edges no longer depended on the weight of the corresponding keywords or articles. The second step consisted in

independently clustering the top and the bottom projections using the Leiden algorithm (Traag, Waltman, & van Eck, 2019), with the resolution parameter tuned to provide a reasonable number of reasonably-sized clusters. The third and final step consisted of creating an aggregate bipartite network from the two sets of clusters (the top and bottom ones) and then running this aggregate network through hierarchical clustering (Newman, 2004). The optimal cut was decided by optimizing the constant Potts model (Traag, Van Dooren, & Nesterov, 2011) of the bipartite network, and the resolution parameter was tuned by inspecting the dendrogram of the hierarchical clustering, not the contents of the clusters. The resulting research themes were named after the most frequent keyword, that is, the one with the largest weight. We also used weighted frequency to select representative keywords for inclusion in co-occurrence diagrams representing the scholarly output as a whole as well as for each of the three main themes. The number of keywords in such diagrams was based on clarity of visualization.

To describe the research themes, we used the centrality and density of their keyword co-occurrence representations (Callon, Courtial, & Laville, 1991; Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011), as well as the weighted number of articles. The centrality of the themes was calculated as the sum of the edges between them and other themes, and indicates their relevance to the overall scholarly output. The density of the themes was calculated as the sum of its internal edges divided by the number of keywords, and indicates their internal cohesion or development¹. The centrality index was divided by 100, and the density index was multiplied by 100. The research themes were also graphically described using a strategic map (Callon et al., 1991; Cobo et al., 2011), which plots the themes as bubbles with the scaled centrality and density indexes as the axes and the weighted number of articles as the bubble size.

We also described the physicians' trajectories in postgraduate education leading to each of the largest research themes, as well as to the total scholarly output. For that purpose, we tabulated the weighted frequency of articles by knowledge area (none, medicine, collective health, other) and level (none, master's, PhD) of the latest postgraduate degree, as well as by the physicians' gender and mode of specialization (medical residency or certification). We also tabulated the five-year periods of publication, to describe the time trends in publication volume.

Network analyses were conducted with packages *igraph* (Csardi & Nepusz, 2006), development version 1.2.8, and *Matrix*, version 1.3-4, for the R language and environment for statistical computing (R Core Team, 2021), version 4.1.2, with *OpenBLAS*, version 0.3.15. The network diagrams were laid out with the *Fruchterman and Reingold* (1991) algorithm (as implemented by the *igraph* package), and plotted with the *ggplot2* 3.3.5 (Wickham, 2016) and *ggrepel* 0.9.1 packages for R. The color of the research themes was chosen from the colorblind-friendly palette suggested by *Okabe and Ito* (2002). We wrote our own implementation of the hierarchical clustering algorithm and constant Potts model to fit the bipartite nature of our data (Fontenelle, Rossi, & Oliveira, 2021b); our code is openly available.

¹Cobo et al. (2011) refer to this density index as "Callon's density", citing Callon et al. (1991). However, the density index as described in Callon et al. (1991) more closely matches the usual network density index: summing the edge weights and dividing by the number of possible edges: $k \times (k - 1)$, where k is the number of keywords. On the other hand, the dual-projection algorithm can yield arbitrarily large clusters, and articles can't have an arbitrarily large number of keywords (say, many tens or hundreds). This would introduce a negative correlation between size and density of the research themes. Hence, we opted for the density index put forward by Cobo et al. (2011).

2. “Primary health care” was the second largest theme, with 194.5 (33.7%) articles and 226.0 (39.2%) keywords. The most common keywords (Suppl. Figure 6)) described primary care (e.g. primary health care, family practice, Family Health Strategy), public health (e.g. Unified Health System, public health, health promotion), medical education (e.g. medical education, internship and residency, curriculum), study methods (qualitative research) and geography (Brazil).
3. “Animals” was the third largest theme, with 27.2 (4.7%) articles and 31.5 (5.5%) keywords. The most common keywords (Suppl. Figure 7) described animals used in preclinical research (e.g. animals, rats, Winstar rats), clinical conditions (e.g. mental health, Chagas disease, complex regional pain syndrome), morphology, physiology or pathology (e.g. blood glucose, oxidative stress, *Trypanosoma cruzi*) and therapy (e.g. psychoanalysis, homeopathy, physical education).

The average article within the “humans” research theme was 27.3% authored by family and community physicians (Suppl. Table 1³). This is about the overall average (30.3%), while lower than within the “primary health care” theme (45.2%) and higher than within the “animals” theme (17.4%).

Articles within both the “humans” (10.4) and the “animals” (12.4) research themes had more keywords than the overall average (Suppl. Table 1⁴). On the other hand, articles in the “primary health care” theme had only 5.5 keywords on average.

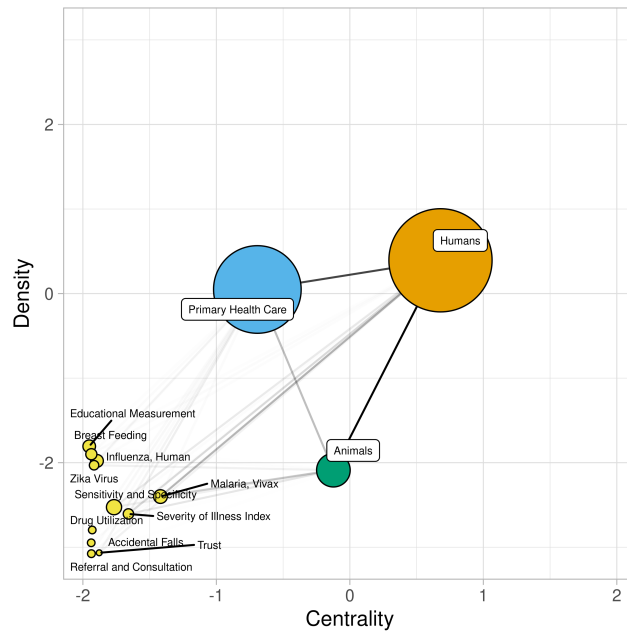
The three largest research themes were also the most central ones, with “primary health care” and “animals” being more strongly connected to “humans” than among themselves (2a). “Humans” and “primary health care” were the most developed (dense) themes, while “animals” was less developed than some of the smaller themes.

The number of articles increased over the time periods analyzed (Figure 3a, Suppl. Table 2⁵). Prior to 2004, research themes “primary health care” and “animals” were even smaller in comparison to “humans”, and the smaller themes didn’t even show up. Throughout the next time periods, smaller themes started being published, and the three largest themes converged to centrality and density indexes (Figure 3a) similar to those of the total time frame (Figure 2a). “Primary health care” saw the largest increase from years 1999–2003 to years 2009–2013, both in relative and absolute numbers (Suppl. Table 2).

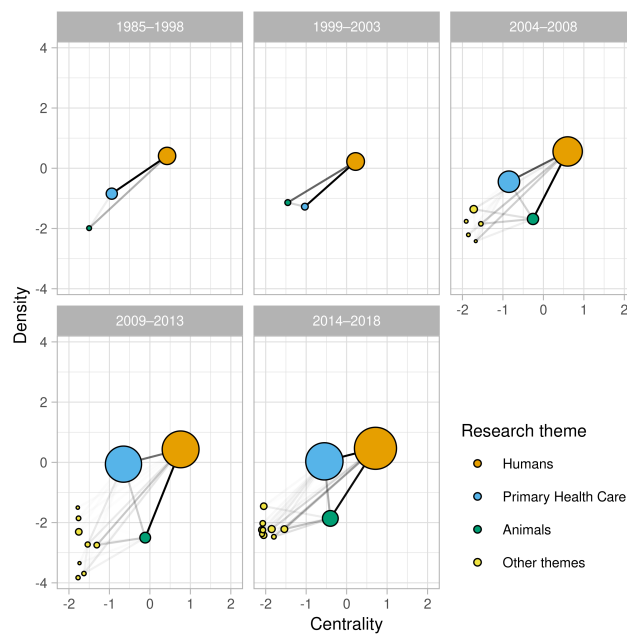
³<https://revistas.ufpr.br/atoz/article/view/87497/51291>

⁴<https://revistas.ufpr.br/atoz/article/view/87497/51291>

⁵<https://revistas.ufpr.br/atoz/article/view/87497/51292>



(a) Figure 2



(a) Figure 3

Figure 3. Evolution of the research themes' strategic map over time. Bubble areas are proportional to the weighted number of articles, edges' opacity is proportional to their weight, five-year periods refer to publication date.

Looking at the article titles (data not shown), the “humans” research theme included clinical research but also studies with a more epidemiological perspective. The difference between clinical and epidemiological research is often blurred: clinicians will do epidemiological research with clinical implications in mind, and most of the country’s primary care is community-based, so that practice-based research can be almost population-based. This ambiguity might explain why “humans” is the largest research theme even though family and community physicians publish mostly in collective health journals (Fontenelle, Rossi, & Oliveira, 2021b).

It is telling that clinical research was found to be closer to epidemiological than to primary care research. The “primary health care” theme had no health conditions among its top keywords (at least up to two thirds of the theme), as depicted in Suppl. Fig6. This suggests family and community physicians in Brazil publish research on management, policy and medical education in primary care, as well as primary care as a concept, but little of their clinical research is specific to primary care. The lower average number of unique keywords per article in the “primary health care” theme seems to reflect this lack of clinical research in primary care.

Postgraduate Trajectories

Family and community physicians with a PhD accounted for most of the articles overall (51.2%) and within research themes “humans” (57.4%) and “animals” (78.4%) (Suppl. Table 2⁶). Within the “primary health care” theme, physicians with a PhD accounted for a similar proportion (39.1%) as those with a master’s (41.4%). Authors with a PhD were twice as likely to publish in the “humans” research theme as in the “primary health care” theme, while those with a master’s or no postgraduate degree published equally in both themes. Looking at the same numbers in another way, family and community physicians with a PhD were twice as likely to publish articles in the “humans” research theme (155.6 out of 296.0) as in the “primary health care” (76.1). Meanwhile, those with a master’s published equally in the “humans” (75.6 articles out of 183.9) and “primary health care” (80.6) themes, as did those with no *stricto sensu* postgraduate degree.

Despite accounting for half the published articles, only 2.7% of family and community physicians in Brazil hold a PhD degree (Fontenelle et al., 2020). This finding emphasizes the importance of *stricto sensu* postgraduate education (master’s and PhD courses) for research capacity in Brazil, and the possible consequences of family and community medicine or primary health care not being recognized as an area of knowledge. All of the few postgraduate programs dedicated to primary health care are inside the “collective health” area of knowledge, which might explain the disconnect between primary care and health conditions in the research themes. Furthermore, these programs conferred only master’s degrees until now, and their purpose is to qualify health professionals more for the health system than for academia (that is, they are professional *stricto sensu* postgraduate programs).

Family and community physicians with a *stricto sensu* degree in medicine or collective health accounted for two thirds of the authorship overall (Figure 4; Suppl. Table 2⁷). Most authors within the “humans” research theme had a master’s or PhD in medicine (40.7%) whereas for the “primary health care” theme it was usually in collective health (41.2%) and for “animals” it was usually in another knowledge area (45.0%). Looking at the same numbers in another way, family and community physicians with a *stricto sensu* postgraduate degree in medicine usually authored articles within the “humans” research theme (110.4 out of 179.2). Meanwhile, the “humans” and the “primary health care” themes received equal attention from those with a degree in collective health (81.7 and 80.2, out of 191.3) or no *stricto sensu* postgraduate degree (39.9 and 37.9, out of 97.7).

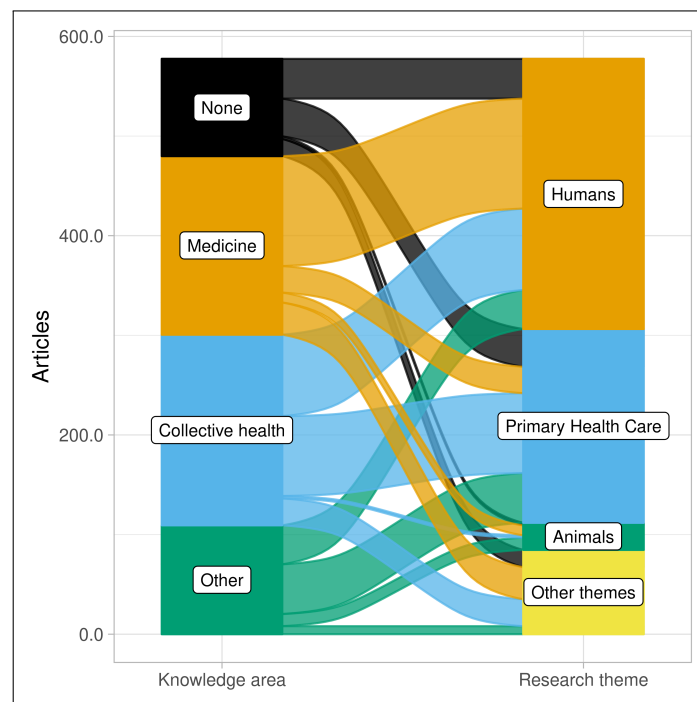


Figure 4. Alluvial plot of the weighted number of articles published by family and community physicians in Brazil, by knowledge area of the postgraduate degree and research theme of the article.

While authors with a *stricto sensu* postgraduate degree in medicine published just as much as those with a degree in collective health, most family and community physicians in Brazil earn their *stricto sensu* postgraduate degrees in collective health (Fontenelle et al., 2020). The larger productivity of those with a *stricto sensu* degree in medicine can be explained (at least in part) because medicine is almost as common as collective health for PhD degrees, and master’s degrees in collective health are more likely than those in medicine to be professional degrees (Fontenelle et al., 2020), that is, not directed towards academia.

⁶<https://revistas.ufpr.br/atoz/article/view/87497/51292>

⁷<https://zenodo.org/records/5797816>

The similarity of research themes with authors with no *stricto sensu* postgraduate degree suggests that earning a degree in collective health allows authors to keep their previous research interests. On the other hand, earning a degree in medicine would allow them to explore new research interests. Wenceslau et al. (2020) have proposed a decentralized professional master's program in family and community medicine as a specialty within medicine⁸. If the proposal moves forward, it will be interesting to examine how the research themes of its alumni will compare to those of alumni of other postgraduate programs.

Physicians with a medical residency accounted for most of authorship overall (70.6%), with the proportion ranging from 74.0% in “humans” to 57.0% in “animals” (Suppl. Table 2⁹). These proportions were similar to that of specialization through medical residency among family and community physicians overall (Fontenelle et al., 2020), suggesting similar productivity between the two modes of specialization. Although authors specialized through certification published somewhat more commonly in the “primary health care” research theme (31.7%) than in the “humans” one (26.0%), this can be explained by certification being available only since 2004, which happens to be when the national specialty journal (*Revista Brasileira de Medicina de Família e Comunidade* – RBMFC) was first published. In 2004–2008, family and community physicians in Brazil started publishing mostly in primary care journals (Fontenelle, Rossi, & Oliveira, 2021b), and published in the “primary health care” research theme thirteen times as much as in 1999–2003 (Suppl. Table 2¹⁰).

Male family and community physicians accounted for most of the authorship overall (64.2%) and in research themes “humans” (64.7%) and “primary health care” (68.9%), but not in “animals” (39.3%) (Suppl. Table 2¹¹). In contrast, most (57%) family and community physicians in Brazil are women (Fontenelle et al., 2020). This authorship gap is even larger than the gap found in the top 3 family and community medicine journals from the United States (Jabbarpour, Wilkinson, Coffman, & Mieses, 2020). One explanation is that, among family and community physicians in Brazil, men have been more likely than women to obtain a master's (adjusted odds ratio, 1.24) or PhD (1.86) degree (Fontenelle et al., 2020). As discussed before, authors with a PhD degree account for a disproportionate share of the articles. Furthermore, whatever is holding women back from pursuing *stricto sensu* postgraduate degrees might also be holding them back from performing research and publishing articles. As discussed in Fontenelle et al. (2020), this phenomenon seems to be more acute among family and community physicians than in the Brazilian society as a whole, and should be better understood.

Strengths and Weaknesses

These findings must be interpreted in light of some methodological aspects, such as our choice of data sources. The Lattes Platform is a well established data source for studying the scholarly output of Brazilian researchers (Lane, 2010; Mena-Chalco, Digiampietri, Lopes, & Cesar, 2014; Sidone, Haddad, & Mena-Chalco, 2016), and starting from a national list of (potential) authors allowed us to explore their postgraduate trajectories. On the other hand, our data lacks any primary care research not done by Brazilian family and community physicians.

Using data from LILACS and MEDLINE allowed the inclusion of articles from all 14 journals publishing most of the articles by family and community physicians in Brazil (Fontenelle, Rossi, & Oliveira, 2021b). (One journal, *Revista AMRIGS*, stopped being indexed by LILACS in 2017.) While that list's top journal (*Revista Brasileira de Medicina de Família e Comunidade* – RBMFC) was not indexed yet in LILACS when Harzheim et al. (2005) described the scholarly output as not indexed, the journal was included in LILACS in 2017 and its contents were retrospectively indexed. On the other hand, using data from both LILACS and MEDLINE made it impossible for us to separate original articles from editorials, opinion pieces and other non-research article types. Thus, our results relate more closely to the scholarly output as a whole than to only the research output.

Another methodological aspect is the choice of clustering algorithm. As justified (Arthur, 2020; Traag et al., 2019) as our choices were, the resulting research themes must be understood as empirical constructs, and different choices would have resulted in a different set of themes. Furthermore, choosing a different resolution parameter would have resulted in a different number of research themes, splitting the “humans” theme in multiple sub-themes or merging it with “primary health care”. The interesting feature is not the number or size of the themes, but where lies the division between them.

Policy Implications

The relative disconnect between primary care and clinical research in the scholarly output of family and community physicians suggests stakeholders need to promote the conduct of clinical research in the primary care setting. One way of doing so would be having primary care as a research line in medical *stricto sensu* postgraduate programs, or even having one or more programs dedicated to family and community medicine, as proposed by Wenceslau et al. (2020). However, the viability of such research lines or postgraduate programs

⁸Here “medicine” is the knowledge area, not the profession.

⁹<https://zenodo.org/records/5797816>

¹⁰<https://zenodo.org/records/5797816>

¹¹<https://revistas.ufrpr.br/atoz/article/view/87497/51292>

might depend on changing how the government evaluates such programs. Currently, the evaluation of *stricto sensu* postgraduate programs depends heavily on citation metrics of the journals in which the students and supervisors publish their research. Primary care research is usually more applied than the average biomedical research, resulting in a citation disadvantage (Donner & Schmoch, 2020; Peleg & Shvartzman, 2006), which might reflect negatively in the evaluation of medical postgraduate programs dedicated to primary care.

Another way of promoting clinical research in primary care would be taking steps to secure adequate funding. Primary care research funding is problematic worldwide, with primary care research being worse-funded than other clinical research areas (Goodyear-Smith & Mash, 2016a). The problem is made worse when there's no funding line dedicated to primary care, as in the US National Institutes of Health (NIH): even though the NIH is the main source of research funding for university departments of family medicine in the US (Weidner, Peterson, Mainous, Datta, & Ewigman, 2019), less than 1% of the projects funded by the NIH are primary care research (Westfall, Wittenberg, & Liaw, 2021). In the Brazilian context, recognizing primary care or family and community medicine as an area of knowledge would enable research funding agencies to dedicate part of their grants to clinical research in primary care.

Finally, another way would be fostering the creation of practice-based research networks (PBRNs) (L. W. Green, 2008; Huas et al., 2019). Such networks allow academia to recruit patients and primary care practices for their research, allowing primary care practices to participate in the prioritization of research projects for real-world impact (Mold & Peterson, 2005). While PBRNs have sometimes relied on volunteerism, the buy-in from societies and funding agencies is important for consolidating and scaling up (L. A. Green & Hickner, 2006). For example, hiring practice facilitators is valuable for binding a PBRN together (Nagykaldi, Mold, Robinson, Niebauer, & Ford, 2006), as primary care providers and academics are often overwhelmed by clinical and teaching responsibilities (Brocato & Mavis, 2005; Goodyear-Smith & Mash, 2016b). Many of the good practices proposed for PBRNs (Dolor et al., 2015) also depend on some level of funding. In the Brazilian context, academia might also have to negotiate with centralized provision programs such as *Mais Médicos* (More Doctors) and *Médicos pelo Brasil* (Doctors for Brazil), as well as their state-level equivalents, if large-scale PBRNs are to be feasible.

Research Implications

Our choice of the dual-projection algorithm was heavily influenced by Arthur (2020), who concluded that applying the Louvain algorithm to the bipartite network was a reasonable but inferior alternative to applying it to both projections and then combining the result with hierarchical clustering (i.e., the dual-projection algorithm). At the same time, we chose the Leiden algorithm over the Louvain one due to the advantages described by Traag et al. (2019). As a result, we had to write extensive custom code which was computationally intensive enough to be impractical outside research projects. Furthermore, applying the algorithm separately for each time period would require finely tuning the resolution parameter again and again. Meanwhile, the *leidenalg* package for Python can directly apply the Leiden algorithm to bipartite networks without user-written functions, in a fraction of the time, and possibly using the overall resolution parameter for the individual time periods. We hope methodological researchers will compare the dual-projection to the direct Leiden algorithm for bipartite networks in the context of research themes, so that perhaps future research similar to ours can be more easily done.

CONCLUDING REMARKS

This study described the research themes of family and community physicians in Brazil, as well as the postgraduate trajectories leading to them. The most common research themes were human health (“humans”) and primary care (“primary health care”), followed by preclinical studies in non-human animals (“animals”). Keywords on health conditions clustered mostly in the “humans” and “animals” themes, while keywords on health services, health systems and medical education clustered in the “primary health care” theme. These three main themes were those more connected to other themes through keyword co-occurrence; “humans” and “primary health care” were the most developed ones in terms of internal density of keyword co-occurrence. Over the years, “primary health care” saw the largest increase in size, and perhaps also in centrality and development. Looking at the authors’ postgraduate trajectories, articles in the “primary health care” theme were much more likely to be authored by family and community physicians with a master’s or PhD in collective health than in medicine. Furthermore, male physicians and those with a PhD accounted for proportionally more articles than their counterparts.

Primary care is an emerging research area, both in Brazil and other countries in Latin America and the Global South at large. The Lattes Platform allowed this study to find primary care researchers even though there are no postgraduate programs in family and community medicine, and the few postgraduate programs in primary health care are nested within collective health. Furthermore, the dual-projection algorithm allowed this study to describe the postgraduate trajectories leading to the research themes. Finally, articulating scientometric techniques with content subject knowledge allowed this study to identify and discuss an array of ways to develop primary care or family and community medicine as a research area.

Of more general interest, this study proposed additional research questions that might prove relevant to other research areas. Understanding why so few women conclude master's and PhD programs (compared to male family and community physicians) might help understand interdisciplinary variations in female representation. Furthermore, validating the bipartite Leiden algorithm for describing research themes might encourage other researchers to correlate research themes with postgraduate trajectories.

SUPPLEMENTARY FIGURES

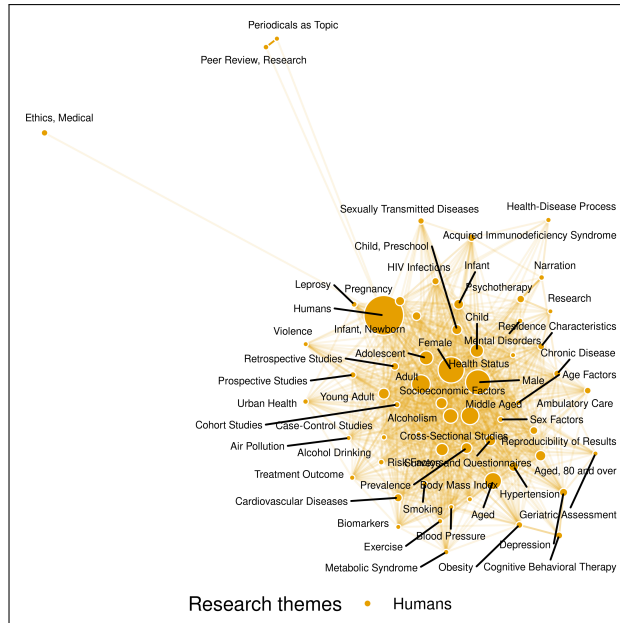


Figure 5. Suppl. Figure 1.

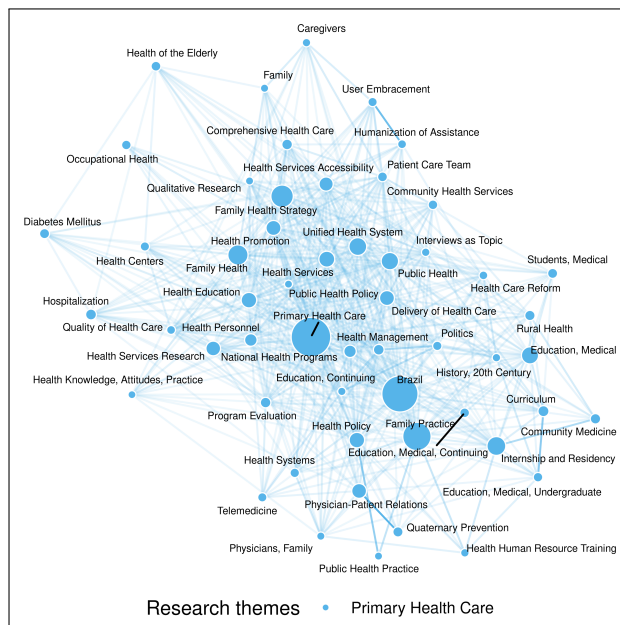


Figure 6. Suppl. Figure 2.

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NOTAS DA OBRA E CONFORMIDADE COM A CIÊNCIA ABERTA

CONTRIBUIÇÃO DE AUTORIA

Papéis e contribuições	Leonardo Ferreira Fontenelle	Stephani Vogt Rossi	Miguel Henrique Moraes de Oliveira	Diego José Brandão	Thiago Dias Sarti
Concepção do manuscrito	X			X	X
Escrita do manuscrito	X	X	X	X	X
Metodologia	X				
Curadoria dos dados	X	X	X		
Discussão dos resultados	X			X	X
Análise dos dados	X			X	X

COMITÊ DE ÉTICA

Declaro que a pesquisa foi avaliada e aprovada por Comitê de Ética e o documento comprobatório foi submetido como documento suplementar.

Número do processo: CAAE 02957118.2.0000.5064

Data da aprovação: 29/11/2018

CONFLITO DE INTERESSE

O(s) autor(es) declara(m) o(s) seguinte(s) conflito(s) de interesse relacionado(s) relacionados à pesquisa submetida: Declaro o(s) seguinte(s) conflito(s) de interesse relacionados a pesquisa submetida para avaliação pela AtoZ: LFF, DJB and TDS are board members of Associação Capixaba de Medicina de Família e Comunidade (ACMFC), an organization affiliated to Sociedade Brasileira de Medicina de Família e Comunidade (SBMFC). TDS is an editor of RBMFC, a journal mentioned in the results and discussion; LFF was an editor and now is an associate editor, and DJB was an associate editor of the same journal. MHMO and SVR have no competing interests.

Disponibilidade de Dados Científicos da Pesquisa

Os conteúdos subjacentes ao texto da pesquisa estarão disponíveis disponíveis sob demanda aos autores.

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